

# Innovation

**SBIR Topic Number:**  
AF071-217

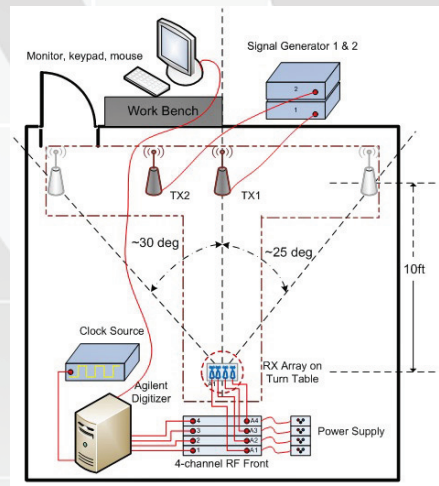
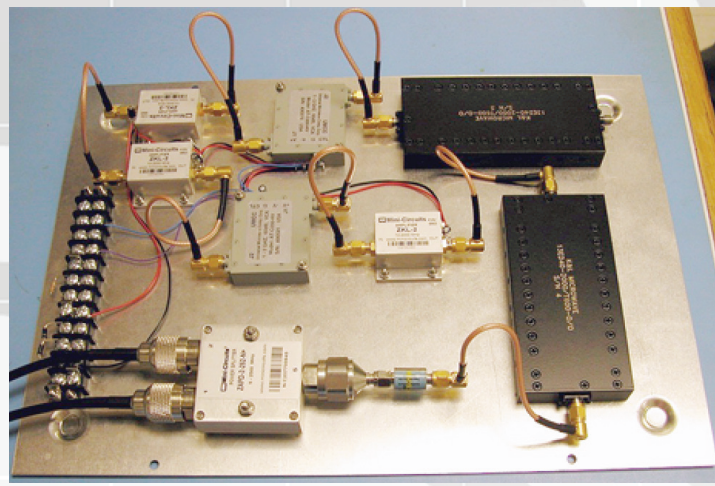
**SBIR Title:**  
Directional Finding for Sources with Unknown Bandwidths and Center Frequencies

**Contract Number:**  
FA8718-08-C-0050

**SBIR Company Name:**  
GIRD Systems, Inc.,  
Cincinnati, OH

**Technical Project Office:**  
AFRL Sensors Directorate,  
Wright-Patterson AFB, OH

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.



**Left: Direction of arrival (DOA) radio frequency (RF) front end. Right: Verification test set-up.**

## Direction Finding for Sources of Unknown Bandwidth and Center Frequencies

- A variety of military missions share a critical need for detecting the direction of arrival (DOA) of unknown electronic emissions
- GIRD Systems developed a new algorithm that provides a wideband extension of the well-known Multiple Signal Classification (MUSIC) algorithm; this algorithm exploits some general signal characteristics to find the DOA of a signal source even when the source parameters are unknown
- The algorithm was implemented in C++ on a host computer that is connected to a high-speed Agilent digitizing system; the host software configures the digitizer and reads the data once a snapshot of radio frequency (RF) data has been taken
- GIRD's algorithm has the potential to deliver high performance to a variety of missions requiring wideband DOA; the solution is complemented by yet another SBIR Phase II project enabling RF polarization invariance

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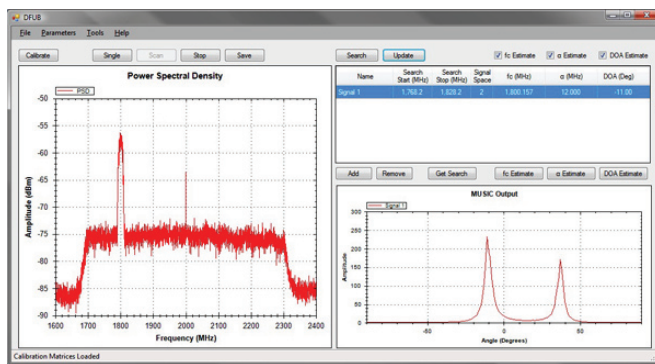
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## Air Force Requirement

A variety of military missions share a critical need for detecting the direction of arrival (DOA) of unknown electronic emissions. Such missions include electronic intelligent collections, aircraft survivability in electronic warfare, and force protection to name a few. Classical direction of arrival algorithms typically assume knowledge of the center frequency and bandwidth of the signal being measured. Most of these algorithms are also narrowband in nature, processing a small bandwidth that only encompasses the desired signal's frequency content. This is sufficient when the signal parameters are known but in a majority of applications, the signal parameters are completely unknown to the operator presenting a substantial challenge to classical DOA estimation approaches.

## SBIR Technology

GIRD Systems developed a new algorithm that provides a wideband extension of the well-known Multiple Signal Classification (MUSIC) algorithm. This algorithm exploits some general signal characteristics to find the DOA of an emission source even when the source parameters are unknown. Initially, the algorithm was implemented in C++ on a host computer connected to a high-speed Agilent digitizing system. The host software configures the digitizer and reads the data once a snapshot of radio frequency (RF) data has been taken.



Graphical User Interface

When integrated with a hardware prototype, the system was shown to operate over a much wider bandwidth than legacy direction finding systems (600 MHz between 1.7 GHz and 2.3 GHz). Experimental tests in an RF anechoic chamber produced exceptional results in a variety of test scenarios. Errors were less than 5° in almost all conditions and less than

2° in a majority of typical cases. The system was able to distinguish between multiple sources with the same center frequency or modulation characteristics and successfully separate independent signals having identical modulation characteristics and center frequencies at different arrival angles.

## Potential Application

With its new hardware implementation, the GIRD algorithm has the potential to deliver high performance for a variety of missions which require wideband DOA.

## Company Impact

“GIRD Systems’ wideband direction finding solution, successfully demonstrated in hardware as part of this SBIR program, is a result of the company’s innovative R&D addressing ways to enhance military electronic systems capabilities,” states David Maldonado, GIRD Systems Director of Business Development. “GIRD is very excited to see that the program success has become the foundation for an extension of the algorithms to address polarization parameter estimation and polarization invariant arrays, leading to an additional contract award. GIRD has over ten years of experience in solving some of the toughest problems faced by the U.S. military. In addition to wideband DOA applications, the company has provided solutions that enable satellite radio communications in presence of in-band interference, and allow continued Global Positioning System (GPS) service from handheld radios in GPS-denied environments. GIRD has a standing commitment to adjust to customer needs. This SBIR effort adds to its proven track record of meeting special needs of the military.”

## Company Contact Information

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