CHRISTOPHER T. RODENBECK, PhD, FIEEE

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EXPERIENCE

Naval Research Laboratory, Washington, DC (12/2014-present)
Radar Division – Office Head, Advanced Concepts Group

Started up a new NRL department focused on "work for others" exploratory radar applications.

mmWave Sensing for Autonomy

- Conceived and led multiyear DoD and ONR rapid reactions (> $5.5M) that developed mmWave radars for precision autonomous navigation of small UAVs. Numerous flight tests demonstrated fully autonomous navigation and guidance.
- 10x SWaP reduction enabled by early access to next-generation automotive ICs and extremely compact embedded GPUs. Novel architecture extended 2D automotive radar techniques to provide 3D MIMO sensing for airborne platforms.
- Transition to two defense contractors. Highly cited patents on sense and avoid, target tracking, terrain aided navigation, and target identification.

mmWave Airborne Radar for Advanced Maritime ISR

- Technical breakthroughs in range-Doppler imaging and sound reproduction for non-cooperative moving targets. On YouTube and in a podcast interview.
- Won NRL IRAD and major capital equipment grants > $8.3M to develop a first-of-its-kind 94-GHz airborne radar prototype. Features the highest power solid-state PA yet developed. Ground-based operational testing begins in April 2021.

Space Based Power Beaming and Phased Arrays

- PI on three externally sponsored projects (> $20M) developing IC and active array technology for X band power beaming demonstrations. See YouTube for highlights of a 1-kW, 1-km demonstration.
- Principle Investigator for the Arachne power beaming satellite, the cornerstone demonstration under the Space Force's SSPIDR program.
- Commercial CRADA to develop GaN ICs for thermally optimized phased arrays transmitters. This is the largest CRADA signed to-date at NRL.

Professional Honors

- Received the 2015 Outstanding Young Engineer Award of the 11,000-member IEEE Microwave Theory and Techniques Society. Elevated to IEEE Fellow in January 2022.
- Selected out of >100,000 engineering alumni as the 2016 winner of the Texas A&M College of Engineering Outstanding Early Career Alumni Award.
- *Publications*: 41 refereed journal papers, 24 patents granted or pending, 30 conference papers, and 29 government reports.

Sandia National Laboratories, Albuquerque, NM (9/2004-12/2014)
Principal Member of the Technical Staff

Radar Technology Leadership

- Led a multi-disciplinary advanced/exploratory research program on radar sensor applications.
- Proposed and won >$10M in radar technology maturation projects in first 2 years at Sandia. The objective was to consolidate >800 discrete radar components into a handful of custom ICs. The success of this project was twice the subject of Congressional testimony by Sandia's President.
- Led the development of a 50-W single-chip UWB radar power amplifier. First ever demonstration of an integrated drain modulator. Highest speed pulse modulation ever demonstrated for >10 W. More than $9 million of pre-production contracts with TriQuint Semiconductor.
- Conception, implementation, and analysis of multiple advanced radar concepts including spatial power combining to mitigate interference between co-located radar systems, detection-at-the-limit digitizers sensitive to the 1-μV level, and novel radiation-hardening techniques applicable to commercial semiconductor processes.
- Mentored a team of engineers that expanded from 2 to 13 RF engineers in < 2 years.
- In a Wall Street Journal interview, a 4-star general shows off Rodenbeck's module with its "tiny little chip[s]".

EXPERIENCE, CONT.

RF/Microwave Research & Advanced Product Development

- *SOI/Si RF/Mixed-Signal ICs*: New rad-hard-by-design-approach. Coherent digital receivers. PLL components and chip-level simulation. First pass design success.
- *GaAs RFICs*: HBT and E/D pHEMT designs including VCOs, mixers, pulsed PAs, switches, etc.
- *Multichip Module Design*: High-power LTCC multichip assemblies, chip-on-board packages, and thin-film circuits. Subsystem pilot production and troubleshooting. Patents in progress on electromagnetic shielding, plasma cleaning of CMOS ICs, 3D glass structures, heat sinking, etc.
- *Radar Analysis*: Introduced and experimentally demonstrated (*i*) simple theory for the coherent detection of radar waveforms, (*ii*) a method for canceling DC offsets in quadrature ADCs, and (*iii*) a technique for analyzing and eliminating transient oscillations in UWB transmitters.
- Electrically-small UHF antenna designs for US government RFID applications. 3 patents issued.
- Long-range research, including: software-defined fusion of radar and telemetry, phase change limiters, acoustic resonators, all-electronic/range-optimal RF matched filters, ΣΔ coherent digitizers, radiation-hardened microprocessors.

Corporate IRAD Wins

- Advanced Radar Digital Signal Processor (2014-2016).
- Ultrawide Bandgap Power Electronics (2014-2016).
- Reconfigurable Matching Networks for High-Efficiency GaN PAs (2013-2015).
- Reverse-Superconducting Microwave Limiters (2011-2013).
- Software-Defined Fusion of Radar and Telemetry (2011-2013).
- Temperature-Stable Dielectrics (2011-2013).
- Faraday Microshields (2009-2011).
- Microresonators for Advanced RF Systems (2008-2010).

Professional Honors

- Young Innovator Award, Sandia National Laboratories (2013).
- Principal Investigator for an R&D program receiving the prestigious NNSA Defense Programs Award of Excellence (2012). Personally received the award, on behalf of a large team, from the director of this $16B/year agency.
- Award of Excellence in Radar Technology Leadership, Sandia National Laboratories (2011).

Texas A&M University, College Station, TX (9/00-8/04, 9/99-5/00, 9/98-5/99, 3/98-5/98)
Electromagnetics and Microwave Lab Manager, Grad Research Asst., Undergrad Research Asst.

- Developed the first phased array radar having multi-octave bandwidth. 1st author of highly-cited 2005 paper downloaded nearly 2400 times since Jan. 2011.
- Published research on mmWave antennas, ultrawideband (8-20 and 10-35 GHz) TR modules and phased arrays, microwave power beaming, reflectarray antennas, and solid-state device modeling.
- Sponsors: OSD, AF, Army, Navy, NSF, JPL, NASA-GRC, TriQuint, and Raytheon.

TriQuint Semiconductor, Dallas, TX (5/00-8/00, 5/99-8/99, 5/98-8/98)
Engineering Intern

- Designed X-Ku band MMIC T/R switch for phased array TR module.
- Developed nonlinear models and extraction methodologies through 45 GHz for GaAs pHEMT transistors and monolithic PIN diodes.

PROFESSIONAL SERVICE

- Editor in Chief, *Wiley Encyclopedia of Microwave & RF Engineering, 2nd ed*. (2020).
- External Advisory Board, Texas A&M University Department of Electrical and Computer Engineering (2020).
- General Chair of Joint Navy – Air Force Workshop on Emerging Technologies in a Special Topic, Washington, DC (2019).
- Plenary Speaker at 70th IEEE National Aerospace Electronics Symp., Dayton, OH (2018).
- Tri-Service Radar Symposium: Technical Program Committee, Springfield, VA (2018).
- IEEE International Microwave Symposium: Steering Committee (2017), Technical Program Committee (2015), and Technical Paper Review Committee (2008-present). Recruited chairs and speakers for a special session on "Women in Defense" (2017). Organized a "Maritime Applications of Radar" special session (2017).
- Guest Editor in Chief, IEEE T-MTT Special Issue (Dec. 2015).

PROFESSIONAL SERVICE, CONT.

- Wiley Interscience: Editor responsible for "Microwave Theory and Techniques" Subject Area, *Wiley Encyclopedia of Electrical and Electronics Engineering* (2011-2019). Book proposal consultant (2005-2011).
- DoD Homeland Defense and Security Information Analysis Center: Subject Matter Expert for Millimeter Wave Technology (2018-present).
- Office of the Secretary of Defense, Advanced Electronics Committee (2015-present).
- Consultant to DARPA MTO (2015-2016).
- Doctoral committee member and Sandia mentor for N.J. Kinzie, University of Colorado (2010).
- Doctoral committee member for L.M. Feldner, Univ. of New Mexico (2006).
- IEEE Antennas and Propagation Symposium: Technical Program Committee (2006).
- Editorial Board for IEEE T-MTT, T-AP, T-AES, T-EC (2004-present).

EDUCATION

Texas A&M University, College Station, TX (9/1995-8/2004)

Ph.D. in Electrical Engineering	8/2004	GPA 4.00 / 4.00
M.S. in Electrical Engineering	5/2001	GPA 3.88 / 4.00
B.S. in Electrical Engineering,	5/1999	GPA 4.00 / 4.00

Received the B.S. *summa cum laude*, **first in a class of 3323 engineering students.**

Scholastic Honors

- Two-time recipient of the NASA Texas Space Grant Graduate Fellowship (2002, 2003).
- Fellowship from the State of Texas "to advance the state of the art in telecommunications" (2002).
- Texas Telecommunications Engineering Consortium Graduate Scholarship (2001).
- Texas A&M University Graduate Merit Fellowship (1999).
- Engineering Scholars' Program Honors (1999).
- National Dean's List (1998) and National Collegiate Engineering Award (1999).
- National Merit Scholarship (1995-1999).
- Texas A&M President's Endowed Scholarship (1995-1999).
- Dow Aggies Scholarship (1997) and Joe Blackwood Scholarship (1998).
- West St. Paul Commercial Club Scholarship (1995).
- 3M Student Science Award (1995).

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[4] **C.T. Rodenbeck**, P.I. Jaffe, B.H. Strassner II, P.E. Hausgen, J.O. McSpadden, H. Kazemi, N. Shinohara, B.B. Tierney, C.B. DePuma, and A.P. Self., "Microwave and millimeter-wave power beaming," invited paper in *IEEE J. Microwaves*, vol. 1, no. 1, pp. 229-260, Jan. 2021.

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[6] **C.T. Rodenbeck** and J.B. Beun, "Identifying the operation of a parked car's engine, transmission, and door using millimetre wave pulse Doppler radar," *IET Electronics Lett.*, vol. 56, no. 18, , pp. 959–961, Sept. 2020.

[7] **C.T. Rodenbeck**, J.B. Beun, R.D. Lipps, and R.G. Raj, "Vibrometry and sound reproduction of acoustic sources on moving platforms using millimeter wave pulse-Doppler radar," *IEEE Access*, pp. 27676-27686, Feb. 2020.

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[11] B.G. Danly, **C.T. Rodenbeck**, and T. Pizzillo, "Active millimeter-wave arrays," *NATO Tech Watch*, 2017.

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[34] C. Wang, **C.T. Rodenbeck**, M.R. Coutant, and K. Chang, "A four-channel full-duplex T/R module for multi-frequency phased array applications," *Microw. J.*, Vol. 48, No. 4, April 2005, pp. 94-106.

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[37] **C.T. Rodenbeck**, J. Aubin, and K. Chang, "Automated pattern measurement for circular-polarized antennas using the phase-amplitude method," *Microw. J.*, Vol., 47, No. 7, July 2004, pp. 68-78.

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[45] **C.T. Rodenbeck**, J.B. Beun, T.L. Ainsworth, and P. Langlois, "Compact polarimetric monopulse aperture antenna," US Patent Application US16/697266, Navy Case Number 109198.

[46] **C.T. Rodenbeck**, "Adaptive signal suppression using a software defined feedforward waveform," US Patent US11329689B1, May 2022.

[47] B. Tierney, **C.T. Rodenbeck**, and D.F. Crouse, "Millimeter-wave radar for unmanned aerial vehicle swarming, tracking, and collision avoidance," US Patent Application 20200284901A1, Navy Case Number 106334.

[48] **C.T. Rodenbeck,** J. Silva-Martinez, and A. Karsilayan, "Blocker resilient broadband wireless transceivers with multi-user collision tolerance based on mixed mode correlation," US Patent US10985797, April 2021.

[49] R. Raj and **C.T. Rodenbeck**, "Millimeter-wave airborne radar for 3-dimensional imaging of moving and stationary targets," US Patent 11029403, June 2019.

[50] **C.T. Rodenbeck**, T.J. Pizzillo, and T.B. Apker, "Autonomous airborne vehicle controlled by millimeter wave airborne radar," US Patent Application 20180174472, June 2018.

[51] **C.T. Rodenbeck**, T.J. Pizzillo, and T.B. Apker, "Autonomous airborne vehicle controlled by millimeter wave airborne radar," Worldwide Patent Application WO2018112404, June 2018.

[52] T.B. Apker and **C.T. Rodenbeck**, "Millimeter-wave terrain aided navigation system," US Patent Application 20180172821, June 2018.

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[55] **C.T. Rodenbeck**, J. Mincey, and J. Silva-Martinez, "Variable bandwidth filter," US Patent 10267896, April 2019.

[56] C.M. Washburn, T.N. Lambert, D.R. Wheeler, **C.T. Rodenbeck**, and T.A. Railkar, "Graphene heat dissipating structure," US Patent 10096536, Oct. 2018.

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[59] **C.T. Rodenbeck**, J. Silva-Martinez, A.I. Karsilayan, and J. Mincey, "Coherent radar receiver that comprises a sigma delta modulator," US Patent 10020968, Mar. 2015.

[60] **C.T. Rodenbeck**, D. Young, T. Chou, L.H. Hsieh, K. Conover, and R. Heintzleman, "Combined radar and telemetry system," US Patent 9720080, Aug. 2017.

[61] **C.T. Rodenbeck** and K.A. Peterson, "Electromagnetic isolation structure," US Patent 10026701, Jul. 2018.

[62] **C.T. Rodenbeck** and M. Girardi, "Protecting integrated circuits from excessive charge accumulation during plasma cleaning of multichip modules," US Patent 9013046, April 2015.

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[69] E. Kwiatkowski, **C.T. Rodenbeck**, T. Barton and Z. Popović, "Power-combined rectenna array for X-band wireless power transfer," *IEEE Int. Microw. Symp*, Aug. 2020, pp. 992-995.

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