Air Force SBIR/STTR

Innovation

Air Force SBIR/STTR Innovation Story

SBIR Topic Number:
AF05-009

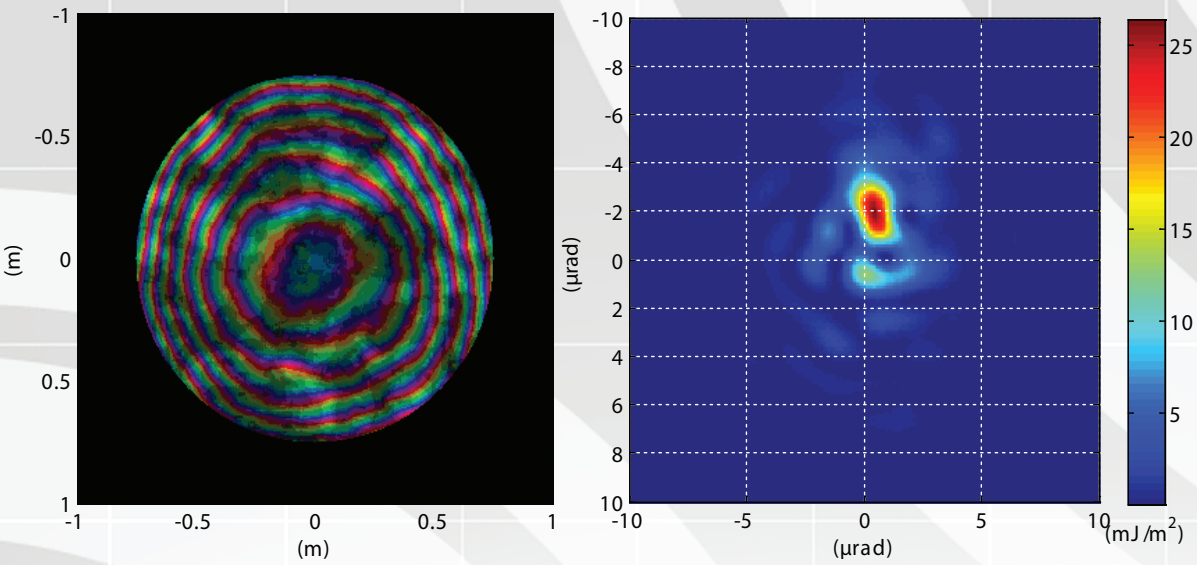
SBIR Title:
Advanced Techniques for Simulation of Electromagnetic Propagation

Contract Number:
FA9451-06-C-0032

SBIR Company Name:
the Optical Sciences Company, Anaheim, 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.



Left: Pupil Plane Depiction of Phase Distortion and Scintillation of a Point Source Propagating through Turbulence. Right: Point Source Image through Turbulence

Advanced Techniques for Electromagnetic Propagation

- The Air Force is interested in increasingly more complex optical systems, which often include optical propagation through the turbulent atmosphere followed by sensing and compensating with complex hardware devices
- Advanced modeling techniques were developed for imaging extended objects, accurately representing disturbance effects such as turbulence and thermal blooming, and dealing with simulation effects such as propagation aliasing
- The simulation technology, developed by the Optical Sciences Company (tOSC) under this SBIR contract, coupled object oriented modeling with the widely used Matrix Laboratory (MATLAB) programming language
- The technologies developed under this effort were integrated into a system simulation tool called WaveProp, which is now being used extensively by the Air Force Research Laboratory and the Air Force Institute of Technology

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Air Force Requirement

The Air Force is interested in increasingly more complex optical systems. These systems often include optical propagation through the turbulent atmosphere followed by sensing and compensating with complex hardware devices. The Air Force requires a system capable of handling the challenging modeling and numerical problems of simulating these systems while maintaining numerical efficiency and ease of use for a wide range of users.

SBIR Technology

The simulation technology, developed by the Optical Sciences Company (tOSC) under this SBIR contract, coupled object oriented modeling with the widely used Matrix Laboratory (MATLAB) programming language. Complex models are encapsulated in classes which allow users to concentrate on simulation development without being encumbered by numerical and other technical details.

Advanced modeling techniques were developed for imaging extended objects, accurately representing disturbance effects such as turbulence and thermal blooming, and dealing with simulation effects such as propagation aliasing. The modeling was supported by rigorous analysis. Intuitive and easy-to-use modeling approaches were developed for systems such as segmented optics. Attention was paid to providing potent diagnostic tools and ease of visibility into the physical processes being modeled. A key component of the development is extensibility which enables non-expert users to not only use existing classes but to enhance or develop new classes.

Potential Application

Advanced Air Force research and development frequently involves complex optical systems and requires modeling and evaluation both before and during the design phases. The technologies developed under this effort were integrated into a system simulation tool called WaveProp and were designed to address these Air Force systems.

WaveProp is now being used extensively by the Air Force Research Laboratory (AFRL). In particular, it is a principal simulation tool on several systems under development by the AFRL Directed Energy Directorate's Optics Division at the Starfire Optical Range and the Maui Branch. It is being used to model lasercom systems, weapons systems, laser guide star systems, and phase array systems. The Air Force Institute of Technology (AFIT) has used WaveProp in its graduate courses on wave optics simulation. Several graduate students have used WaveProp in their dissertation research.

Company Impact

"Our company performs many research studies for the Air Force," states Dr. Terry J. Brennan, tOSC senior scientist. "In addition to analytical work, contracts for the Air Force frequently involve the design and fabrication of high speed adaptive optics systems for use in research experiments and operational telescope systems. Wave optics simulation studies are almost always a component of both analytical studies and experimental work. tOSC has gained a reputation for our ability to match analysis, simulation, and field data results by recognizing where each result is applicable and demonstrating agreement across all results when appropriate assumptions are satisfied, typically in weak turbulence. WaveProp has become an important tool in the company's work and has been a crucial feature of many proposal efforts. It has recently been adopted for use in studies being performed by the Naval Space and Warfare Systems Command (SPAWAR) propagation research group.

"Because of the ease of use and MATLAB base, several of tOSC's Air Force customers are able to work with us in the development and execution of simulation projects. This has been attractive to customers who wish to participate in the technical aspects of the study and gain as much insight as possible into the important issues."

U.S. AIR FORCE

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