



NASA SBIR 2018 Phase I Solicitation

S1.04 Sensor and Detector Technology for Visible, IR, Far IR and Submillimeter

Lead Center: JPL

Participating Center(s): ARC, GSFC, LaRC

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

NASA is seeking new technologies or improvements to existing technologies to meet the detector needs of future missions, as described in the most recent decadal surveys:

- Earth science - (<http://www.nap.edu/catalog/11820.html>).
- Planetary science - (<http://www.nap.edu/catalog/10432.html>).
- Astronomy and astrophysics - (<http://www.nap.edu/books/0309070317/html/>).

In pixel digital readout integrated circuit (DROIC) for high dynamic range infrared focal plane arrays to circumvent the limitations in charge well capacity, by using in-pixel digital counters that can provide orders of magnitude larger effective well depth, thereby affording longer integration times. Longer integration times provide improved signal-to-noise ratio and/or higher operating temperature, which reduces cooler capacity, resulting in savings in size, weight, power and cost.

Compact, low power, ASICs for readout of Kinetic Inductance Detector arrays **each with a low operating power and capable of operation at both room temperature and cryogenic temperatures to perform one of the following functions.**

- 8192 point FFT processor with 5 bits of depth using a polyphase oversampling or a Hanning window. Input format would be SERDES (2-4Gsamples/sec) and output format USB2.0 or similar and Power $\leq 2W$.
- >10 bit ADC at >1 GHz sampling rate with >2000 bands, ~ 5 kHz bandwidth, power $< 0.3W$.

Two-dimensional row and column, cryogenic, multiplexing readout system for hybridization to two dimensional Far IR and Submillimeter bolometer arrays. Of particular interest are SQUID based systems with a first stage operating at sub-Kelvin temperatures and compatible with 32X40 detector array format.

New or improved technologies leading to measurement of trace atmospheric species (e.g., CO, CH₄, N₂O) or broadband energy balance in the IR and far-IR from geostationary and low-Earth orbital platforms. Of particular interest are new direct detectors or heterodyne detectors technologies made using high temperature superconducting films (YBCO, MgB₂) or engineered semiconductor materials, especially 2Dimensional Electron Gas (2DEG) and Quantum Wells (QW). Candidate missions are thermal imaging, LANDSAT Thermal InfraRed Sensor (TIRS), Climate Absolute Radiance and Refractivity Observatory (CLARREO), BOREal Ecosystem Atmosphere Study (BOREAS), Methane Trace Gas Sounder or other infrared earth observing missions.

Development of a robust wafer-level integration technology that will allow high-frequency capable interconnects and allow two dis-similar substrates (i.e., Silicon and GaAs) to be aligned and mechanically 'welded' together.
• Specially develop ball grid and/or Through Silicon Via (TSV) technology that can support submillimeter-wave arrays. Initially the technology can be demonstrated at 1-inch die level but should be do-able at 4-inch wafer level.

Single photon avalanche diode or silicon photomultiplier photon-counting detector technology for high-speed, non-imaging lidar applications. Detector(s) (single or array) to provide $\approx 10^{10}$ ph/s linear counting dynamic range, $< 5 \times 10^5$ dark count rate at non-cryogenic temperatures, $> 30\%$ detection efficiency at 532 nm.

Space qualify a commercial 2k x 2k polarization camera for a solar coronagraph for low Earth orbit and Earth-Sun lagrange point environments.

Higher power THz local oscillators and backend electronics for high resolution spectroscopy for astrophysics. Local Oscillator capable of spectral coverage 2-5 THz; Output power up to > 2 mW; Frequency agility with > 1 GHz near chosen THz frequency; Continuous phase-locking ability over the THz laser tunable range with < 100 kHz line width. Backend ASIC capable of binning > 1 GHz intermediate frequency bandwidth into 0.1-0.5 MHz channels with low power dissipation < 0.5 W.

Development of an un-cooled broadband photon detector with average QE $> 50\%$ over the spectral range from 3 μ m to 50 μ m. The Detectivity D^* must be greater than 5×10^9 . The detector may have electrically tunable spectral range.