BRIDGING DARPA THE GAP

Counter Underground Facilities

Greg Duckworth

Deep facilities

Unimproved caves

"Spider" holes

Cut and cover facilities
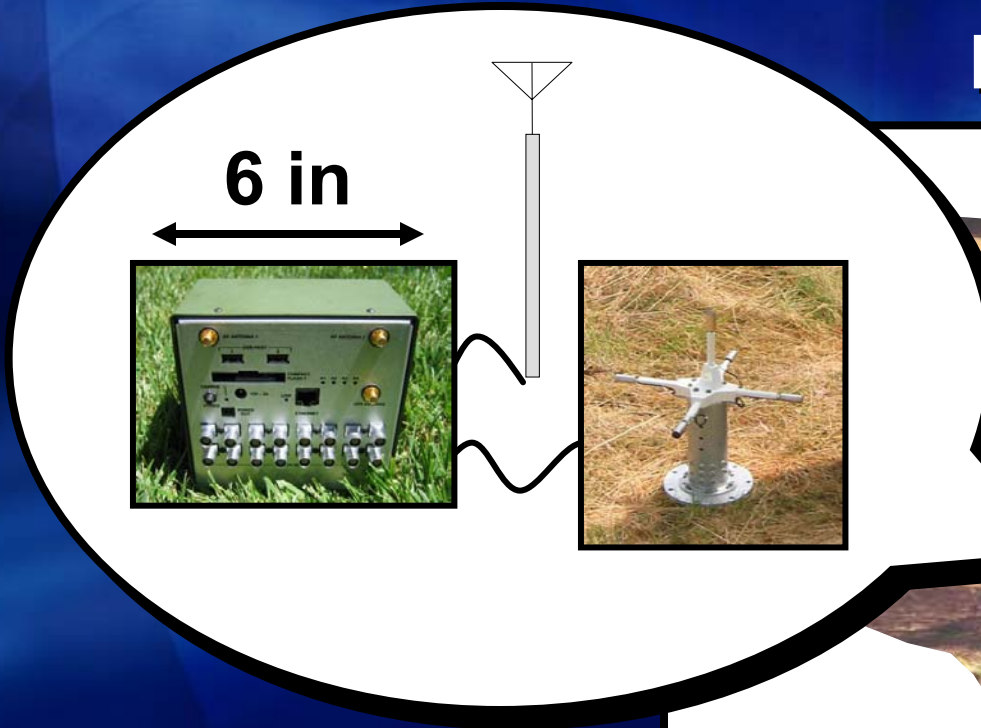
Urban facilities and interconnects

PASEM:

Passive Acoustic, Seismic, and Electromagnetic Monitoring

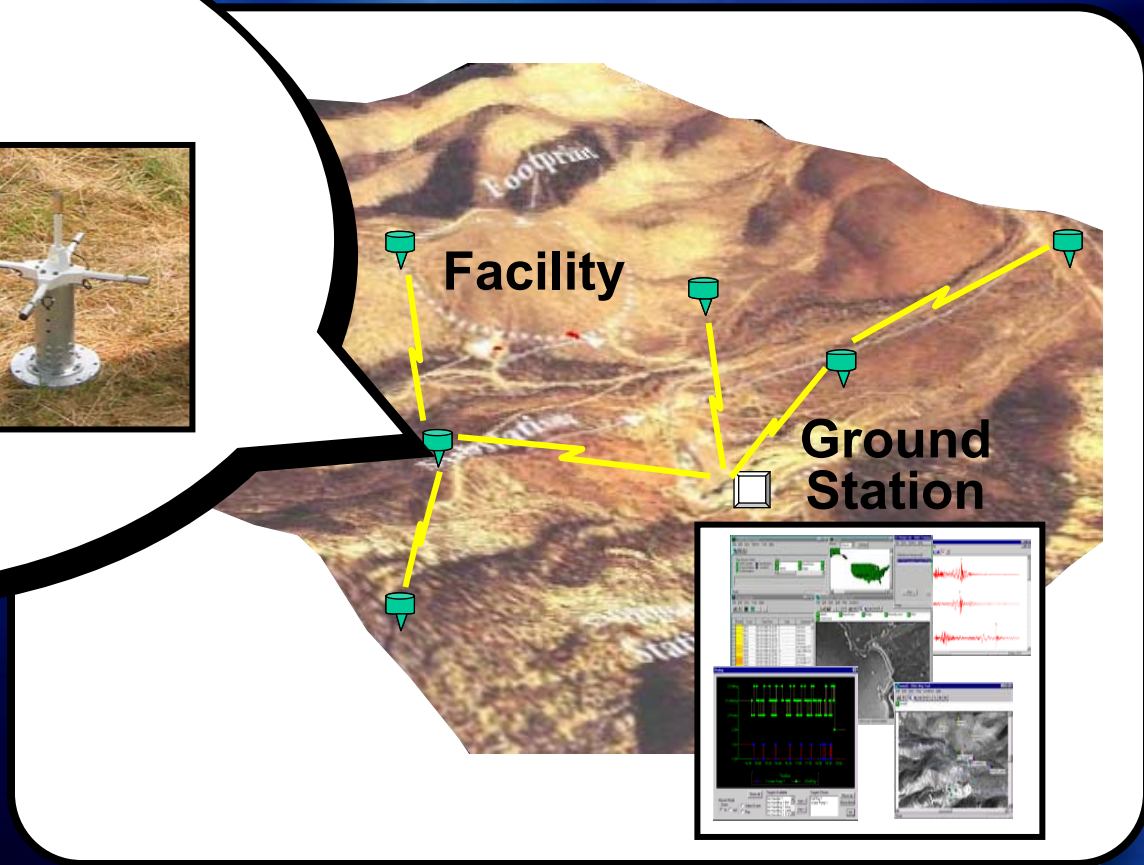Exploits the signals emitted by activities
within the Underground Facility (UGF)

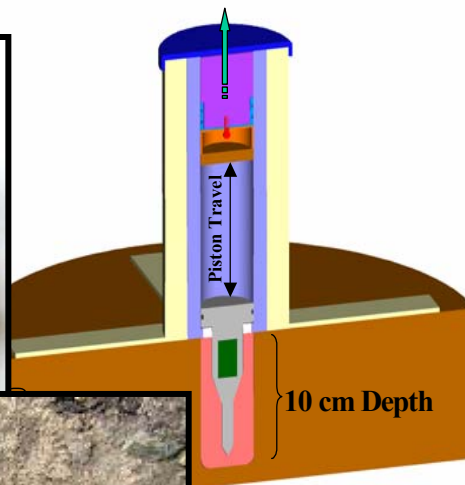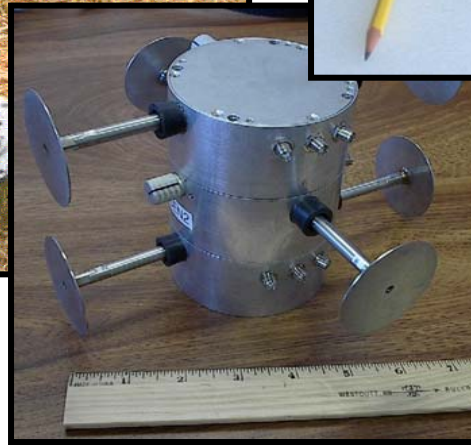# CUGF Ground Sensor System - Functional Prototype

Prototype Sensor Node

6 in

Network of Nodes

Facility

Ground Station
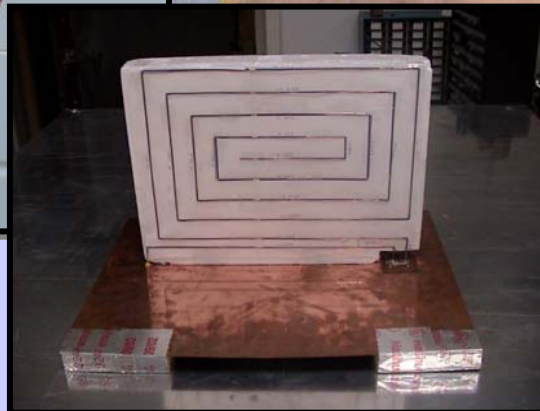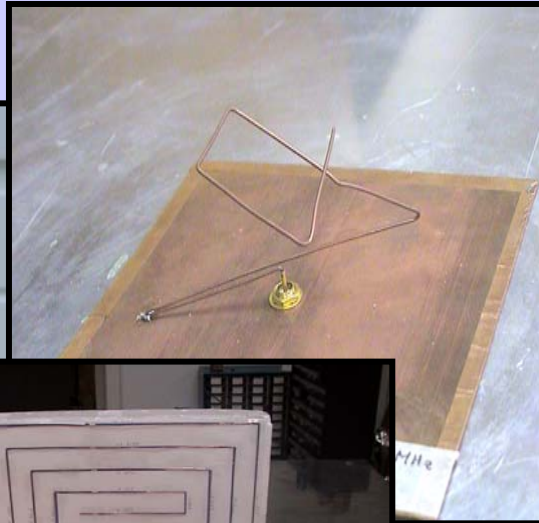
Robust Geophone Coupling

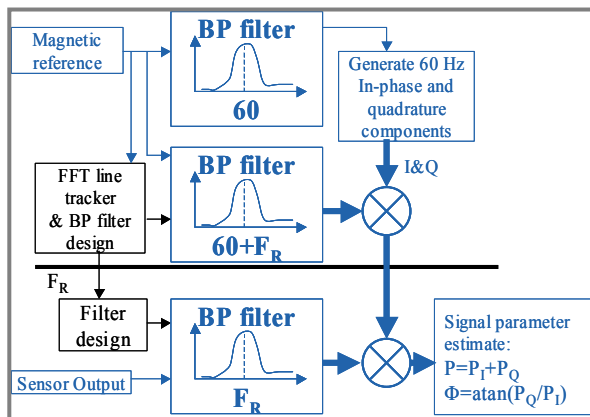Piston Travel

10 cm Depth

Advanced EM Sensors
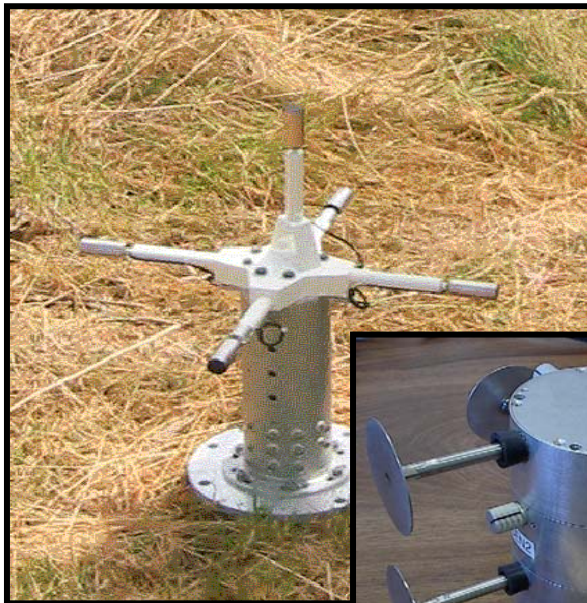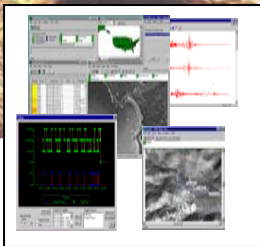
Coherent Signal Processing

NLOS Antennas

Small "N" systems
High performance sensors

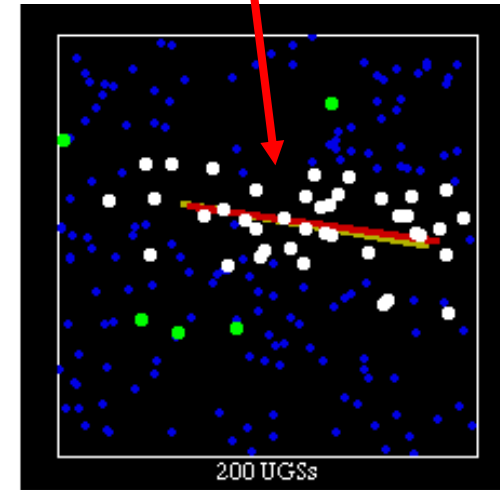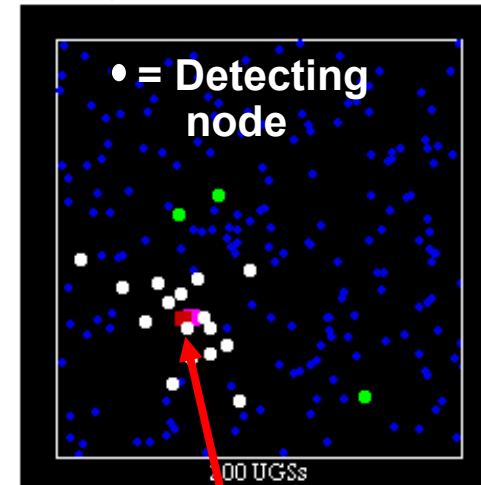

Facility

Ground Station

Magnetic reference

BP filter 60

Generate 60 Hz In-phase and quadrature components

FFT line tracker & BP filter design

BP filter 60+F_R

I&Q

F_R

Filter design

Sensor Output

BP filter F_R

Signal parameter estimate:
$P=P_I+P_Q$
$\Phi=atan(P_Q/P_I)$

Small "N" systems
High performance sensors

Facility

Ground Station

Magnetic reference	
BP filter 60	Generate 60 Hz In-phase and quadrature components
FFT line tracker & BP filter design	
BP filter 60+F_R	I&Q
F_R	
Filter design	
Sensor Output	**BP filter** F_R	Signal parameter estimate: $P=P_I+P_Q$ $\Phi=atan(P_Q/P_I)$

Large "N" systems
μ-sensors

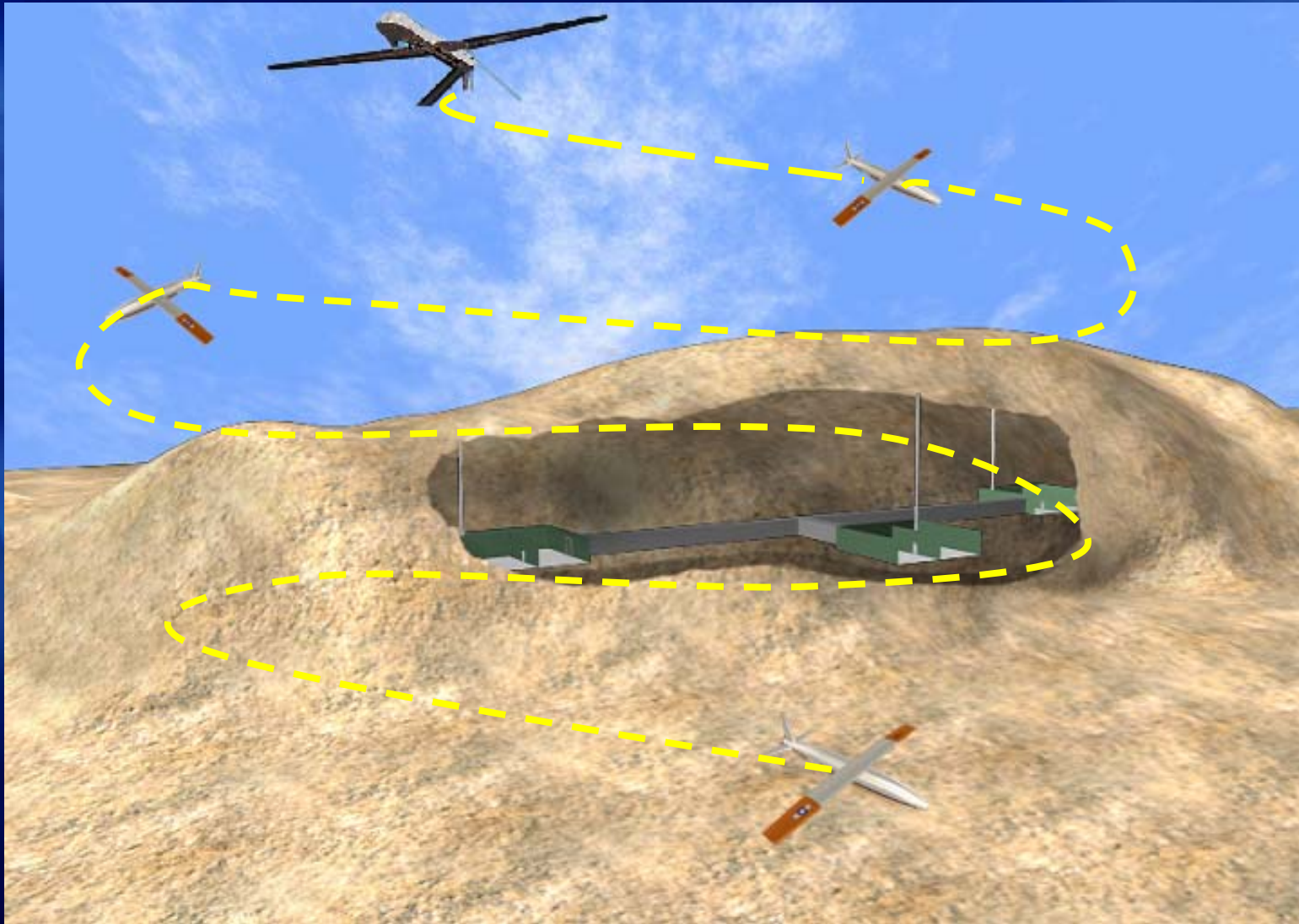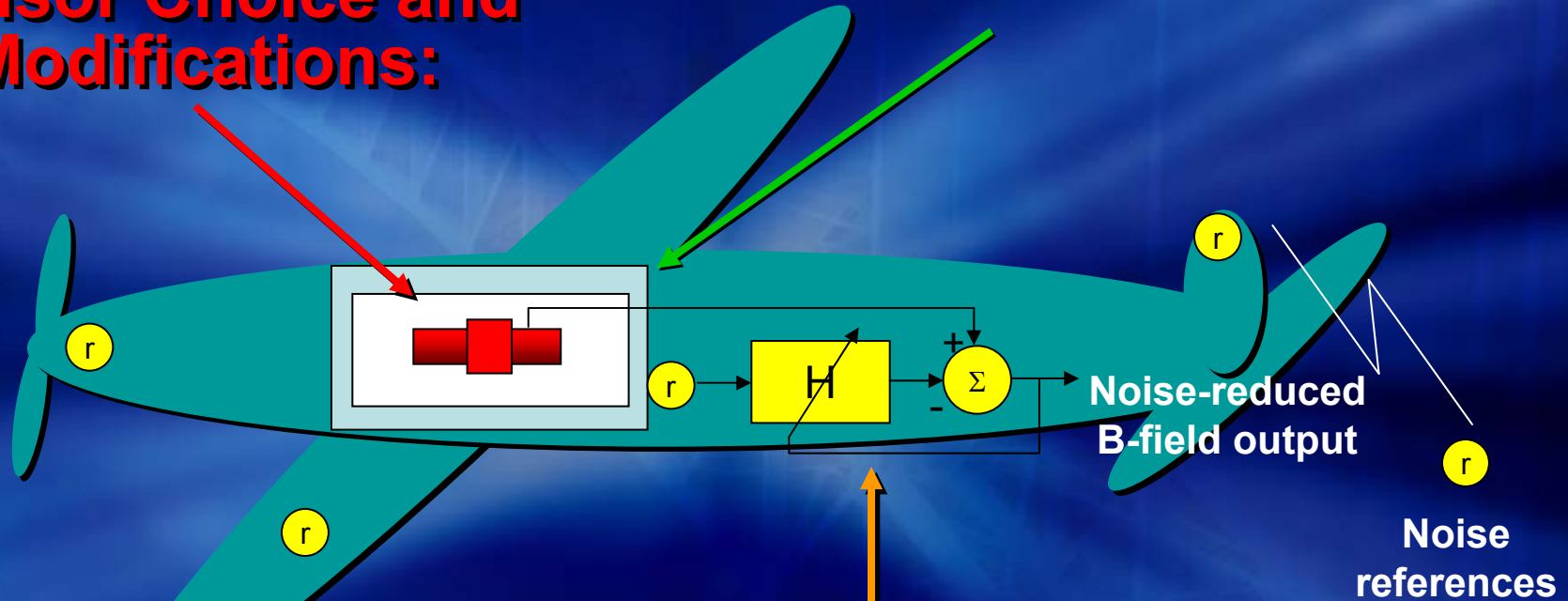$\bullet$ = Detecting node

200 UGSs

Facility

200 UGSs

LAASS
Low-Altitude Airborne Sensor System

EM noise mitigation approaches

Sensor Choice and Modifications:

Passive Vibration Isolation

r r Σ r r

Noise-reduced B-field output

Noise references
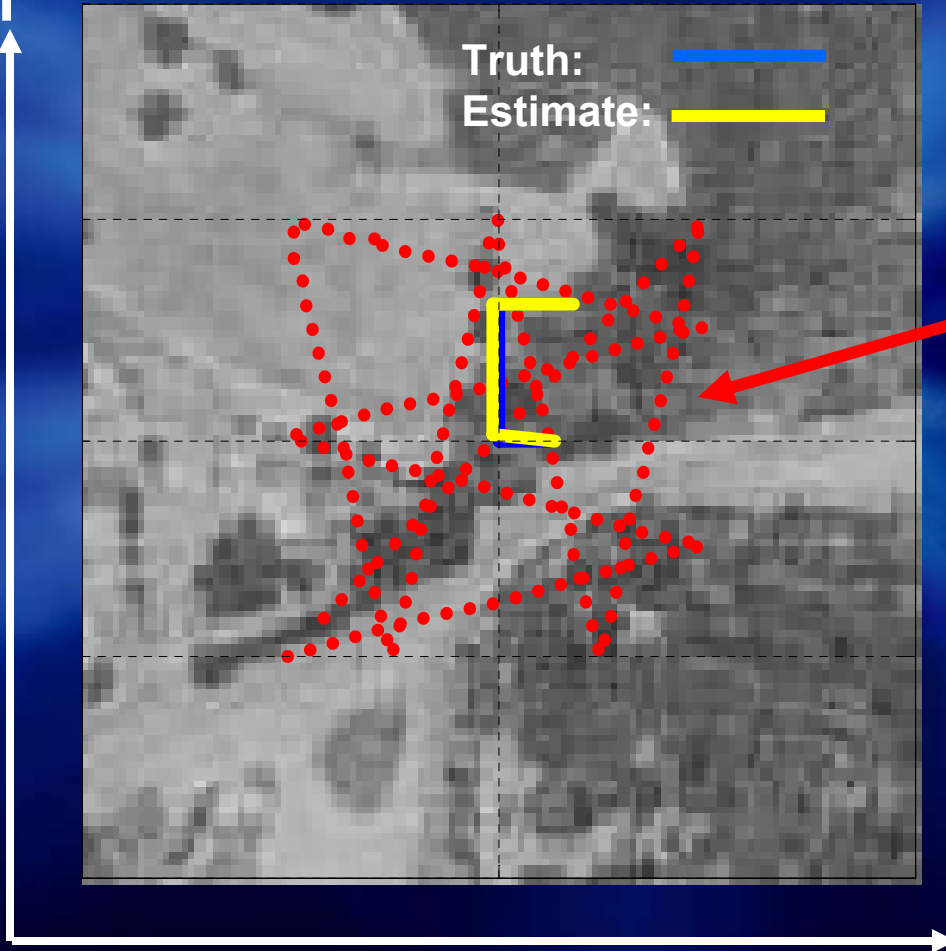
Active Electronic Noise Cancellation

Platform Choice and Modifications

LAASS EM Inversion Problem

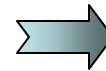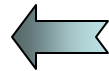**Parametric inversion of EM sources at depth**

North

Truth:
Estimate:

Flight Paths

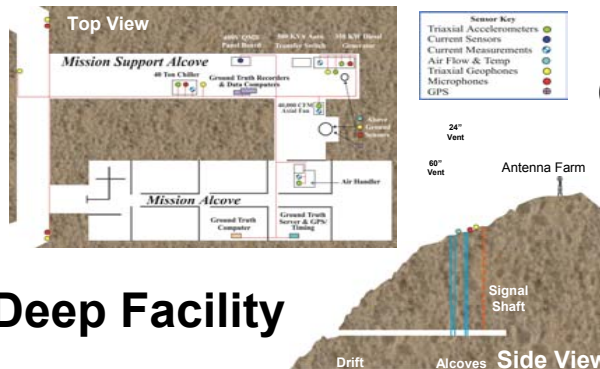East

LAASS
Data Collection and Proof-of-Principle Demo
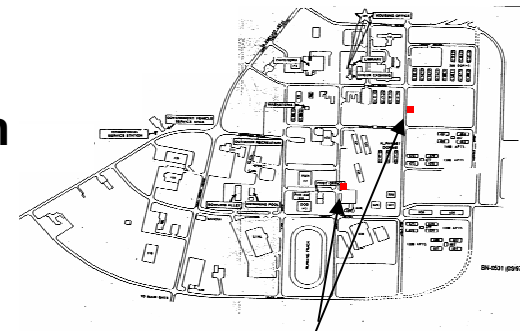

Rural Site

"Urban" Site
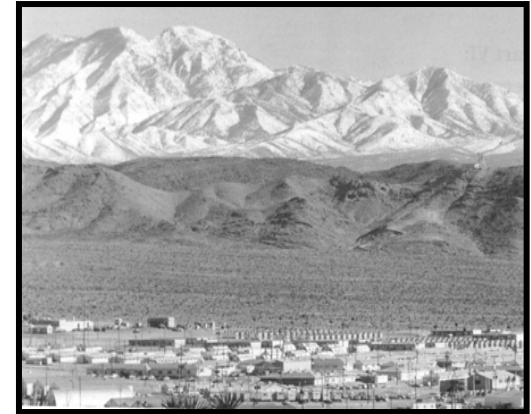
Ground Truth Sensors

Collection Platform

Deep Facility

Generators/Ground Truth Sensors

Interconnect Assessment
Strategic and Tactical Applications

Example Data for Tracer Gas Detection

Scene-Based Gas Estimation

Spectral Radiance Data

Thermal Infrared Composite Scene

Detection of Tracer Gas at Remote Building

Tracer Gas Release Site

Deep facilities

Unimproved caves

"Spider" holes

Cut and cover facilities

Urban facilities and interconnects