NASA SBIR 2011 Phase I Solicitation

S1.01 Lidar and Laser System Components

Lead Center: LaRC

Participating Center(s): GSFC, JPL

Accurate measurements of atmospheric parameters with high spatial resolution from ground, airborne, and space-based platforms require advances in the state-of-the-art lidar technology with emphasis on compactness, efficiency, reliability, lifetime, and high performance. Innovative lidar component technologies that directly address the measurements of the atmosphere and surface topography of the Earth, Mars, the Moon, and other planetary bodies will be considered under this subtopic. Frequency-stabilized lasers for a number of lidar applications such as CO_2 concentration measurements as well as for highly accurate measurements of the distance between spacecraft for gravitational wave astronomy and gravitational field planetary science are among technologies of interest. Single longitudinal mode lasers and optical filter technologies for high spectral resolution lidars are also of interest. Proposals relevant to the development of components that can be used in planned missions or current technology programs are highly encouraged. Examples of planned missions and technology programs are: Laser Interferometer Space Antenna (LISA), Doppler Wind Lidar, Lidar for Surface Topography (LIST), Active Sensing of CO_2 Emissions over Nights, Days, and Seasons (ASCENDS), and Aerosols-Clouds-Ecosystems (ACE). In addition, innovative technologies relevant to the NASA sub-orbital programs, such as Unmanned Aircraft Systems (UAS) and Venture-class focusing on the studies of the Earth climate, carbon cycle, weather, and atmospheric composition, are being sought.

Research should be conducted to demonstrate technical feasibility during Phase I and show a path toward a Phase II prototype demonstration. For the PY11 SBIR Program, we are soliciting only the specific component technologies described below:

- Highly efficient solid state laser transmitter operating in the 1.0 Âµm - 1.7 Âµm range with wall-plug efficiency of greater than 25%. Â The proposed laser must show path in maturing to space applications. The laser transmitter must be capable of single frequency with narrow spectral width capable of generating transform-limited pulses, and M2 beam quality 70% are of interest. Although amplifiers such as planar waveguide or grazing incidence have been shown to generate optical efficiencies >50%, much higher efficiency is needed for space applications. Â Proposed solutions should incorporate electronics packages suitable for use in aircraft demonstration (i.e., small, well packaged, low power).
- Narrow linewidth laser transmitters and receiver components (seeds, fiber amplifiers, modulators, drivers, etc.) supporting laser absorption spectroscopy applications in the 1.3, 1.5 and 2.0 micron wavelength

regimes. The lasers and components should be tunable by several nm, support amplitude modulation at frequencies from 50 KHz to 10 MHz, have frequency stability of less than 3 MHz, and be capable of mixing and simultaneous transmission of multiple lines for differential absorption measurements without introducing non-linear mixing effects. Techniques for cloud and aerosol discrimination are also sought.

- Efficient and compact single mode solid state or fiber lasers operating at 1.5 and 2.0 micron wavelength regimes suitable for direct detection differential absorption lidar (DIAL) and coherent lidar applications. These lasers must meet the following general requirements: pulse energy 0.5 mJ to 50 mJ, repetition rate 10 Hz to 10 kHz, and pulse duration of either 10 nsec or 200 nsec regimes.

- Low noise detectors operating in 1.5 to 2.0 micron wavelength for use in differential absorption lidar (DIAL) instruments measuring CO_2 concentration. Large area (>250 micron dia.) detectors with high quantum efficiency (>75%), noise equivalent power of less than 2x 10-14 W/Hz1/2, and bandwidth greater than 50 MHZ are being sought. Additionally, arrays of 4x4 PIN detectors for coherent detection and avalanche photodiodes with a minimum gain of 10 are of interest. Other detectors relevant to NASA programs are low-noise, high quantum efficiency devices operating at 355 nm, 532 nm, and 1064 nm with gain greater than or equal to 100. These detectors must be linear or correctable for incident power levels ranging from 0.1 pW to 50 nW and have bandwidths exceeding 200 MHz with excellent transient recovery.

- Novel compact solid-state UV laser for Ozone DIAL measurements from surface and airborne UAS science platforms that also enables technology demonstrations for future spaceborne measurements are needed. New and novel technology developments that enable solid-state UV lasers operating within the 280 nm - 320 nm wavelength range (305-320 nm for the spaceborne lasers) generating laser pulses of up to 1 KHz rate and average output power greater than 1 Watt. Operation at two distinct wavelengths separated by 10 nm to 15 nm is required for the Ozone measurements. Scalability of the laser design to power levels greater than 10 W for space deployment is important.

- Novel scanning telescope capable of scanning over 360 degrees in azimuth with nadir angle fixed in the range of 30 to 45 degrees. Clear apertures scalable to 1 m, good optical performance (although diffraction limited performance is not necessary), and high optical efficiency are desired, as is ability to operate at multiple wavelengths from 1064 nm to 355 nm. Optical materials (e.g., substrates and coatings) and components should be space qualifiable. Phase II should result in a prototype unit capable of demonstration in a high-altitude aircraft environment, with aperture on the order 8 inches. Due to issues with spacecraft momentum compensation and previous investments, concepts for large articulating telescopes will not be considered responsive to this request, nor will holographic substrates.

- Flash Lidar Receiver for planetary landing application with at least 128X128 pixels capable of generating 3-dimensional images and detection of hazardous terrain features, such a as rocks, craters and steep slopes from at least 1 km distance. The receiver must include real-time image processing capability with 30 Hz frame rate. Embedded image enhancement and classification algorithms are highly desirable. Proposals for low noise Avalanche Photodiode (APD) arrays with 256x256 pixels format suitable for use in Flash Lidar receiver will be also considered. The detector array must operate in the 1.06 to 1.57 micron region and be able to detect laser pulses with 6 nsec in duration. The array needs to achieve greater than 90% fill factor with a pitch size of 50 to 100 microns with provisions for hybridization with an Integrated Readout Circuit (ROIC).

Proposals should show an understanding of one or more relevant science needs, and present a feasible plan to fully develop a technology and infuse it into a NASA program.