

SBIR Topic Number:
AF06-001

SBIR Title:
High Power
Optical Amplifier

Contract Number:
FA9451-07-C-0024

SBIR Company Name:
Photon-X, LLC,
Malvern, PA

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.



Compact Radiation Hardened, High Power Optical Amplifier

- The Air Force needs advanced, state-of-the-art High Power Optical Amplifiers (HPOA), particularly with respect to reliability in space environment and output power for satellite communications
- Photon-X developed new highly reliable radiation hardened (RH) optical fiber amplifiers and lasers by utilizing proprietary radiation hardening and shielding techniques
- Techniques were engineered to further harden and shield the commercial off-the-shelf rare earth doped fibers for space-based applications, with the RH modules providing 2X improvement over commercially available counterparts without any shielding
- As a result of the SBIR program, Photon-X now offers a wide range of unique RH optical modules for a variety of applications to be deployed in both natural and man-made radiation environments

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Air Force Requirement

The Air Force needs advanced state-of-the-art High Power Optical Amplifiers (HPOA), particularly with respect to reliability in space environment and output power for Satellite Communications (SATCOM) Laser Communications. Warfighters will require significantly greater bandwidth to access all of the information necessary to maximize mission effectiveness. This bandwidth can only be addressed by optical means of communication that provide more than a three order of magnitude bandwidth increase in capacity over existing Radio Frequency (RF) based SATCOM.

HPOAs are an enabling technology for laser communications, and their availability promotes the warfighter's mission effectiveness. Given that the useful operating lifetime for communications satellites can exceed twenty years, HPOA reliability, especially in a radiation environment, is crucial to reliable and cost effective delivery of bandwidth to the warfighters.

SBIR Technology

Photon-X developed new highly reliable radiation hardened (RH) optical fiber amplifiers and lasers by utilizing proprietary radiation hardening and shielding techniques under this Air Force SBIR Phase II program. Conventional rare earth (RE) doped fibers are affected by radiation exposure via ionization induced color defects that cause the pump light and input signal to be absorbed and, in turn, degrade the amplifiers' gain and noise figure properties. As indications of radiation induce defects, two significant absorption bands (i.e., ultraviolet (UV) and 1.6 μm centered band) grow, generated by silica (UV) and phosphorus (1.6 μm). The stability of these defects and activation energies are analyzed through thermal annealing and subsequent analysis via the master curve technique.

Photon-X has engineered techniques to further radiation harden and shield the commercial off-the-shelf (COTS) RE doped fibers for space-based applications. The RH modules provide 2X improvement over commercially available counterparts without any shielding

Potential Air Force Application

HPOAs play a key role in advanced spaced-based photonic applications such as optical communications, radar, sensors and high speed signal processing. The HPOA's resistance to radiation is a crucial feature in addition to known reliability requirements (e.g., mechanical and thermal stress) in space-based applications. The proprietary hardening and shielding techniques provide superior RE doped fibers with much improved performance in harsh radiation environment for fiber-based HPOA and laser applications.

The main advantages of the RH module platform include:

- Superior radiation reliability with low radiation induced performance degradation over a 10-year life time.
- High efficient proprietary electronic circuitry designs (i.e., 90% electrical-to-electrical pump driving efficiency) for low power consumption and heat dissipation.
- Small foot print and lightweight.
- Improved mechanical stress reliability.
- Automatic Power Control (APC) for improved reliability and safety.

Company Impact

"This Air Force SBIR Phase II program enabled us to develop state-of-the-art compact HPOAs with superior radiation reliability and electrical-to-optical efficiencies for space-based optical communication applications," states Dr. Yongming Cai, Chief Executive Officer of Photon-X, LLC. "As a result of the SBIR program, Photon-X now offers a wide range of unique radiation hardened (RH) optical modules for a variety of applications to be deployed in both natural and man-made radiation environments. Besides aerospace and defense applications, our RH HPOA technology promises unique commercial opportunities in the private free space laser communication market, where we have already started to witness increased volume in inquiries and sales for our RH compact HPOA modules."

Photon-X is a customer-driven, technology-based company dedicated to the research, development and manufacturing of advanced photonic devices for optical communications, biomedical sensors, RF/military applications and other emerging commercial markets. Visit Photon-X at www.photon-x.net.



SBIR/STTR

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