

# Curriculum Vitae

BRIAN D. JEFFS

Professor and Graduate Coordinator  
Department of Electrical and Computer Engineering  
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## 1. Education

Ph.D., Electrical Engineering, University of Southern California, May 1989.  
Emphasis in signal and image processing, biomedical imaging, and digital image reconstruction. Dissertation title: “Maximally Sparse Constrained Optimization for Signal Processing Applications.” Hughes Aircraft Ph.D. Fellow. Major advisor: Richard M. Leahy.

M.S., Electrical Engineering, Brigham Young University, Dec. 1982  
Emphasis in digital signal processing and speech encoding and recognition. Thesis title: “An Algorithm for Feature Change Detection in Speech Using Cepstral Coefficients.” Major advisor: Douglas M. Chabries.

B.S., Electrical Engineering, Brigham Young University, Aug. 1978, Magna Cum Laude. Computer option.

## 2. Employment

Brigham Young University, Provo Utah, 2009 to present, Professor; 1996 to 2009, Associate Professor; 1990 to 1996 Assistant Professor, Department of Electrical and Computer Engineering. Instructor of graduate and undergraduate courses in digital signal processing, digital image processing, signals and systems, introductory circuits, and linear systems theory. Current primary research emphasis is signal processing for radio astronomy, including interference mitigation, focal plane array feeds for large radio telescopes, and low frequency self calibration algorithms. Other research activities include signal processing for MIMO wireless communications systems and statistically optimal methods for image restoration and reconstruction. Co director of the BYU Radio Astronomy, RFI Mitigation Research Laboratory.

Hughes Aircraft Company, Fullerton California, Oct. 1982 to Dec. 1989  
Staff Engineer, Signal and Sonar Processing, Anti-Submarine Warfare Division. Responsibilities include theoretical analysis, system engineering, and signal

processing algorithm design for military sonar systems. Major project involvement included: 1) Signal Processing and acoustic array analysis for the ADCAP Mark 48 torpedo system, 2) lead system engineer for signal processing on the advanced low frequency (ALFS) helicopter-borne dipping sonar system, 3) system engineering and signal processing design and analysis for towed array sonar systems.

Eyring Research Institute, Provo Utah, Apr. 1978 to Oct. 1982.

Digital Systems Engineer. Responsibilities included system and logic design of custom military and commercial computer hardware. Project leader for several large hardware design projects including a Minute Man III ballistic missile flight computer simulation system.

Eyring Research Institute, Provo Utah, Feb. 1976 to Apr. 1978.

Digital Electronics Technician. Responsibilities included construction, maintenance, and repair of custom minicomputer systems and interfaces.

### 3. *Publications*

Downloadable PDF file copies are available from the author's web site at:  
<http://www.ece.byu.edu/faculty/bjeffs/publications.phtml>

(Note: “\*” Indicates student co-authors, “†” indicates an invited paper or presentation.)

#### Books and book chapters (full manuscript reviewed)

1. Karl F. Warnick, Rob Maaskant, Marianna V. Ivashina, David B. Davidson, and Brian D. Jeffs, *Phased Arrays for Radio Astronomy, Remote Sensing, and Satellite Communications*, Cambridge University Press, 2018, DOI: 10.1017/9781108539258
2. † A.L. Swindlehurst, B.D. Jeffs, G. Seco-Grenados, and Jian Li, Chapter 20, “Applications of Array Signal Processing,” in *Academic Press Library in Signal Processing, 1st Ed.*, Editors: Rama Chellappa and Sergios Theodoridis, Academic Press, 7 Oct, 2013, ISBN 9780124115972 and 9780124116214, 73 pages for chapter 20. Sole author of sections on radio astronomy and sonar.

#### Journal articles

1. K. M. Rajwade, D. Agarwal, D. R. Lorimer, N. M. Pingel, D. J. Pisano, M. Ruzindana\*, B. Jeffs, K. Warnick, D.A. Roshi, and M. A. McLaughlin, “A 21 cm pilot survey for pulsars and transients using the Focal L-Band Array for the Green Bank Telescope,” *Monthly Notices of the Royal Astronomical Society*, August 2019, 10 pages, archive access: arXiv:1908.02690 [astro-ph.HE].
2. R.A. Black\*, B.D. Jeffs, and Karl F. Warnick, “Deep, Broad Null Formation For Canceling Moving RF in Radio Astronomical Arrays,” *Journal of Astronomical Instrumentation*, date of acceptance for publication: November 12, 2018, published December 21, 2018, DOI: [10.1142/S2251171719400038](https://doi.org/10.1142/S2251171719400038).

3. D. Anish Roshi, W. Shillue, B. Simon, K. F. Warnick, B. Jeffs, D. J. Pisano, R. Prestage, S. White, J. R. Fisher, M. Morgan, R. Black, M. Burnett, J. Diao, M. Ruzindana, V. van Tonder, L. Hawkins, P. Marganian, T. Chamberlin, J. Ray, N. M. Pingel, K. Rajwade, D.R. Lorimer, A. Rane, J. Castro, W. Groves, L. Jensen, J. D. Nelson, T. Boyd, A. J. Beasley, "Performance of a Highly Sensitive, 19-element, Dual-polarization, Cryogenic L-band Phased Array Feed on the Green Bank Telescope," *The Astronomical Journal*, Volume 155, Issue 5, article id. 202, 18 pp. (2018), DOI: 10.3847/1538-3881/aab965
4. M. C. Burnett\*, B. D. Jeffs, R. A. Black, K. F. Warnick, "Subarray Processing for Projection-based RFI Mitigation in Radio Astronomical Interferometers," *Astronomical Journal*, vol. 155, no. 4, 9 pp., March, 2018, DOI: [10.3847/1538-3881/aaae6f](https://doi.org/10.3847/1538-3881/aaae6f)
5. † K. F. Warnick, R. Maaskant, M. V. Ivashina, D. B. Davidson, and B. D. Jeffs, "High sensitivity phased array receivers for radio astronomy," *Proceedings of the IEEE*, vol. 104, Issue 3, pp. 607 – 622, DOI: [10.1109/JPROC.2015.2491886](https://doi.org/10.1109/JPROC.2015.2491886), 2016, invited.
6. G. Cortes-Medellin, A. Vishwas, S.C. Parshley, D.B. Campbell, P. Perilatt, R. Black\*, J. Brady\*, K.F. Warnick, B.D. Jeffs, "A Fully Cryogenic Phased Array Camera for Radio Astronomy," *IEEE Transactions on Antennas and Propagation*, vol. 63 no. 6, June 2015, pp. 2471-2481, doi: 10.1109/TAP.2015.2415527.
7. A. Hotan, J. Bunton, L. Harvey-Smith, B. Humphreys, B. Jeffs, T. Shimwell, J. Tuthill, M. Voronkov, et al (92 additional co-authors), "The Australian Square Kilometre Array Pathfinder System Architecture and Specifications of the Boolardy Engineering Test Array," *Publications of the Astronomical Society of Australia (PASA)*, Sep. 4, 2014, doi: 10.1017/pas.2014.xxx.
8. M.J. Elmer\*, B.D. Jeffs, and K.F. Warnick, "Reducing Relative Gain and Noise Response Variations for Phased Array Feeds," *IEEE Transactions on Antennas and Propagation*, vol. 26, no. 12, pp. 6067-6080, Sep. 2014.
9. M.J. Elmer\*, B.D. Jeffs, and K.F. Warnick, "Long-term Calibration Stability of a Radio Astronomical Phased Array Feed," *The Astronomical Journal*, Vol. AJ 145, 24, Jan. 2013, <http://stacks.iop.org/1538-3881/145/24>
10. J. Landon\*, B.D. Jeffs, and K.F. Warnick, "Model-Based Subspace Projection Beamforming for Deep Interference Nulling," *IEEE Transactions on Signal Processing*, vol. 60, no. 3, March 2012, pp. 1215-1228.
11. M. Elmer\*, B.D. Jeffs, K.F. Warnick, J.R. Fisher, and R. Norrod, "Beamformer Design Methods for Radio Astronomical Phased Array Feeds," *IEEE Transactions on Antennas and Propagation*, vol. 60, no. 2, Feb. 2012, pp. 903-914.
12. K.F. Warnick, D. Carter\*, T. Webb\*, J. Landon\*, M. Elmer\*, B.D. Jeffs, "Design and characterization of an active impedance matched low noise phased array

- feed,” *IEEE Transactions on Antennas and Propagation*, vol. 59, no. 6, June, 2011.
13. J. Landon\*, M. Elmer\*, J. Waldron\*, D. Jones\*, A. Stemmons\*, B.D. Jeffs, K. F. Warnick, J. R. Fisher, and R. D. Norrod, “Phased array feed calibration, beamforming, and imaging,” *Astronomical Journal*, vol. 139, no. 3, March. 2010, pp. 1154-1167.
  14. B.D. Jeffs and K.F. Warnick, “Spectral bias in adaptive beamforming with narrowband interference,” *IEEE Transactions on Signal Processing*, vol. 57, no. 4, Apr., 2009, pp 1373-1382.
  15. † B.D. Jeffs, K.F. Warnick, J. Landon\*, J. Waldron\*, D. Jones\*, J.R. Fisher, and R.D. Norrod, “Signal processing for phased array feeds in radio astronomical telescopes,” *IEEE Journal of Selected Topics in Signal Processing*, vol. 2, no. 5, Oct., 2008, pp. 635-646.
  16. K. F. Warnick and B. D. Jeffs, “Efficiencies and system temperature for a focal plane array,” *IEEE Antennas and Wireless Propagation Letters*, vol. 7, 2008, pp. 564-567.
  17. B.D. Jeffs and K.F. Warnick, “Bias corrected PSD estimation for an adaptive array with moving interference,” *IEEE Transactions on Signal Processing*, vol. 56, no. 7, doi:10.1109/TSP.2008.919637, pp. 3108-3121 July, 2008.
  18. J. R. Nagel\*, K. F. Warnick, B. D. Jeffs, J. R. Fisher, and R. Bradley, “Experimental verification of radio frequency interference mitigation with a focal plane array feed,” *Radio Science*, vol. 42, RS6013, doi:10.1029/2007RS003630, 2007.
  19. S. van der Tol\*, B.D. Jeffs and A.-J. van der Veen, “Self calibration for the LOFAR radio astronomical array,” *IEEE Trans. on Signal Processing*, vol. 55, no. 9, pp. 4497-4510, Sept., 2007.
  20. K.F. Warnick and B.D. Jeffs, “Gain and aperture efficiency for a reflector antenna with an array feed,” *IEEE Antennas and Wireless Propagation Letters*, vol. 5, pp. 499-502, December, 2006.
  21. B.D. Jeffs, W. Lazarte\*, and J.R. Fisher, “Bayesian detection of radar interference in radio astronomy,” *Radio Science*, vol. 41, RS3006, doi:10.1029/2005RS003400, June, 2006.
  22. A.J. Poulsen\*, B.D. Jeffs, K.F. Warnick and J.R. Fisher, “Programmable real-time cancellation of GLONASS interference with the Green Bank Telescope,” *Astronomical Journal*, vol. 130, no. 6, pp. 2916-2927, December, 2005.
  23. W. Dong\*, B.D. Jeffs and J.R. Fisher, “Radar interference blanking in radio astronomy using a Kalman tracker,” *Radio Science*, RS5S04, doi:10.1029/2004RS003130, vol. 40, no. 5, June, 2005.

24. C.K. Hansen\*, K.F. Warnick, B.D. Jeffs, J.R. Fisher and R. Bradley, "Interference mitigation using a focal plane array," *Radio Science*, RS5S16, doi:10.1029/2004RS003138, vol. 40, no. 5, 2005, June, 2005.
25. B.D. Jeffs, L. Li\* and K.F. Warnick, "Auxiliary antenna assisted interference mitigation for radio astronomy arrays," *IEEE Transactions on Signal Processing*, vol. 53, No. 2, pp. 439-451, February, 2005.
26. J.W. Wallace, M.A. Jensen, A.L. Swindlehurst, and B.D. Jeffs, "Experimental characterization of the MIMO wireless channel: data acquisition and analysis," *IEEE Transactions on Wireless Communications*, vol. 2, No. 2, pp. 335-343, March 2003.
27. Q.H. Spencer\*, B.D. Jeffs, M.A. Jensen, and A.L. Swindlehurst, "Modeling the statistical time and angle of arrival characteristics of an indoor multipath channel," *IEEE Journal on Selected Areas in Communications*, vol. 18, No. 3, pp 347-360, March 2000.
28. M. Gunsay\* and B.D. Jeffs, "Point source localization in blurred images by a frequency domain eigenvector based method," *IEEE Trans. on Image Processing*, vol. 4., No. 12, pp. 1602-1612, Dec., 1995.
29. W.H. Pun\* and B.D. Jeffs, "Adaptive image restoration using a generalized Gaussian model for unknown noise," *IEEE Trans. on Image Processing*, vol. 4., No. 10, pp. 1451-1456, Oct., 1995.
30. B.D. Jeffs and M. Gunsay\*, "Restoration of blurred star field images by maximally sparse optimization," *IEEE Transactions on Image Processing*, vol. IP-2 No. 2, pp. 202-211, Apr., 1993.
31. R.M. Leahy and B.D. Jeffs, "Maximally sparse beamforming array design," *IEEE Trans. Antennas and Prop.*, vol. AP-39, No. 8, pp. 1178-1187, Aug. 1991.
32. B.D. Jeffs, R.M. Leahy, and Manbir Singh, "An evaluation of methods for neuromagnetic image reconstruction," *IEEE Trans. Biomed. Eng.*, vol. BME-34, pp. 713-723, 1987.

Full manuscript reviewed conference proceedings

1. D. Anish Roshi; W. Shillue; J. R. Fisher; M. Morgan; J. Castro; W. Groves; T. Boyd; B. Simon; L. Hawkins; V. van Tonder; J. D. Nelson; J. Ray; T. Chamberlain; S. White; R. Black; K. F. Wamick; B. Jeffs; R. Prestage, "A highly-sensitive cryogenic phased array feed for the Green Bank Telescope," Proceedings of the 2017 XXXIInd General Assembly and Scientific Symposium of the International Union of Radio Science (URSI GASS), Aug. 2017, Montreal Canada.
2. G. Cortes-Medellin, S. Parshley, D.B. Campbell, K.F. Warnick, B.D. Jeffs, G. Rajagopalan, "Concept design of an 80-dual polarization element cryogenic phased array camera for the Arecibo Radio Telescope," Proc. SPIE 9908,

Ground-based and Airborne Instrumentation for Astronomy VI, 99085F, August 9, 2016, doi:10.1117/12.2233899

3. R.A. Black\*, B.D. Jeffs, K.F. Warnick, G. Hellbourg, A. Chippendale, "Multi-tier Interference-canceling Array Processing for the ASKAP Radio Telescope," IEEE Signal Processing & SP Education Workshop 2015, Snow Bird Resort, Utah, Aug. 9-12, 2015, pp. 261-266, DOI: 10.1109/DSP-SPE.2015.7369563.
4. Y. Wu\*, R.A. Black\*, B.D. Jeffs, K.F. Warnick, "Canceling Non-linear Processing Products due to Strong Out-of-band Interference in Radio Astronomical Arrays," IEEE Signal Processing & SP Education Workshop 2015, Snow Bird Resort, Utah, Aug. 9-12, 2015, pp. 273-277, DOI: 10.1109/DSP-SPE.2015.7369565.
5. K. F. Warnick, B. D. Jeffs, J. Diao\*, R. Black\*, J. Brady\*, A. Roshi, B. Shillue, S. White, B. Simon, R. Fisher, "Experimental Tests and Signal Processing for a Cryogenic L-band Phased Array Feed on the Green Bank Telescope," IEEE 2014 International Conference on Electromagnetics in Advanced Applications (ICEAA-14), 3-9 August, 2014, Aruba.
6. G. Hellbourg, A.P. Chippendale, M.J. Kesteven, B.D. Jeffs, "Reference antenna-based subspace tracking for RFI mitigation in radio astronomy," 2nd IEEE Global Conference on Signal and Information Processing, GlobalSIP-14, Dec. 3-5, 2014, Atlanta Georgia, USA.
7. M. Elmer\* and B.D. Jeffs, "Beamformer Design for Radio Astronomical Phased Array Feeds," *Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP-2010*, pp. 2790-2793, March, 2010, Dallas, TX.
8. B.D. Jeffs and K.F. Warnick, "Bias corrected PSD estimation with an interference canceling array," *Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP-2007*, vol. II, pp 1145-1148, April 15-20, 2007, Honolulu.
9. B.D. Jeffs, S. van der Tol\*, and A.-J. van der Veen, "Direction dependent self calibration of large distributed sensor arrays," *Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP-2006*, vol. IV, pp 1069-1072, May 2006, Toulouse, France.
10. S. van der Tol\*, B.D. Jeffs, and A.-J. van der Veen, "Direction dependent calibration for radio astronomical arrays," *Proceedings of EUSIPCO-2005*, Sept. 2005, Antalya, Turkey.
11. W. Dong\*, B.D. Jeffs and J.R. Fisher, "A Kalman-tracker-based Bayesian detector for radar interference in radio astronomy," *Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP-2005*, vol. IV, pp. 657-660, March, 2005, Philadelphia.
12. A.J. Boonstra, S.J. Wijnholds, S. v.d. Tol and B. Jeffs, "Calibration, sensitivity, and RFI mitigation requirements for LOFAR," *Proc. of IEEE International*

- Conf. Acous., Speech, and Sig. Proc., ICASSP-2005*, vol. V, pp. 869-872, March, 2005, Philadelphia.
13. N.B. Shelton\* and B.D. Jeffs, "A robust iterative algorithm for wireless MIMO array auto-calibration," *Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP-2004*, vol. II, pp. 341-344, May, 2004, Montreal.
  14. C.K. Hansen\*, K.F. Warnick, and B.D. Jeffs, "Interference cancellation using an array feed design for radio telescopes," *Proceedings of IEEE Antennas and Propagation Society International Symposium*, vol. 1, pp. 539-542, Monterey, CA, pp. 539-542, June 20-25, 2004.
  15. J.W. Wallace, B.D. Jeffs, and M.A. Jensen, "A real-time multiple antenna element testbed for MIMO algorithm development and assessment," *Proceedings of IEEE Antennas and Propagation Society International Symposium*, vol. 2, Monterey, CA, pp. 1716-1719, June 20-25, 2004.
  16. B.D. Jeffs, K.F. Warnick and L. Li\*, "Improved interference cancellation in synthesis array radio imaging using auxiliary antennas," *Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP-2003*, April, 2003, Hong Kong, vol. V, pp. V-77-V-80.
  17. B.D. Jeffs and J.W. Wallace\*, "MIMO wireless multipath ray parameter estimation from channel transfer matrix measurements," *Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP-2002*, vol. III, May 13-17, 2002, Orlando, pp. 2345-2348.
  18. B.D. Jeffs, E. Pyper\*, and B. Hunter\*, "A wireless MIMO channel probing approach for arbitrary antenna arrays," *Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP-2001*, vol. IV, May 7-11, 2001, Salt Lake City, UT, pp. 2493-2496.
  19. † E. Pyper\* and B.D. Jeffs, "Recovery of MIMO wireless channel ray structure using a modified CLEAN deconvolution algorithm," *Optical Society of America Technical Digest, Signal Recovery and Synthesis*, Nov. 5-7, 2001, pp. 121-123. Invited paper.
  20. B.A. Chipman\* and B.D. Jeffs, "Blind point-source image restoration using subspace techniques," *Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP-2000*, vol. IV, June 5-9, 2000, Istanbul, Turkey, pp. 2207-2210.
  21. M. Willis\*, B.D. Jeffs and D.G. Long, "Maximum entropy image restoration revisited," *Proceedings of ICIP'2000, IEEE International Conference on Image Processing*, Sept. 10-13, 2000, Vancouver, Canada, vol. 1, pp. 89-92.
  22. † B.A. Chipman\* and B.D. Jeffs, "Blind multiframe point source image restoration using MAP estimation," *Conference Record, Thirty-Third Asilomar Conference on Signals, Systems, & Computers*, Nov. 1999, Pacific Grove CA, vol. 2, pp 1267-1271. Invited paper.

23. M. Willis\*, B.D. Jeffs and D.G. Long, "A new look at maximum entropy image reconstruction," *Conference Record, Thirty-Third Asilomar Conference on Signals, Systems, & Computers*, Nov. 1999, Pacific Grove CA, vol. 2, pp. 1272-1276.
24. M.A. Jensen, Q.H. Spencer\*, A.L. Swindlehurst, and B.D. Jeffs, "Measurement and modeling of temporal and spatial indoor multipath," *Proceedings of the IEEE Antennas and Propagation Society International Symposium*, July 11-16, 1999, vol. 1, pp. 388-391.
25. B.D. Jeffs, S. Hong\* and J. Christou, "A generalized Gauss Markov model for space objects in blind restoration of adaptive optics telescope images," *Proceedings of ICIP'98, IEEE International Conference on Image Processing*, Oct. 4-7, 1998, Chicago, IL, pp. 737-741.
26. A.H. Gardiner\* and B.D. Jeffs, "A Non-uniformly sampled Markov random field model for MAP reconstruction of magnetoencephalogram images," *Proceedings of ICIP'98, IEEE International Conference on Image Processing*, Oct. 4-7, 1998, Chicago, IL, pp. 375-379.
27. B.D. Jeffs, J. Christou and S. Hong\*, "Blind MAP restoration of adaptive optics telescope images using estimated shape parameters for generalized Gaussian MRF models," *Proceedings of the 1998 IEEE DSP Workshop*, August 9-12, 1998, Bryce Canyon, Utah, Paper no. 156.
28. B.D. Jeffs and A.H. Gardiner\*, "Markov random field image prior models for MAP reconstruction of magnetoencephalogram images," *Conference Record, Thirty-Sixth Asilomar Conference on Signals, Systems, and Computers*, Nov. 1-4, 1998, Pacific Grove, CA, vol. 1, pp. 314-318.
29. † B.D. Jeffs, "Sparse inverse solution methods for signal and image processing applications," *Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP-98*, May 12-15, 1998, Seattle Washington, vol. 3, pp. 1885-1888.  
Invited Paper.

Extended summary/abstract reviewed conference proceedings

1. † M. Lambert\*, Urvashi Rao Venkata, M.C. Burnett\*, and B.D. Jeffs, "Experimental Evaluation Using VLA Datasets of RFI Mitigation Performance over Long ngVLA Baselines," USNC-URSI National Radio Science Meeting 2019, Boulder CO, Jan. 9-12, 2019.
2. B. D. Jeffs, K. F. Warnick, R. A. Black\*, M. Ruzindanna\*, M. Burnett\*, D. J. Pisano, D. R. Lorimer, N. Pingel\*, K. Rajwade\*, R. M. Prestage, S. White, B. Simon, L. Hawkins, W. Shillue, A. Roshi, "Beamformer and Calibration Performance for the Focal-Plane L-band Array feed for the Green Bank Telescope (FLAG)," PAF Workshop 2017, Phased Array Feed Workshop, Sydney, Australia, Nov. 14-16, 2017, ISBN 978 0 646 98052 2



3. Brian D. Jeffs, R.A. Black\*, and K.F. Warnick, “Array Processing Methods for Radio Astronomical RFI Mitigation: A Case Study for the ngVLA,” USNC-URSI National Radio Science Meeting 2017, Boulder CO, Jan. 4-6, 2017.
4. N. M. Pingel\*, R. Black\*, D.J. Pisano, B. D. Jeffs, “Results from the Latest Commissioning Run of a Cryogenically Cooled Phased Array Feed for the Green Bank Telescope,” USNC-URSI National Radio Science Meeting 2017, Boulder CO, Jan. 4-6, 2017.
5. W. Shillue, D. A. Roshi, J. R. Fisher, M. A. Morgan, J. Castro, W. Groves, T. Boyd, R. Prestage, S. White, R. Simon, V. van Tonder, J. D. Nelson, J. Ray, T. Chamberlain, K. F. Warnick, B. D. Jeffs, “An L-band cryogenic phased array for the Green Bank Telescope: Instrumentation upgrades and expanded field-of-view,” Proceedings of the USNC-URSI National Radio Science Meeting, January, 2017, Boulder, CO.
6. G. Cortes-Medellin, S. Parshley, D.B. Campbell, K.F. Warnick, B.D. Jeffs, G. Rajagopalan, “Concept Design of an 80 dual-polarization-element Cryogenic Phased Array Camera for the Arecibo Radio Telescop,” to appear in *SPIE International Symposium on Astronomical Instrumentation*. Vol. *Ground-based and Airborne Instrumentation for Astronomy VI*, (2016).
7. D. A. Roshi, K. F. Warnick, J. Brandt, J. R. Fisher, P. Ford, B. D. Jeffs, P. Marganian, M. McLeod, M. Mello, M. Morgan, R. Norrod, W. Shillue, R. Simon, S. White, “A 19 element cryogenic phased array feed for the Green Bank Telescope,” 2015 IEEE International Symposium on Antennas and Propagation and CNC/USNC-URSI Meeting, Vancouver, Canada, July 19-25, 2015.
8. J. Diao\*, R. Black\*, J. Brady\*, J. Sypherd\*, K.F. Warnick, B.D. Jeffs, “Modeling and system development for the FLAG L-band phased array feed for large-dish astronomical observations,” 2015 IEEE International Symposium on Antennas and Propagation and CNC/USNC-URSI Meeting, Vancouver, Canada, July 19-25, 2015, p. 263, DOI:10.1109/USNC-URSI.2015.7303647
9. N. Erickson, G. Narayanan, J. Bardin, K. F. Warnick, and B. D. Jeffs, and J. Diao, “A 64 element 70-95 GHz focal plane phased array,” 2015 IEEE International Symposium on Antennas and Propagation and CNC/USNC-URSI Meeting, Vancouver, Canada, July 19-25, 2015, pp. 1514-1515.
10. G. Cortes-Medellin, A. Viswash, S. Parsley, D.B. Campbell, P. Perilat, R. Black\*, J. Brady\*, K. Warnick, B. Jeffs, “Fully Cryogenic Phased Array Camera Prototype,” 2014 IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting, July 6-11, 2014, Memphis Tennessee
11. † B.D. Jeffs and K.F. Warnick, “Spatial Array Processing Methods for Radio Astronomical RFI Mitigation,” invited tutorial, 2013 USNC-URSI National Radio Science Meeting, Jan. 9-12, 2013, Boulder CO.

12. † K.F. Warnick and B.D. Jeffs, “Tutorial: Phased Array Antennas for Radio Astronomy,” invited tutorial, 2013 USNC-URSI National Radio Science Meeting, Jan. 9-12, 2013, Boulder CO.
13. M. Elmer\*, B.D. Jeffs, K.F. Warnick, J.R. Fisher, and D.A. Rosh, “Calibration and Field Flattening for Single Dish Astronomical Phased Array Feed Radio Camera Imaging,” International Conference on Electromagnetics in Advanced Applications, ICEAA 2012, September 2-7, Cape Town, South Africa.
14. K. F. Warnick, T. Webb\*, M. Adhikari, B. D. Jeffs, M. Elmer\*, V. Asthana\*, M. Fuller\*, C. Jin, Y. Wu, A. Rosh, R. Fisher, “Progress in high sensitivity phased array feeds for large single-dish radio telescopes,” International Conference on Electromagnetics in Advanced Applications, ICEAA 2012, September 2-7, Cape Town, South Africa.
15. Warnick, Karl F.; Carter, D.\*; Webb, T.\*; Jeffs, B.D.; Landon, J.\*; Asthana, V.\*; Elmer, M.\*; Norrod, R.; Rosh, D.A.; Fisher, J.R., “Towards a high sensitivity cryogenic phased array feed antenna for the Green Bank Telescope,” General Assembly and Scientific Symposium, 2011 XXXth URSI, 2011, DOI: 10.1109/URSIGASS.2011.6050403
16. J. S. Waldron\*, D. A. Jones\*, K. F. Warnick, and B. D. Jeffs, “Effects of focal plane array offset and beam steering on sensitivity,” *Proceedings of IEEE Antennas and Propagation Society International Symposium*, San Diego, CA, July 5-12, 2008.
17. D. A. Jones\*, K. F. Warnick, B. D. Jeffs, J. Landon\*, and J. Waldron\*, “Modeled and measured mutual impedances, element patterns, and sensitivity for a 19 element focal plane array,” *Proceedings of IEEE Antennas and Propagation Society International Symposium*, San Diego, CA, July 5-12, 2008.
18. K. F. Warnick, J. Waldron\*, J. Landon\*, M. Lilrose\*, and B. D. Jeffs, “Experimental results on interference mitigation with a 19 element array feed,” *Proceedings of 2<sup>nd</sup> European Conference on Antennas and Propagation*, Edinburgh, UK, Nov. 11-16, 2007.
19. K. F. Warnick, B. D. Jeffs, J. Landon, J. Waldron, R. Fisher, and R. Norrod, “BYU/NRAO 19-element phased array feed modeling and experimental results,” in *Proceedings of URSI General Assembly*, Chicago, IL, Aug. 8-15 2008.
20. † K. F. Warnick, B. D. Jeffs, J. Landon\*, J. Waldron\*, D. Jones\*, A. Stemmons, “BYU/NRAO 2007 Green Bank 20 Meter Telescope focal plane array – modeling and experimental results,” invited presentation, SKADS MCCT Technical Workshop on ‘Design of Wideband Receiving Array Systems,’ Dwingeloo, The Netherlands, Nov. 26-30, 2007.
21. Q.H Spencer\*, B.D. Jeffs, M.A. Jensen, and A.L. Swindlehurst, “Experiments in modeling the space-time indoor wireless communication channel,” IEEE Workshop on Signal Processing Advances in Wireless Communications, 1997. [PDF file](#)

22. B.D. Jeffs and W.H. Pun\*, "Simple shape parameter estimation from blurred observations for a generalized Gaussian MRF image prior used in map image restoration," Proceedings of the IEEE International Conference on Image Processing, ICIP-96, 16-19 Sept., 1996, vol. II, pp. 465-468. [PDF file](#)
23. B.D. Jeffs, "Rank enhancement for eigenstructure-based direction finding using arrays with non-uniform element responses," Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP'96, May 7-10, 1996, Atlanta GA, vol. VI, pp. 2181-3184. [PDF file](#)
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25. W.H. Pun\* and B.D. Jeffs, "Shape parameter estimation for generalized Gaussian Markov random field models used in MAP image restoration," Conference Record, 29th Asilomar Conf. on Signals, Systems, and Computers, Oct. 29-Nov. 2, 1995, IEEE Computer Society Press, pp. 1472-1476. [PDF file](#)
26. W.H. Pun\* and B.D. Jeffs, "MAP image restoration using an adaptive generalized Gaussian Markov random field model," Record, IASTED International Conference on Signal and Image Processing (SIP-95), Nov. 20-23, 1995.
27. B.D. Jeffs and M. Gunsay\*, "Performance analysis for a subspace decomposition point-source image restoration algorithm," Proc. of the IEEE International Conf. on Image Processing, ICIP-94, vol. 2, 13-16 Nov., 1994, pp. 675-679. [PDF file](#)
28. W.H. Pun\* and B.D. Jeffs, "Iterative adaptive lp restoration of blurred images," Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP'94, vol. 5, 19-22 April 1994, pp. 449-452. [PDF file](#)
29. M. Gunsay\* and B.D. Jeffs, "A subspace decomposition method for point source localization in blurred images," Proc. of IEEE Intern. Conf. Acous., Speech, and Sig. Proc., ICASSP'94, vol. 5, 19-22 April 1994, pp. 469-472. [PDF file](#)
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31. W.H. Pun\* and B.D. Jeffs, "Model adaptive restoration," Conference Record, 27th Asilomar Conf. Signals, Syst., Comp., pp. 573-577, Nov. 1-3. 1993. [PDF file](#)
32. B.D. Jeffs and D. Elsmore\*, "Maximally sparse reconstruction of blurred star field images," Proc. of IEEE International Conf. Acous., Speech, and Sig. Proc., ICASSP '91, vol. 4, pp. 2937-2940 May 1991. [PDF file](#)

33. R.M. Leahy and B.D. Jeffs, "Optimal element placement in conformal beamforming," Proc. 22nd Asilomar Conf. Signals, Syst. Comp., Nov. 1988. [PDF file](#)
34. R. Leahy, B. Jeffs and Z. Wu, "A DSP algorithm for minimum order solutions," Proc. 21st Asilomar Conf. Signals, Syst., Comp., Asilomar, CA, Nov. 1987.

Abstract reviewed and other conference articles, presentations and technical reports

35. † B.D. Jeffs, M. Burnett, M. Lambert, K. Warnick, D. Campbell, G. Cortes, S. Parshley, J. Cordes, and A. Vishwas, RFI Cancellation Methods for the VLA and ngVLA, and ALPACA: Development of a Phased Array Feed Radio Camera for Arecibo, NRAO-Socorro Colloquium Series, Socorro New Mexico, Nov. 1 2019, (invited and sponsored talk).
36. † B.D. Jeffs, "What a Blast! Overview of an Ongoing Career in Electrical Engineering," PRefreshman Engineering Program (PREP) Seminar, June 20, 2019, South Jordan, Utah.
37. B.D. Jeffs, K.F. Warnick, D.B. Campbell, G. Cortes-Medellin, S. Parshley, J. Cordes, T. Herter, C. Brum, and F. Cordova, "The Advanced L-Band Phased Array Camera for Arecibo (ALPACA): Design, Capabilities, and Status," Arecibo Observatory Futures Workshop, San Juan, Puerto Rico, Feb. 17-20, 2019. Invited presentation.
38. D.B. Campbell, G. Cortes, S. Parshley, A. Vishwas, B.D. Jeffs, K.F. Warnick, P. Perillat, L. Quintero, and J. Gago, "ALPACA: Its Genesis and Development History," Arecibo Observatory Futures Workshop, San Juan, Puerto Rico, Feb. 17-20, 2019. Invited presentation.
39. M. Lambert\* and B.D. Jeffs, "Radio Frequency Interference Cancellation, Appraisal, Detection, and Correction," ngVLA Memo Series, National Radio Astronomy Observatory (NRAO), memo 56, Feb. 2019 [https://library.nrao.edu/public/memos/ngvla/NGVLA\\_56.pdf](https://library.nrao.edu/public/memos/ngvla/NGVLA_56.pdf)
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41. † Brian D. Jeffs and Karl F. Warnick, Don Campbell, Jim Cordes, G. Cortes Medellin, S. Parshley, T. Herter, C. Brum, "ALPACA: An L-band Wide-field Radio Camera Array Feed for the Arecibo Radio Telescope," University of Utah High Energy Astro-Physics Colloquium (U-HEAP), Salt Lake City UT, Oct. 18, 2018.
42. † Mitchell C. Burnett, Brian D. Jeffs and Karl F. "Warnick, Advanced Spatial Filtering Methods for RFI Mitigation at the ngVLA," NRAO Workshop on Developing the ngVLA Science Program, June 26-30, 2017, Socorro, NM.

43. † Brian D. Jeffs, “Progress in Single Dish PAF Development: Arrays, Beamforming & RFI Mitigation,” Presentation to the National Astronomical Observatory of China (NAOC) and CETC54, December 12 -14, 2016, Beijing and Shijiazhaung China. \*\*This was an invited paper with full travel funding.
44. Brian D. Jeffs, “Array Processing Methods for Radio Astronomical RFI Mitigation: Assessment of the State of the Art, with demonstration software,” SERA Workshop on Phased Array Modeling and Signal Processing, October 24, 2016, BYU Hinkley Center, Provo, UT.
45. Brian D. Jeffs, R.A. Black, K.F. Warnick, “Array Processing Methods for Radio Astronomical RFI Mitigation: Assessment of the State of the Art,” RFI 2016, Coexisting with Radio Frequency Interference, Socorro NM, Oct. 17-20, 2016.
46. R.A. Black\* and B.D. Jeffs, “Spatial Null Broadening for Smearred RFI Mitigation in Phased Array Feed Radio Astronomy,” RFI 2016, Coexisting with Radio Frequency Interference, Socorro NM, Oct. 17-20, 2016.
47. Brian D. Jeffs, R. Black\*, J. Diao\*, M. Ruzindanna\*, K. Warnick, R. Prestage, J. Ford, S. White, R. Simon, W. Shillue, A. Roshi, V. Van Tonder, N. Pingel, K. Rajwade, D.J. Pisano, D. Lorimer , “Early Commissioning Results from the Focal-plane L-band Array Feed for the Green Bank Telescope (FLAG),” PAF Workshop 2016, Phased Array Feed Workshop, Aug. 24 – 26, 2016, Cagliari, Italy.
48. D. Roshi, W. Shillue, J.R. Fisher, M. Morgan, J. Castro, W. Groves, T. Camberline, R. Prestage, J. Ray, R. Simon, V. van Tonder, S. White, K. Warnick, B.D. Jeffs, “Focal L-band array for the GBT (FLAG): instrumentation upgrades and initial commissioning results,” PAF Workshop 2016, Phased Array Feed Workshop, Aug. 24 – 26, 2016, Cagliari, Italy.
49. B.D. Jeffs, K.F. Warnick, R. Black\*, D. Campbell, G. Cortes, S Parshley, A. Chippendale, A. Hotan and G. Hellbourg, “Calibration, Beamforming, and RFI Mitigation with Radio Astronomical Phased Array Feeds, China – US Workshop, 13-16 October, 2015, Shanghai Radio Observatory, Shanghai, China.
50. † B.D. Jeffs, “PAF Beamformer Calibration Using Extended Sources,” Calibration and Imaging Workshop 2014, CALIM 2014, 2-7 March, 2014, Kiama, NSW, Australia.
51. † B.D. Jeffs. “Array Processing for Radio Astronomical RFI – Moving Theory to Practice,” CSIRO CASS Colloquium, 14 August, 2013, Marsfield, NSW, Australia.
52. † B.D. Jeffs, “Adaptive Nulling with PAFs,” Seminar on RFI and its impact on the new generation of HI spectral-line surveys, 17-18 June 2013, CSIRO, Marsfield, NSW, Australia.
53. † B.D. Jeffs, “Progress in Adaptive Spatial Filtering for RFI Mitigation in Radio Astronomy,” NRAO Socorro Friday Colloquium Series, New Mexico, March 8, 2013 (Invited presentation with travel expenses grant).

54. B.D. Jeffs, K.F. Warnick, T. Webb,\* M. Adhikari, M. Elmer\*, and R. Black\*, “Progress in High Sensitivity Phased Array Feeds for Large Single-Dish Radio Telescopes,” PAFSKA Meeting, Sep. 7, 2012, Cape Town, South Africa.
55. † B.D. Jeffs, K.F. Warnick, J. Landon\*, M. Elmer\*, D. Carter\*, V. Asthana\*, T. Webb\*, J.R. Fisher, R. Norrod, G. Cortes-Medellin, “Progress in Array Design, Calibration, Beamforming, and RFI Mitigation for PAFs,” Calibration and Imaging Workshop 2010, CALIM 2010, Dwingeloo, The Netherlands, August 2010.
56. J. Landon\*, B. D. Jeffs, K. F. Warnick, D. Carter\*, T. Webb\*, M. Elmer\*, J. R. Fisher, and R. Norrod, “An interference canceling phased array feed for the Green Bank Telescope,” URSI National Radio Science Meeting, Boulder, CO, Jan. 5-8, 2011.
57. † M. V. Ivashina, S. J. Wijnholds, R. Maaskant, K. F. Warnick, and B. D. Jeffs, “Polarimetric beamforming methods for PAF systems,” CALIM 2010: The 5th SKA Workshop on Calibration and Imaging, Dwingeloo, The Netherlands, Aug. 22-27, 2010.
58. K. F. Warnick, D. E. Carter, T. Webb, B. D. Jeffs, R. Norrod, and J. R. Fisher, “Active impedance matched dual-polarization phased array feed for the GBT,” International Workshop on Phased Array Antenna Systems for Radio Astronomy, Provo, UT, May 3-5, 2010.
59. G. Cortes-Medellin, K. F. Warnick, and B. D. Jeffs, “Obtaining the simulated response of a 19 element focal phased array for the feasibility study for the Arecibo radio telescope,” International Workshop on Phased Array Antenna Systems for Radio Astronomy, Provo, UT, May 3-5, 2010.
60. † M. Elmer, B. D. Jeffs, and K. F. Warnick, “Beamformer design methods for phased array feeds,” International Workshop on Phased Array Antenna Systems for Radio Astronomy, Provo, UT, May 3-5, 2010.
61. † K. F. Warnick, B. Jeffs, and T. Webb, “Calibration and beamforming for polarimetric phased array feeds,” International Workshop on Phased Array Antenna Systems for Radio Astronomy, Provo, UT, May 3-5, 2010.
62. † J. Landon, B. D. Jeffs, and K. F. Warnick, “Deep nulling interference cancelation for phased array feeds,” International Workshop on Phased Array Antenna Systems for Radio Astronomy, Provo, UT, May 3-5, 2010.
63. † R. Norrod, J. R. Fisher, B. Jeffs, and K. F. Warnick, “Steps toward a cryogenic L-band phased array feed for reflector antennas, International Workshop on Phased Array Antenna Systems for Radio Astronomy, Provo, UT, May 3-5, 2010.
64. K. F. Warnick, D. Carter, T. Webb, B. D. Jeffs, J. Landon, M. Elmer, J. R. Fisher, and R. Norrod, “Sensitivity optimization and signal processing for the BYU/NRAO L-band phased array feed,” URSI National Radio Science Meeting, Boulder, CO, Jan. 6-9, 2010 (invited).

65. † B.D. Jeffs, K.F. Warnick, J.L. Landon, M. Elmer, J.R. Fisher, and R. Norrod, "Progress in Phased Array Feed Development for Radio Astronomy," CSC/SETI Institute Colloquium Series, invited paper, Jul. 1, 2009, Mountain View, CA, <http://archive.seti.org/pdfs/csc-Jeffs.pdf>.
66. † B.D. Jeffs, K.F. Warnick, J.L. Landon, M. Elmer, J.R. Fisher, and R. Norrod, "Recent progress with the BYU/NRAO phased array feed," CALIM 2009, Socorro, New Mexico, Mar. 30 - Apr. 3 2009, [https://safe.nrao.edu/wiki/pub/Software/CalIm09Program/brian\\_jeffs.pdf](https://safe.nrao.edu/wiki/pub/Software/CalIm09Program/brian_jeffs.pdf).
67. K.F. Warnick, B.D. Jeffs, J. Landon, J. Waldron, D. Jones, J.R. Fisher, and R. Norrod, "Beamforming and imaging with the BYU/NRAO L-Band 19-element phased array feed," Antenna Technology and Applied Electromagnetics and the Canadian Radio Science Meeting, ANTEM/URSI 2009, 13th International Symposium on, 15-18 Feb., 2009.
68. K. F. Warnick, B. D. Jeffs, J. Landon\*, J. Waldron\*, D. Jones\*, R. Fisher, and R. Norrod, "BYU/NRAO 19-element phased array feed modeling and experimental results," URSI General Assembly, Chicago, IL, Aug. 8-15, 2008.
69. M. J. Elmer\*, J. Landon\*, B. D. Jeffs, K. F. Warnick, R. Fisher, and R. Norrod, "Optimizing phased array feeds to reduce elevation dependent spillover noise in radio telescopes," URSI General Assembly, Chicago, IL, Aug. 8-15, 2008.
70. J. C. Landon\*, B. D. Jeffs, K. F. Warnick, J. R. Fisher, R. D. Norrod, "Improved low INR interference cancellation using phased array feeds," URSI General Assembly, Chicago, IL, Aug. 8-15, 2008.
71. † B.D. Jeffs, K.F. Warnick, M. Elmer\*, J. Landon\*, J. Waldron\*, D. Jones\*, R. Fisher, and R. Norrod, "Calibration and optimal beamforming for a 19 element phased array feed," Calibration and Imaging Workshop, CALIM2008, Perth Australia, 7-9 Apr. 2008. <http://calim2008.atnf.csiro.au/twiki/pub/Main/WorkshopProgram/JeffsCalim.pdf> PDF file
72. K. F. Warnick, D. Jones\*, B. D. Jeffs, and M. A. Jensen, "Noise penalty due to mutual coupling for receive arrays," URSI National Radio Science Meeting, Boulder, CO, Jan. 3-6, 2008.
73. J. Landon\*, D. Jones\*, B. D. Jeffs, K. F. Warnick, R. Fisher, and R. Norrod, "Interference cancellation and sensitivity optimization using an L-band focal plane array on the Green Bank 20m Telescope," URSI National Radio Science Meeting, Boulder, CO, Jan. 3-6, 2008.
74. K. F. Warnick, J. Waldron\*, J. Landon\*, M. Lilrose\*, and B. D. Jeffs, "Experimental results on interference mitigation with a 19 element array feed," Proceedings of 2nd European Conference on Antennas and Propagation, Edinburgh, UK, Nov. 11-16, 2007.
75. † K. F. Warnick, B. D. Jeffs, J. Landon\*, J. Waldron, D. Jones\*, A. Stemmons\*, "BYU/NRAO 2007 Green Bank 20 Meter Telescope focal plane array –

- modeling and experimental results,” † presentation, SKADS MCCT Technical Workshop on ‘Design of Wideband Receiving Array Systems,’ Dwingeloo, The Netherlands, Nov. 26-30, 2007.
76. B.D. Jeffs, K.F. Warnick and J. Nagel\*, “On interference cancellation with a focal plane array,” Square Kilometer Array Calibration and Imaging Workshop, CALIM2006, Cape Town, South Africa, Dec. 4-6, 2006, <http://www.kat.ac.za/calim2006/wiki/Program>.
  77. J. R. Nagel\*, M. A. Lillrose\*, K. F. Warnick, and B. D. Jeffs, “Prototype platform for array feed development,” Proceedings of USNC/URSI National Radio Science Meeting, 2006.
  78. S. van der Tol\* and B.D. Jeffs, “Theoretical performance bounds for LOFAR calibration,” Square Kilometer Array Widefield Imaging Workshop, June 22-24, 2005, Dwingeloo, The Netherlands, <http://www.skatelescope.org/pages/news/Wrksp20220605.htm>.
  79. B.D. Jeffs and S. van der Tol\*, “Analysis of the peeling algorithm,” Square Kilometer Array Widefield Imaging Workshop, June 22-24, 2005, Dwingeloo, The Netherlands, <http://www.skatelescope.org/pages/news/Wrksp20220605.htm>.
  80. W. Dong\* and B.D. Jeffs, “Kalman tracking and Bayesian detection for radar RFI blanking,” *Proceedings of RFI2004, IUCAD DRAO Workshop in Mitigation of Radio Frequency Interference in Radio Astronomy*, Penticton, British Columbia, July 16 - 18, 2004, <http://www.drao-ofr.hia-ihc.nrc-cnrc.gc.ca/rfi2004/>.
  81. C. Hansen\*, K. Warnick, B. Jeffs, R. Fisher and R. Bradley, “Interference mitigation using an array feed,” *Proceedings of RFI2004, IUCAD DRAO Workshop in Mitigation of Radio Frequency Interference in Radio Astronomy*, Penticton, British Columbia, July 16 - 18, 2004, <http://www.drao-ofr.hia-ihc.nrc-cnrc.gc.ca/rfi2004/>.
  82. A. Poulsen\*, B.D. Jeffs, C. Hansen, K. Warnick, and R. Fisher, “Real-time adaptive cancellation of GLONASS interference in OH signal observations at the Green Bank Telescope,” *Proceedings of the USNC/CNC/URSI North American Radio Science Meeting*, Columbus OH, p. 641, June 22-27, 2003.
  83. C. Hansen\*, K. F. Warnick, and B. D. Jeffs, “Adaptive interference cancellation using an array feed design for radio telescopes,” *Proceedings of the USNC/CNC/URSI North American Radio Science Meeting*, Columbus, OH, p. 642, June 22-27, 2003.
  84. † L. Li\*, B.D. Jeffs, A. Poulsen\*, and K. Warnick, “Analysis of adaptive array algorithms performance for satellite interference cancellation in radio astronomy,” Nat. Academies of Sciences and Engineering, URSI General Assembly XXVII, Aug. 2002, Maastricht the Netherlands. Invited paper.
  85. B.D. Jeffs, J.R. Fisher, and R.F. Bradley, “Development of a programmable real-time interference canceller for a small radio telescope array,” *Nat. Academies of*



- Sciences and Engineering, URSI National Radio Science Meeting*, p. 322, Jan. 8-11, 2001, Boulder CO.
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  87. Q. Spencer\*, B. Jeffs, M. Jensen, M. Rice, "Indoor wideband time/angle of arrival multipath propagation results," *Proceedings of the IEEE Vehicular Technology Conference*, Phoenix, vol. 3, May, 1997, pp. 1410-1414. PDF file
  88. Q. Spencer\*, B. Jeffs, M. Jensen, M. Rice, "A statistical model for angle of arrival in indoor multipath propagation," *Proceedings of the IEEE Vehicular Technology Conference*, Phoenix, vol. 3, May, 1997, pp. 1415-1419. PDF file
  89. B.D. Jeffs and W.H. Pun\*, "Model adaptive optimal image restoration," *Proc. of the SPIE Conf. on Applications of Digital Image Processing XV*, SPIE vol. 1771, pp. 307-321, July 19-24, 1992.
  90. B.D. Jeffs, M. Gunsay\*, and J Dougal\*, "Resolution enhancement of blurred star field images by maximally sparse restoration," *Proc. of the SPIE Conf. on Applications of Digital Image Processing XIV*, SPIE vol. 1567, pp. 511-521, July 22-26, 1991.
  91. R. Leahy, B. Jeffs, M. Singh, and R. Brechner, "Evaluation of algorithms for a SQUID detector neuromagnetic imaging system," *Proc. of the SPIE Conf. on Medical Imaging*, Newport Beach, CA, Feb. 1987.
  92. B.D. Jeffs, R.M. Leahy and M. Singh, "Analysis of reconstruction algorithms for neuromagnetic imaging using SQUID-detectors," *Proc. of IEEE ASSP 1986 Digital Signal Processing Workshop*, Chatham, MA, Oct. 20-22, 1986.

#### 4. Externally Funded Research Grants and Contracts

1. *National Science Foundation*. (PI)  
B.D. Jeffs and K.F. Warnick, "Advanced L-band Phased Array Camera for Arecibo." NSF award AST-1636645, \$5,820,519, June 2018 – May 2022.
2. *National Radio Astronomy Observatory (NRAO)*. (PI),  
"Experimental Evaluation Using VLA Datasets of RFI Mitigation Performance over Long ngVLA Baselines," \$6,000, Apr. 2018 – Nov. 2018.
3. *Office of Naval Research (ONR)*. (co-PI)  
K.F. Warnick and B.D. Jeffs, "Real-time Adaptive Beamforming and Interference Mitigation," January 2018 – December 2020, \$679,784.
4. *National Radio Astronomy Observatory (NRAO)*. (PI)  
B.D. Jeffs and K.F. Warnick, "Advanced Spatial Filtering Methods for RFI

- Mitigation at the ngVLA,” ngVLA Community Studies Grant program, November 2016 – August 2017, \$23,660.
5. Cornell University, National Science Foundation Sub Award. (PI)  
B.D. Jeffs and K.F. Warnick, “Digital Back End Conceptual Design for the Arecibo AO-40 Phased Array Feed,” February – August 2015, \$19,953.
  6. *National Science Foundation.* (co-PI)  
K.F. Warnick and B.D. Jeffs, “Collaborative Research: Wide-Field L-Banned Focal Plane Array Beamformer for Pulsar, Defuse Hydrogen, and Fast Transient Surveys on the GBT,” September 2013 – August 2016, \$441,063. NSF ATI award no. 1309832.
  7. *Cornell University, National Science Foundation Sub Award.* (co-PI)  
K.F. Warnick and B.D. Jeffs, “Digital Processing for 2012-2013 Arecibo AO40 Cryogenic PAF Prototype Test,” September 2012 - September 2013, BYU subaward on NSF #1207727 to Cornell University, \$65,488.
  8. *National Science Foundation.* (PI)  
B.D. Jeffs and K.F. Warnick, “Collaborative Research: Development of a Millimeter-wave Phased Focal Plane Array,” July 2011-June 2014, \$305,923. NSF ATI award no. 1106218.
  9. *National Astronomy and Ionosphere Center.* (co-PI)  
K. F. Warnick and B.D. Jeffs, “Focal Region Characterization, Beamforming, and Demonstrator Integration for Arecibo AO40 Phased Array Feed Feasibility Study.” Sep. 2009, \$120,750.
  10. *National Science Foundation.* (co-PI)  
K.F. Warnick, J.R. Fisher, B.D. Jeffs, R.D. Norrod, “MRI: Development of a Flexible Multichannel Digital Receiver for Radio Astronomy,” Aug. 2008, \$641,275
  11. *National Science Foundation.* (PI)  
B.D. Jeffs, K.F. Warnick, J.R. Fisher and R.F. Bradley, “Research experience for undergraduates: RFI mitigation for radio astronomy with emphasis on array feeds,” Aug. 2007, 12 months, supplemental award, \$22,500.
  12. *National Science Foundation.* (co-PI)  
J.R. Fisher, R.F. Bradley, B.D. Jeffs and K.F. Warnick, “Development of real-time interference mitigation instrumentation for radio astronomy,” Feb. 2005, \$321,919, BYU subcontract: \$117,900.
  13. *National Science Foundation.* (PI)  
B.D. Jeffs, K.F. Warnick, J.R. Fisher and R.F. Bradley, “RFI mitigation for radio astronomy with emphasis on array feeds,” Sep. 2004, 36 months, \$573,665. NSF ATI award no. 0352705.
  14. *Stichting voor de Technische Wetenschappen, STW (Foundation for Technical Sciences, Netherlands equivalent of NSF).* (co-PI)  
B.D. Jeffs and A.-J. van der Veen, “Grant for living expenses and travel for

- research sabbatical visit to Technical University of Delft,” competitive, Aug. 2004, 11 months, \$30,000.
15. *Technical University of Delft.* (co-PI)  
B.D. Jeffs and A.-J. van der Veen, "Grant for half salary for research sabbatical visit to Technical University of Delft," Aug. 2004, 11 months, \$30,000.
  16. *U.S. Army Communications-Electronics Command.* (PI)  
B.D. Jeffs, principal investigator “Experimental analysis of impairments to RFI mitigation,” Mar. 2003, 12 months, \$97,530.
  17. *National Science Foundation.* (co-PI)  
A.L. Swindlehurst, B.D. Jeffs, M.A. Jensen, and M. Rice, “Development of a comprehensive real-time instrument for MIMO wireless channel measurement,” Aug. 2000, 36 months, \$370,567.
  18. *National Science Foundation.* (co-PI)  
A.L. Swindlehurst, B.D. Jeffs, M.A. Jensen, and M.D. Rice, “Analysis of the capacity improvement for wireless networks with multiple transmit and receive antennas,” Sep. 2000, 36 months, \$499,761.
  19. *National Science Foundation.* (PI)  
B.D. Jeffs, D.V. Arnold, R.F. Bradley, and J.R. Fisher, “Real-time adaptive cancellation of non-stationary interference in radio astronomy,” Jul. 2000, 36 months, \$600,280. NSF ATI award number 9987339.
  20. *National Science Foundation.* (co-PI)  
A.L. Swindlehurst, B.D. Jeffs, M.A. Jensen, and M. Rice, “Modeling and design for the lower layers of 4th generation indoor/outdoor wireless networks,” Sep. 1999, 36 months, \$697,636.
  21. *Air Force Office of Scientific Research.* (PI)  
B.D. Jeffs, “Algebraic methods for improved blind restoration of adaptive optics images of space objects,” Air Force Office of Scientific Research, Summer Research Extension Program, 1999, \$25,000.
  22. *Air Force Office of Scientific Research.* (PI)  
Brian D. Jeffs, “Bayesian restoration of space object images from adaptive optics data with unknown residual blur,” Air Force Office of Scientific Research, Summer Research Extension Program, 1998, \$25,000.
  23. *Department of Energy / Los Alamos National Laboratory.* (PI)  
B.D. Jeffs, “Airborne plume identification using generalized Gauss-Markov model parameter estimation,” Jul. 1997, 12 months, \$20,000.
  24. *Engineering Foundation, Air Force Engineering Research Initiation Grant.* (PI)  
B.D. Jeffs, “Design of sparse beamforming arrays using an optimization theoretic approach,” Sep. 1991, 11 months, \$23,000.  
(Note, this award was subsequently returned to the Engineering Foundation as per

their policy after receiving the NSF Research Initiation Award on a different proposed project.)

25. *National Science Foundation, Research Initiation Award.* (PI)  
B.D. Jeffs, "Optimally sparse restoration of blurred star field images," Aug. 1991, 36 months, \$59,980.
26. *Space Dynamics Laboratory / Utah State University.* (PI)  
B.D. Jeffs, "Algorithm development for Spirit III," including research to evaluate candidate algorithms for space-born infrared imaging array data preprocessing and resolution enhancement, Nov. 1991, four months, \$1,500.
27. *Space Dynamics Laboratory / Utah State University.* (PI)  
B.D. Jeffs, BYU IR Initiative, subcontract number C868770. "Adaptive optimal image restoration," Sep. 1991, 27 months, \$46,716.
28. *Naval Research Laboratory, subcontract through JIL Systems Incorporated.* (co-PI)  
D.M. Chabries, R.H. Selfridge, and B.D. Jeffs, "Advanced submarine technologies," including research in the areas of underwater acoustic imaging and modeling of acoustic scattering from submerged bodies, Jul. 1990, 13 months, \$116,800.

## 5. *Research Emphasis*

The major area of focus for Dr. Jeffs' research includes the related disciplines of digital signal processing, sensor array processing, and digital image restoration. The following list describes research topics Dr. Jeffs has been involved with, with the most recent activities listed first.

1. Phased array feeds for radio telescopes dishes: A new trend in developing the next generation of radio telescopes is to use a compact array of antennas at the focal plane of a large dish reflector. Compared to traditional single waveguide feeds, these phased array feeds (PAFs) can increase the instrument field of view and sky survey speed. Unique challenges associated with PAF observations, including extremely low signal levels, long-term system gain stability requirements, spatially correlated noise due to mutual coupling, and tight beamshape tolerances, require the development of new array signal processing techniques for this application. Dr. Jeffs has studied calibration and beamforming strategies for PAFs including interference mitigation with power spectral density (PSD) estimation bias correction. Key efficiency metrics for single-feed instruments have been extended to the array case and are using these to verify performance of the algorithms. In collaboration with the National Radio Astronomy Observatory (NRAO) and Cornell University, these techniques have been validated in experiments on the Robert C. Byrd Green Bank Telescope, the Green Bank 20-Meter Telescope, and the Arecibo Telescope.
2. Self calibration for low frequency radio astronomical arrays: There is growing interest in radio astronomical observations in the low frequency range where it

- may be possible to detect the most distant, and highly red shifted celestial objects yet observed. Instruments must detect signals at unusually low frequencies (10-350 MHz) and over large apertures (100 km). Major projects include the Dutch Low Frequency Array (LOFAR), the Giant Metre-wave Radio Telescope (GMRT), the Long Wavelength Array (LWA), and low-frequency retrofits to the Very Large Array (VLA) in New Mexico, and the Murchison Wide Field Array in Australia. Our research addresses the most significant outstanding calibration challenge for large low-frequency arrays, i.e. correction for ionospheric phase distortion. At these frequencies the Earth's ionosphere acts as a random refractive sheet which over the large aperture induces source-direction-dependent gain and phase errors that must be estimated and calibrated out. Due to direction dependence, existing self calibration techniques cannot be applied. We have studied the direction dependent calibration problem in detail for the LOFAR and VLA arrays from a parameter estimation theoretic perspective. Self calibration algorithms have been proposed, and Cramer-Rao lower bounds (CRB) have been developed to guide further algorithm development and array geometry design.
3. Adaptive interference mitigation for radio astronomy: Radio astronomical observation is increasingly plagued by man-made interference from ground based broadcast, mobile wireless communications, and satellite downlink sources. Dr. Jeffs has studied several mitigation approaches. Real-time signal processing tools have been developed to cancel space-based interference using adaptive filtering techniques. This has been successfully demonstrated at the National Radio Astronomy Observatory (NRAO) 100m Green Bank Telescope (GBT). New algorithms have been developed and analyzed for algebraically projecting out interference seen in imaging arrays like the Very Large Array in New Mexico. Kalman tracking techniques have been adapted to improve data time blanking for removing aviation radar interference seen at the GBT. Adaptive beamforming cancellation has been employed with a phased array feed on the Green Bank 20 meter Telescope dish to remove mobile interference. Estimation bias caused by array interference cancellation has been studied and correction algorithms proposed.
  4. Multiple antenna arrays for wireless communication: Recently developed algorithms for space-time coded Multiple Input, Multiple Output (MIMO) wireless systems have been shown to be theoretically capable of increasing channel capacity by an order of magnitude or more. This gain is achieved using multiple antennas at both the transmit and receive ends of a wireless link to exploit the presence of multipath scattering, without increasing radio frequency bandwidth requirements. We have studied both the indoor and outdoor MIMO channel environments with an experimental channel sounding platform. Based on these observations, statistical models to enable realistic channel capacity calculations were proposed.

## 6. *Professional Activities*

Dr. Jeffs is active in IEEE professional programs related to digital signal processing and digital image processing. He is a founding member of the Utah Chapter of the IEEE Signal Processing and Communications Societies. He regularly participates and contributes at the related international conferences and workshops, including the IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), URSI Conferences in the area of radio Astronomy, Square Kilometer Array (SKA) workshops, and the Asilomar Conference on Signals, Systems & Computers. Specific professional activities include:

1. Member of the technical organizing committee, RFI 2016 Workshop, Coexisting with Radio Frequency Interference, Socorro NM, Oct. 17-20, 2016.
2. Member of the executive organizing committee, Local arrangements chair, IEEE Signal Processing & SP Education Workshop 2015, Aug. 9-12, 2015, Snowbird Ski & Summer Resort, Salt Lake City, Utah.
3. Member of the scientific organizing committee, Calibration and Imaging Workshop, CALIM 2014, 3 – 6 February, 2014, Kiama, NSW, Australia.
4. June 2011 to 2014, Member of International Telecommunications Union Working Party 7 D (US WP7D) – Radio Astronomy. This is part of the international regulating body for radio allocations. Served as principal author of the now adopted international standard document “Report ITU-R RA.2126, Techniques for mitigation of radio frequency interference in radio astronomy, Question ITU-R 237/7.”
5. May 2011, Conference Co-Chair and co-organizer, International Workshop on Phased Array Antenna Systems for Radio Astronomy, Provo, UT. This workshop held on the campus of Brigham Young University was attended by over 25 international experts in the field.
6. May 2010, Conference Co-Chair and co-organizer, International Workshop on Phased Array Antenna Systems for Radio Astronomy, Provo, UT. This workshop held on the campus of Brigham Young University was attended by over 40 international experts in the field.
7. July 2007 - October 2008, Guest Editor for IEEE Journal on Selected Topics in Signal Processing. With four other guest editors, responsibilities include: a) proposing the “Special issue on Signal Processing for Astronomical and Space Research Applications,” to the JSTSP board, b) creating and distributing the call for papers, c) promoting the special issue by individual contact with members of the target community, d) soliciting and assigning reviewers for papers, e) assessing reviews to make final editorial acceptance decisions for papers, and f) coordinating with JSTSP staff for final production.
8. 1996 - 2001, Vice General Chair for IEEE ICASSP 2001. Local arrangements chair. This premier signal processing conference was held in Salt Lake City, May

- 2001 and had have over 2,000 participants. The executive committee, including me and three other faculty from BYU and Utah, were responsible for all technical, financial, publications, and facilities arrangements.
9. 1996 - 1998, Executive Committee member for IEEE DSP Workshop 98. Local arrangements chair and technical committee member. This workshop was held at Bryce Canyon National Park, Aug. 9-12, 1998 and had approximately 250 attendees. A significant amount of time was spent in 1998 in detailed planning, making contractual arrangements with the hotel and caterers, and in hosting the event.
  10. 1998 - 2001, Chair of the Utah Chapter for the IEEE Signal Processing and Communications Societies. Previous assignments include Vice Chair, and Secretary/Treasurer.
  11. 1998, Member of the Technical Committee for IEEE ICIP-98 and ICIP-99. Duties included reviewing 12 papers for the conference to determine acceptance or rejection.
  12. Chaired technical conference sessions for the 1998 Asilomar Conference on Signals and Systems, 1998 IEEE DSP Workshop, and ICASSP - 96. At Asilomar '98 organized a special session on "Blind Image Restoration and Image Processing Applications."
  13. Critically reviewed over 130 technical papers for publication acceptance or rejection. A frequent technical reviewer for *IEEE Transactions on Signal Processing*, *IEEE Transactions on Image Processing*, *Radio Science*, *Journal of Electronic Imaging*, *IEEE Transactions on Aerospace and Electronic Systems*, *SPIE Optical Engineering*. Have also performed reviews for *IEEE Signal Processing Letters*, *Proceedings of the IEEE*, several publishers of technical text books, ICIP-98, ICIP-99, and 1998 IEEE DSP Workshop.
  14. 1999 and 2005, National Science Foundation review panelist on multiple occasions. Critically reviewed more than 70 NSF proposals for grant funding.
  15. 2003, elevated to Senior Member, IEEE.
  16. Licensed amateur radio operator, extra class, call signs WJ7B (US) and VK2ZAA (Australia).

## 7. Teaching

Dr. Jeffs teaches a wide variety of graduate and undergraduate courses in the areas of signals and systems, and electronic circuits. At the graduate level his regular lectures include Advanced Digital Signal Processing (ECEn 777), Detection and

estimation Theory (ECEn 672) and Stochastic Processes (ECEn 670), and Mathematics of Signal Processing (ECEn 671)s. Undergraduate offerings include Introduction to Digital Signal Processing (ECEn 487), Real-time DSP laboratory (ECEn 487 Lab), Probability theory (ECEn 370), Software Radio Senior Project (ECEn 490), Signals and Systems (ECEn 380), Introduction to Circuits (ECEn 212), and Electronic Circuits and Devices (ECEn 313).

The following list itemizes some of the curriculum innovations and new courses developed and introduced by Dr. Jeffs.

1. ECEn 487, Discrete-Time Signal Processing lecture and Real-Time Digital Signal Processing Laboratory. The lecture course was revised and moved to the undergraduate level by Dr. Jeffs. This permitted much more advanced offerings at the graduate level. The associated real-time DSP lab, developed by Dr. Jeffs, uses the TMS320C6701 floating point signal processor evaluation module. Students develop code for filters, a spectrum analyzer, acoustic direction finder, and adaptive noise canceller.
2. ECEn 490, Software Radio Senior Project. In this lab course, teams of upper division students (four per team) design a complete operational DSP-based digital communications receiver in a competitive environment. The 924 MHz QPSK receiver is implemented in real-time DSP code on a Texas Instruments TMS320C6701 floating point evaluation board. Students must design and build the antenna, radio frequency front-end circuits, and develop code for the digital demodulation. Teams compete based on lowest transmit power required for a specified bit error rate at a fixed distance. Winning teams receive a significant cash award from corporate sponsors.
3. ECEn 212 lab, Circuits Laboratory. This course is based on a semester-long major project where the students design and build a complete stereo audio amplifier and speaker system, and in the process apply all of the major circuits principles taught in class.
4. ECEn 380 Signals and systems. Dr. Jeffs led the effort in 1991 to have this course on linear systems and transforms expanded and moved from the graduate level to be taught at the Junior level. The current course syllabus was developed and first taught by Dr. Jeffs.
5. ECEn 316, Signals and Systems Laboratory. This companion to ECEn 380 included op-amp and DSP-based experiments to study principles of both analog and digital linear systems.
6. ECEn 687, Advanced Digital Signal Processing. Includes topics of statistically optimal signal processing, array processing, adaptive filtering, parametric spectral analysis, etc.



7. ECEn 619, Advanced Digital Image Processing. Includes in depth study of iterative and regularized methods for image restoration and medical image reconstruction. The ill-posed inverse problem is analyzed.

#### 8. *University Administrative Activities*

1. 2017 – present, member of the Department of Electrical and Computer Engineering External Relations Committee.
2. 2016 – 2017, member of the Department of Electrical and Computer Engineering Undergraduate Committee.
3. 2011 – 2016, member of the Department of Electrical and Computer Engineering Executive Committee.
4. 2011 - 2016, Graduate Coordinator. Responsibilities include oversight of graduate programs in the ECEN department, managing budgets, establishing policy and program directions, advising and recruiting quality graduate students, making admissions and student ratings decisions, chairing the graduate faculty committee, approving all graduate program changes and student milestones (e.g. advancement to candidacy).
5. 2006 - 2011, member of the Department of Electrical and Computer Engineering graduate committee. Responsibilities include admissions decisions, graduate exam development and administration, policy advisement, and graduate student advisement prior to being assigned a thesis advisor.
6. 2001 - present, member of the Department of Electrical and Computer Engineering Rank and Status Committee. This committee is responsible to review and make recommendations on faculty applications for tenure status and promotions.
7. 1999 - 2002 (3 year appointment), member of the University Internal Review Committee. This committee is charged with performing detailed graduate and undergraduate academic reviews of each department in the University on a seven year cycle. These internal reviews are used to guide University assessment and planning, and to encourage continuous improvement of departments and institutional excellence.
8. 1999-2000, ABET accreditation coordinator for the department. duties include planning and implementing policies to comply with ABET requirements for outcomes and objectives assessment.
9. 1993 -1997, Chair of the University Forum Committee. Responsible to solicit and review nominations for University Forum speakers. Speakers of international renown are invited to address the entire University community in the Marriott

Center four times a semester. Speakers are selected based on scholarly record, academic contributions, and respect and standing in national and international communities.

10. 1995 - 1999, member of the Department Undergraduate Committee. Responsible for curriculum improvement and oversight, accreditation, and student academic standards implementation, and student academic advising.
11. 1994 - 1999, member of the Analog Laboratory Committee. Responsible for instrument acquisition, laboratory policy, laboratory curriculum improvement.
12. 1994 - 1995, Chair, Undergraduate Curriculum Committee. Supervised a major renovation of the undergraduate curriculum which included changing over 50% of the course offerings.
13. 1990 - 1994, IEEE Student Chapter Faculty Advisor.

9. *Awards and Society Memberships*

Awards:

Outstanding Faculty Award, 2016, Ira A. Fulton College of Engineering & Technology, Department of Electrical and Computer Engineering.

Hughes Aircraft Ph.D. Fellow; recipient of Brigham Young University's President's and Alvina S. Barrett scholarships; Magna Cum Laude citation, Brigham Young University; Utah Section of the IEEE Award of Merit for outstanding service, Signal Processing and Communications Societies, 1998-2000.

Society Memberships:

IEEE member 1990-2001, IEEE senior member 2002-present, IEEE Signal Processing Society, Tau Beta Pi and Phi Kappa Phi honor societies.

10. *Professional Development*

Sabbatical at the Technical University of Delft, The Netherlands, research in signal processing for radio astronomy, course development and teaching, 11 months (2004 – 2005).

Sabbatical at CSIRO in Sydney Australia. Research in phased array feed systems for radio astronomy, 11 months (2013 – 2014).