

Airborne ISR at Sandia National Laboratories

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Sandia Airborne ISR: www.sandia.gov/radar/



Overview

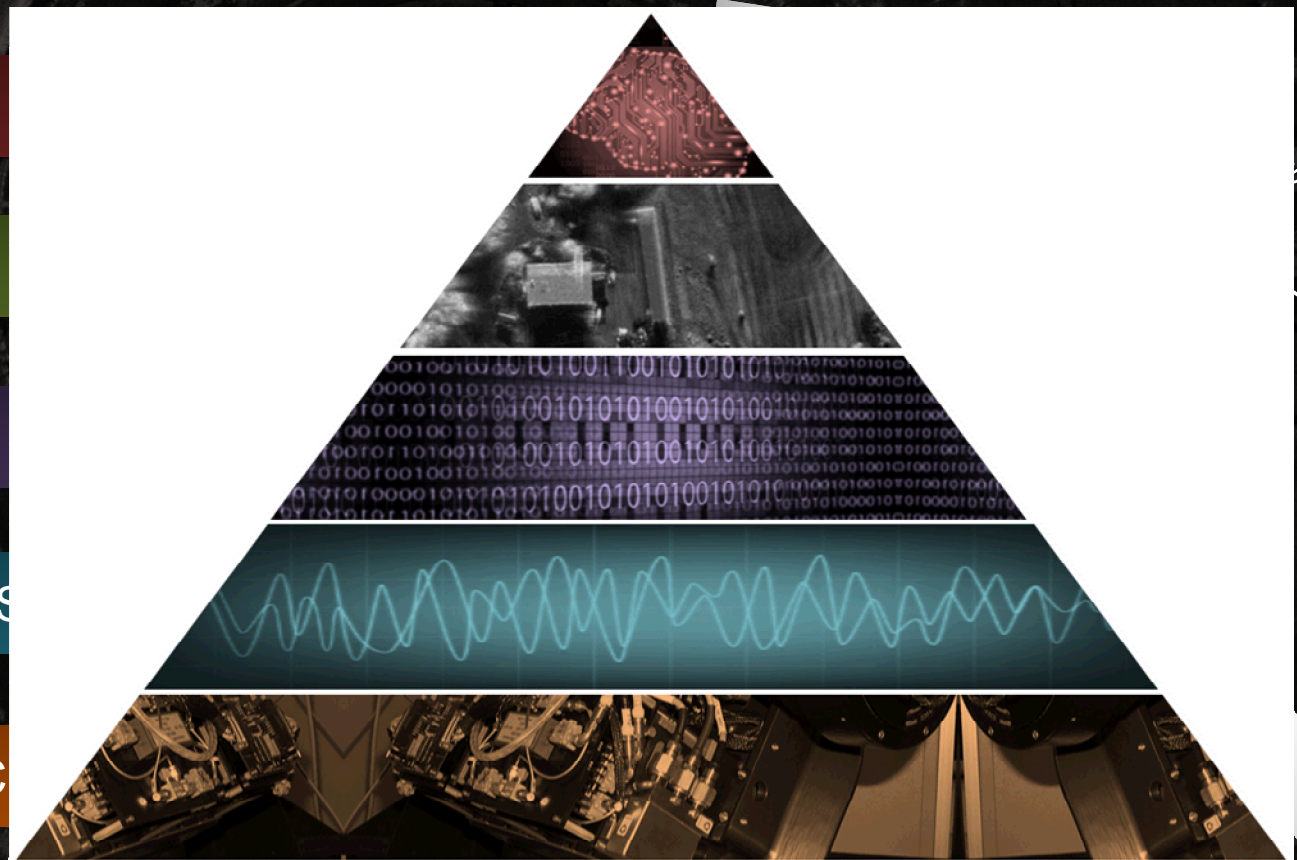
- General Introduction
- New Directions
- Detection and Tracking; Polarimetric Imaging
- Advanced Exploitation and Automation
- Future Radar Directions
- Human Factors
- Advanced SAR Testbed R&D Capability

Airborne ISR at Sandia

Provider of system solutions across the entire Intelligence, Surveillance and Reconnaissance (ISR) architecture



DECISION MAKER



PHYSIC

Pathfinder Airborne ISR Solutions

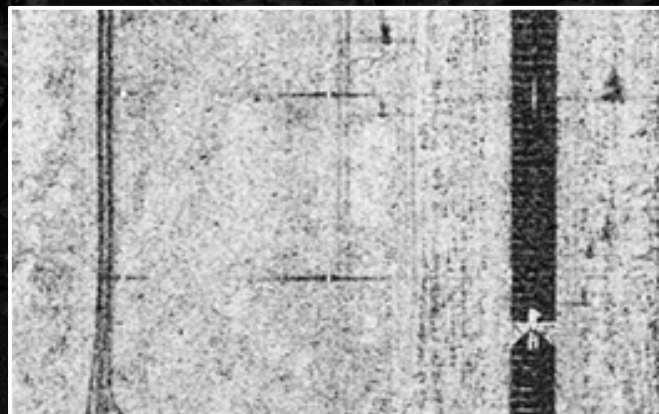
**3+ decades of experience
delivering pathfinder ISR
solutions for complex, critical
and urgent national security
problems (FFRDC)**

- All Weather, Day or Night
- High Resolution, Optical-like
- On-board and Real-time Processing
- Flexible platform and TPED configuration
- HMI analysis and design

***Design, Deliver and Support Systems
Currently Operating Around the World***

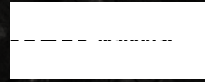


**High Resolution
SAR/VideoSAR**

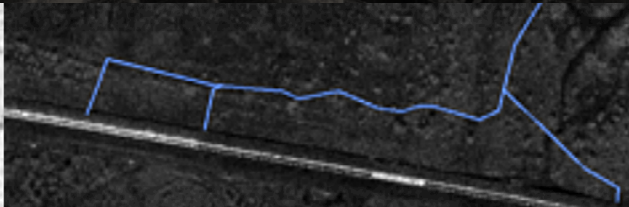


**High Resolution
CCD/VideoCCD**

Real World Applications



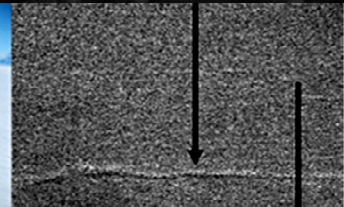
Coherent Change Detection



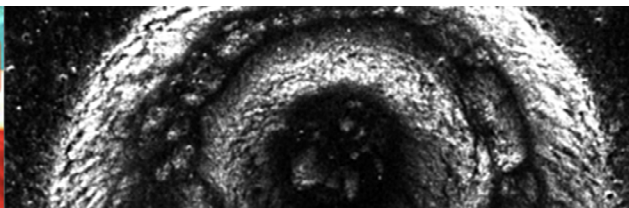
Facilities and Border Protection



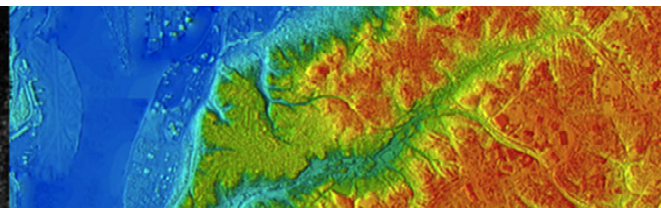
Crevasse Detection



Environmental Monitoring



Earth Sciences



High Res. Terrain Elevation Mapping



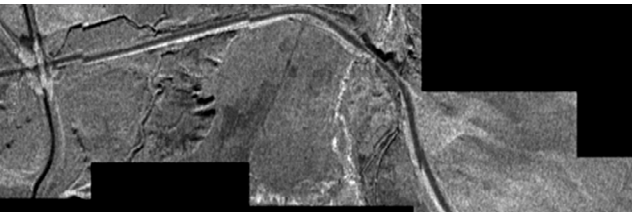
Maritime & Littoral



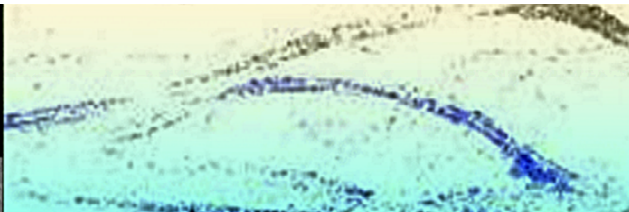
Tracking



S&R and Targeting



C-IED & Route Reconnaissance



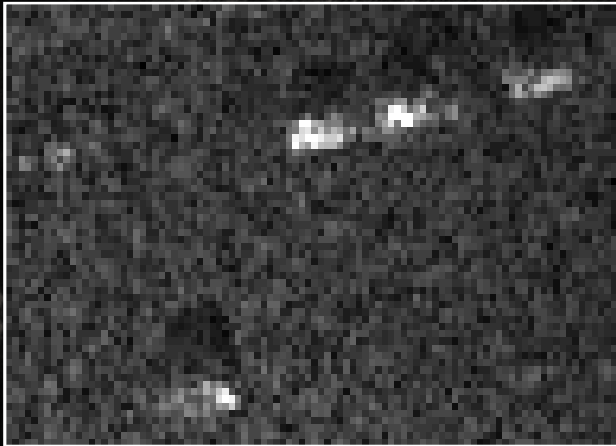
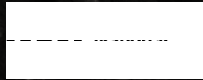
Patterns of Life



Precision Guidance

Since 1997, Sandia radars have been used to address critical military problems in all geographic Unified Combatant Commands (COCOMs)

Resolution Matters



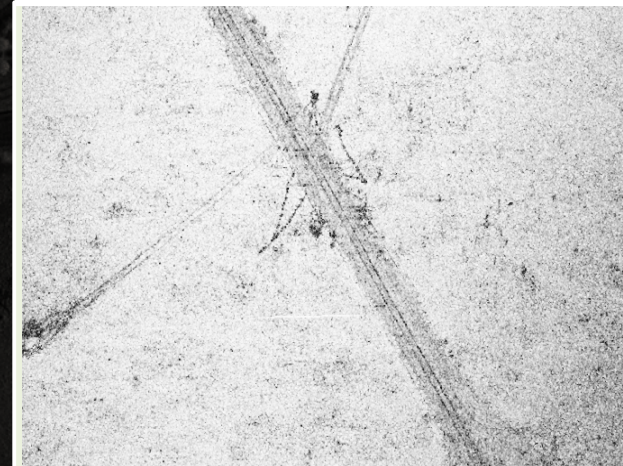
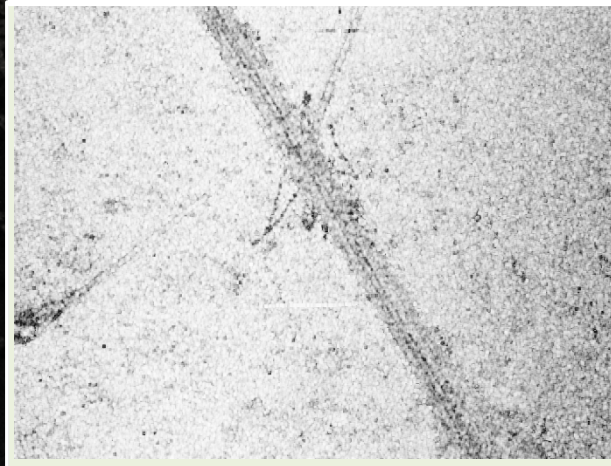
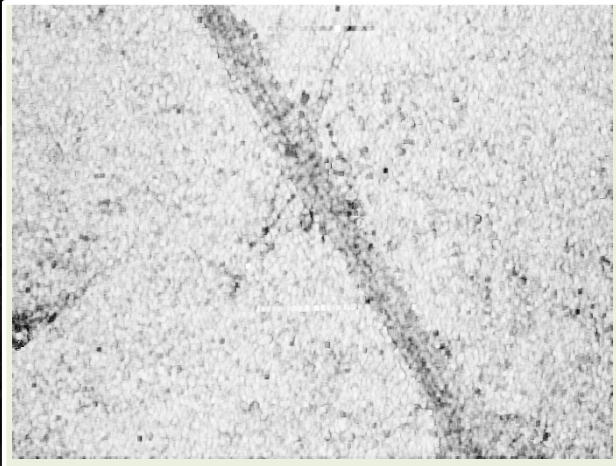
12" resolution



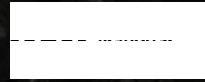
6" resolution



4" resolution

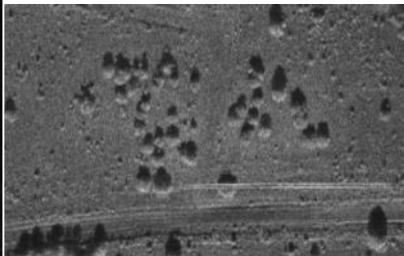


Sandia SAR Image Products

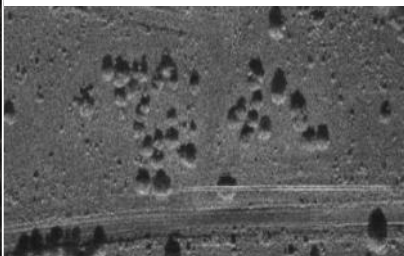


SAR Magnitude Image

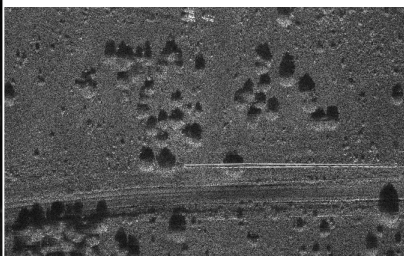
Pass 1: Before Activity



Pass 2: Before Activity



Pass 3: After Activity



Coherent Change Detection (CCD)

is a sensitive technique for identifying subtle differences that occur in a ground scene between two SAR passes

CCD: Reference



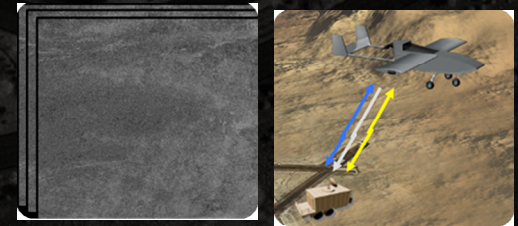
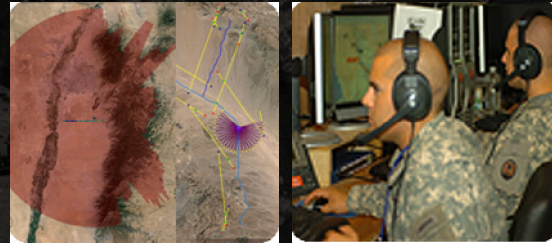
CCD: Post Activity



All products produced on the radar in real-time for analyst-driven exploitation within two minutes.

Complete Mission Solutions

- Provider of end-to-end solutions that leverage physics, engineering, and data and information science to support national security decision making
 - **Mission Engineering**
 - Pre-Mission Analysis & Flight Planning
 - Highly customized TTPs and CONOPs
 - Continuous performance assessments
 - Analyst Training in SAR phenomenology
 - **Real-time Processing**
 - Real-time Delivery of Multiple Image Products to Analysts
 - Image Formation
 - Change Detection Products
 - Transmission of Real-time Products
 - **Advanced Sensor Exploitation and Dissemination**
 - Predictive Intelligence
 - Human-Machine Interface
 - Advanced Exploitation Techniques



SAR imagery integration into PED cycle is difficult at best.

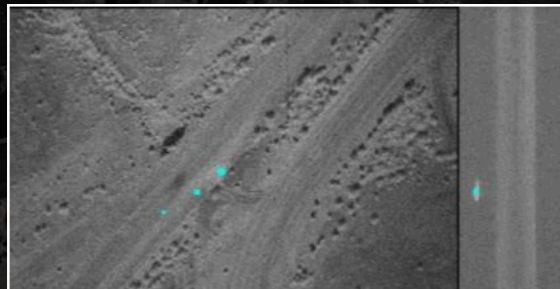
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- Future Radar Directions
- Human Factors
- Advanced SAR Testbed R&D Capability

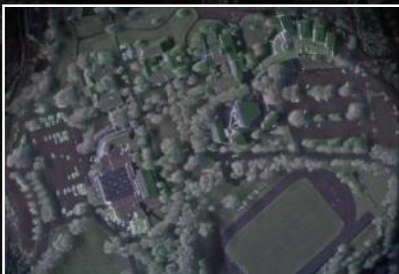
The Future of Sandia's Airborne ISR



Next-GEN RADAR



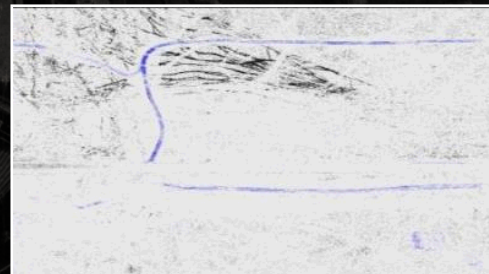
Simultaneous VideoSAR/GMTI



Polarimetric SAR



Human Factors

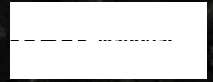


Patterns of Life

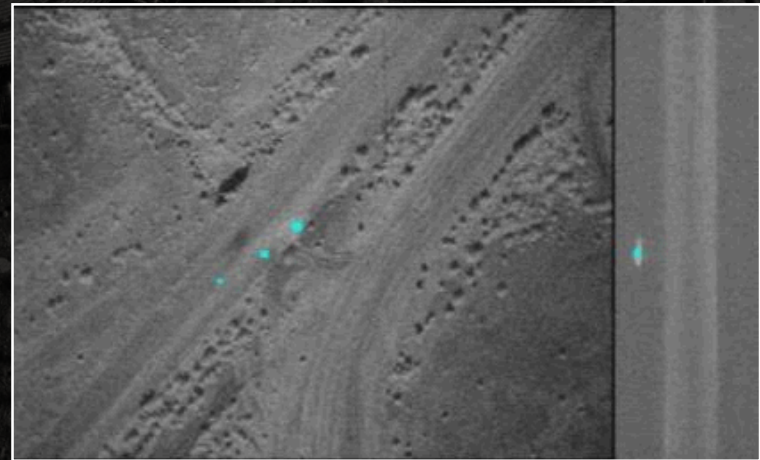
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Collecting Additional RF Physics

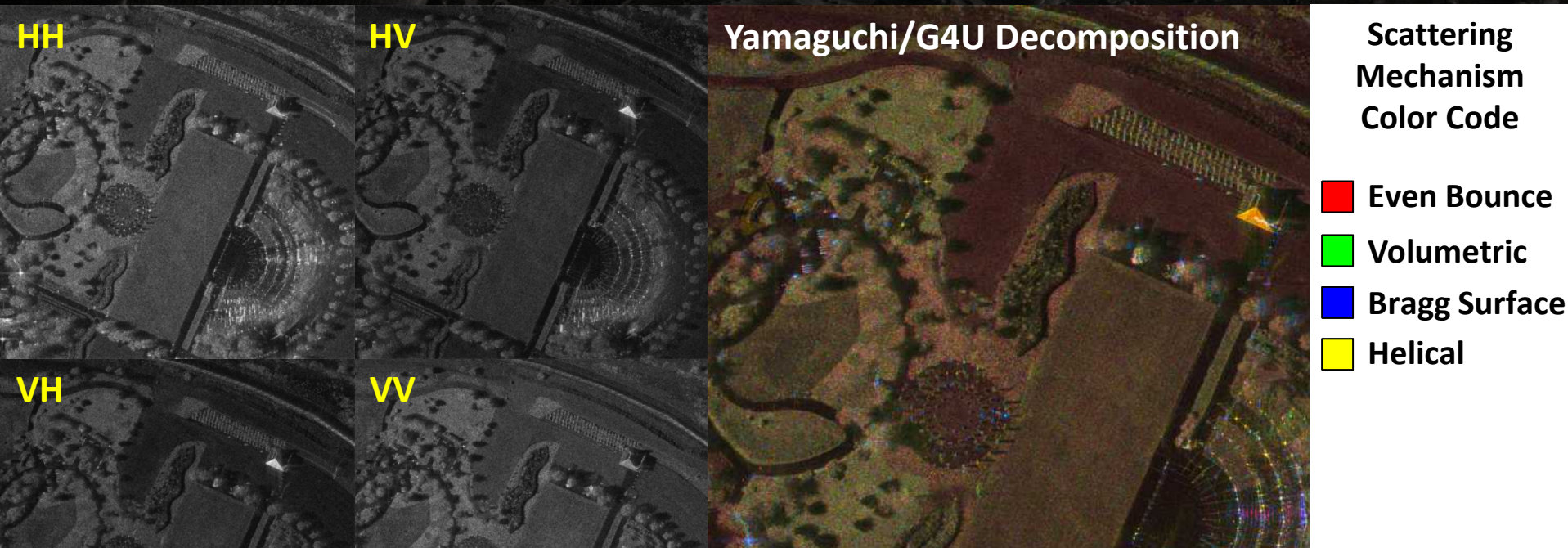


- Multiple channels with the same instantaneous bandwidth.
- Multiple phase centers – sum and difference yield clutter suppression and increased ability to track targets.
- Polarimetric (HH, VV, HV, VH) yields additional information around scattering phenomena.



High Resolution Polarimetric SAR

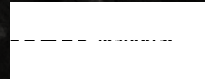
Value in polarimetric SAR is not in visual comparison of individual channel (HH, VV, HV, VH) backscatter intensity maps, but rather in the inference of underlying scattering mechanisms from these independent phase coherent measures.



The underlying scattering mechanism together with the brightness of the scattering adds an information rich dimension to the SAR image products.

SNL FARAD, X Band, 0.2m Full-Pol Imagery of New Mexico Veterans Memorial, Model Based Decomposition Example

Velocity Independent Continuous Tracking Radar (VICTR)



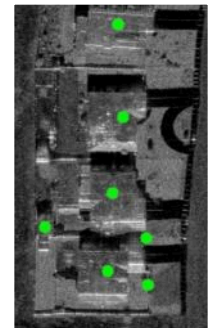
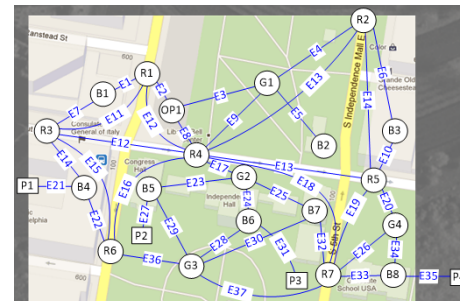
Simultaneous VideoSAR/GMTI with automated tracking

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Automation - SAR Feature Extraction

- Aiding analysis in exploiting massive amounts of SAR image data.
- Moving from pixels to analysis:
 - Augment analyst capabilities through automated query and search of SAR data products.
 - Represent spatial and temporal relationships of scene features in searchable graph.
 - Automate classification of static structures and terrains.
 - Automate detection of ephemeral tracks, disturbances, and vehicle movement.



Raw SAR data

Generate Data Products

Register Data Products

Extract Scene-features

Build Spatio-temporal Graph

Provide Query Capability

Image Analysts

Evaluate Image Quality

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Next Generation Radar

- Multi-Mission RF Architecture
 - Flexible operations in complex electronic environments
 - Multi-Channel Depending on Application
 - Simplified RF Frontend
 - Digital processing at full instantaneous bandwidth of radar
- Applications in Addition to Radar:
 - COMMS
 - SIGNALS (agile waveforms)
 - A2AD (sense, analyze, respond)
- Emerging high-speed digital COTS hardware
 - Decreased hardware costs
 - High-performance, real-time processing for multiple missions will be required.

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Human Factors Issues Permeate ISR

- Human-system integration remains the weakest link in the analytics research-development-deployment process
 - Human factors requirements may not be adequately addressed in acquisitions process.
 - As a result, situation awareness and general ergonomics may not be optimal for the TCPED cycle
 - Sandia is investing in its understanding of the Human-Machine Interface (HMI) in efforts to deliver optimal PED solutions.



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FARAD – SAR R&D Testbed

- An in-house, high-performance, multi-mode airborne radar capability for the continued advancement of SAR ISR capabilities
- FARAD works in accord with R&D efforts, both internal and external, to provide advanced radar airborne data collection and exploitation assets to facilitate specific research goals
- FARAD provides a “testbed laboratory”/research tool set that can be widely utilized in support of internal R&D, new program development, and collection of nationally-important data products.

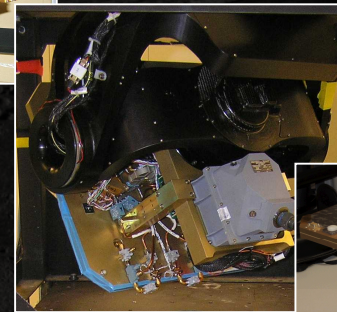
- **PhoeniX**

- X-Band
- Fully polarimetric



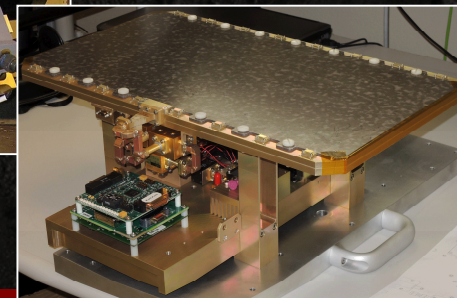
- **Ku-Band**

- Quad-phase-center planar antenna



- **Ka-Band**

- Dual-phase-center planar antenna



An aerial, high-angle photograph of a city, likely Washington D.C., showing a prominent circular structure in the center, possibly a stadium or arena, surrounded by dense urban development. The image is dark and serves as a background for the text.

Questions!