

# Innovation

**SBIR Topic Number:**  
AF06-219

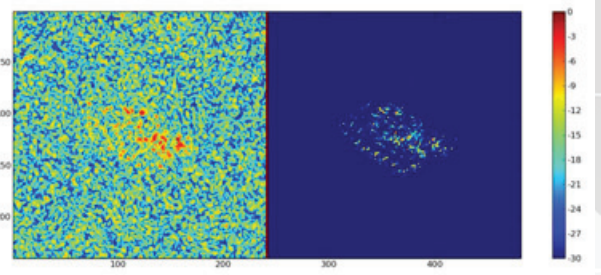
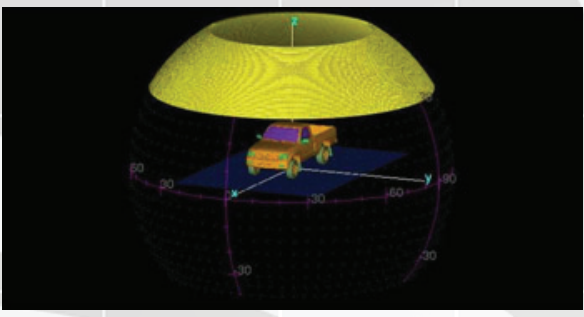
**SBIR Title:**  
Signal Processing and Exploitation for High-Dimensional Synthetic Aperture Radar

**Contract Number:**  
FA8650-07-C-1199

**SBIR Company Name:**  
SET Corporation (now, a Science Applications International Corporation (SAIC) company), Dayton, 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: Visualization of elevation and azimuth angles used in computing simulated monostatic scattering. The viewing sphere is shown with a Tacoma computer-aided design (CAD) model. Right: Least squares regularization and approximate L1-norm regularized reconstruction from sparse Fourier data from the National Ground Intelligence Center (NGIC) T72 chamber data.**

## Physics-Driven Constrained Sparse Inverses for High-Dimensional Synthetic Aperture Radar

- The Air Force needs to develop, test, and analyze signal processing and exploitation techniques for high-dimensional Synthetic Aperture Radar (SAR) data to build a foundation for improving its high-confidence combat identification capability
- SET has a family of exploitation products for 3-D SAR resulting from the technology developed on this SBIR effort, with the initial product focused on military applications and consisting of real-time software for 3-D SAR recovery for the Gotcha Radar Exploitation Program (GREP)
- During this SBIR project, SET Corporation investigated three distinct technologies, i.e., the Civilian Vehicle Radar Data Domes (CVDomes) challenge problem, sparse imaging, and combined SAR and Space Time Adaptive Processing (SAR/STAP) with data rate constraints
- Associated with this first product will be follow-on products that provide assisted or automated target extraction, tracking, localization, and recognition

01-02NOV11/AF06-219

**A**

DISTRIBUTION A:  
Approved for public release; distribution unlimited.

## SBIR Requirement

The need to improve the military combat identification capability is driving an interest in putting more sensed information at the disposal of the image analyst and his exploitation system. Information can be collected by single or multiple platforms and can come in the form of increased bandwidth, multiple polarizations, and enhanced apertures (e.g., wide-angle data) including interferometric and fully two-dimensional (2-D) apertures. This information can be used to characterize a target in 3-D space and to discriminate and recognize it by parts. Further, the Air Force seeks semi-automated, multi-dimensional data visualization and aided target recognition (ATR) systems and components.

The Air Force needs to develop, implement, test, and analyze signal processing and exploitation techniques for high-dimensional Synthetic Aperture Radar (SAR) data to build a foundation for improving its high-confidence combat identification capability.

## SBIR Technology

During this SBIR project, SET Corporation investigated three distinct technologies, listed below, to assess their potential innovations.

- Civilian Vehicle Radar Data Domes (CVDomes) Challenge Problem. SET completed the largest Air Force high-performance computing project to date (72,000 CPU hours) resulting in electromagnetic signature simulation for a set of ten civilian vehicles. The impact allowed the study of target recognition performance as a function of radar parameters and collection geometry. The data set uniquely supports geometries present in the Air Force's Gotcha radar and Angel Fire programs.
- Sparse imaging. In order to form high-resolution radar images from sparse apertures, SET introduced an innovative approach for exploiting parsimony in the image itself. A Bayesian formulation was adopted to express image structure, reducing the data collection requirements. The approach has been adopted in the Defense Advanced Research Projects Agency (DARPA) Knowledge Enhanced Compressive Measurement (KECoM) program and is part of the infusion of so-called "compressive sensing" concepts into numerous Air Force 6.2 (Applied Research) and 6.3 (Advanced Technology Development) programs.

- Combined SAR and Space Time Adaptive Processing (SAR/STAP) processing with Data Rate Constraints. SET introduced a novel radar imaging approach that combines synthetic aperture imaging and space-time adaptive processing. The approach enables combined use of these radar modes in a single system with only one low-rate data channel. The impact is improved high-definition, all-weather tracking of moving vehicles in an urban scene. The novelty is the use of multiple orthogonal waveforms on transmit with a single-antenna receive channel employing chirp processing. The imaging mode has been applied to the Air Force Gotcha radar program.

## Potential Application

SET has a family of exploitation products for 3-D SAR resulting from the technology developed in this SBIR effort. The initial product is aimed at military applications and consists of real-time software for 3-D SAR recovery for the Gotcha Radar Exploitation Program (GREP). This product will be packaged as a processing module on the Gotcha ground station. It will initially provide 3-D representations of SAR scenes and provide a suite of visualization software that will let an analyst view Gotcha data in any desired perspective.

Associated with this first product will be follow-on products that provide assisted or automated target extraction, tracking, localization, and recognition. SET also anticipates developing a software developer kit (SDK) that will allow other contractors to access the extracted 3-D radar data so that they can develop their own exploitation tools for 3-D SAR.

## Company Impact

"SET is a start-up company founded in 2002 by experienced researchers in signal and image understanding with a history of the application of these disciplines to automatic target recognition," states Dr. Majid Nayeri, Senior Scientist, SET Corporation. "SET's objective is to make significant contributions to commercial and military applications that could benefit from rapid advances in the image and signal domains. We strongly believe that winning Phase II SBIR funding is a milestone in our business development strategy and not a business objective in itself. At SET, we are committed to commercializing technology developed through the Department of Defense SBIR program."

SET Corporation was acquired by Science Applications International Corporation (SAIC) in January 2010. SET will operate as a wholly owned SAIC subsidiary, joining the Technology and Advanced Systems Business Unit.



# SBIR/STTR

Air Force SBIR Program  
AFRL/XP  
1864 4th Street  
Wright-Patterson AFB OH 45433

AF SBIR/STTR Program Manager: Augustine Vu  
Website: [www.afsbirsttr.com](http://www.afsbirsttr.com)  
Comm: (800) 222-0336  
Fax: (937) 255-2219  
e-mail: [afrl.xppn.dl.sbir.hq@wpafb.af.mil](mailto:afrl.xppn.dl.sbir.hq@wpafb.af.mil)

