Department of the Navy SBIR/STTR Transition Program

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MCSC-PRR-5052

Topic # N201-002
Focused Directed Energy Antenna System (FoDEAS) for Long-Range Vehicle/Vessel Stopping with reduced overall system size, weight, power consumption, thermal cooling, and system cost (SWAP/C2)
Physical Sciences Inc.

WHO

SYSCOM: MCSC

Sponsoring Program: Joint Non-Lethal Weapons Directorate (JIFCO)

Transition Target: Short – mid range, platform mounted directed energy system for Joint DoD (including Marine Corps) use against vehicle/vessel engine targets.

TPOC: sbir.admin@usmc.mil

Other Transition Opportunities: Vehicle/vessel stopping for Department of Justice (DoJ) and the Department of Homeland Security (DHS). Port security and vehicle interdiction (car chases) for local civilian law enforcement.

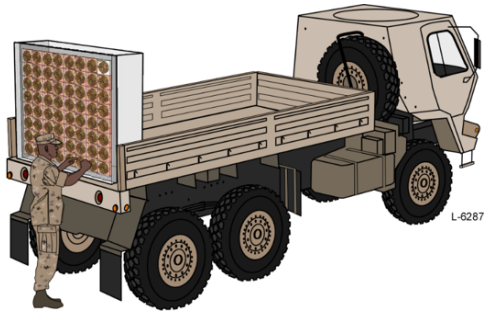

Image Courtesy of Physical Sciences, Inc.

Notes: The SAFE antenna Phase II base program is currently underway. The projected period of performance is 9/1/2022-9/1/2024.

Accomplishments To-Date:
• Physical Sciences, Inc. built an initial prototype of the SAFE antenna and successfully validated RF simulations of the design across the 1-3 GHz operating range
• PSI successfully demonstrated adjustable frequency notching
• PSI identified a supplier and procured custom extruded coax for the antenna element with an associated high-rate manufacturing plan

Future Work:
• PSI will build a high-power (>300 kW) SAFE antenna element and demonstrate program objective RF performance
• PSI will shrink the antenna to <100 mm in diameter for array operation without grating lobes between 1-3 GHz
• PSI will build arrays and associated feeds for both low-power wideband and high-power narrowband field tests in operationally relevant environments, and against vehicle/vessel engine targets

WHAT

Operational Need and Improvement: The joint forces need a broadband high-power microwave (HPM) antenna system with longer range and probability of effect than narrowband systems of equivalent power. In addition, the forces need a HPM directed energy weapon system with rapidly tunable frequency carve-outs to avoid interference with friendly frequencies.

Specifications Required: • Frequency Range: 1-3 GHz
• Antenna Gain: 20 dBi
• Total Output Power: 20 MW
• Total Weight: <350 lbs.
• Aperture Size: 1.5 m x 1.5 m x 1.5 m
• Bandwidth: 1-3 GHz
• Frequency Notch 1: 1227 MHz (20 MHz wide)
• Frequency Notch 2: 1381 MHz (20 MHz wide)
• Frequency Notch 3: 2800 MHz (20 MHz wide)

Technology Developed: During the 1st year of the Phase II Base program, PSI developed the 300 kW SAFE antenna element, which operates across 0.77-3.5 GHz and can be made small enough (<100 mm in diameter) to be arrayed without grating lobes between 1-3 GHz. PSI also designed a 2 x 2 array and feed that we will build and test during the 2nd year of the program.

Warfighter Value: • The SAFE antenna will increase the vehicle/vessel stopping potential and range of high-power microwave directed energy weapons (DEWs)
• The SAFE antenna will enable DEWs with smaller and lighter form factors, with modularity supporting lower cost
• Frequency notching avoids interference with friendly frequencies, enabling deployment in more warfighter arenas

WHEN

Contract Number: M67854-22-C-6521 **Ending on:** Sep 01, 2024

Milestone	Risk Level	Measure of Success	Ending TRL	Date
High-Power Prototype Far-Field Scans	Medium	<2:1 VSWR and >6 dBi gain across 1-3 GHz. Adjustable notching and 16 kV DC hold-off voltage	3	4th QTR FY23
Arrayable Element Build and Test	Low	100-mm Diameter Prototype with Identical RF Performance	4	2nd QTR FY24
Wideband Notching Test with 2 x 2 Array	Low	Successful non-interference with friendly frequencies during field test	5	4th QTR FY24
High-Power Narrowband Vehicle/Vessel Stopping Test	High	Demonstrate stopping vehicle and vessel engine targets with a narrowband >4 MW magnetron source	6	4th QTR FY25

HOW

Projected Business Model: PSI will pursue Phase III funding for integrating the antenna with a HPM source. PSI will use Phase II program testing against vehicle/vessel engine targets as a key capability demonstration for the Phase III proposal. We will continue to work closely with JIFCO to understand ConOps and mission requirements. PSI plans to manufacture and sell both the SAFE antenna and the full DEW system with source integrated. We are seeking business partners for both the RF source and a target detection, ID and tracking system.

Company Objectives: We are looking to engage with RF source and target detection, ID and tracking system providers. Our goal is to become a provider of fully integrated HPM directed energy weapons systems for several counter-electronic missions, including C-UAS and vehicle/vessel stopping.

Potential Commercial Applications: Organizations with technology need include the joint forces represented by the JIFCO and several domestic agencies.
• The DHS requires vessel stopping for port security (Coast Guard), vehicle stopping for border and high value asset protection (U.S. Customs and Border Protection, Secret Service)
• The DOJ requires vehicle stopping for interdiction and protection of high-value assets (FBI, Federal Bureau of Prisons)
• Low law enforcement requires vehicle and vessel stopping for interdiction (car and boat chases)

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