Small Business Innovation Research (SBIR) and
Small Business Technology Transfer (STTR)
Opportunity Announcement
HR001120S0019-05
Wearable Laser Detection and Alert System

Which program will fund this topic?
SBIR
What type of proposals will be accepted?
Phase I Only

Technology Area(s): Battle Space, Electronics, Sensors

I. I INTRODUCTION

The Defense Advanced Research Projects Agency (DARPA) Small Business Programs Office (SBPO) is issuing an SBIR/STTR Opportunity (SBO) inviting submissions of innovative research concepts in the technical domain(s) of Battle Space, Electronics, Sensors. In particular, DARPA is interested in understanding the feasibility of a wearable laser sensor that can rapidly detect laser irradiation day and night and rapidly alert the wearer of lasing. A desirable system would have low SWaP (size, weight, and power), act as a stand-alone sensor, and be used as a wearable sensor. The system must have very low weight and volume; detect and alert of lasing in real time; and detect laser illumination over the visible to shortwave infrared region of the electromagnetic spectrum (450-1600 nm target wave band). The system goal is for the wearable detection system to be 100 grams (g) or less and be powered by a rechargeable Conformal Wearable Battery, or CWB, that is less than 1.5 kg (to include wires and connectors) and can power the system for 72-hours of continuous operations. The wearable system must be comfortable to wear and be easily integrated into existing military use headgear.

This SBO is issued under the Broad Agency Announcement (BAA) for SBIR/STTR, HR001120S0019. All proposals in response to the technical area(s) described herein will be submitted in accordance with the instructions provided under HR001120S0019, found here: https://beta.sam.gov/opp/a94b0df9470b4b65b3b3443d52bb8c3b/view.

a. Eligibility

The eligibility requirements for the SBIR/STTR programs are unique and do not correspond to those of other small business programs. Please refer to Section 3.1, Eligible Applicants, of HR001120S0019 for full eligibility requirements.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Proposers must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with applicable proposal preparation instructions. Please refer to section 2.3 of the Announcement for further information on Export Control.

b. Anticipated Structure/Award Information

Please refer to Section 1, Funding Opportunity Description provided in HR001120S0019 for detailed information regarding SBIR/STTR phase structure and flexibility.
For this SBO, DARPA will accept Phase I proposals for cost of up to $225,000 for a 12 months period of performance. Proposers awarded a Phase I contract will be eligible to submit a proposal for Phase II and will be contacted by the DARPA Small Business Programs Office at the appropriate time during their Phase I period of performance. If selected, Phase II will have a Period of Performance of up to 18 months with a ceiling of $1.5M.

Proposers should refer to Section 4, Application and Submission Information, of HR001120S0019 for detailed proposal preparation instructions. Proposals that do not comply with the requirements detailed in HR001120S0019 and the research objectives of this SBO are considered non-conforming and therefore are not evaluated nor considered for award.

Phase I proposals shall not exceed 20 pages. Phase I commercialization strategy shall not exceed 5 pages. This should be the last section of the Technical Volume and will not count against the 20-page limit. Please refer to Appendix A of HR001120S0019 for detailed instructions on Phase I proposal preparation.

c. Human Subjects Research (HSR)/Animal Use

Proposers that anticipate involving Human Subjects Research or Animal Use must comply with the approval procedures detailed at http://www.darpa.mil/work-with-us/additional-baa. For more information, refer to Section 4.7, Human Subjects/Research/Animal Use, of HR001120S0019.

Proposers are highly encouraged to clearly segregate research tasks from human and/or animal testing tasks to allow for partial funding while internal and DoD approvals are being obtained.

d. Evaluation of Proposals

Section 5, Evaluation of Proposals, in HR001120S0019 provides detailed information on proposal evaluation and the selection process for this SBO.

e. Due Date/Time

Full proposal packages (Proposal Cover Sheet, Technical Volume, Price/Cost Volume inclusive of supporting documentation, and Company Commercialization Report) must be submitted via the DoD SBIR/STTR Proposal Submission website per the instructions outlined in HR001120S0019 no later than **2:00 pm ET, May 26, 2020.**

II. TOPIC OVERVIEW

a. Objective

Develop a lightweight (~100 grams or less) laser alert sensor system that can act as a stand-alone system and be personnel-wearable that can detect laser irradiation from 450 to 1600 nanometers at energies of 500 microwatts/cm2 and greater to warn personnel of

potential ocular damage or damage to electro-optical and infrared sensors in near-real time. The wearable system should be very lightweight and comfortable to wear and work through all natural environmental and lighting conditions. The system should also be compatible with integration into standard civil and military issued headgear without significantly increasing the bulkiness or weight. Broadband coverage is desired but solutions that detect a subset of wavelengths to include 532, 632, 1064, 1300, and 1550 nm and meet all other requirements of this solicitation may also be considered. The system must operate in both day and night conditions with a continuous 2-pi steradian field of view. The wearable sensor must be powered by a battery system that is less than 1.5 kg (to include both battery and connectors) and operates for at least 72 hours on a single charge. The laser alert system should detect only laser irradiation and not other background sources. The system should not react to bright non-laser sources such as solar phenomenon, flares, background light, thermal light, headlights, rocket plumes, muzzle flashes, and other sudden bursts of high intensity light not related to laser illumination as these would be considered system false alarms and degrade functional performance. This feature of the system is anticipated to be a hard technical challenge to address particularly in a low SWaP system, but will be critical for a successful demonstration.

b. Description

In recent years, high power fiber and semiconductor laser technology has improved rapidly, with power density increasing by an order of magnitude or more. Much of this increase has been driven by demand for industrial cutting machines and high-bandwidth, long-range telecommunications. These same laser materials and devices can also be used as directed energy weapons against personnel and electro-optical and infrared (EO/IR) sensors. Purposeful laser strikes on aircraft have increased rapidly over the last decade. In 2018, the Wall Street Journal reported that hostile forces have been lasing American planes with laser pointers at a growing rate and these irradiance incidents have the potential to affect the operation of EO/IR sensors.

Small, lightweight, high-energy laser systems are a reality today due to decades of research activity. High power, small footprint lasers enable deployment of mobile and transportable high-energy laser systems. The small form factor makes these systems easy to disguise and bring into environments without detection. For example, such systems could be hidden in a delivery van or in a truck carrying supplies. Small lasers could be hidden in a backpack and carried into public venues. Given these advances in laser technology, there exists a need for low SWaP laser detection systems that are easily transportable and work in both day and night conditions to alert personnel of active lasing.

Successful proposals will provide a feasibility study for developing a laser detection system that meets the criteria of the objective system. This will include modeling and simulation that leads to both an achievable breadboard intermediate unit (Phase I) and an initial prototype (Phase II). Proposals should identify commercial off-the-shelf sensors or components that can be used to demonstrate the system objectives within the cost and time constraints of this effort. Proposals offering to do extensive trade studies without a

defined path to achieving the objectives of this topic are discouraged. A detection technique that enables location information for the high energy weapon source would be a desirable feature of the system but is not a requirement. The system should detect both continuous wave lasers and pulsed lasers.

c. Phase I

Evaluate concepts to detect irradiation in the band of 450-1600 nm in both day and night lighting conditions at energies of 500 microwatt/cm2 and above. These approaches should include a method to detect coherent laser irradiation and differentiate coherent laser illumination from incoherent spikes above the ambient background. Solutions to eliminate a bright daytime background and reduce system SWaP should also be investigated.

Schedule/Milestones/Deliverables Phase I fixed payable milestones:

- Month 1: Kick-off meeting to confirm approach and objectives.
- Month 3: Report on initial architectures and conceptual design (both hardware and software) for a system with a weight target of 100 gm or less, detects laser irradiation in the 450-1600 nm band at a threshold of 500 microwatts/cm2, and is powered by a battery source that provides adequate power for 72 hours of continuous use, and weighs less than 1.5 kg (see Table 1 for a list of design to specifications).
- Month 6: Report on acquisition of initial modeling and simulation data sets, proposed evaluation metrics and initial analyses results.
- Month 8: Initial demonstration in a simulation environment that models a detection threshold of 500 microwatt/cm2 or higher under day and night lighting conditions.
- Month 9: Develop a hardware and software specification for a Phase II system and estimate their SWaP, performance and cost.
- Month 10: Identify development needs and create a plan to address them in Phase II, including technology maturation and demonstration plans that systematically mature key technologies through the remainder of Phase I and Phase II and culminate in a compelling system-level demonstration in Phase II.
- Month 11: Perform breadboard demonstration of detection and provide a plan to scale successful demonstration to a wearable system that meets the objectives of the solicitation.
- Month 12: Final Phase I Report summarizing approach; prototype architectures; initial test results; comparison with alternative state-of-the-art methodology; quantification of accuracy; quantification of robustness to errors, noise, dropouts, distortions; and quantification of scalability.

d. Phase II

Develop and demonstrate wearable laser detection and alert technology that meets or exceeds all of the requirements listed in Table 1. Test and deliver a working prototype. Prototype includes a wearable system and a system integrated into a standard civil/military issued helmet or head-set.

Detection threshold at all operational bands	500 microwatts/cm2
Maximum time to detect illumination from laser source	<1 second
Time to alert	< 5 millisecond
Wavebands detected	450-1600 nanometers
Sensor field of view	~2-pi stearadians
Headset maximum mass	100 gram
Battery pack maximum mass to include connectors, wires, cabling, etc.	1.5 kilogram (must be CWB)
Maximum mass of entire operating unit	~1.6 kilogram
Minimum normal operating time on a single charge	72 hours
Operating conditions	All-weather** day and night

Table 1 (**All weather refers to conditions that may be encountered in the United States and Territories)

Schedule/Milestones/Deliverables Phase II fixed milestones for this program should include:

- Month 1: Kick-off meeting to confirm approach and objectives.
- Month 2: Report on lessons learned, updated architectures, and development plan.
- Month 4: Report on acquisition of Phase II real-world data sets, proposed evaluation metrics and initial analyses results.
- Month 6: Demonstrate the performance capabilities of the system components and architecture through a breadboard system. The breadboard system should verify system performance in the 450-1600 nm band at a detection threshold of 500 microwatt/cm2 in both day and night conditions, through a series of simulated hardware in the loop runs.
- Month 9: Build and demonstrate a lighter-weight "real world" brassboard system suitable for testing on a personnel representative platform (such as a mannequin, not human testing) and demonstrate system performance in operationally representative environments, including exposure across the 450-1600 nm bandwidth under day and night lighting conditions that meet the specifications of Table 1.
- Month 12: Final Phase II report that describes performance of real world system, quantifies system performance, compares with alternative state-of-the art approaches, documents lessons learned, and outlines a path to achieving a wearable system that meets all of the specifications of Table I.

- Month 15 (Phase II Increment/Option): Conduct a compelling representative test demonstration that validates critical technologies and system attributes and meets benchmark performance targets identified above.
- Month 18 (Phase II Increment/Option): Final Phase II Option report that documents final prototype architectures, hardware and software; methods; test results; comparisons with alternative methods; and quantifies accuracy, robustness and generalizability

e. Dual Use Applications (Phase III)

Maturation of this technology would greatly benefit the Department of Defense (DoD) mission in many areas including force protection. This technology has significant commercialization potential. The proliferation of laser technology poses significant risks to commercial aircraft pilots during takeoff and landing operations. A successful system demonstration is expected to yield significant interest in the airline and commercial aviation industry. A secondary market for a laser detection system is civil and law enforcement personnel deployed in the field.

f. References

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g. Keywords

High energy laser countermeasures, laser detection, laser protection, wearable detection, eye protection, coherent detection

III. SUBMISSION OF QUESTIONS

DARPA intends to use electronic mail for all correspondence regarding this SBO. Questions related to the technical aspect of the research objectives and awards specifically related to this SBO should be emailed to HR001120S0019@darpa.mil. Please reference BAA HR001120S0019-05 in the subject line. All questions must be in English and must include the name, email address, and the telephone number of a point of contact.

DARPA will attempt to answer questions in a timely manner; however, questions submitted within seven (7) calendar days of the proposal due date listed herein may not be answered.

DARPA will post a consolidated Frequently Asked Questions (FAQ) document. To access the posting please visit: http://www.darpa.mil/work-with-us/opportunities. Under the HR001120S0019-05 summary, there will be a link to the FAQ. The FAQ will be updated on an ongoing basis until one week prior to the proposal due date.

In addition to the FAQ specific to this SBO, proposers should also review the SBIR/STTR General FAQ list at: http://www.darpa.mil/work-with-us/opportunities?tFilter=&oFilter=29934. Under the HR001120S0019 summary, there is a link to the general FAQ.

Technical support for the DoD SBIR/STTR Proposal Submission website is available Monday through Friday, 9:00 a.m. – 5:00 p.m. ET. Requests for technical support must be emailed to DoDSBIRSupport@reisystems.com with a copy to HR001120S0019@darpa.mil.