

An example of Air Force supported SBIR/STTR technology that has been transitioned into an Air Force or other DoD system or subsystem or used by Air Force test ranges and facilities or maintenance depots.

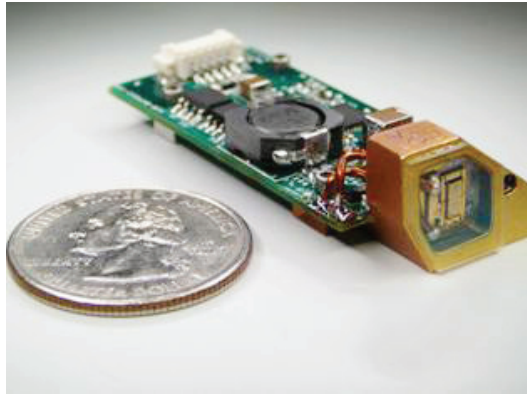
**SBIR Topic Number:**  
AF04-156

**SBIR Title:**  
Vertical Cavity Surface  
Emitting Lasers

**Contract Number:**  
FA8651-05-C-0098

**SBIR Company Name:**  
Aerius Photonics, LLC,  
Ventura, CA

**Technical Project Office:**  
AFRL Munitions  
Directorate,  
Eglin AFB, FL



**Figure 1 (left):** Close-up picture of the Aerius Compact Laser Illuminator (CLI) module. The illuminator uses a small Aerius Vertical-Cavity Surface Emitting Laser (VCSEL) chip that produces narrow-band illumination in the short-wavelength infrared (SWIR) band. **Figure 2 (right):** Aerius illuminator mounted and bore sighted with the customer's system.

## Short-Wavelength Infrared (SWIR) Laser Illuminator System

- To support the development of new smart munitions and high-power diode-pumped laser systems, higher power and lower cost diode lasers are needed by the Air Force
- Aerius Photonics, LLC, successfully applied a new semiconductor laser technology, named Vertical-Cavity Surface-Emitting Laser (VCSEL), to pulsed laser radar and rangefinders and demonstrated high continuous-wave laser output powers for pumping applications
- By leveraging the Phase II VCSEL technology in a follow-on Phase III project, Aerius Photonics was able to develop a short-wavelength infrared (SWIR) laser illuminator system that is now used in an unmanned aerial vehicle (UAV) program
- The illuminator beam quality surpasses the capability of either light-emitting diode (LED) or edge-emitting laser (EEL) diode illumination, in that it produces a perfectly symmetric and bore sighted low-divergence illumination beam without the need for any optical lens elements

Commercialization Pilot  
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96ABW-2010-0079

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## Air Force Requirement

To support the development of new smart munitions and high-power diode-pumped laser systems, higher power and lower cost diode lasers are needed. With more power available, rangefinders and illuminators can work at greater distances even with low reflectance targets in total darkness.

Current technologies require mechanical assembly of 1-D laser bars to fabricate 2-D diode pump arrays. This assembly adds substantial cost and the lasers used emit highly divergent and elliptical beams. To enhance the capabilities and reduce the cost of these systems, a new technology platform is required.

## SBIR Technology

During this SBIR project, Aerius Photonics, LLC, successfully applied a new semiconductor laser technology to the application of pulsed laser radar, rangefinders, and laser illuminators and demonstrated high continuous-wave (CW) laser output powers for pumping applications. This is known as Vertical-Cavity Surface-Emitting Laser (VCSEL) technology. Like most semiconductor lasers, VCSELs are fabricated from semiconductor wafers. However, unlike their edge-emitting laser (EEL) predecessors, they are fabricated using common volume semiconductor manufacturing techniques.

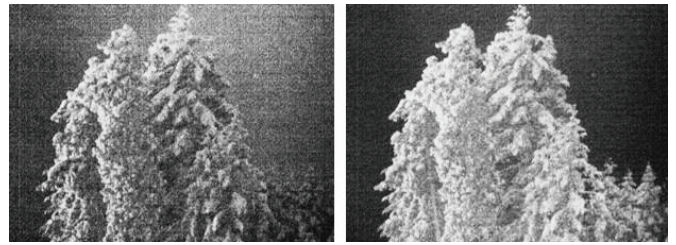
Aerius' VCSELs have several benefits over other semiconductor lasers, to include:

- They require no mechanical die-level packaging assembly to produce the laser, and thus can be tested on the wafer with no additional process steps.
- They produce a circular laser output beam that can be used without complex lenses.
- They can be fabricated into dense 2-D arrays.
- They are efficient and have greater wavelength stability over temperature.
- They can be produced at reduced manufacturing costs.
- They have a distributed aperture and are not susceptible to optical facet damage or to harsh environmental conditions.

## Transition Impact

By leveraging the Phase II VCSEL technology in a follow-on Phase III project, Aerius Photonics was able to develop a short-wavelength infrared (SWIR) laser illuminator system that is now used in an unmanned aerial vehicle (UAV) program. The Compact Laser Illuminator (CLI) application uses Aerius' high brightness, low-speckle, low-coherence VCSEL

technology. The CLI is capable of illuminating in the SWIR and near infrared (NIR) band with the illumination uniformity of a light-emitting diode (LED) system but with the efficiency of a laser diode.



**Figure 3 (left) and Figure 4 (right) show contrasting imaging results at 900 feet. While snow covering the trees enhances their visibility and reduces contrast without the illuminator, the image is clearly brighter with the illuminator.**

The CLI beam quality surpasses the capability of either LED or EEL diode illumination, in that it produces a perfectly symmetric and bore sighted low-divergence illumination beam without the need for any optical lens elements. This beam quality enhances the effectiveness of the illuminator in imaging applications.

## Company Impact

Development of the transitioned illuminator systems was substantially facilitated by utilization of the high power laser diodes developed under this SBIR project. In 2008, Aerius also successfully transitioned a VCSEL based rangefinder from the laser diodes developed under this SBIR project.

Aerius Photonics specializes in the design and manufacture of photonic components and systems, including infrared detector arrays and focal plane arrays, ultralight laser rangefinders, high-power pulsed and CW semiconductor lasers, vertical-cavity laser design software, high-sensitivity optical detectors and receivers, and multi-spectral scene projectors.



U.S. AIR FORCE

# SBIR/STTR

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