OBJECTIVE: Develop a compact, low-phase-noise, semiconductor or diode-pumped solid-state laser to provide next-generation, low-noise-figure radio frequency (RF) photonic capabilities for electronic warfare (EW) applications. Ensure that the 100 mW class fiber-pigtailed lasers emits in the 1.32- or 1.5-micron wavelength range and is packaged in industry standard butterfly-type packages.

DESCRIPTION: Dominance of the electromagnetic (EM) spectrum is critical for DoD. As threat carrier frequencies extend above 20 GHz, electronics technologies are challenged to process wide bandwidths. RF photonics technologies have natural capabilities to above 100 GHz and can augment electronics to provide comprehensive electromagnetic maneuver warfare (EMW) solutions. To penetrate the electronic warfare application space, RF photonics technology requires low noise figures. The best path to achieving low noise figures is the development of low-phase-noise lasers that have shot-noise-limited noise performance throughout the 1 to 100 GHz frequency range [Ref 4]. Both diode-pumped solid state and quantum dot semiconductor lasers have been shown to have superior phase noise properties throughout the gigahertz regime inherent in their design due to the slow gain dynamics of rare-earth doped crystals and glasses (solid state) or due to the discreteness of their energy levels (quantum dot). (updated in SITIS 01/16/2020)

PHASE I: Design an approach and determine its feasibility and expected performance. Develop a design that uses 100 mW low-phase-noise lasers that are compact (50 to 100 cubic centimeters), emit in the 1.32- or 1.5-micron range, and have superior noise performance throughout the 1 to 100 GHz frequency range. Specifically, the laser should achieve a Relative Intensity Noise (RIN) level of better than -165 dBc/Hz to achieve link performance within 1 dB of the signal-to-noise level at 10 mA photocurrents from 1 to 100 GHz. In addition, the laser phase noise should be less than or equal to the theoretical noise performance of a laser contained within a 100 ps delayed-homodyne 10 mA detection scheme having a Lorentzian linewidth below 2 kHz from 1 to 100 Ghz. Simulations or practical supporting measurement data in this Phase are highly desirable and preferred over literature searches researching prior art. Supporting information stating how the proposed design will meet the power and shot noise limits is advantageous. Develop a Phase II plan. (updated in SITIS 01/16/2020)

PHASE II: Fabricate and package a laser in a representative small (25 to 50 cubic centimeters) butterfly package. Perform laboratory measurements of laser amplitude, phase noise, and power output. Ensure, that at the end of Phase II, this packaged laser should be at Technology Readiness Level (TRL) 4, performance measured in a laboratory environment.

PHASE III DUAL-USE APPLICATIONS: Mature the laser to a higher TRL level (at least TRL-6) so a transition to a Program of Record can be achieved. Tailor the design to a specific air or submarine platform system to be determined between Phases II and Phase III.

Low phase-noise lasers may be of interest in commercial communication systems for use with modern coherent modulation formats, combined with high symbol rates, both of which stress the need for lower phase-noise lasers.

REFERENCES:


