

Commercializing THz Imaging through the SiGe Revolution in Germany

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Abstract:

In 2024, a visionary entrepreneur was the catalyst for bringing together a small group of very experienced terahertz technologists to develop and field a commercial non-portal-based THz radar imaging system for the particular purpose of revealing hidden weapons routinely carried into kindergarten through 12th grade schools in the United States. During the first twelve months of the development effort, a prototype heterodyne instrument was assembled from traditional millimeter waveguide technology – high performance RF multipliers and heterodyne mixers. Although the imaging methodology and efficacy was adequate, it was apparent that there were substantial hurdles – both financial, as well as technical – that precluded such an approach from realizing the envisioned application in a crowded and uncontrolled open space. Fortunately, the silicon germanium integrated circuit community had already advanced to the stage of having demonstrated both sufficient output power generation and full heterodyne transceiver functionality above 300 GHz. In particular, both IHP and Infineon in Germany, were at the leading edge of this revolution in high performance ultra-high frequency devices, with particular emphasis and expertise on advanced radar circuitry that stemmed from lower frequency millimeter-wave automotive applications.

The pivot into a fully integrated multi-pixel imaging array, based on SiGe output circuits integrated with high-throughput CMOS analog-to-digital conversion and AI-based digital image processing, began in year two through the unique academic-industrial model represented by the Fraunhofer Institutes in Germany, and in particular the Leibniz Institute for High Performance Microelectronics (IHP) in Frankfurt. Through a partnership that included SiGe and CMOS experts both in the US and Germany, a state-of-the-art SiGe circuit design was merged with a novel THz instrument optical concept, and a fully commercializable platform is now being realized.

In this talk, the speaker will discuss the demonstration instrument, with its performance and limitations, and the push for the ultimately much more cost-effective SiGe-based system. As far as he is able, the speaker will show imagery and compare capabilities of the two instruments and discuss trade-offs for each approach. Also of philosophic interest to the speaker, is the unique path to commercialization provided by the small start-up company model and the challenges of engaging and retaining traditional academic researchers in this endeavor. In the United States, there is a particular regard for the

entrepreneurial risk and the potential rewards offered by this model, and recent political consequences that have attacked and significantly reduced government funding for academic institutions and science have only increased engagement. The speaker will sprinkle the talk with his own views on this topic and hopes to highlight some of the positive and negative aspects of the current trend.

Bio:

PETER H. SIEGEL received the B.A. degree in astronomy from Colgate University, in 1976, the M.S. degree in physics from Columbia University, in 1978, and the Ph.D. degree in electrical engineering (EE) from Columbia University, in 1983. He held appointments as a Research Fellow and Engineering Staff at the NASA Goddard Institute for Space Studies, New York City, NY, USA, from 1975 to 1983, a Staff Scientist at the National Radio Astronomy Observatory, Central Development Labs, Charlottesville, Virginia, USA, from 1984 to 1986, a Technical Group Supervisor and a Senior Research Scientist at the Jet Propulsion Laboratory (JPL), National Aeronautics and Space Administration (NASA), Pasadena, California, USA, from 1987 to 2014, and a Faculty Associate in electrical engineering and a Senior Scientist in biology at the California Institute of Technology (Caltech), Pasadena, California, USA, from 2002 to 2014. He is currently CEO of THz Global, a small consulting company, and a founding member of Cover AI, a start-up company that began in 2024 to develop and commercialize a THz FMCW radar imaging system to tackle the problem of covertly screening for weapons being routinely carried into US K-12 school systems. Dr. Siegel has been involved in THz technology and development for over 50 years. He has served as an IEEE Distinguished Lecturer, and the Vice-Chair and Chair of the IEEE MTTTS THz Technology Committee, and has been the founding Editor-in-Chief of two extremely successful technical journals: IEEE Transactions on Terahertz Science and Technology from 2010-2014 and most recently, IEEE Journal of Microwaves which, in 2024, received the highest impact factor ever for any journal in the MTT suite of more than 10 publications over the last 75 years. Dr. Siegel is also the founder, in 2008, and first elected chair of the International Society of Infrared, Millimeter, and Terahertz Waves, the world's largest and longest running conference series on high-frequency science and technology, and has served as its annually elected general secretary and treasurer since 2011.