NASA SBIR 2008 Phase I Solicitation

O1.06 Long Range Optical Telecommunications

Lead Center: JPL

Participating Center(s): ARC, GRC, GSFC

This subtopic seeks innovative technologies for long range Optical Telecommunications supporting the needs of space missions. Proposals are sought in the following areas:

- Systems and technologies relating to acquisition, tracking and sub-microradian pointing of the optical communications beam under typical deep-space ranges (to 40 AU) and spacecraft micro-vibration environments.
- Small lightweight (< 1-Kg), 2-axis gimbals with < 30-Î¼rad rms error and blind-pointing accuracy of < 35-Î¼rad. Must be able to actuate payload mass of approximately 6-Kg at rates up to 5-deg/sec. Assume that the payload is shaped as an 8-cm diameter cylinder, 30-cm long, with uniformly distributed mass. Proposals should come up with innovative pragmatic designs that can be flown in space.
- Light-weighted afocal optical telescopes with diameters varying from 10-50-cm diameter with an average areal density of < 45 Kg/m2 (Areal density is average over large and small optics used to gather and focus light on to sensors/detectors). The telescopes should be capable of operating in the near-infrared spectral range (1.0 â€“ 1.6 micrometers) with less than a tenth wave root-sum squared wavefront error.
- Uncooled photon counting imagers with >1024 x 1024 formats, ultra low dark count rates and 400 - 2000 nm sensitivity.
- Ultra-low (<0.1%) fixed pattern non-uniformity NIR imagers with large format (1024 x 1024), low noise (<1 e- read, <1ke/pix/sec dark) and high QE (>0.7).
- Nutating fiber pointing mechanisms with high precision (<0.01 urad) and high bandwidth (> 3 kHz).
- Compact, lightweight, low power, broad bandwidth (0 - 3 kHz) disturbance rejection and/or isolation platforms.
- Space-qualifiable, > 20% wall plug efficiency, lightweight, 20-500 psec pulse-width (10 to > 100 MHz PRF), tunable (Â± 0.1 nm) pulsed 1064-nm or 1550-nm laser transmitter fiber MOPA sources with >1 kW of peak power per pulse (over the entire pulse-repetition rate), with Stimulated Brillouin Scattering (SBS) suppression and > 10 W of average power, near transform limited spectral width, and <10 psec pulse rise and fall times. Also of interest for the laser transmitter are: robust and compact packaging with radiation tolerant electronics inherent in the design, and high speed electrical interface to support output of pulse position modulation encoding of sub nanosecond pulses and inputs such as Spacewire, Firewire or Gigabit Ethernet.Description of approaches to achieve the stated efficiency is a must.
- > 2-m diameter, <30-nm bandpass optical filters on a membrane substrate to pass center. Wavelengths in the 1000 to 1600 nm band with >90% transmission.
- > 2-m diameter f/1.1 primary mirror and Cassegrain focus of ~f/6 optical communication receiver telescopes. Maximum RMS surface figure error of 1-wave at 1000 nm wavelength. Telescope is positioned with a 2-axis gimbal capable of 0.25 mrad pointing. Combined telescope and gimbal shall be manufacturable in quantity (tens) for <$400k each.

- Daytime atmospheric compensation techniques capable of removing all significant atmospheric turbulence distortions (tilt and higher-order components) on an uplink laser beam; and/or for a 2-m diameter downlink receiver telescope. Also of interest are technologies to compensate for the static and dynamic (gravity sag and thermal) aberrations of 2-m diameter telescopes with a surface figure of 10â€™s of waves.
- Ground-based, relatively low-cost diode-pumped laser technology capable of reaching 100 kW average power levels in a TEM00 mode, for uplink to spacecraft.
- Photon counting Si, InGaAs, and HgCdTe detectors and arrays for the 1000 to 1600 nm wavelength range with single photon detection efficiencies > 60% and output jitters less than 20 psec, active areas > 20 microns/pixel, and 1 dB saturation rates of at least 100 megaphotons (detected) per pixel and dark count rates of < 1 MHz / mm^2.
- Radiation hard (100 Mrad level) photon counting detectors and arrays for the 1000 to 1600 nm wavelength range with single photon detection efficiencies > 40% and 1 dB saturation rates of at least 30 megaphotons/pixel and operational temperatures above 220 K and dark count rates of < 10 MHz / mm.
- Single-photon-sensitive, high-bandwidth (1 GHz), linear mode, high gain (> 1000), low-noise (< 1 kcps), large diameter (200 micron), HgCdTe avalanche photodiode and/or (small diameter) arrays for optical detection at 1060 nm or 1550 nm.

Research should be conducted to convincingly prove technical feasibility during Phase 1, with clear pathways to demonstrating and delivering functional hardware, meeting all objectives and specifications, in Phase 2.

The proposer to this subtopic is advised that the products proposed may be included in a future small satellite flight opportunity. Please see the SMD Topic S4 on Small Satellites for details regarding those opportunities. If the proposer would like to have their proposal considered for flight in the small satellite program, the proposal should state such and recommend a pathway for that possibility.