Technology Plan
for the
Coherent Subsystem of a
Space-Based Hybrid Doppler Wind Lidar

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Working Group on Space-Based Lidar Winds
The Hybrid DWL Approach

- Direct detection component will be optimized to provide wind observations in the cloud free mid and upper troposphere (potentially lower stratosphere also)
- Coherent detection component will be optimized for the lower troposphere and cloudy regions
- The cost and time (and risk) of technology development is reduced
Hybrid target: 0.5 J 12 Hz conductively cooled with lifetime of 5 years
Hybrid target: 0.5 m diameter telescope with rapid step/stare pointing (shared telescope with direct detection subsystem to be considered)
Coherent Doppler Lidar Tunable Local Oscillator Laser

Crystal Tunable LO Laser

Semiconductor Tunable LO Laser

Ground Lidar Validation

Airborne Lidar Validation

Space Lidar Demonstration

Space Operational Mission

Target: 25 mW, ±6 GHz tuning
< 10 kHz/ms drift

In Progress

Completed Item

Primary Path
Secondary Path

Progress Mark
Coherent Doppler Lidar Photon Efficiency Technology

Discrete Components

Integrated Balanced-Detectors Receiver

Ground Lidar Validation

Ground Lidar Validation

Airborne Lidar Validation

Space Lidar Demonstration

Space Operational Mission

Target: 12% lidar system (photon) efficiency
Coherent Doppler Lidar Autoalignment Technology

Alignment Controller & Mirror Actuator
Detection Array
Alignment Algorithm
Wavefront Sensor And Corrector
Ground Lidar Validation
Ground Lidar Validation
Airborne Lidar Validation
Space Lidar Demonstration
Space Operational Mission

Hybrid target: < 150 μrad alignment (where beam is 1 cm diameter)
Coherent Doppler Lidar Pointing Technology

Telescope-to-Optical Bench Alignment Sensor

Ground Lidar Validation

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INS/GPS

Surface Return Algorithm

Airborne Lidar Validation

Space Lidar Demonstration

Space Operational Mission

**Target:**

0.2 deg. pre-shot pointing knowledge;
50 μrad final pointing knowledge
Dual-Wavelength Telescope/Scanner

Optical Coatings → Beam Combining/Splitting → Coherent Sub-Aperture → Fabrication

Dual-Wavelength Scanner

Ground Lidar Validation

Airborne Lidar Validation

Space Lidar Demonstration

Space Operational Mission

Hybrid target: 0.8 m; 355 and 2051.8 nm

In Progress

Completed Item

Progress Mark
Conclusions

- The hybrid Doppler wind lidar may be the optimum solution to the difficult global wind measurement opportunity
- The technology roadmap to a hybrid DWL is consistent and almost identical to the former “go it alone” technology paths
- There is much studying to do regarding shared technology, shared scan patterns, and shared spacecraft
Progress Mark Explanations

- **Pulsed Laser**
  - LaRC all-liquid laser validated on the ground already; 700 mJ
  - CTI all-liquid laser, different material, validated in aircraft
  - LaRC partial CC laser close to completion

- **Scanner**
  - Rotating wedge validated on aircraft by MSFC (MACAWS)
  - Rotating telescope concept examined by GSFC ISAL/IMDC teams
  - LaRC developing low-mass telescope, begun FY02 (ALTP/ECTP/LRRP)

- **LO Laser**
  - JPL crystal LO validated on ground by CTI (SPARCLE PDR, 12/98)
  - JPL semiconductor laser under development (ATIP)

- **Photon Efficiency**
  - CTI measured discrete component system efficiency (1999 CLRC, p. 247)
    - \( LSE_{\text{CTI}} = LSE_{\text{LARC}} \times 0.46 \times 0.955 = LSE_{\text{LARC}} \times 0.44 = LSE_{\text{LARC}}/2.28 \)
  - LaRC developing integrated receiver, begun FY02 (ALTP/ECTP/LRRP)

- **Autoalignment**
  - CTI SBIR produced 5-element detector array
  - U. Colorado developed detector array theory and algorithm
  - Mirror and controller are COTS; not procured yet

- **Pointing**
  - GSFC IMDC team designed telescope sensor (2/02)
  - SPARCLE procured INS/GPS (SIGI)
  - SWA developed surface return algorithm
  - TODWL tested surface return algorithm on aircraft (LAHDSSA)
  - GSFC IMDC team stated that current star trackers are adequate (2/02)