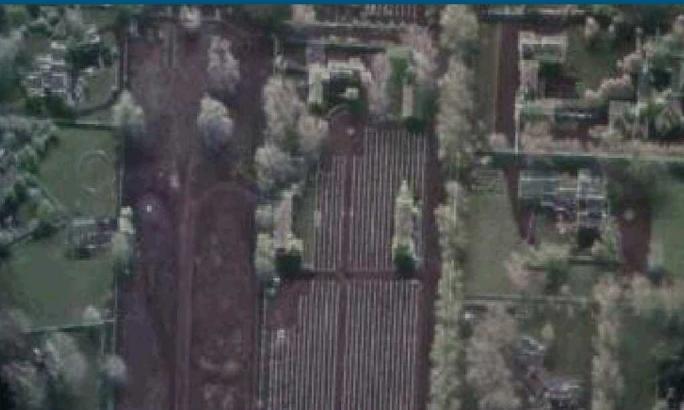


[Sandia.gov/radar](http://Sandia.gov/radar)



# RADAR ISR OVERVIEW

Matthew R. Lewis

Manager, Mission Engineering, Radar ISR Systems

mrlewi@sandia.gov, (505) 844-9318

# Sandia's History

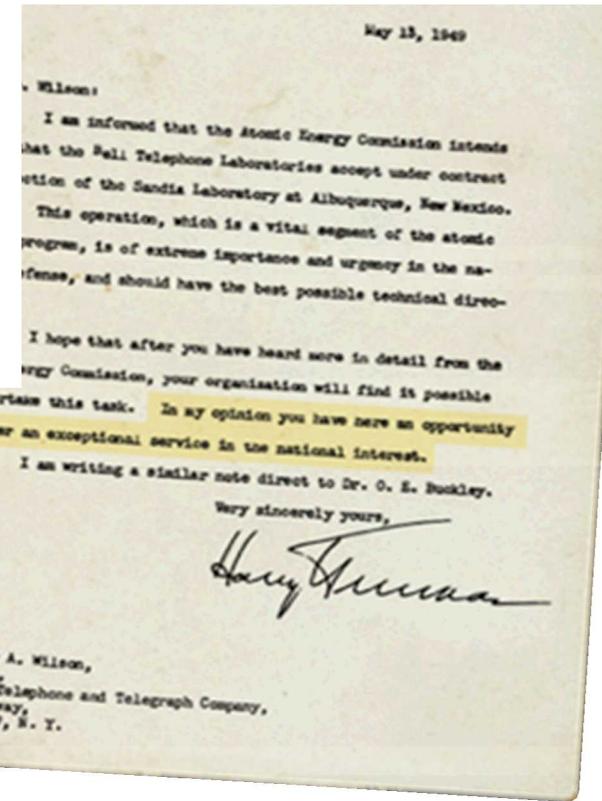
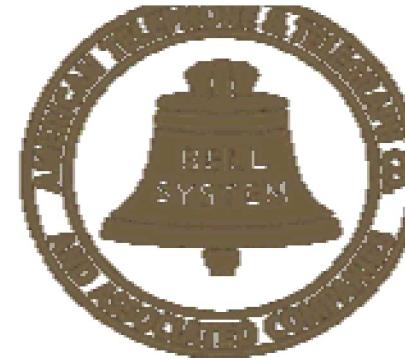
- July 1945: Los Alamos c  
Z Division
- Nonnuclear component  
engineering
- November 1, 1949: Sandia  
Laboratory established

to undertake this task.  
In my opinion you have here an  
opportunity  
to render an exceptional service in the national interest.

to undertake this task.  
In my opinion you have here an  
opportunity  
to render an exceptional service in the national interest.



*Exceptional service in the national interest*



# Governance of Sandia Laboratories

## National Technology and Engineering Solutions of Sandia (NTESS) Corporation



- AT&T: 1949–1993
- Martin Marietta: 1993–1995
- Lockheed Martin: 1995–2017
- Honeywell: 2017- present
- Government owned, contractor operated

### Federally Funded Research and Development Center (FFRDC)

Unique nonprofit entities sponsored and funded by the U.S. government to meet some special long-term research or development need

Sandia is 1 of 39 recognized FFRDCs





## **Mission:**

We develop, deliver and support advanced, high performance RF imaging solutions for the most challenging and urgent national security problems.

## **Vision:**

Be recognized as the leader of innovative RF imaging solutions that support Sandia's national security mission and solve extreme national security challenges through a flexible, world class workforce, broad, robust programmatic engagement, and relevant, cutting edge technologies.

## **Workforce:**

- 89 full time Engineers, Technologists, and support staff.
- 24 patents issued since 2012.

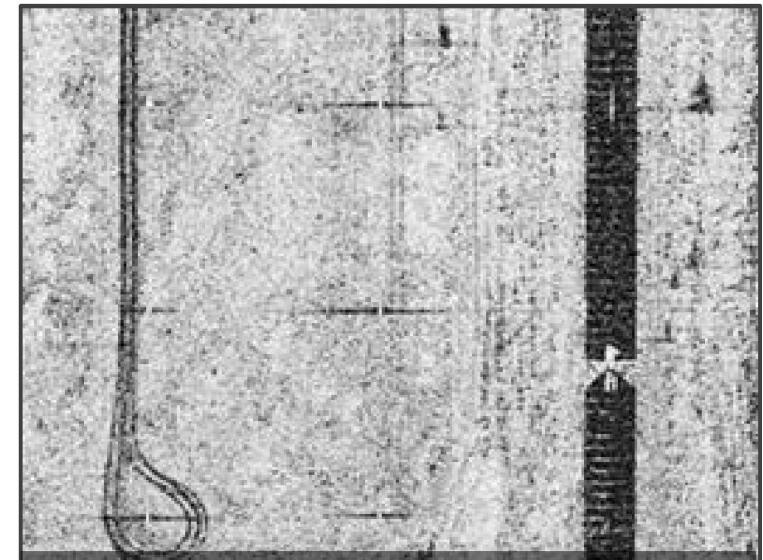
# Pathfinder Radar ISR Solutions

**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

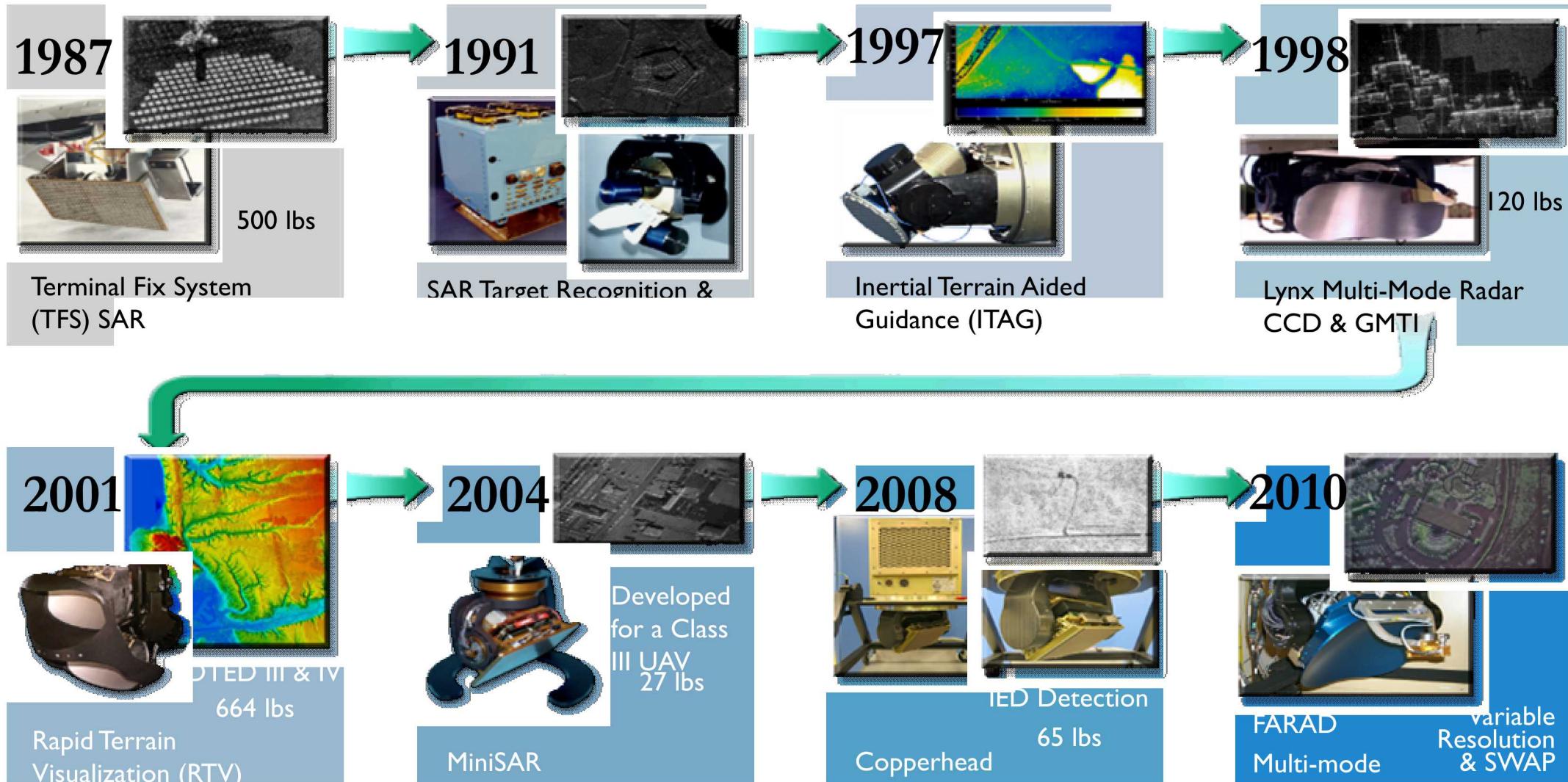


**High Resolution SAR/VideoSAR**



**High Resolution CCD/VideoCCD**

# Sandia Sar Evolution



Improving radar performance & reducing SWAP for three decades

# 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

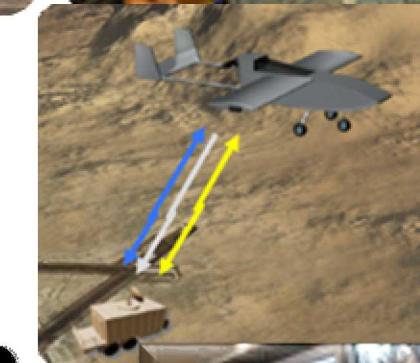
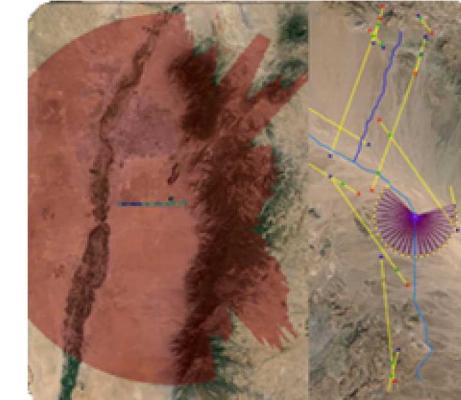
## Real-time Processing

- Real-time Delivery of Multiple Image Products to Analysts
- Image Formation
- Change Detection Products
- Transmission of Real-time Products

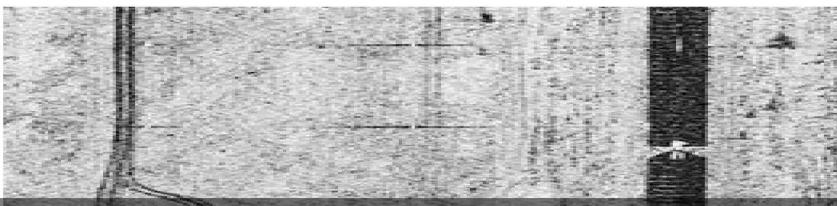
## Advanced Sensor Exploitation

- Predictive Intelligence
- Human Factors
- Advanced Exploitation Techniques

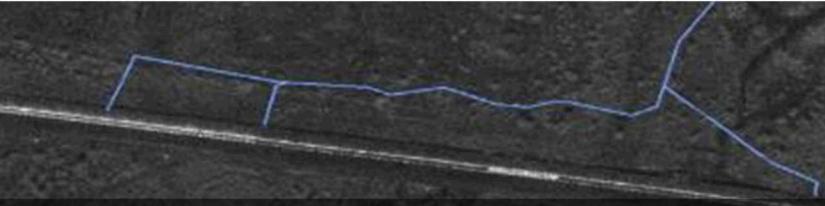
## Analyst Training



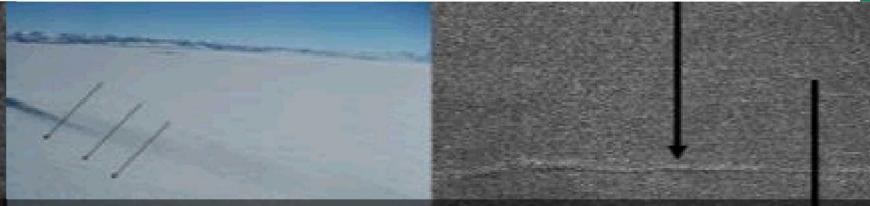
# Real World Applications



**Coherent Change Detection**



**Facilities and Border Protection**



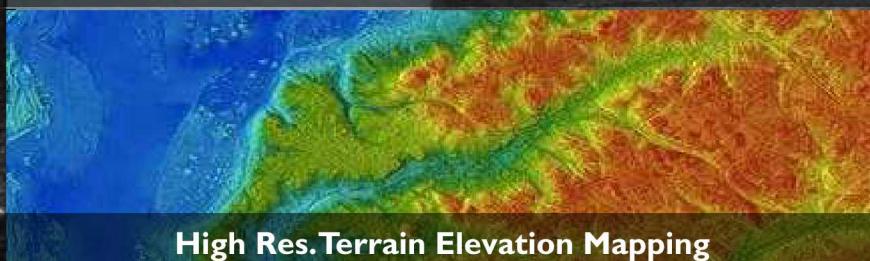
**Crevasse Detection**



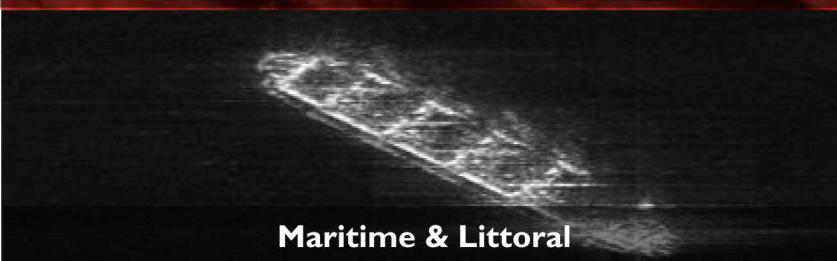
**Environmental Monitoring**



**Space Missions**



**High Res. Terrain Elevation Mapping**



**Maritime & Littoral**



**Advanced Exploitation**



**S&R and Targeting**



**C-IED & Route Reconnaissance**



**Patterns of Life**

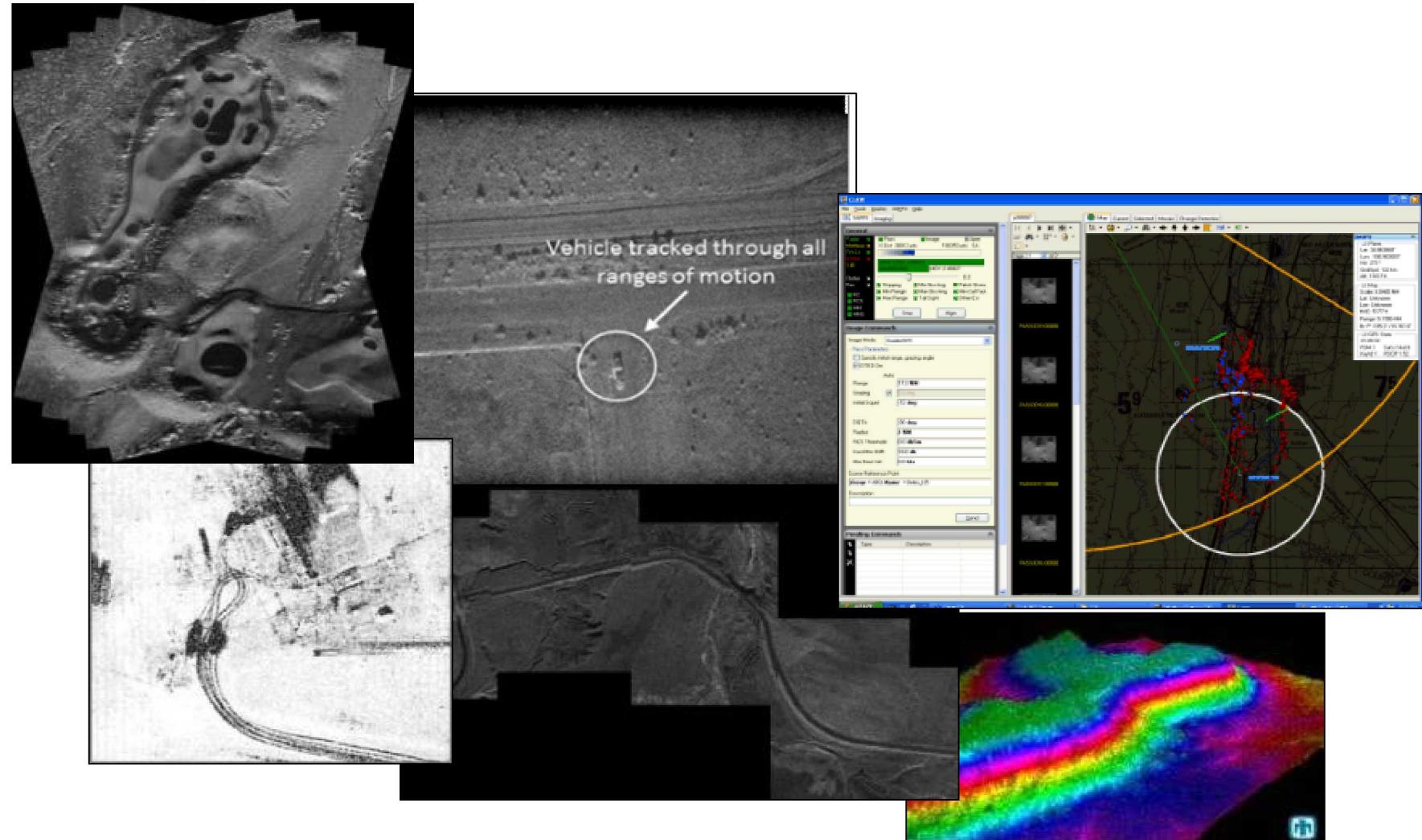


**Precision Guidance**

Since '97, Sandia radars have operated in all geographic COCOMS

# Multi-Mode Functionality

- Spotlight
- SpotDwell
- Circle
- Stripmap
- Arbitrary Stripmap
- CCD/NCP
- IFSAR
- VideoSAR/VICTR
- GMTI/DMTI
- Wide Area Search
- High Range Resolution



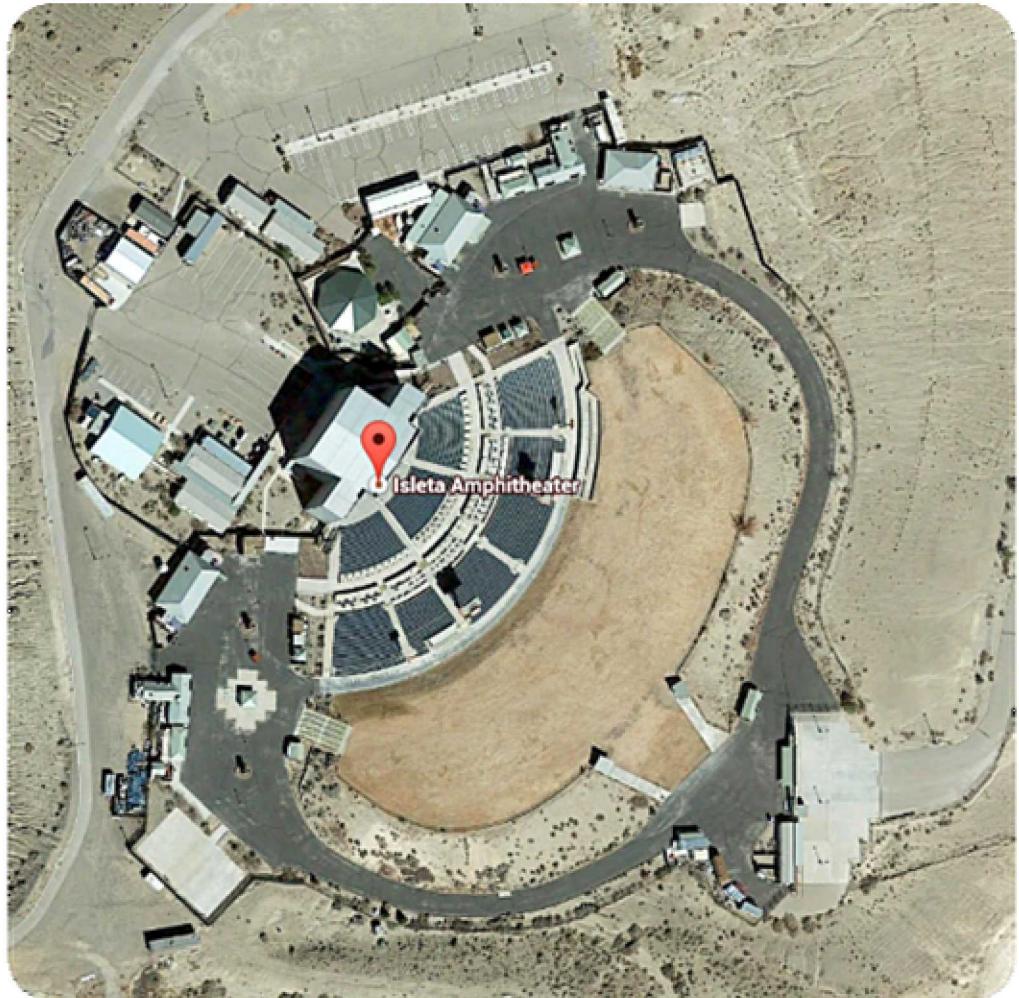
As new radar modes are developed they can be integrated into existing Sandia radars during product improvement phases without redeveloping the entire system

# VideoSAR Vehicles Example

- This is VideoSAR footage of a gate at a facility. The video shows vehicle traffic moving through the gate.
- As the vehicles are in motion their location is indicated by a shadow.
- As the vehicles stop the reflected energy of the vehicles fall on top of the shadow. Once the vehicle continues in motion the shadow is again visible.
- The lines moving across the screen are Doppler shifts caused by the moving vehicles.

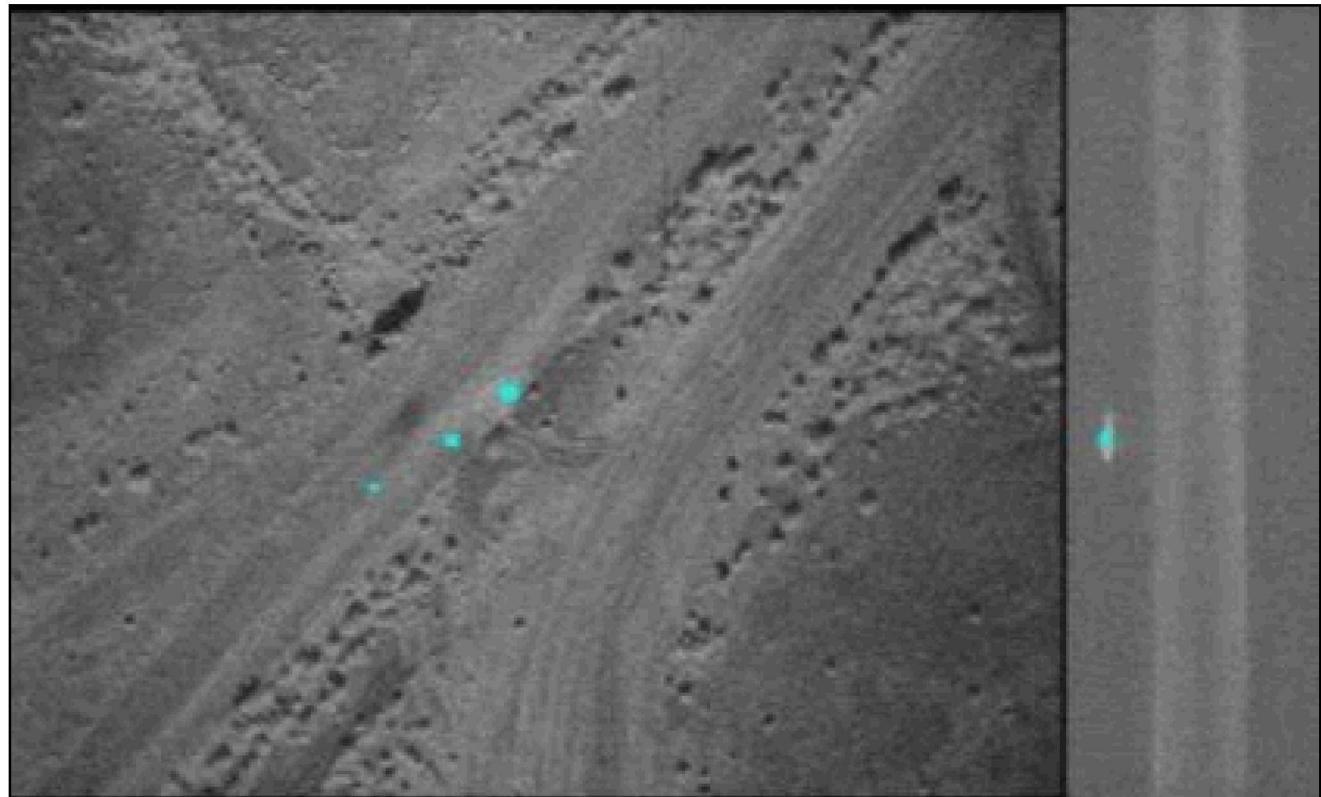


# VideoSAR Facility Example



# Advanced Capabilities

- 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) backscatter intensity maps, but rather in the inference of underlying scattering mechanisms from these independent phase coherent measures



# The Purpose of FARAD

- 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 customer requested data products.



DeHavilland DHC-6 "Twin Otter" research aircraft operated for Sandia by Twin Otter International

# FARAD-SAR R&D Testbed



## PhoeniX

- X-band
- Fully Polarimetric



## Ku-Band

- Quad-phase center planar antenna



## Ka-Band

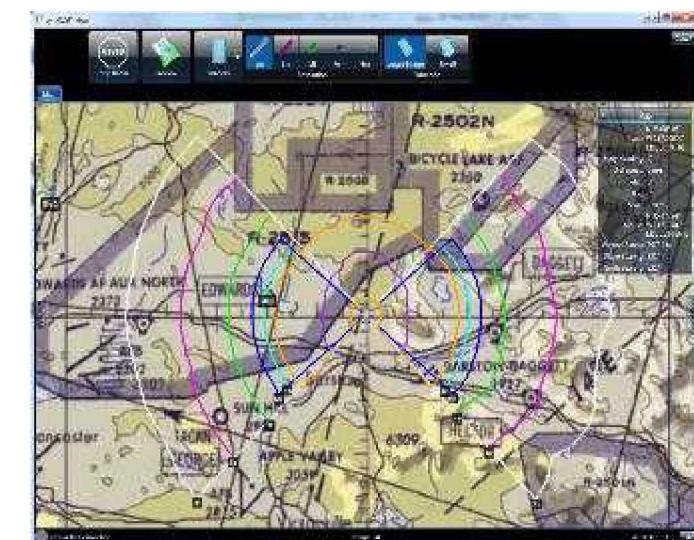
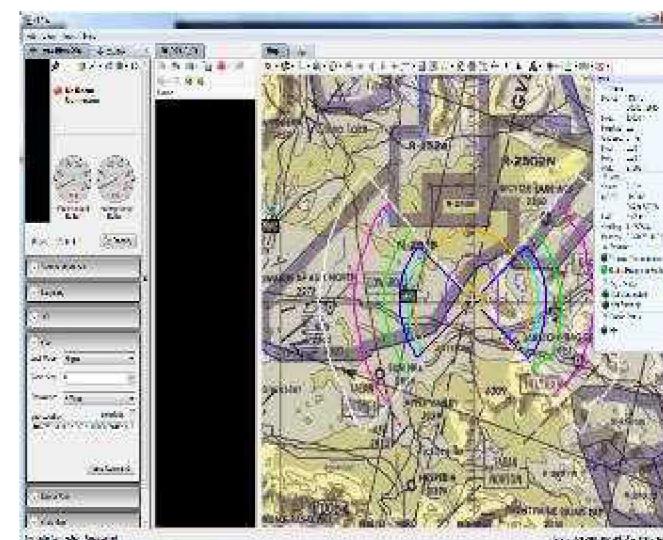
- Dual-phase center planar antenna



# Optimize Human Machine Interface

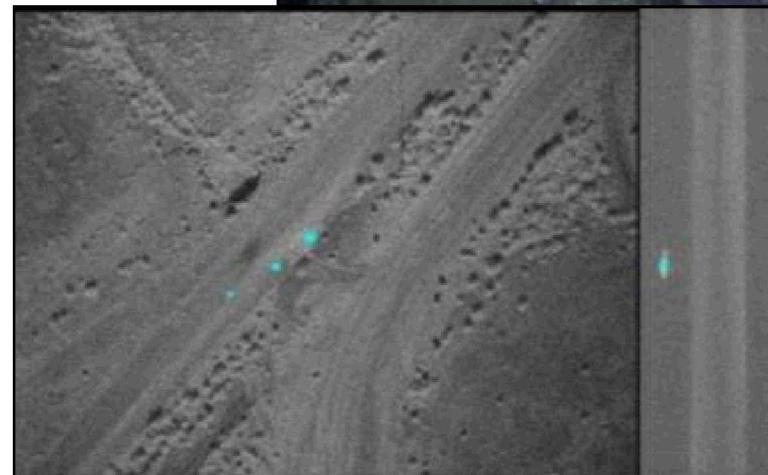
**Human-system integration remains the weakest link in the analytics research-development-deployment process**

- Human factors requirements may not be adequately addressed in acquisitions process
- Sandia is investing in its understanding of the Human-Machine Interface in efforts to deliver optimal Processing, Exploitation, and Dissemination solutions



# Radar Modernization

- VPX Multi-Channel for All Sandia Designed, Delivered and Deployed Radars
- More physics – more information
- Drive down costs
- Enables collection of a broader set of physics:
- Enhanced Coherent Change Detection
- Maritime Situational Awareness
- Mover Detection
- Tracking Capabilities
- Other
- Common hardware and software base
- Encompassing various SWAP configurations
- In progress



# Next Generation + I Radar Concept

- Cognitive Digital Radar
- 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
- A2AD (sense, analyze, respond)
- Emerging high-speed digital COTS hardware
- Decreased hardware costs
- High-performance, real-time