Department of the Navy SBIR/STTR Transition Program

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ONR Approval #43-5915-19/43-6031-19

Topic # N172-135

Fast Rise-time High Power Radio Frequency (HPRF) Pulse Shaping

XL Scientific, LLC dba Verus Research

WHO

SYSCOM: ONR

Sponsoring Program: ONR Code 35: High-power Joint Electromagnetic Non-Kinetic Strike (HIJENKS) FY17-22 Leap Ahead

Transition Target: The device will be used with existing suites of high power RF sources at various Warfare Centers and/or Navy Labs for generalized RF Directed Energy Weapons effects research to inform non-kinetic strike weapons capability and non-lethal vehicle/vessel stopping.

https://www.onr.navy.mil/-/media/Files/35/code-35-naval-air-warfare-and-weapons-program-guide.ashx?la=en&hash=66F4B02F6FC4269E790E8813A6B1FA47D3F3DCF0

TPOC:
Mr. Ryan Hoffman
ryan.hoffman@navy.mil

Other transition opportunities: Verus Research received a $7.2M Phase III SBIR through the Air Force Research Laboratory (AFRL) to develop a plasma based switch for High Voltage pulsed applications based upon this technology for integration into an AFRL Directed Energy program. The system is immune to Electromagnetic Interference (EMI) from the generated RF environment and have as minimal as possible SWaP footprint and can easily be integrated into existing Navy test systems, such as Radio-Frequency Vehicle Stopper (RFVS), with minimal modifications to power and control systems.

Notes: Verus Research built the Tactical High Power Microwave Operational Responder (THOR) in cooperation with global engineering firms BAE Systems and Leidos, a $15 million AFRL Directed Energy Directorate program focused on negating swarms of drones; disabling unmanned aerial vehicles in a flash, sending them spiraling to the ground the moment the electromagnetic ray hits them.

WHAT

Operational Need and Improvement: Advances in HPRF source technology are constantly expanding access to the Radio Frequency (RF) spectrum for counter-electronic exploitation. This push creates challenges for testing and the test systems used to conduct lethality and counter-electronics testing. The current approach of building new RF sources and modulators that can only investigate discrete portions of the waveform space is primarily driven by technology limitations, but this is an inefficient methodology. Each source typically has limited flexibility, so a suite of sources is required to fully explore the parameter space. The benefit of using a fast plasma switch is that it allows for continuous pulse width agility without having to change or use a different HPRF source or modulator.

Specifications Required: Produce an affordable ($10s of thousands vs. $1M for a collection of multiple sources), compact (<50lbs and <.5m3) device or switch capable of multi megawatt power levels and closing times of tens of nanoseconds. Current state-of-the-art microwave switches have been demonstrated, but have not explored sub-10ns closing times and rep-rate conditions. The device will significantly reduce the Size, Weight and Power (SWaP) needs for complex or multiple modulators to produce the necessary HPRF envelopes as in historical systems such as ORION).

Technology Developed: A family of plasma switches that integrate into existing HPRF sources that enables pulse shaping beyond the original source capabilities. This pulse shaping capability will allow for existing slow rise, long pulse systems to generate a fast rise, “dial-a-pulse” capability to augment existing ONR capabilities. It provides an inexpensive modification to Navy sources,in contrast to the acquisition of multiple new sources at potentially millions of dollars in additional expenses. The new capability can be used for any application requiring adjustable pulse width for high power, fast risetime, PRF testing, including electronics effects testing, antenna testing, or modeling of RF coupling.

Warfighter Value: This system benefits the warfighter by reducing cost and time for systems to be developed by increasing the capabilities of the test systems. The benefit of using a fast plasma switch is that it allows for continuous pulse width agility without having to change or use a different HPRF source or modulator. Switch development utilizing pulse breakdown studies and benchmark code will help create a pulse shaper that can target multiple frequencies and power levels.

WHEN

Contract Number: N68335-19-C-0071 **Ending on:** October 11, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
S Band Prototype <2MW	Low	Full power operation achieving operational requirements	4	1st QTR FY20
Testing of Fast HV pulser for L band	Med	Achieve risetime & PRF requirements	4	2nd QTR FY20
L Band Prototype 2MW	Med	Full power operation achieving operational requirements	4	3rd QTR FY20
Prototype HPPS Switch Testing and Verification	Low	Full power operation matching expected M&S results	5	3rd QTR FY20
L & S Band Demonstrator - 8MW	Med	Demonstration of High Power Pulse Shaping (HPPS) for ONR partners	6	3rd QTR FY21
Sponsor demonstration	N/A	Full system demonstration coordinated by ONR to other interested groups	6	4th QTR FY21

HOW

Projected Business Model: Verus Research (VR) is a small research and development (R&D) company focused on providing best-value engineering services in the federal R&D space. Founded in Albuquerque, New Mexico in 2014, VR employs systems engineering and broad subject matter expertise to solve complex development and integration problems. VR is intimately aware of the needs of the High Power Radio Frequency (HPRF) effects testing community, given our involvement in numerous effects research programs including working relationships with several universities and government labs. Verus Research is aware of the need to generate short, fast risetime pulse widths for specific applications and will leverage this knowledge, coupled with the requirements to effectively target both government agencies and universities that must be cost-effective and timely in their research or test programs.

Company Objectives: Verus Research's primary objectives include the development of this technology to further enhance the capabilities of our customers in the areas of Directed Energy, HPRF effects, and source development. For example, it would help to fully investigate the HPRF parameter space on an effects system without having to procure or build multiple HPRF systems. Allowing resources to be utilized more efficiently. Several broader objectives include the areas of space systems, sensor development and test and evaluation.

Potential Commercial Applications: There are a wide variety of potential commercial applications for this type of technology, ranging from (EMI) testing of vehicles, airplanes, and/or other commercial systems such as high power communications and aircraft surveillance radar used by the Federal Aviation Administration (FAA). Plasma switch applications can expand into other Directed Energy applications or compact high power switching for power modulators. The use of the HPPS in research environments will be a very powerful tool for the rapid development and testing of HPRF pulse duration and PRF capabilities on targets to quantify the type of HPRF pulses required for specific applications.

Contact: Michael Butcher, Senior Pulsed Power Engineer
michael.butcher@verusresearch.net (505) 338-2179