OBJECTIVE: To develop a tactical beaconless atmospheric turbulence measurement system capable of measuring range resolved $C_n^2$ over path lengths of 0.5 to 10 km with 10m range resolution.

The challenge is to create a tactical grade beaconless atmospheric turbulence measurement system capable of field deployment and measuring range resolved atmospheric turbulence $C_n^2$ values over ranges of 0.5 to 10 km with a range resolution of 10m.

DESCRIPTION: As modern laser weapon systems begin to move into the field, measuring atmospheric turbulence for predicting the laser system effectiveness will be of great concern. Current methods of measuring turbulence include scintillometers, Shack Hartman Wavefront Sensors, and differential image motion monitor systems which require a beacon be placed down range and directed back toward a detector. Other methods use passive targets placed down range along with imaging systems to determine the level of turbulence. Placing a beacon or known available passive target downrange is not a feasible option for fielded systems, thus a single ended approach is needed.

The challenge is to create a tactical grade beaconless atmospheric turbulence measurement system capable of field deployment and measuring range resolved atmospheric turbulence $C_n^2$ values over ranges of 0.5 to 10 km with a range resolution of 10m. The system should be ruggedized to withstand inclement weather in varied environments and should be capable of quantifying $C_n^2$ in the range of $1 \times 10^{-16} < C_n^2 < 1 \times 10^{-12}$. Although $C_n^2$ can be derived from direct measurements of scintillation, wavefront phase aberration, localized wavefront tilt, or lidar backscatter, this topic is not limited to those types of approaches. An approach that uses local meteorological data along with real time atmospheric modeling and produces accurate results is also a viable solution.

-Environment: Threshold: 24/7 Outdoor operation, Temperature 0-50C; Objective: 24/7 Outdoor operation, Temperature -15-60C
-Measurement Dynamic Range: Threshold: $1 \times 10^4 - 15 < C_n^2 < 1 \times 10^4 - 12$; Objective: $1 \times 10^4 - 16$, $C_n^2 < 1 \times 10^4 - 12$
-Measurement Range: Threshold: 1km < Rmax < 3km; Objective: 0.5km < Rmax < 10 km
-Range Resolution: Threshold: 100m; Objective: 10m
-Form Factor/Size/Weight: Threshold/Objective: Single Ended (no beacon or known available passive target) Tripod Mountable

PHASE I: The phase I effort will result in a trade study and final design of a new beaconless atmospheric turbulence measurement system capable of meeting measurement requirements.

PHASE II: The Phase I designs will be utilized to fabricate, test and evaluate a prototype system. The designs will then be modified as necessary to produce a final prototype. The final prototype will be demonstrated to highlight the effectiveness of measurements.

PHASE III: DUAL-USE APPLICATIONS: High energy DoD laser weapons offer benefits of graduated lethality, rapid deployment to counter time-sensitive targets, and the ability to deliver significant force either at great distance or to nearby threats with high accuracy for
minimal collateral damage. Knowledge of the atmospheric turbulence along the shot path is a key limiting factor for lethality and as such it is a critical input for the fire control system. The Phase III effort shall be to design and build a sensor that could be integrated into an Army’s High Energy Laser Weapon System for real time use as part of the fire control system. Military funding for this Phase III effort would be executed by the US Army Space and Missile Defense Technical Center as part of its Directed Energy research.

REFERENCES:


KEYWORDS: High energy lasers, Atmospheric turbulence measurement, Atmospheric turbulence profiling