

Phase-Coherent Fiber Laser Arrays



S&T Campaign: Sciences for Lethality & Protection
Tier 2 Subtopic: Tactical Laser Systems

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Research Objective

- To develop next-gen adaptive phase-coherent fiber laser arrays that will provide compact, light-weight, and mobile directed energy (DE) systems.
- To revolutionize battlefield tactical beam directing, communication, target designating, tracking, and maximum power delivery through atmospheric turbulence.

World's first demonstrated 7-channel phase-locked fiber laser array

The 19-channel array system

Local phase locking theory:

$$J_{i,j,m}[\delta_i(t), \delta_j(t), \delta_m(t)] = 2I_i \{ \gamma_{ij}^2 + \gamma_{jm}^2 \cos(\delta_i - \delta_j) + \gamma_{im}^2 \cos(\delta_j - \delta_m) + \gamma_{ij} \gamma_{im} \cos(\delta_i - \delta_m) \}$$

Laser beam output from a single fiber collimator

Random phased 7-channel fiber array

Phase-locked 7-channel fiber laser array

Phase-locked 19-channel fiber laser array

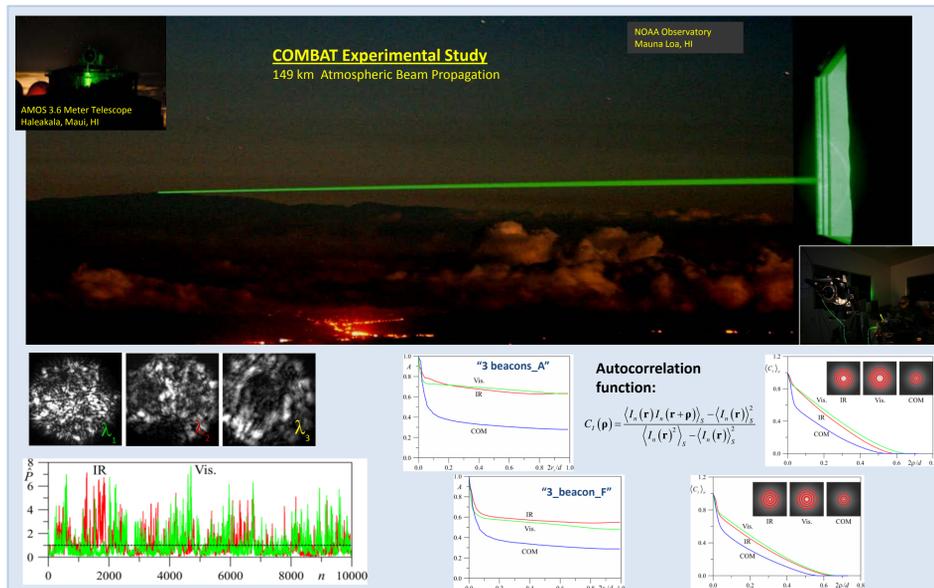
Helicopter Fiber Laser (HEFL)

Ground-based Aerial Defense On The Move (GBAD_OTM)

ARL has been developing compact and high-performance phase coherent fiber laser arrays for aerial and ground mobile platforms

Challenges

- Innovative approaches for phase locking, beam combining, and maximizing the throughput of fiber laser array radiation in the far-field diffraction limited space.
- long-range atmospheric beam propagation for different wavelengths from visible to near-mid IR regions.
- Wavefront phase aberration and scintillation intensity characteristics under deep atmospheric turbulence.



Long-range laser beam propagation experiment in deep turbulence

ARL Facilities and Capabilities Available to Support Collaborative Research

- The Intelligent Optics Lab (IOL) is equipped state-of-the-art instruments and test facilities to support sophisticated investigations in:
 - Adaptive, nonlinear optics, and processing algorithms,
 - Advanced real-time atmospheric imaging and image processing,
 - Laser communications for ground-to-ground and ground-to-air mobile platforms,
 - Other advanced techniques for algorithm development, simulation, imaging, and laser communication system performance.

A LOT Atmospheric Laser Optics Testbed

Investigating major atmospheric effects that impact laser optic system performance

- Turbulence
- Molecules
- Particulates
- Water Droplets

2.3 Km

ARL IOL

Water Tower Site

Tower laser communication transceiver systems

Rooftop laser communication transceiver systems

ARMY RESEARCH LABORATORY Intelligent Optics Laboratory

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- New designs of high-power and high-resolution deformable mirrors for wavefront senseless beam control
- Advanced beam control technique and hardware that will operate in deep turbulence conditions.
- Investigate and develop new efficient processing algorithms for laser beam propagation in deep atmospheric turbulence.
- Advanced conformal phase-locked optical transmission modules and systems that are capable of overcome deep atmospheric turbulence.