



NASA SBIR 2019 Phase I Solicitation

S1.03 Technologies for Passive Microwave Remote Sensing

Lead Center: GSFC

Participating Center(s): JPL

Technology Area: TA15 Aeronautics

NASA employs passive microwave and millimeter-wave instruments for a wide range of remote sensing applications from measurements of the Earth's surface and atmosphere to cosmic background emission. Proposals are sought for the development of innovative technology to support future science and exploration missions MHz to THz sensors. Technology innovations should either enhance measurement capabilities (e.g., improve spatial, temporal, or spectral resolution, or improve calibration accuracy) or ease implementation in spaceborne missions (e.g., reduce size, weight, or power, improve reliability, or lower cost). Specific technology innovations of interest are listed below, however other concepts will be entertained.

Ultra-Compact Radiometer

An ultra-compact radiometer of either a switching or pseudo-correlation architecture with internal calibration sources is needed. Designs with operating frequencies at the conventional passive microwave bands of 36.6 GHz (priority), 18.65 GHz, and 23.8 GHz enabling dual-polarization inputs. Interfaces include waveguide input, control, and digital data output. Ideal design features enable subsystems of multiple (10's of) integrated units to be efficiently realized.

This technology, in conjunction with deployable antenna technology, would enable traditional Earth land and ocean radiometry with significantly reduced instrument size, making it suitable for CubeSat or SmallSat platforms.

The expected Technology Readiness Level (TRL) range at completion of the project is 4-5.

Compact, scalable, 3D routing of LO, IF and DC signals for focal plane arrays at room and cryogenic temperatures

Compact, scalable, 3D routing of LO, IF and DC signals for focal plane arrays at room and cryogenic temperatures. A single routing block should perform the following functions: Accept 32 IF inputs, 16 LO inputs and 160 DC inputs, on one side of the routing block. Input interfaces to IF, LO and DC should facilitate blind-mating (e.g., push-on connectors). At the output, all IF signals should be concentrated into no more than 4 connectors (using e.g., multi-core coaxial connectors). The 16 LO input connections should be internally combined into a single connector at the output. All DC signals should be concentrated into no more than 4 connectors at the output. All output signals connectors should be on the opposite side of the routing block to the inputs. The LO should be able to route signals up to 60 GHz and the IF up to 12 GHz with max. 8dB loss at LO and package of 4"x 4"x 4". This routing block should be scalable by forming close-packing arrays of such blocks to arbitrary sizes.

The expected Technology Readiness Level (TRL) range at completion of the project is 2-4.

Photonic Integrated Circuits for Microwave Remote Sensing Systems

Photonic Integrated Circuits are an emerging technology for passive microwave remote sensing. NASA is looking for photonic integrated circuits for utilization in processing microwave signals in spectrometers, beam forming arrays, correlation arrays and other active or passive microwave instruments. Small businesses are encouraged to identify, propose, and utilize designs where PIC technology would be most beneficial for a microwave remote sensing instrument subsystem.

PICs may enable significantly increased bandwidth of Earth viewing, astrophysics, and planetary science missions. In particular, this may allow for increased bandwidth or resolution receivers, with applications such as hyperspectral radiometry.

The expected Technology Readiness Level (TRL) range at completion of the project is 3-5.

Low power RFI mitigating receiver back ends for broad band microwave radiometers

NASA requires a low power, low mass, low volume, and low data rate RFI mitigating receiver back-end that can be incorporated into existing and future radiometer designs. The system should be able to channelize up to 1 GHz with 16 sub bands and be able to identify RFI contamination using tools such as kurtosis.

The expected Technology Readiness Level (TRL) range at completion of the project is 3-5.

Miniature W-band Diplexer

As NASA seeks to develop broadband and array microwave radiometer technology, there is a need for miniaturized diplexers to separate W-band signals from Ka-band and lower frequency signals. Specifically, a diplexer unit that separates and passes the frequency bands allocated to and traditionally used for passive sensing is needed. A successful design has features enabling integration into subsystems including other supporting elements such as broadband antenna array elements and MMIC LNA's.

The expected Technology Readiness Level (TRL) range at completion of the project is 4-5.

Low power, compact lasers for THz time domain and frequency domain spectroscopy

NASA is developing a compact broadband THz spectrometer based on asynchronous optical sampling time domain spectroscopy (TDS). Erbium femtosecond lasers with low volume, low mass and low power are required. The lasers are to use 1550 nm erbium technology with pulse width < 100 fs and repetition rate of 80-100 MHz. The lasers should operate with single mode-lock state, high stability and low amplitude and phase noise. The fiber coupled output power should be > 100 mW.

The expected Technology Readiness Level (TRL) range at completion of the project is 2-3.

References:

- J. T. Good, , D. B. Holland, , I. A. Finneran, P. B. Carroll, M. J. Kelley, and G. A. Blake, "A decade-spanning high-resolution asynchronous optical sampling terahertz time domain and frequency comb spectrometer", *Review of Scientific Instruments* 86, 103107 (2015).
- T. Yasui, E. Saneyoshi, and T. Araki, "Asynchronous optical sampling terahertz time domain spectroscopy for ultrahigh spectral resolution and rapid data acquisition," *Appl. Phys. Lett.* 87(6), 061101 (2005).
- T. Yasui, M. Nose, A. Ihara, K. Kawamoto, S. Yokoyama, H. Inaba, K. Minoshima, and T. Araki, "Fiber-based, hybrid terahertz spectrometer using dual fiber combs," *Opt. Lett.* 35(10), 1689–1691 (2010).