Air Force SBIR/STTR Innovation

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STTR Topic Number:
AF073-002

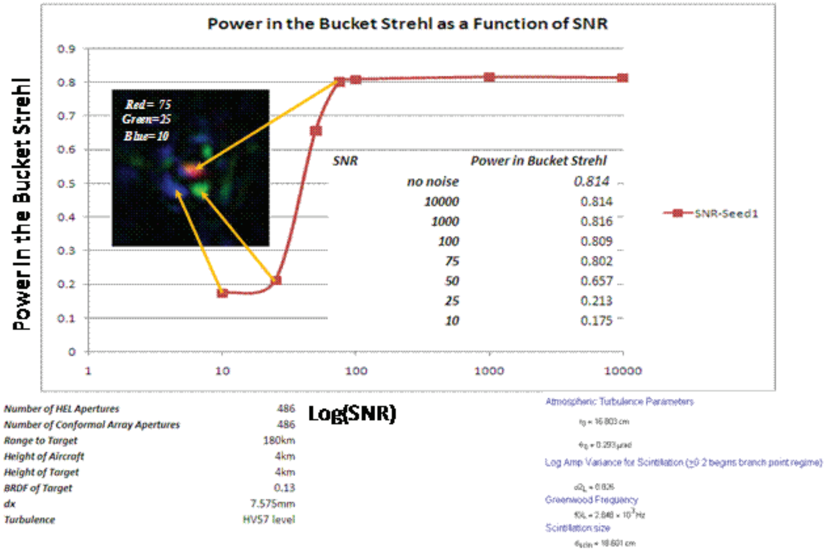
STTR Title:
Adaptive Optics Compensation in Deep Atmospheric Turbulence

Contract Number:
FA9451-09-C-0002

STTR Company Name:
Optical Physics Company, Calabasas, CA

Technical Project Office:
AFRL Directed Energy Directorate, Kirtland AFB, NM

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.



Power in the Bucket Strehl as a function of Signal to Noise Ratio (SNR). The Green's Function Inversion (GFI) process shows very high correction performance in deep turbulence with Log Amplitude variance values that exceed saturation. The process also permits the same level of correction in the point ahead direction.

Green's Function Inversion for Deep Atmospheric Turbulence Compensation

- The Air Force needs to develop compensation techniques to correct High Energy Laser (HEL) wavefronts for phase distortions caused by atmospheric turbulence

- Optical Physics Company (OPC) developed a technique to measure the Green's Function Inversion (GFI) and apply it to deep turbulence conditions to achieve high quality hit spots on the target

- The process provides for high quality wavefront correction, as well as aim point selection and maintenance, through GFI Imaging; GFI imaging is a breakthrough in itself, supporting Identification Friend or Foe (IFF) and intelligence activity

- This SBIR project has led to increasing interest in OPC's GFI technology from government and prime contractors (e.g., High Energy Laser-Joint Technology Office, Air Force Office of Scientific Research)

RD09-1551

Air Force Requirement

The Air Force has been working for years to develop compensation techniques to correct High Energy Laser (HEL) wavefronts for phase distortions caused by atmospheric turbulence. These adaptive optics developments have been reasonably successful in scenarios where the disturbances have not been too severe.

However, there was never a concept for correcting the phase fluctuations arising from "deep turbulence" where long propagations distances cause log amplitude variation saturation. The Green's Function Inversion (GFI) technique was proposed as a potential breakthrough solution.

STTR Technology

The Electromagnetic Propagation Green's Function completely characterizes the atmospheric disturbance between the HEL and the target. Optical Physics Company (OPC) developed a technique to measure this Green's function and apply it to deep turbulence conditions to achieve high quality hit spots on the target. Through the conformal processes developed, excellent GFI images were also produced, which allow effective aim point selection and control. This technology has been demonstrated both in full wave optics simulations and realistic laboratory demonstrations.

Potential Air Force Application

The GFI technique provides effective HEL engagement of distant targets (~200 Km) through deep turbulence. This was not possible until GFI was developed. In addition, the GFI process provides improved performance for the more numerous mid-range applications (~ 40 Km). The process provides for high quality wavefront correction, as well as aim point selection and maintenance, through GFI Imaging. GFI Imaging is a breakthrough in itself, supporting Identification Friend or Foe (IFF) and intelligence activity.

Tactical and long-range HEL systems are set to transform military operations in all services in the next 10-20 years. Much faster than missiles and with surgical precision, they will be extraordinarily effective against other weapons systems with minimal collateral damage. Conformal HEL designs promise extremely lightweight, high performance and cost-effective options which can enhance utility and speed deployment. GFI is valuable because it is an enabling technology for conformal HEL and Imaging.

Company Impact

This SBIR project has led to increasing interest in OPC's GFI technology from government and prime contractors, as noted below:

• The High Energy Laser-Joint Technology Office (HEL-JTO) invited OPC to submit a proposal to execute a field test of the GFI beam control technology in response to a white paper which the company submitted for a HEL-JTO broad agency announcement. The initial TRL 5 test would be over a 1 km horizontal ground path with turbulence conditions varying from moderate to deep. The update rate of 200 Hz would allow good performance under low-moderate wind conditions.

• OPC has received a contract from the Air Force Office of Scientific Research (AFOSR) for the development of a conformal imaging system using similar technology to the GFI imaging.

• OPC's basic GFI process has been successfully demonstrated in another SBIR project to provide real time, three-dimensional, atmospheric turbulence measurements. The successful development of the three-dimensional turbulence measurement process will provide the capability of characterizing the details of atmospheric turbulence through large volumes of atmosphere.

• OPC has teamed with a significant prime contractor and submitted another SBIR proposal. The proposed work involves formulating a complete conformal HEL architecture with well defined options for all components needed to achieve similar on-target performance to that of a 30 cm conventional beam control system using a 25 kW laser. The OPC teammate will provide information on master oscillator power amplifier (MOPA) fiber laser trees during the SBIR project, with the possibility of the teammate becoming the supplier for the fiber MOPA for later demonstrations. This teammate is an excellent prime for insertion of conformal HEL technology into fighter aircraft.

Optical Physics Company was founded in 1997. OPC designs and manufactures advanced optical subsystems for imaging, beam control and filtering, with specializations in the development of electro-optical sensor systems covering visible to medium-wavelength infrared (MWIR) bands that combine imaging and spectroscopy, including the mechanical assembly, electronics, optics, computer interface, signal acquisition and algorithms for signal processing.

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