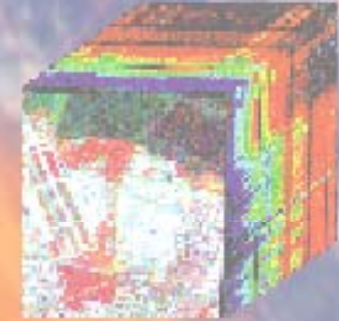




Geo*View

A

Visualization and Spectral Analysis Tool



**Air Force Research Laboratory
PAR Government Systems Corporation
LPA Systems Inc**



Discussion Topics



- **Geo*View Overview**
- **Spectral Analysis Functionality**
- **Chem-Bio Application Highlights**
- **EPA Data Collection Results**
- **Summary & Conclusions**

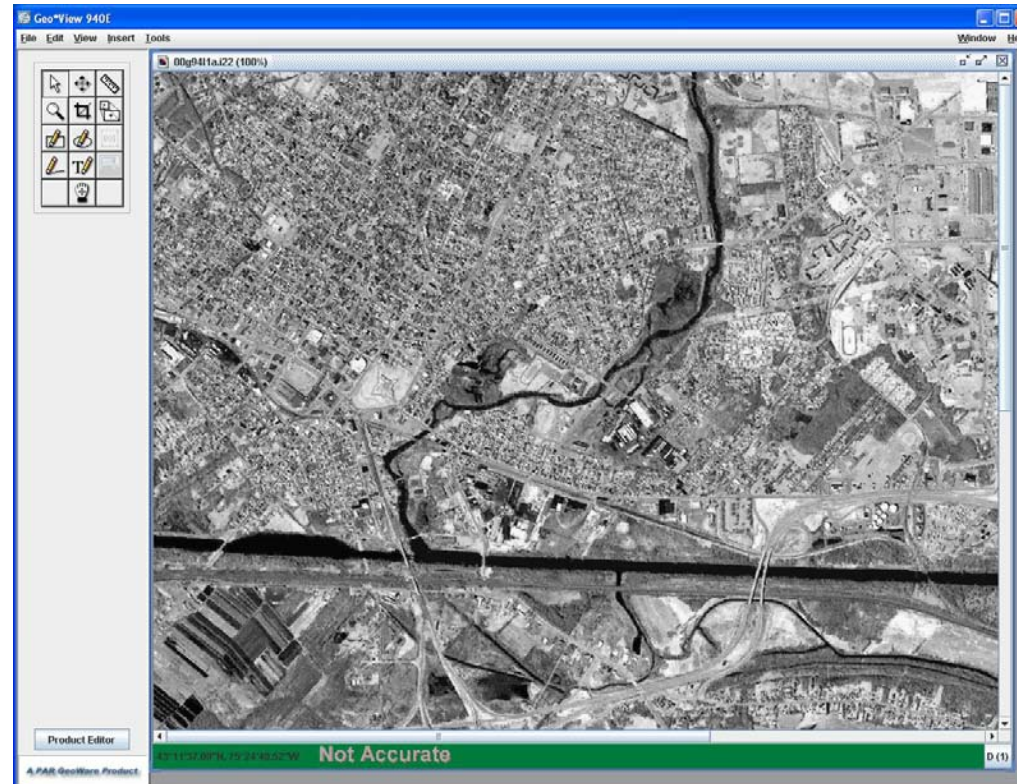


Geo*View



General Functions

- Zoom
- Pan
- Crop
- Text & Graphics
- Measure
- Geo-Coordinates



Features

- Easy to Use, Point & Click Oriented, Platform Independent
- DOD & Commercial Imagery Formats
- MPEG2/Predator Video Player, Mosaicker & Frame Grabber
- NITF Certified Complexity Level 7 Viewer with Meta Data Editor
- Hyperspectral Analysis



Geo*View – Spectral Analysis

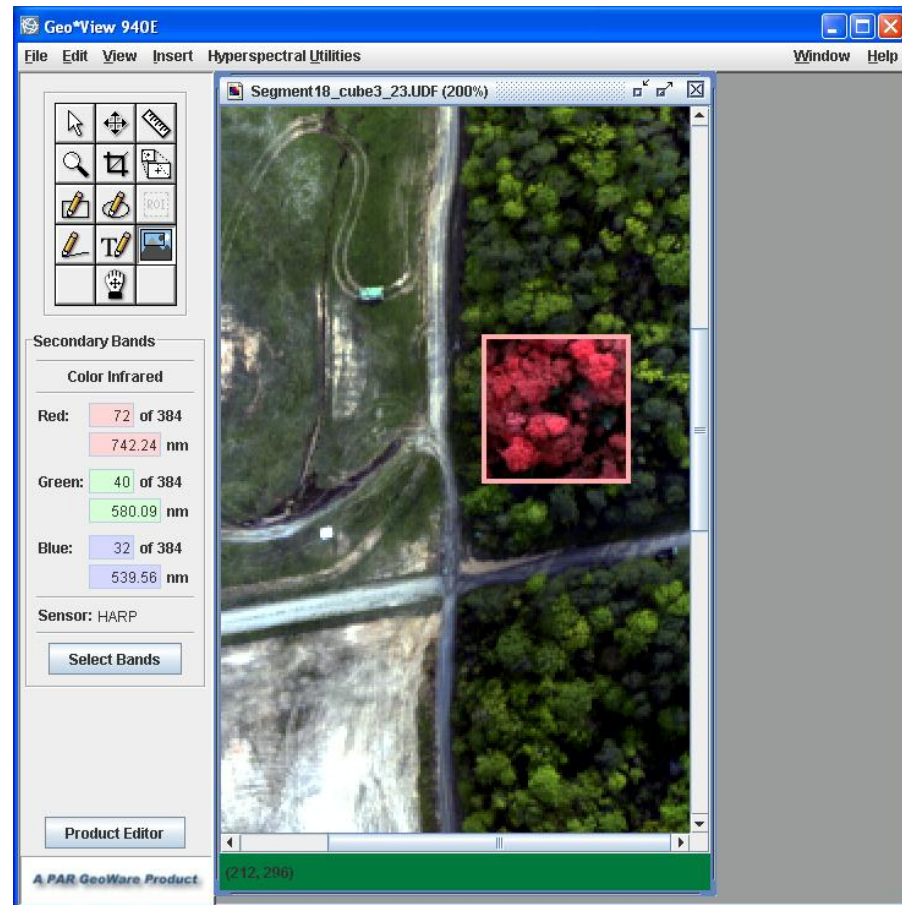


Hyperspectral Visualization & Spectral Exploitation (HyperVISE)

- Automated Band Selection
- 11 Pre-Set Combinations for Primary & Secondary View Ports
- Resizable Floating Monocle with Alternate Band Combinations
- Hyperspectral Plug-ins for Anomaly Detection and Spectral Matched Filtering

Other Features

- Spectral Analysis and Management System (SAMS) Local Spectral Library
- Band Reduction/Band Aggregation
- Empirical Line Method Atmospheric Correction
- Pixel Classification





SAMS Local Signature Library



SAMS - C:\Projects\TEMP.samsdb

Database Selected Plot Help

Right-click for options

- imported
 - Rocks
 - vegetation
 - ACTINOLITE_IN-4A
 - ALBITE_TS-6A
 - ALUNITE_SO-4A
 - AMBLYGONITE_P-
 - ANALCIME_TS-18A
 - ANDESINE_TS-4A
 - ANGLESITE_SO-1
 - ANHYDRITE_SO-1
 - ANORTHITE_TS-5A**
 - ANTHOPHYLLITE_
 - ANTLERITE_SO-1
 - APATITE_P-1A.spc
 - APHTHALITE_SO
 - ARSENOPYRITE_S
 - ATACAMITE_H-4A
 - AUGITE_IN-15A.spc
 - AZURITE_C-12A.spc
 - AZURITE_C-12A.b
 - BARITE_SO-3A.spc
 - BERYL_CS-2A.spc
 - BIOTITE_PS-23A.spc

Spectra table

Sort Filter

location	name	status	foo	bar	green	super
/imported/veg...	grass.bt_1	good	jjj			calafragilistic...
/imported/veg...	ANATASE_S...	good				calafragilistic...
/imported/Ro...	schist4c.bt_1	good				calafragilistic...

Plot print reset format fill x y c

Reflectance

Wavelength

/imported/ANORTHITE_TS-5A.spc

Signature selection: /imported/ANORTHITE_TS-5A.spc

Reference signature: None

Focused: /imported/ANORTHITE_TS-5A.spc

Group selection: None

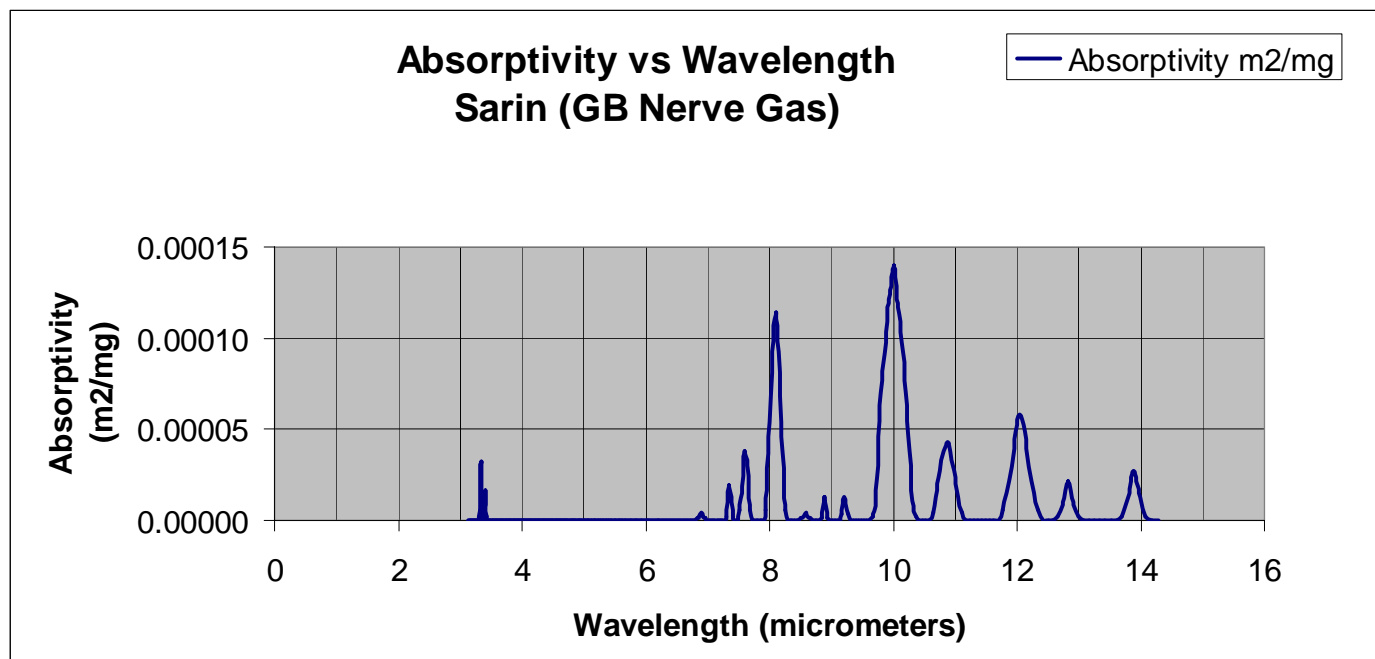
Clipboard: None



Chem-Bio Application Highlights



- Investigated Spectral Analysis techniques in LWIR Hyperspectral Region for the Detection & Identification of Various Chemical Agents
- Assessed Black Body Regions for Absorption Effects Produced by Agents at Different Concentration Levels
 - SARIN Nerve Gas (100 mg min/m³ ~ 10 ppm for 8 minutes)
 - SOMAN Nerve Gas (50 mg min/m³ ~ 10 ppm for 4 minutes)

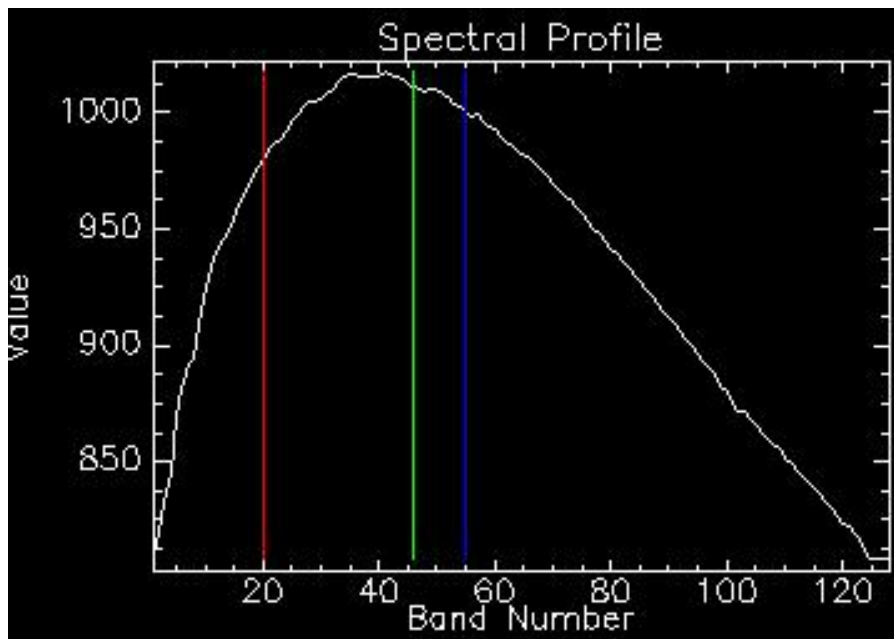




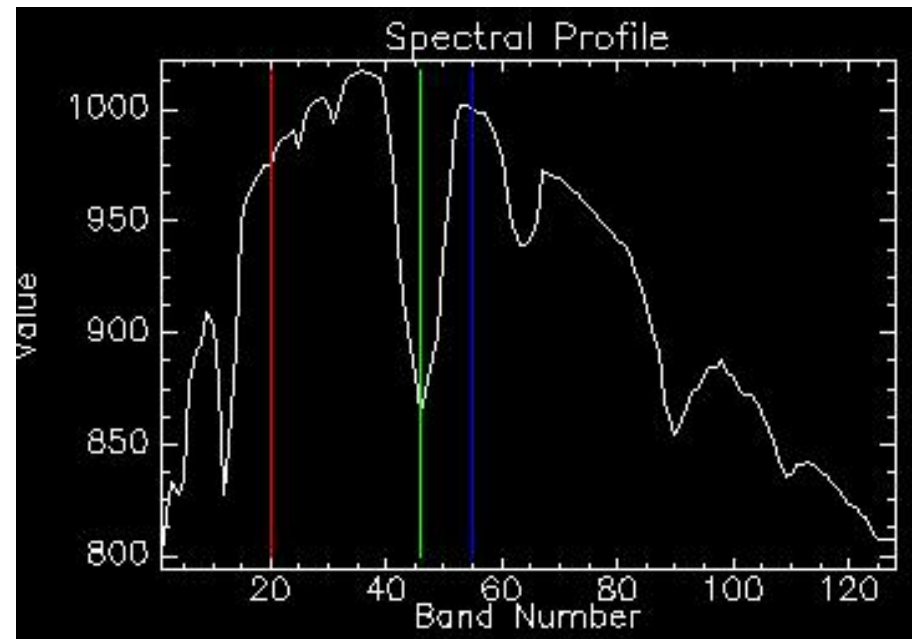
Detection Method



- **LWIR Hyperspectral Imagery Provides Blackbody Backgrounds**
 - **Ponds, Fields, Foliage, Parking Lots, Roads**
- **Presence of an Agent Affects Black Body Spectral Response and Provides Method for Detection using Absorption Phenomenology**



Black Body Spectral Profile



Black Body with Agent

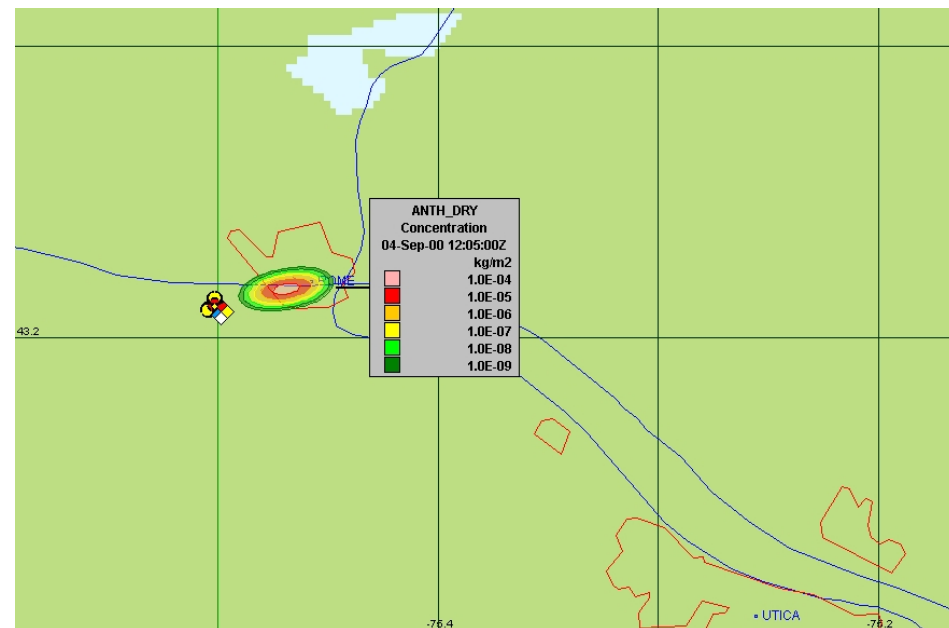


Chem-Bio Scenario



- **Generate Synthetic Clouds using Hazard Prediction Assessment Capability (HPAC)**
- **Modify SEBASS Data with Clouds of Chemical Agents**
- **Vary Concentration of Clouds**
- **Determine Limits of Detectability**

HPAC
Produces 3D Cloud
Concentration File

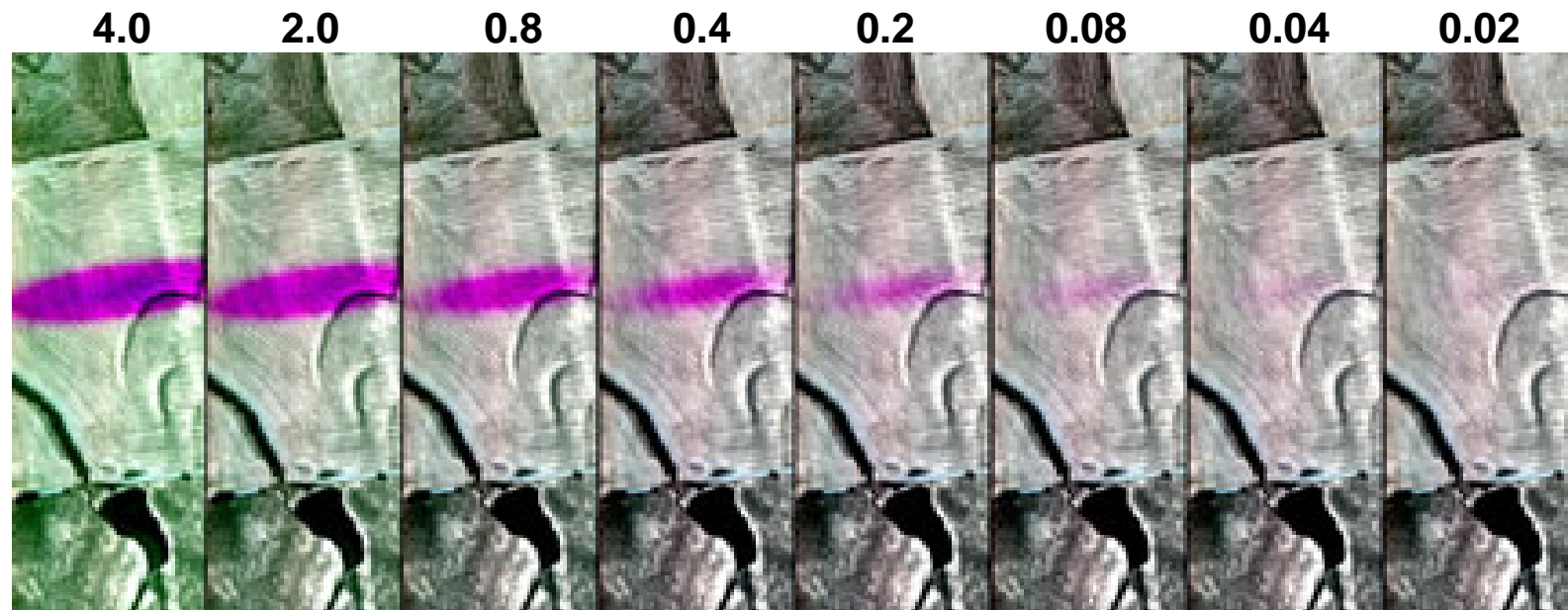




Chemical Agent Analysis



- SEBASS LWIR Sensor 7.3 - 13.6 Micron Range with 128 Bands
- Methods of Detectability
 - Visual (Selected Bands 20, 46 & 55 Emphasize SARIN Agent)
 - Spectral Matched Filter (SMF)
- SARIN Cloud concentration Below is Scaled from 4 gm/m² at Center to .02 gm/m²
- Minimal Detectable Concentration using SMF is .005 gm/m²





Applying Similar Process to EPA Data



- **Anomaly Detection**

- Finds Statistically Unique Areas Compared to Background
- Background Calculated using the entire R1 1000' Flight Line
- Spectral Anomalies can be
 - Hot or Cold Objects
 - Non-Blackbody
 - Gases of Interest

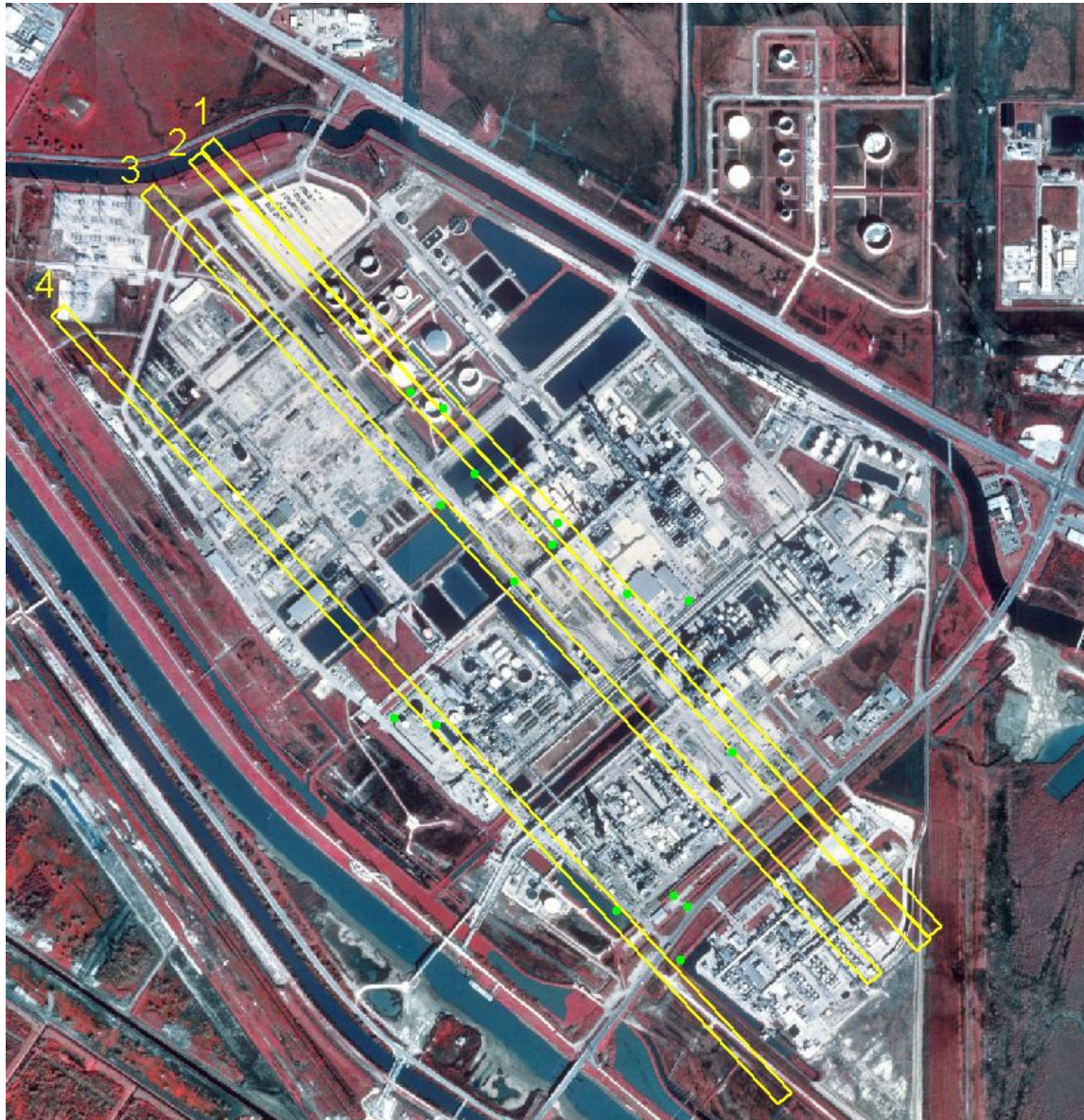
- **Spectral Matched Filter**

- Optimal Detector for a Signature in a Gaussian Background
- Signatures Derived from EPA Fourier Transform Infrared Reference Spectra Database and Mapped to AHI Sensor
 - 1,3 Butadiene
 - Acetone
 - Ethylene Oxide
 - Propylene Oxide

- **Automatic Target Cues – Thresholds SMF Output**



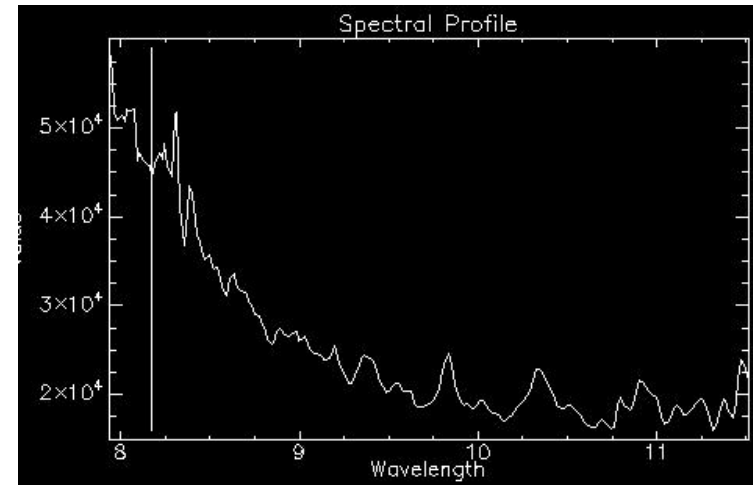
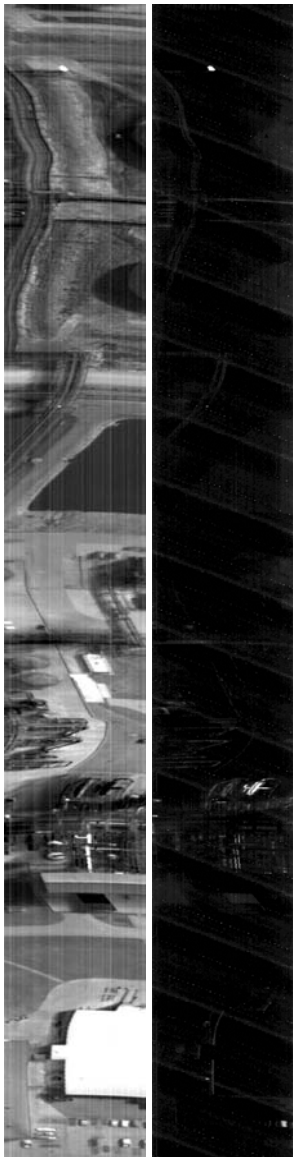
AHI Sensor Flight Lines



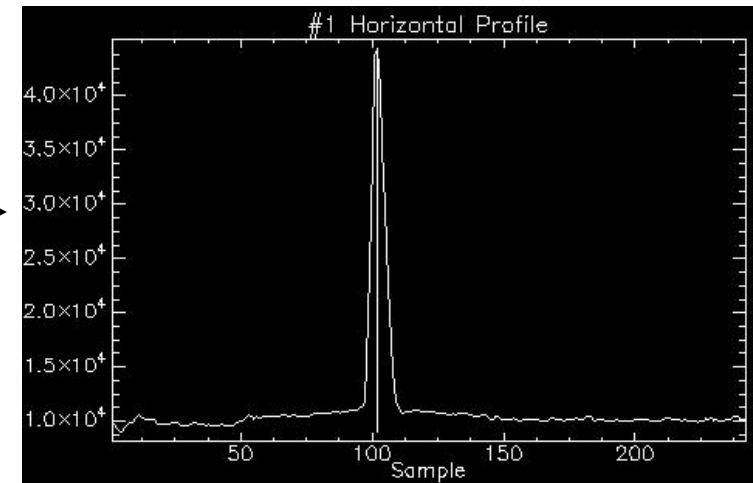
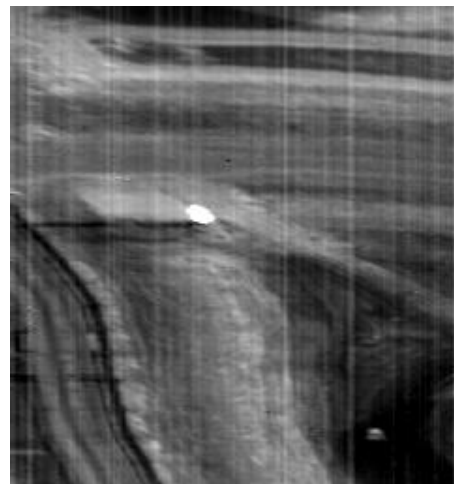
- **AHI LWIR Sensor Observes 200+ Bands**
- **Analyzed 1000' Altitude Flights**



AHI R4 Anomaly



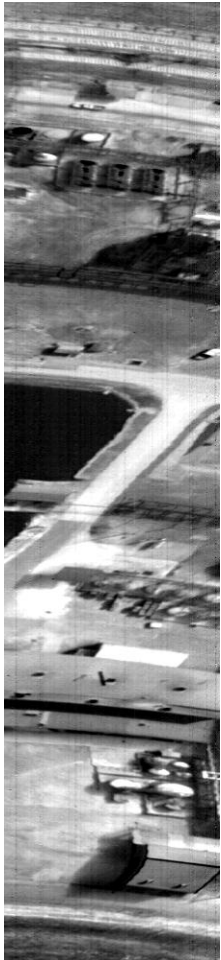
**R4 Line 4113 Anomaly is a Hot Spot
with Black Body Curve Shifted Relative to Background**





Spectral Matched Filter

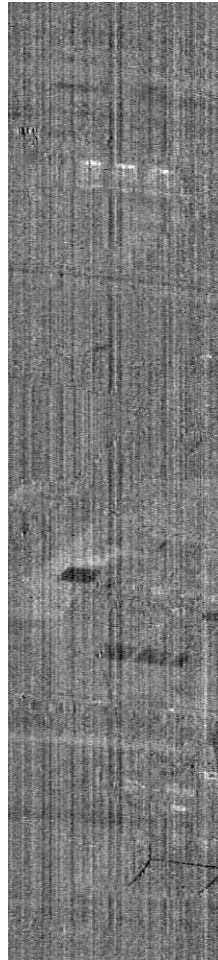
R1 Flight Line 4000 to 5000



**AHJ
Band 30**



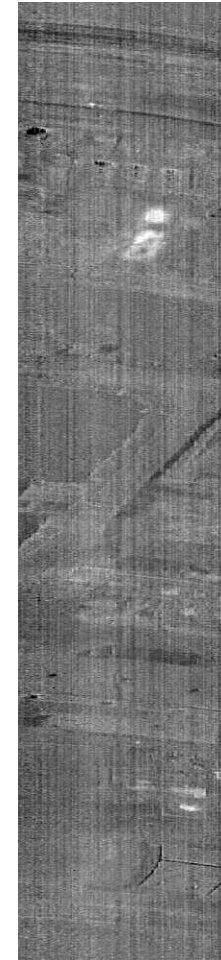
**Anomaly
Detector**



**1,3
Butadiene**



Acetone



**Ethylene
Oxide**



**Propylene
Oxide₁₄**

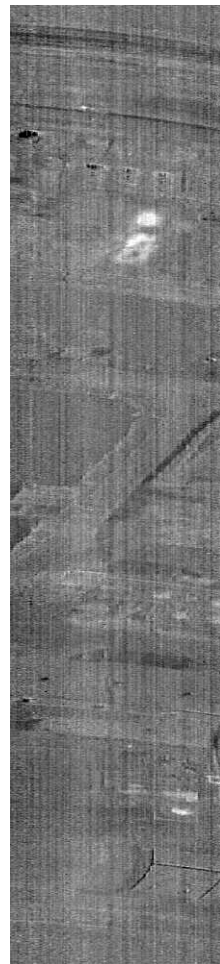


Automatic Target Cuer



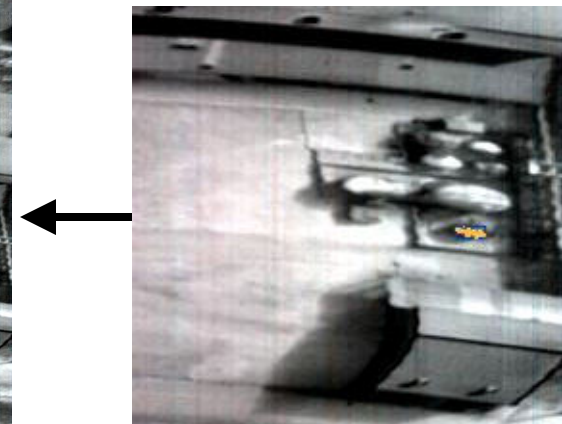
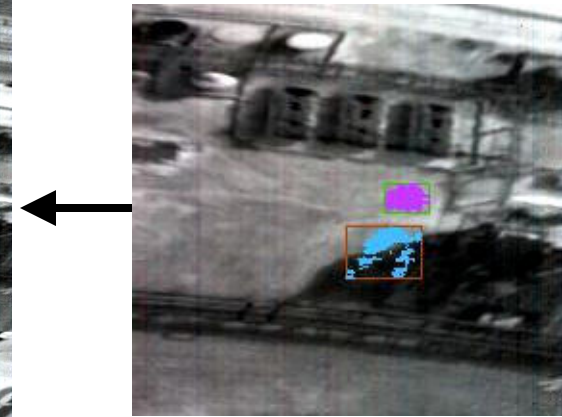
AHI
Band 30

Spectral
Matched
Filter
→
Ethylene
Oxide
Signature



Ethylene
Oxide

→
Automatic
Target
Cuer





Summary & Conclusions



- **This is a Preliminary Evaluation**
- **The Chemical Plant Environment is more Complex than the Battlefield**
 - **More Chemicals of Interest**
 - **Complex Background**
- **Anomaly Detection is of Little Utility**
- **Spectral Matched Filter may be Useful**
 - **Need Extensive Ground Truth to Verify Results**
 - **Modification Required for Hot Plumes**