NASA SBIR 2012 Phase I Solicitation

S1.03  Sensor and Detector Technology for Visible, IR, Far IR and Submillimeter

Lead Center: JPL

Participating Center(s): ARC, GSFC, KSC, LaRC

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 for Earth science (http://www.nap.edu/catalog/11820.html), planetary science (http://www.nap.edu/catalog/10432.html), and astronomy and astrophysics (http://www.nap.edu/books/0309070317/html/).

The following technologies are of interest for the Scanning Microwave Limb Sounder (http://mls.jpl.nasa.gov/index-cameo.php) on the Global Atmospheric Composition Mission and the SOFIA (Stratospheric Observatory for Infrared Astronomy) airborne observatory:

- Radiation tolerant digital polyphase filterbank back ends for sideband separating microwave spectrometers. Requirements are >5GHz instantaneous bandwidth per sideband, 2 MHz resolution, low power
- Improved submillimeter mixers for frequencies >2 THz are needed for heterodyne receivers to fly on SOFIA. Minimum noise temperatures for cryogenic operation and instantaneous bandwidths >5 GHz are key parameters.
- Efficient, flight qualifiable, spur free, local oscillators for SIS mixers operating in low earth orbit. Two bands:
  - Tunable from 200 to 250 GHz.
  - Tunable from 610 to 650 GHz, phase-locked to or derived from an ultra-stable 5 MHz reference.
- Quantum cascade laser-based local oscillators >2THz for astrophysics applications

Thermal imaging, LANDSAT Thermal InfraRed Sensor (TIRS), Climate Absolute Radiance and Refractivity Observatory (CLARREO), BOREal Ecosystem Atmosphere Study (BOREAS), other infrared earth observing missions, Trojan Tour, Europa Jupiter System Mission (EJSM) such as a descoped Jupiter Europa Orbiter (JEO), Io Observer, or Jupiter Io Callisto Europa (JuICE) missions (see the Jupiter Europa Orbiter Mission Study 2008: Final Report, (http://opfm.jpl.nasa.gov/library/) and future planetary missions:

- Development of un-cooled or cooled Infrared detectors (hybridized or designed to be hybridized to an appropriate read-out integrated circuit) with NET30% and dark currents 2 in the 5-14 µm infrared wavelength region. Array formats may be variable, 640 x 512 typical, with a goal to meet or exceed 2k X 2k pixel arrays. Evolve new technologies such as InAs/GaSb type-II strain layer super-lattices to meet these
specifications.

- 2-D arrays of thermopile detectors (wavelength range 20-100 \( \mu \text{m} \); Detectivity = \( 4 \times 10^9 \); operating temp 100-200 K).

1kx1k MCT detector arrays with cutoff wavelength extended to =12 \( \mu \text{m} \) for use in missions to NEOs, comets and the outer planets.

New or improved technologies leading to measurement of trace atmospheric species (e.g., CO, CH\(_4\), N\(_2\)O) from geostationary and low-Earth orbital platforms; see Methane Trace Gas Sounder. Of particular interest are new techniques in gas filter correlation spectroscopy, Fabry-Perot spectroscopy, or improved component technologies. Technologies are needed for active and passive wave front and amplitude control, and relevant missions include Extra solar Planetary Imaging Coronagraph (EPIC), and other coronagraphic missions such as Terrestrial Planet Finder (http://exep.jpl.nasa.gov/TPF-C/tpf-C_index.cfm) and Stellar Imager (http://hires.gsfc.nasa.gov/si):

- MEMS based segmented deformable mirrors consisting of arrays of up to 1200 hexagonal packed segments with strokes over the range of 0 to 1.0 microns, quantized with 16-bit electronics with segment level stabilities of 0.015 nm rms (1-bit) over 1 hour intervals. Segments should be flat to 2 nm rms or better and the substrate flat to 125 nm or better and high uniformity of coatings (1% rms).
- Technologies for high contrast integral field spectroscopy, in particular for microlens arrays with or without accompanying mask arrays, working in the visible and NIR (0.4 - 1.8 microns), with lenslet separations in the 0.2 - 0.5 mm range, with contrast between neighboring spectra of \( \sim 10^{-4} \), and uniform focal lengths to
- Spatial Filter Array (SFA) consisting of a monolithic array of up to 1200 coherent, polarization preserving, single mode fibers, or custom waveguides, that operate with minimal coupling losses over a large fraction of the spectral range from 0.4 - 1.0 microns. The SFA should have input and output lenslet with each pair mapped to a single fiber or waveguide and such that the lenslets maintain path length uniformity to

Blazed, holographic optical gratings on convex surfaces: The Offner spectrometer design uses a symmetric optical layout to balance aberrations, producing good imaging performance and spectral images with little or no distortion. Both of these attributes improve the measurement capability of the spectrometer by eliminating the spatial-spectral information mixing that other spectrometer forms typically produce. The key element in an Offner spectrometer is the convex spherical grating that is used to disperse the light spectrally. While such gratings can be made holographically, these gratings suffer from low efficiency due to their lack of signal-enhancing blazed groove structure. Development is needed for production of holographically-generated convex gratings that have a continuously-varying blaze angle to provide high efficiency diffraction into a chosen wavelength range and diffraction order (415 nm to 695 nm in first order and 290 nm to 390 nm in the second order). Such gratings also should have less scattered light than similar mechanically-ruled gratings, improving spectrometer performance.