NASA SBIR 2014 Phase I Solicitation

H9.02 Long Range Optical Telecommunications

Lead Center: JPL

Participating Center(s): GRC, GSFC

This subtopic seeks innovative technologies for long range Interplanetary Optical Telecommunications supporting the needs of space missions where robotic explorers will visit distant bodies within the solar system and beyond. Our goals are increased data-rate capability in both directions, in conjunction with significant reductions of mass, power-consumption, and volume at the spacecraft. Proposals are sought in the following areas:

Systems and technologies relating to acquisition, tracking and sub-micro-radian pointing of the optical communications beam under typical deep-space ranges and spacecraft micro-vibration environment (TRL3 Phase I, and TRL4 Phase II).

- *Vibration Isolation and Rejection Platforms and Related Technologies* - Compact, lightweight, space qualifiable vibration isolation and rejection platforms for payloads with a mass between 3 and 20 kg that require less than 5 W of power and have a mass less than 3 kg that will attenuate an integrated spacecraft micro-vibration angular disturbance of 150 micro-radians to less than 0.5 micro-radians (1-sigma), from < 0.1 Hz to ~500 Hz (TRL3 Phase I, and TRL4 Phase II).Also, innovative low-noise, low mass, low power, DC-kHz inertial, angular, position, or rate sensors. Compact, ultra-low-power, low-mass, kHz bandwidth, tip-tilt mechanisms with sub-micro-radian pointing accuracies, angular ranges of ±5 mrad and supporting up to 50 gram payloads.
- *Laser Transmitters* - Space-qualifiable, >25% DC-to-optical (wall-plug) efficiency, 0.2 to 16ns pulse width 1550-nm laser transmitter for pulse-position modulated (PPM) data with random pulses at duty cycles of 0.3% to 6.25%, <35ps pulse rise and fall times and jitter, <25% pulse-to pulse energy variation (at a given pulse width) near transform limited spectral width, single polarization output with at least 20 dB polarization extinction ratio, amplitude extinction ratio greater than 45dB, average power of 5 to 20W, massing less than 500 g/W. Laser transmitter to feature slot-serial PPM data input at CML or AC-coupled PCEL levels and an RS-422 or USB control port. All power consumed by control electronics will be considered as part of DC-to-optical efficiency. Also of interest for the laser transmitter is robust and compact packaging with >100krad radiation tolerant electronics inherent in the design. Detailed description of approaches to achieve the stated efficiency is a must (TRL3 Phase I, TRL4 Phase II).
- *Photon Counting Near-infrared Detectors Arrays for Ground Receivers* - Readout electronics and close packed (not lens-coupled) kilo-pixel arrays sensitive to 1520 to 1650 nm wavelength range with single photon detection efficiencies greater than 90%. Single photon detection jitters less than 40 picoseconds 1-sigma, active diameter greater than 500 microns, 1 dB saturation rates of at least 10 mega-photons (detected) per pixel, false count rates of less than 1 MHz/square-mm, all at an operational temperature > 1.2K.
- *Photon Counting Near-infrared Detectors Arrays for Flight Receivers* - 64x64 or larger array with integrated read-out integrated circuit for the 1030 to 1080 nm or 1520 to 1650 nm wavelength range with single photon detection efficiencies greater than 40% and 1dB saturation loss rates of at least 2 mega-photons/pixel and

operational temperatures above 220K and dark count rates of <10 MHz/mm. Radiation doses of at least 5 Krad (unshielded) shall result in less than 10% drop in single photon detection efficiency and less than 2X increase in dark count rate.

- *Ground-based Telescope Assembly* - Ground station telescope/photon-bucket technologies for developing effective aperture diameter of e10 meter at modest cost. Operations wavelength is monochromatic at a wavelength in the range of 1000-1600nm. Key requirements: a maximum image spot size of <20 micro-radian; capable of operation while pointing to within 5° of the Sun; and field-of-view of >50 micro-radian. Telescope shall be positioned with a two-axis gimbal capable of <50 micro-radian pointing accuracy, with dynamic error <10 micro-radian RMS while tracking after tip-tilt correction.

Research should be conducted to convincingly prove technical feasibility (proof-of-concept) during Phase I ideally through hardware development, with clear pathways to demonstrating and delivering functional hardware, meeting all objectives and specifications, in Phase II.

References:

- (http://trs-new.jpl.nasa.gov/dspace/bitstream/2014/42091/1/11-1338.pdf)
- (http://ipnpr.jpl.nasa.gov/progress_report/42-183/183A.pdf)
- (http://ipnpr.jpl.nasa.gov/progress_report/42-185/185D.pdf)
- (http://ipnpr.jpl.nasa.gov/progress_report/42-182/182C.pdf)