# Airborne Spectral Photometric Environmental Collection Technology

ASPECT

Industria Probitas Utilitatas Velocitatem

## *-Remote-Sensing & Imagery-*
## *Chemical, Radiological & Situational Awareness*

**April 2014**

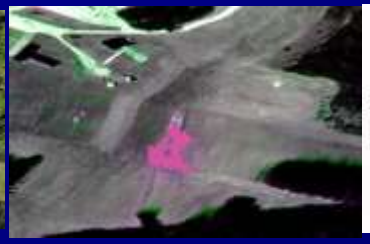
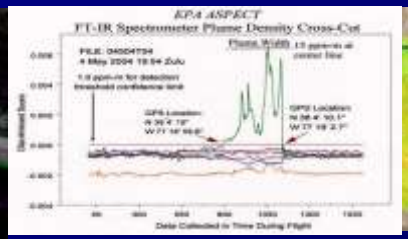
# Typical ASPECT Questions

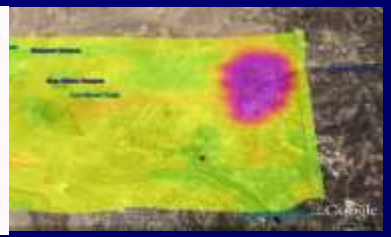
- What is the system and how does it work?
- How might this system assist the OSC?
- What types of data are generated and what are the formats?
- How much does it Cost?
- How do you activate the service?
- Who controls the Data?
- What support needs are required by the OSC?

# Operational Concept

- Provide a readiness level on a 24/7 basis
- Provide a simple, one phone call activation of the aircraft
- Wheels up in under 1 hour from the time of activation
- Once onsite and data is collected it takes about….

**~ 5 minutes to process and turn around data to first responders**



- Deployment Simplified:
  - Once on-scene collect chemical, radiological, or situational data (imagery) using established collection procedures
  - Process all data within the aircraft using tested automated algorithms
  - Extract the near real time data from the aircraft using a broadband satellite system and rapidly QA/QC the data by a dedicated scientific reach back team
  - Provide the qualified data to the first responder enabling them to make informed decisions in minimal time

# Typical ASPECT Field Setup

# Current Aircraft Platform

- **Cessna 208B Cargo Master**
  - ✓ Normal Base of Operation: Addison, Texas
  - ✓ IFR/GPS Equipped
  - ✓ High Quality Filtered Power
  - ✓ STC Sensor Hole and Exhaust Modifications
  - ✓ 2000 lbs. Available Cargo (Sensors)

- **Crew**
  - ✓ Two Pilots, Commercial/ATP rated
  - ✓ One Operator
- **Speeds:**
  - ✓ Data Collection at 110 – 120 knots
  - ✓ Cruise at 160 – 180 knots
- **Range/Aloft Time:**
  - ✓ Range ~1,100 NM
  - ✓ Aloft Time 5 – 7 hours
- **Service Altitude:**
  - ✓ Data Collection at 300 to 5,000 ft AGL,
  - ✓ Cruise at 20,000 ft (with Supplemental Oxygen)
- **Ground Needs** – Standard FBO, JP Fuel (Av Gas in an Emergency)

# ASPECT Range

**Estimates Include:**

1. 1 hour prep
2. Refueling stop
3. >1 hour data collection

**Communications:**

1. Near real-time status
2. Flight parameters developed and uploaded while in-flight
3. Preliminary products while in-flight

# Data QA/QC and Dissemination

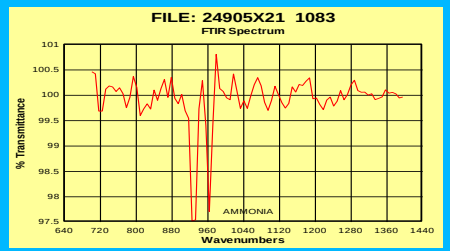
**Performed in about 5 minutes**

Data package unzipped by scientific reach back team

Compressed data package sent via satellite

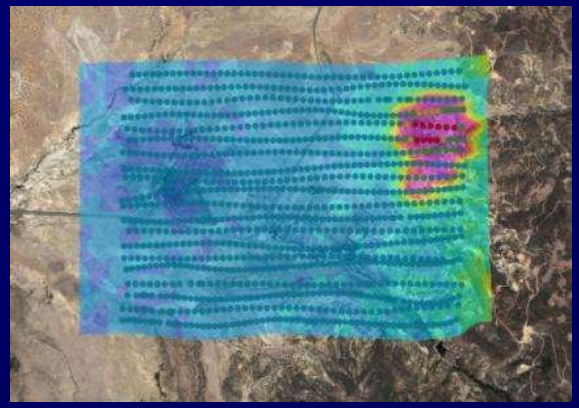
Automated airborne processing and packaging

Chem/Rad/Situational data collected



Reach Back Analysis and Confirmation

Data dissemination using Google Earth



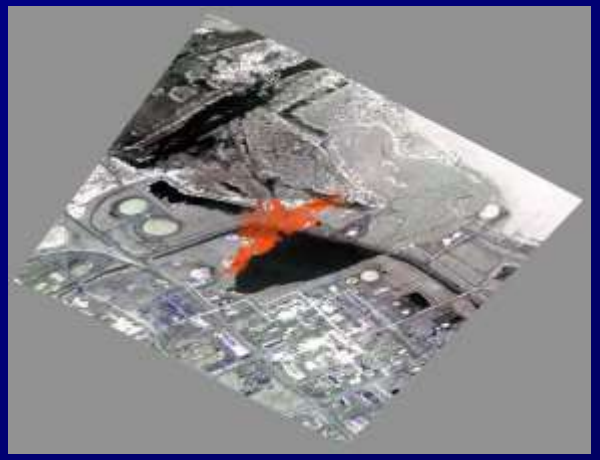
$1,500 per flight hour

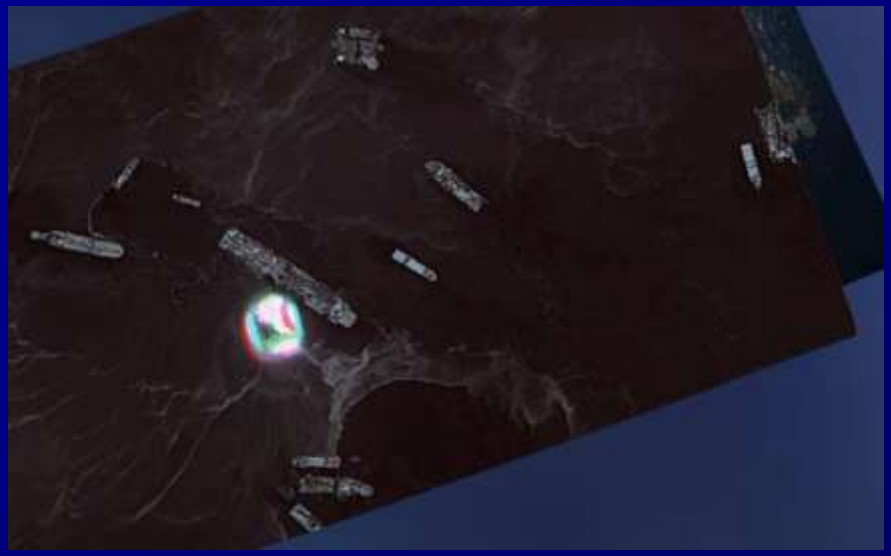
# CURRENT SYSTEMS

- ASPECT Uses Six Primary Sensors/Systems:
  - ✓ An Infrared Line Scanner to image the plume
  - ✓ A High Speed Infrared Spectrometer to identify and quantify the composition of the plume
  - ✓ Gamma-Ray Spectrometer Packs for Radiological Detection NaI and LaBr and 4 tube He-3 Neutron Detector
  - ✓ High Resolution Digital Aerial Cameras with ability to rectify for inclusion into GIS
  - ✓ Broadband Satellite Data System (SatCom)

# Types of ASPECT Deployments

- Pre-Deployments to NSSEs/SERE (Presidential Inauguration, Rose Bowl, Super Bowl, 9/11 Anniversary)
- Hurricane Sandy
- West Texas Explosion
- Halliburton Lost Source
- Field Exercises with NGB WMD-CSTs & DOE
- Chem & Rad Urban Background Surveys

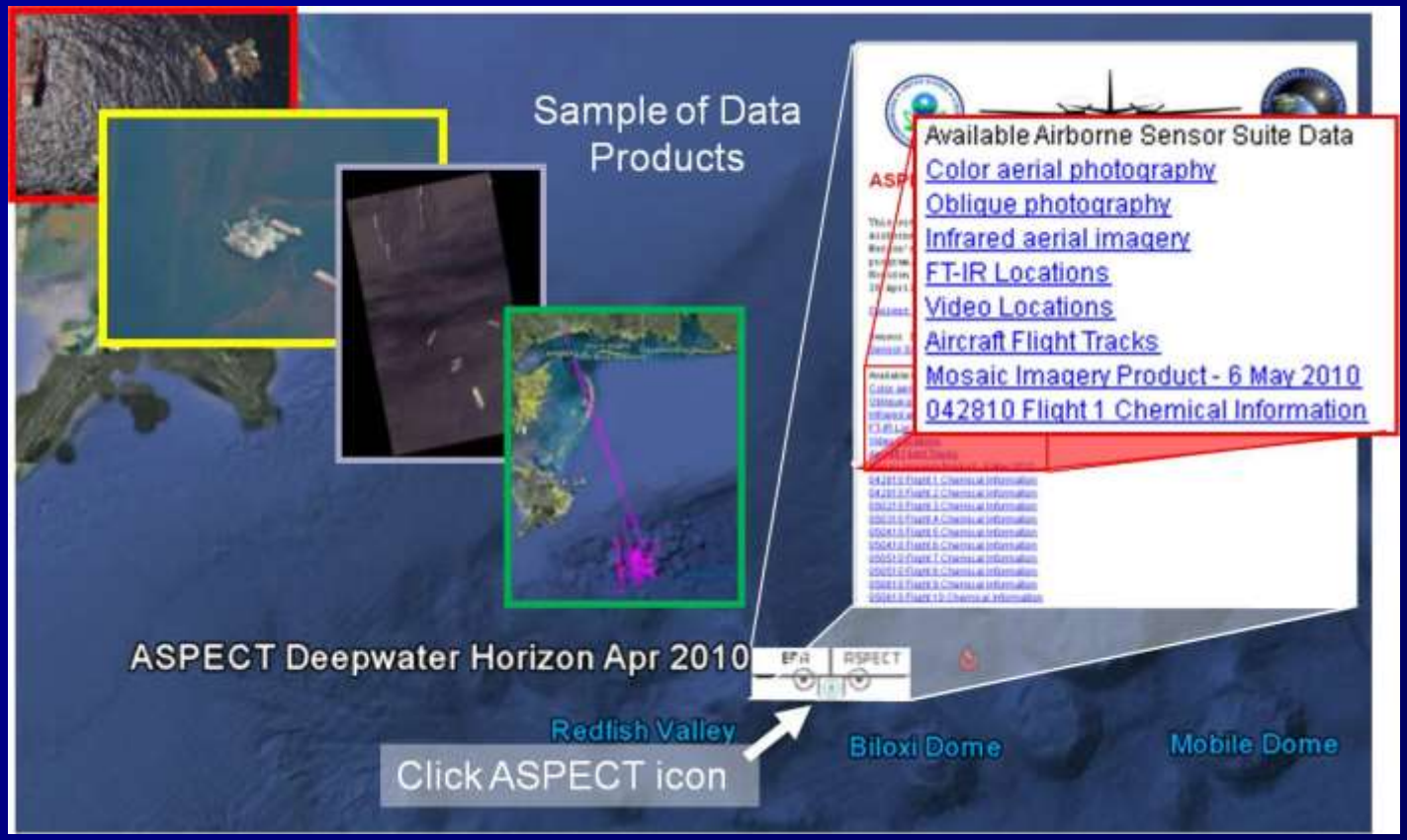




**Program Costs**

The cost per flight hour is less than $1,500. There is no additional cost for data processing and QA/QC since the Federal Employees who run the team are getting paid regardless. Mobilization /Demobilization costs are covered by the ASPECT program.

# ASPECT Data Dissemination Using Google Earth




- Google Earth is used to manage and display all ASPECT data and products
- The application is **free** to the users (and public) and greatly accelerates the delivery of data to the users
- Operation of the application is simple and requires minimal (if any) training

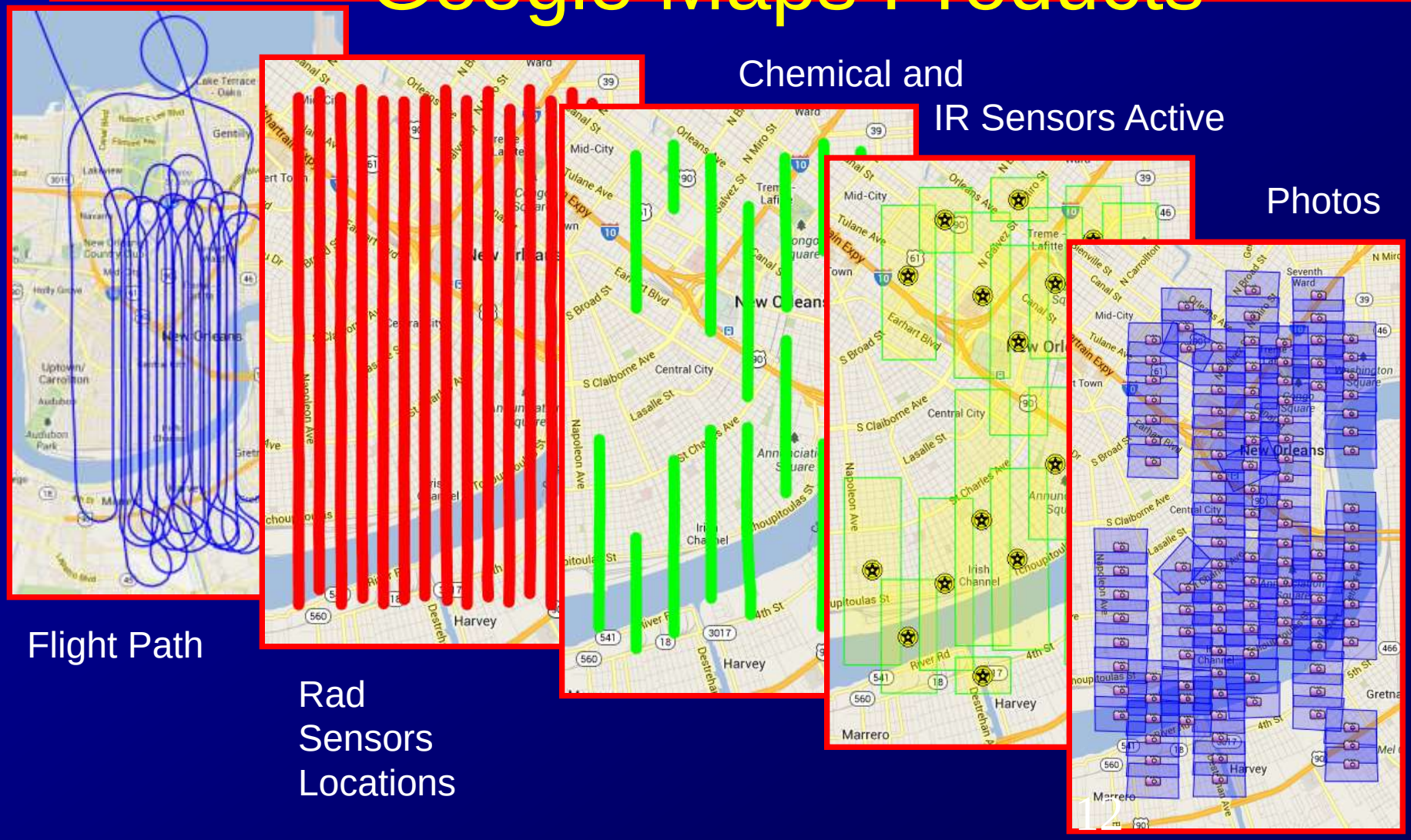
# ASPECT Products

**(Secured, ESRI Flex Viewer, Google Earth, Google Maps)**

Single URL will offer all of our products in all formats – no need to send updates all done on the back side

http://www.epaaspect3.net/googleearth/BSA_Jamboree_July2013/web/gallery/index.html

# Sample ASPECT Google Maps Products



# Deployments and Responses

ASPECT Statistics

**58** Emergency Responses

**29** SEAR Deployments

**12** NSSE Deployments

**10** FEMA Activations

**35** Special Projects

LEGEND

Responses

Deployments

Special Projects

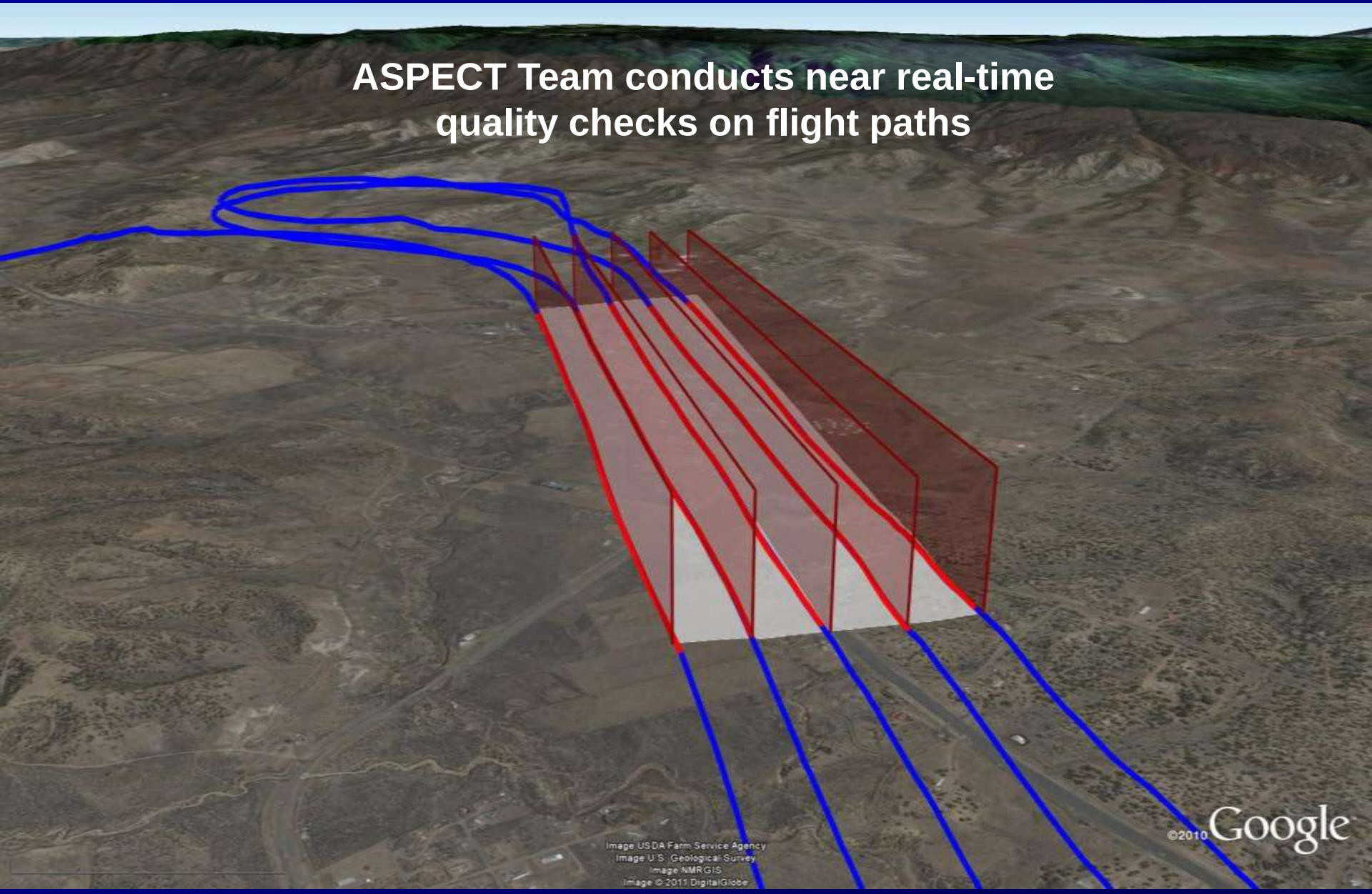
144 Responses and Deployments Since 2001

# Area to be surveyed

Survey area to be identified by customer
Image USDA Farm Service Agency
Image U.S. Geological Survey
Image NMRGIS
Image © 2011 DigitalGlobe
©2010 Google

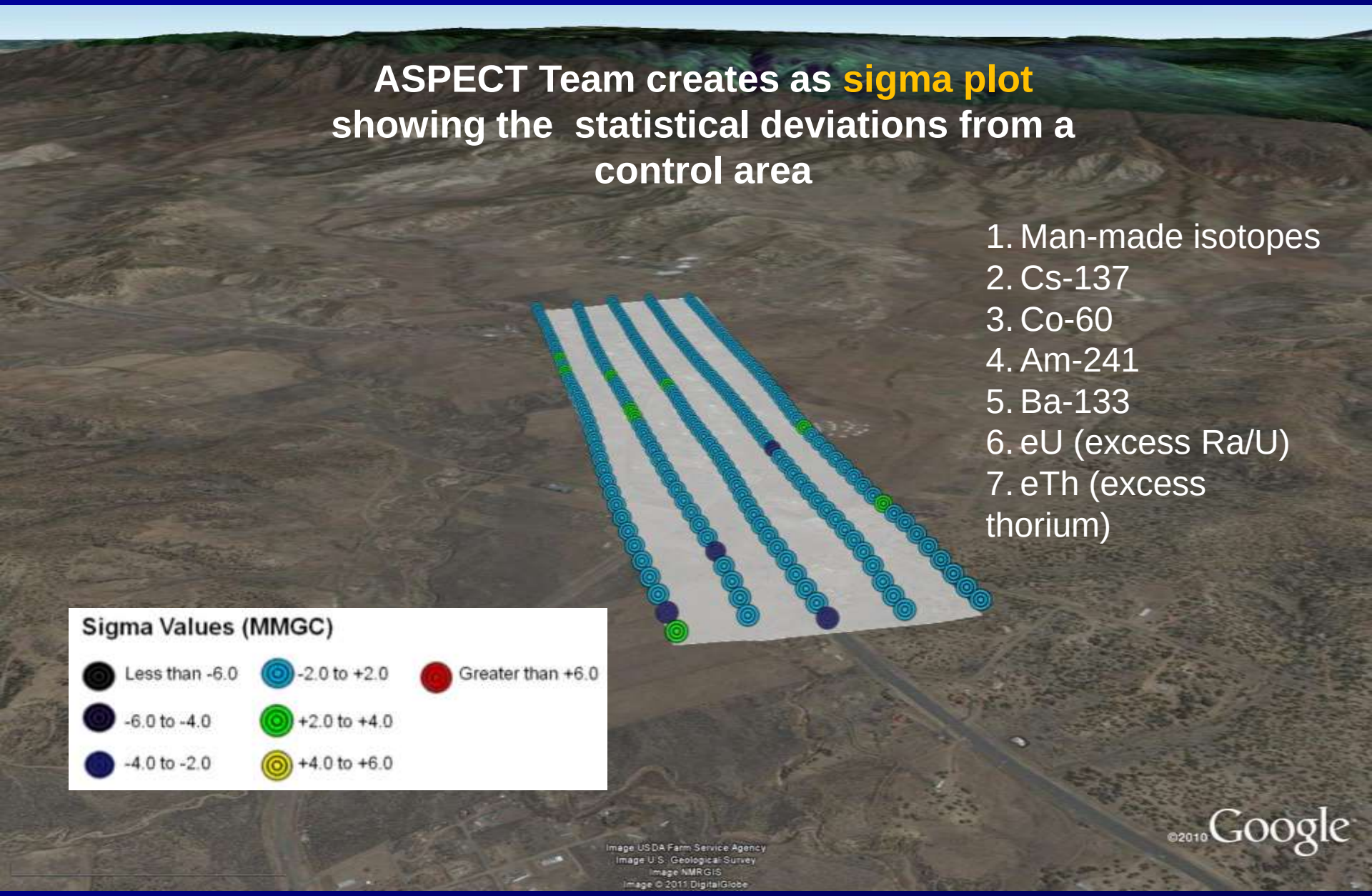
# ASPECT Team develops flight plans and receives approval from customer prior to flight

# ASPECT Team conducts near real-time quality checks on flight paths

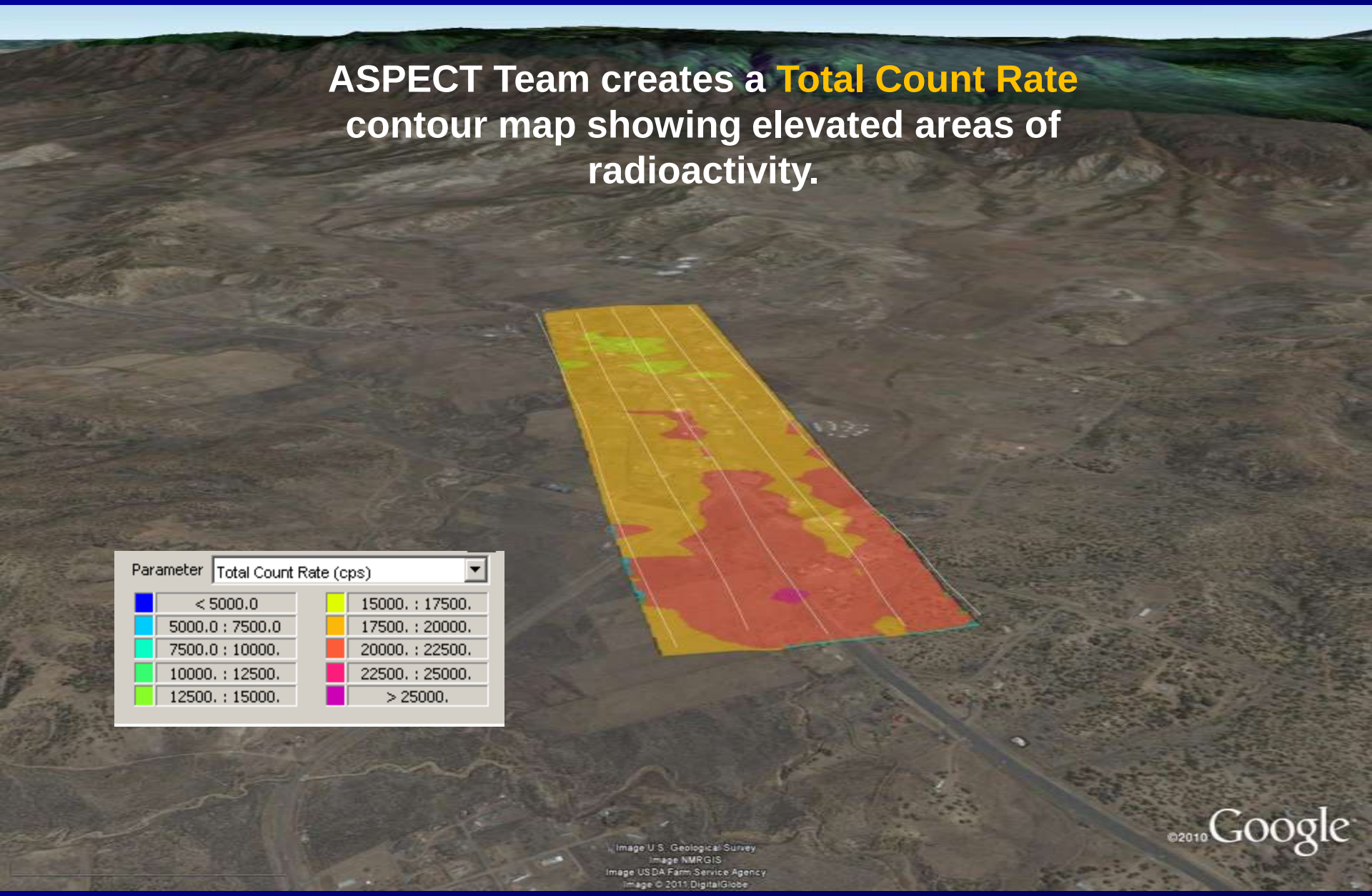


## ASPECT Team creates as sigma plot showing the statistical deviations from a control area

1. Man-made isotopes
2. Cs-137
3. Co-60
4. Am-241
5. Ba-133
6. eU (excess Ra/U)
7. eTh (excess thorium)

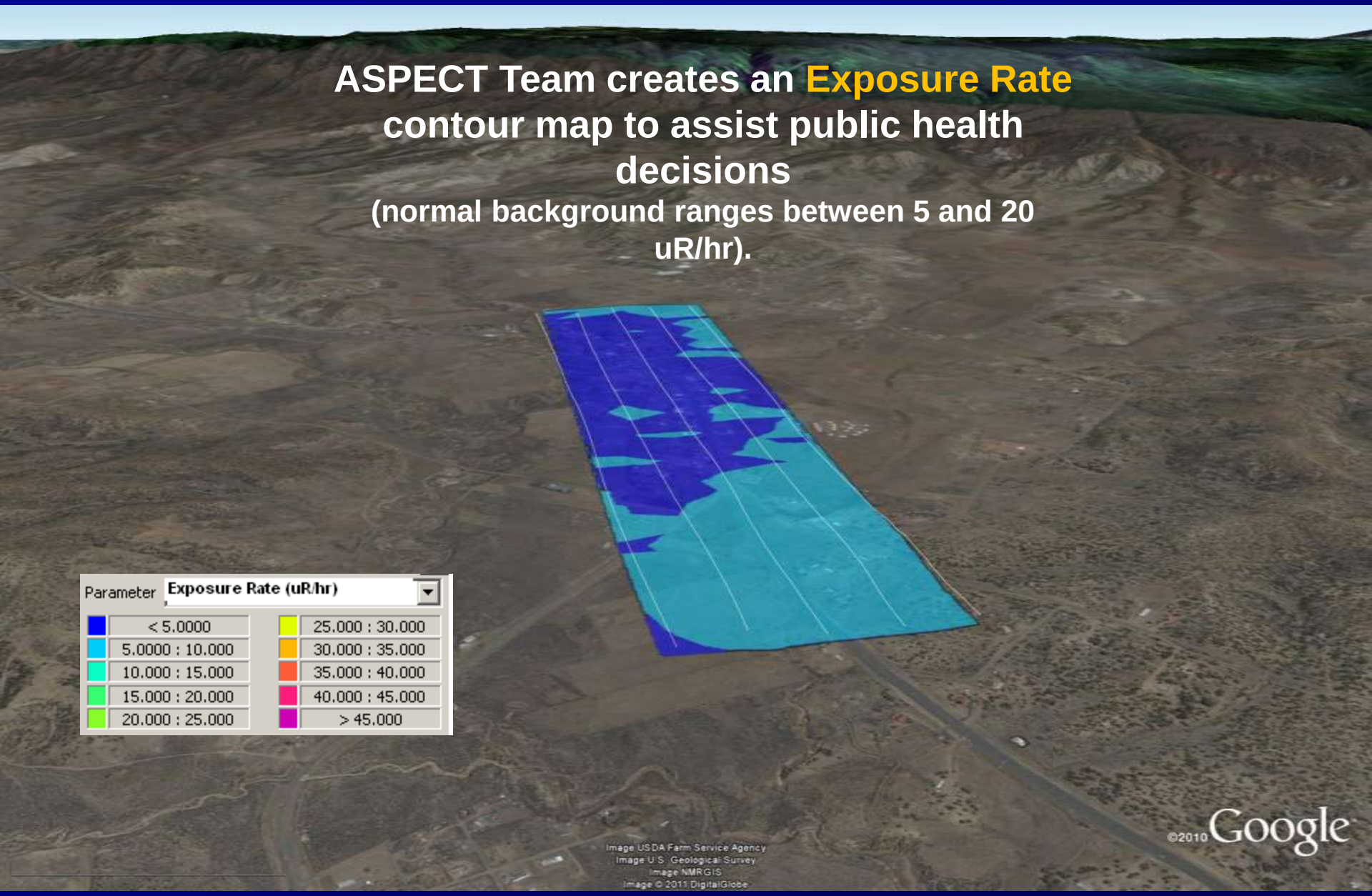


# ASPECT Team creates a Total Count Rate contour map showing elevated areas of radioactivity.



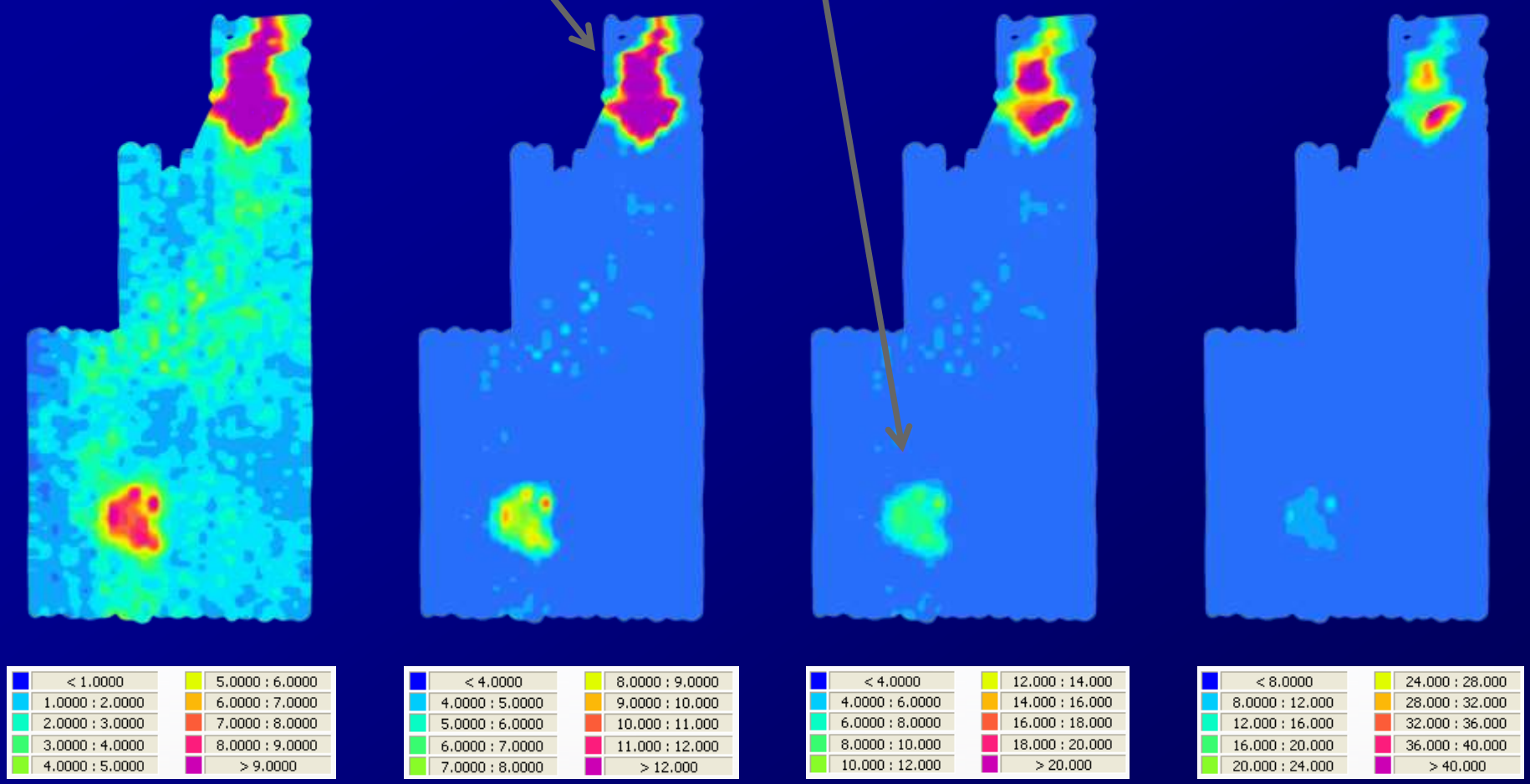
# ASPECT Team creates an Exposure Rate contour map to assist public health decisions

**(normal background ranges between 5 and 20 uR/hr).**



# Same Data – Different Scale

## Midnite vs. Sherwood Mines

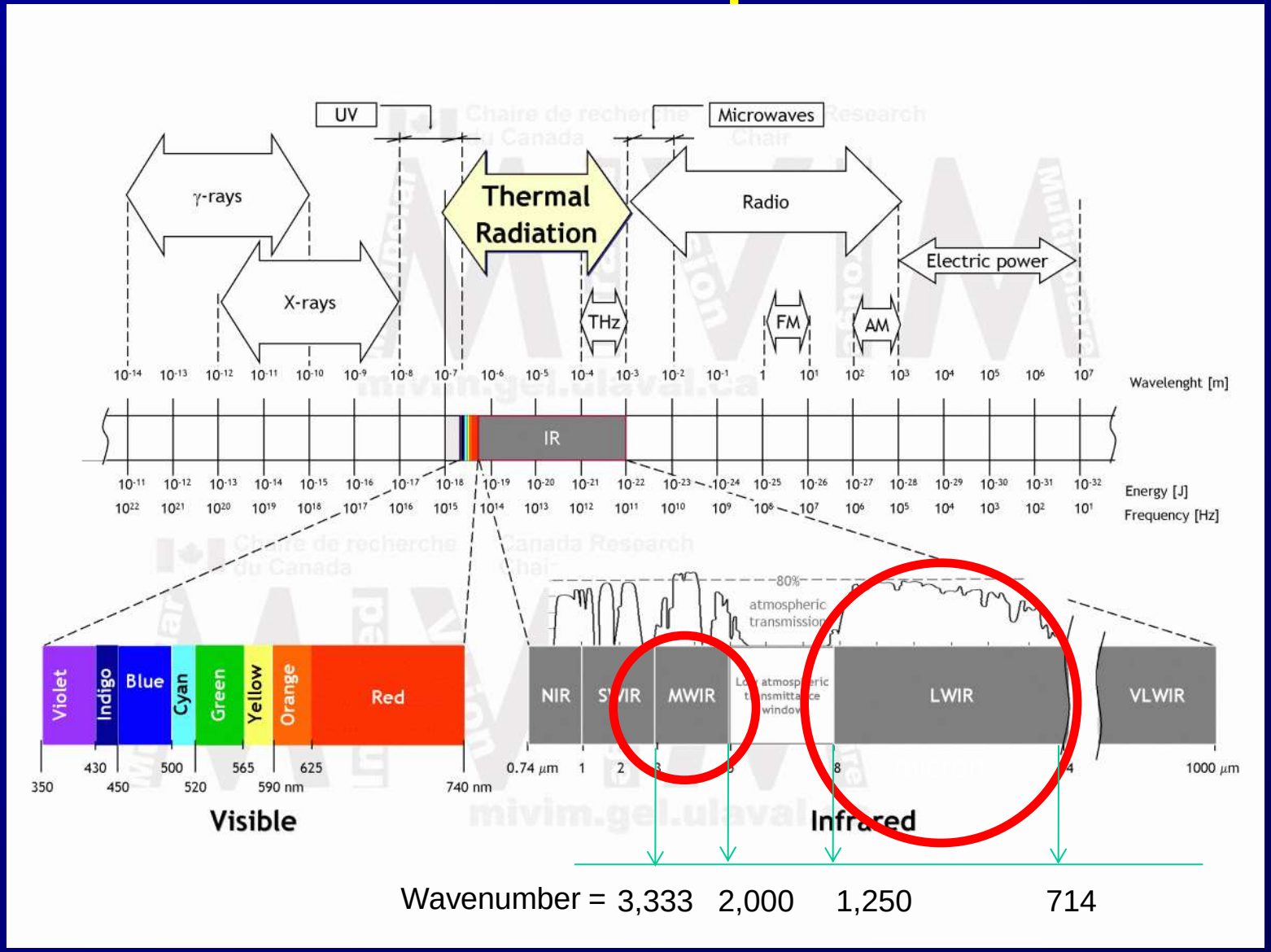



**<1 to >9** **<4 to >12** **<4 to >20** **<8 to >40**

Equivalent Uranium Concentration (pCi/g)

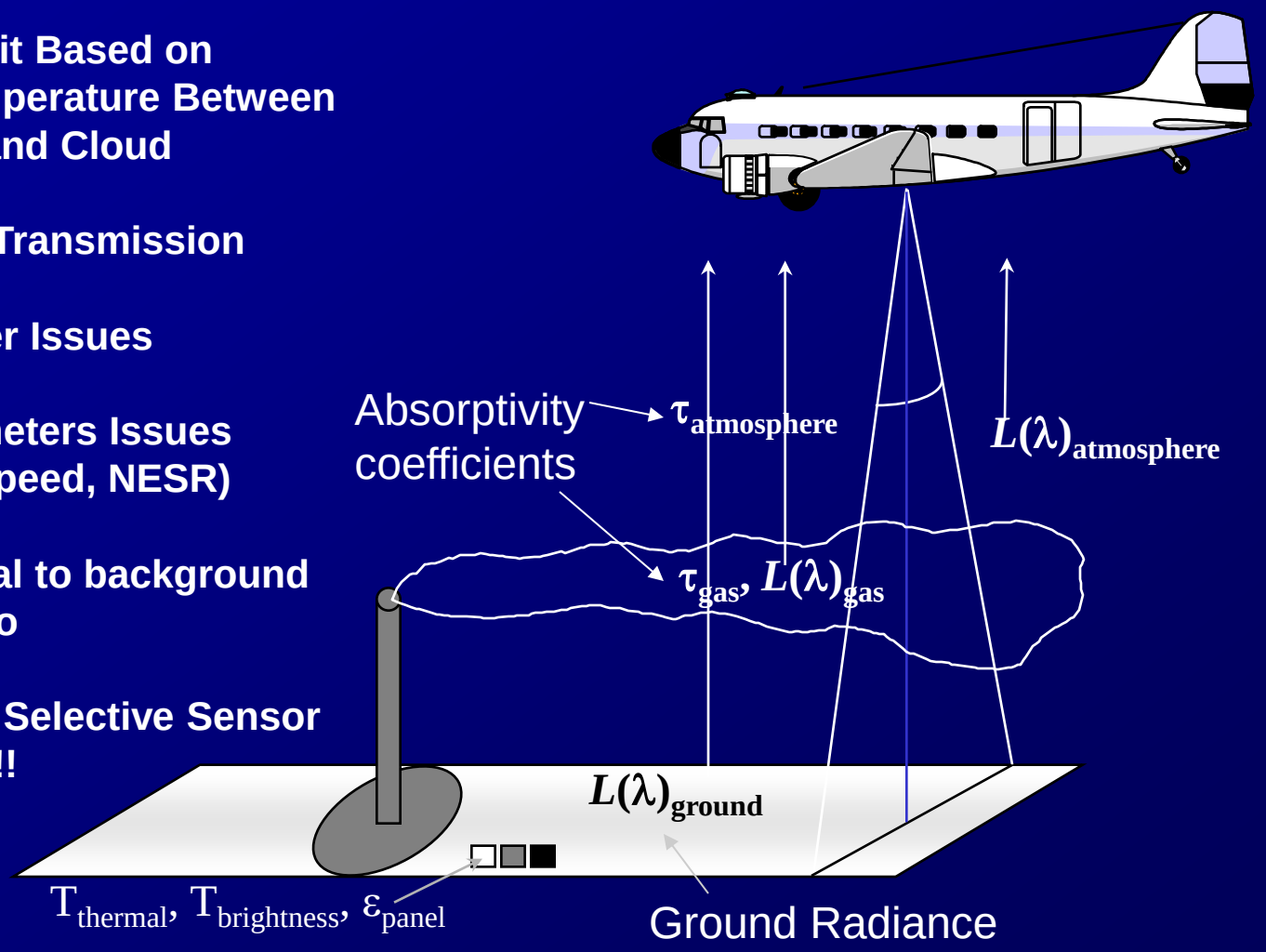
# CHEMICAL DETECTION

# Infrared Spectrum



# Basic Remote IR Methodology

- Detection Limit Based on Radiance Temperature Between Background and Cloud
- Atmospheric Transmission
- Ground Clutter Issues
- Sensor Parameters Issues (IFOV, Scan Speed, NESR)
- Very low signal to background and noise ratio
- Sensitive and Selective Sensor must be used!!



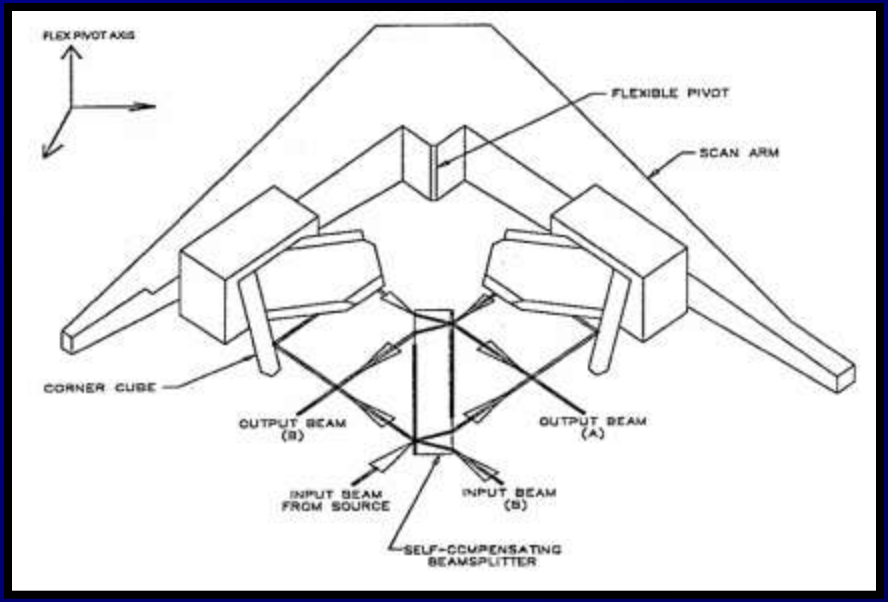
# Bomem MR-254AB FTS

- The FTIR utilized by ASPECT consist of a modified MR-254; high temporal resolution (75 Hz) system
- Dual input design
- Signal port
- Cold source reference port
- Two detectors are utilized including a 3 –5 and 8 – 12 micron providing coverage in the atmospheric IR window
- Unit ready for operation in under 4 minutes after power-up
- Chemical detection is automatic using a pattern recognition algorithm

Aircraft Configuration

# FTS System

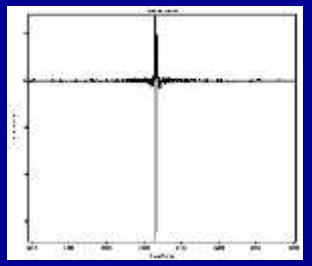
- Scan Speed - 70 scans/sec
- Telescope - 10” (0.2° FOV)
- Dual Scan Direction
- Throughput - 0.01 $cm^2$*sr
- 1.0 to 32 $cm^{-1}$ resolution
- Channel 1 : 3 - 5 microns
  $6*10^{-9}$ $W/cm^2srcm^{-1}$ NESR
- Channel 2 : 8-12 microns
  $1.8*10^{-8}$ $W/cm^2srcm^{-1}$ NESR



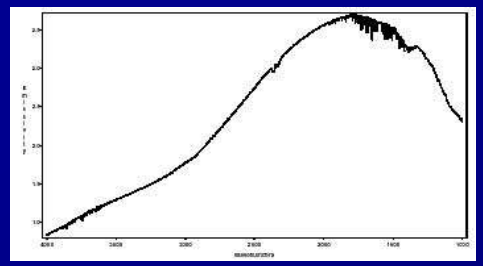

***INTERFEROMETER DESIGN***

# Signal Processing

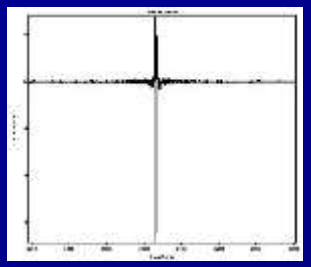
## Difficulty Using Traditional FTIR Methods



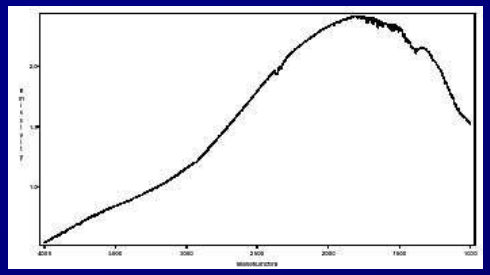
FFT →



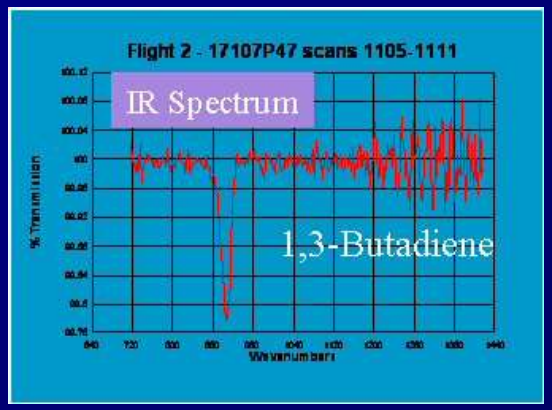
Sample Data



FFT →



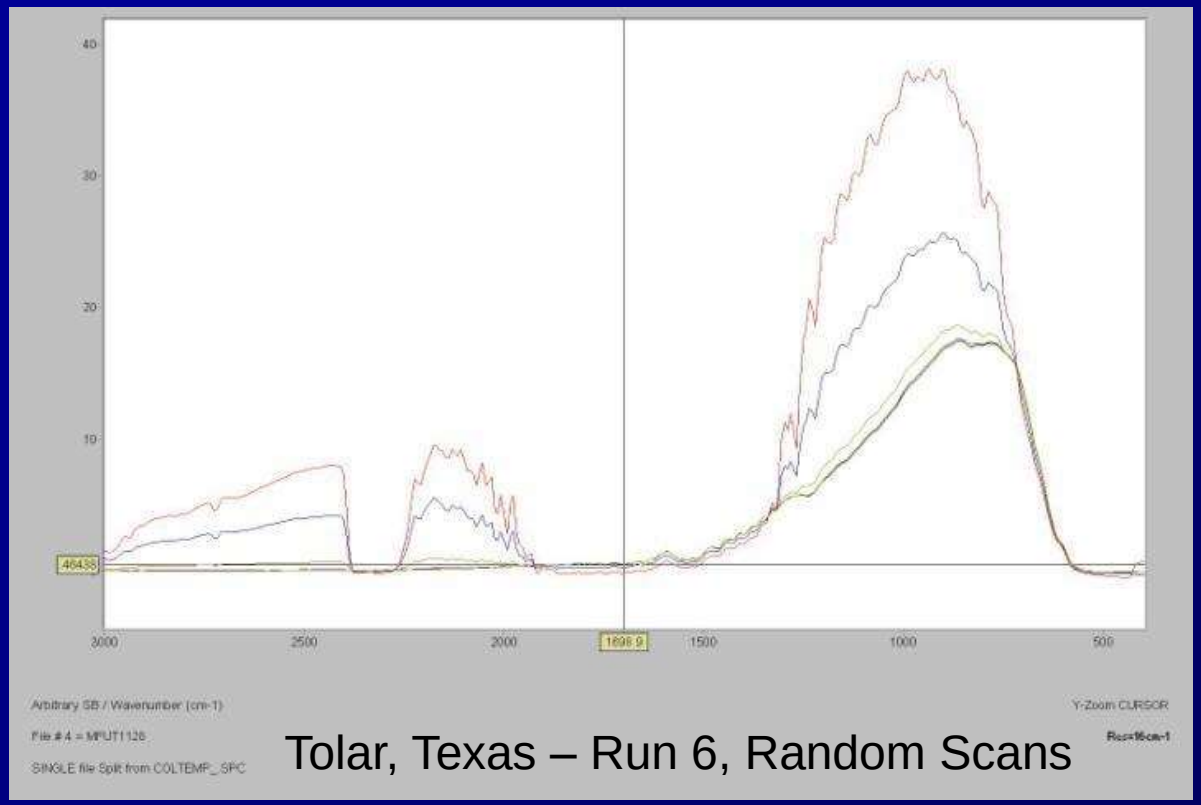
Background Data




Sample – Background = Result

- This method effectively strips the signal from the background.
- Method requires a stable radiometric background $\Delta R >> L$

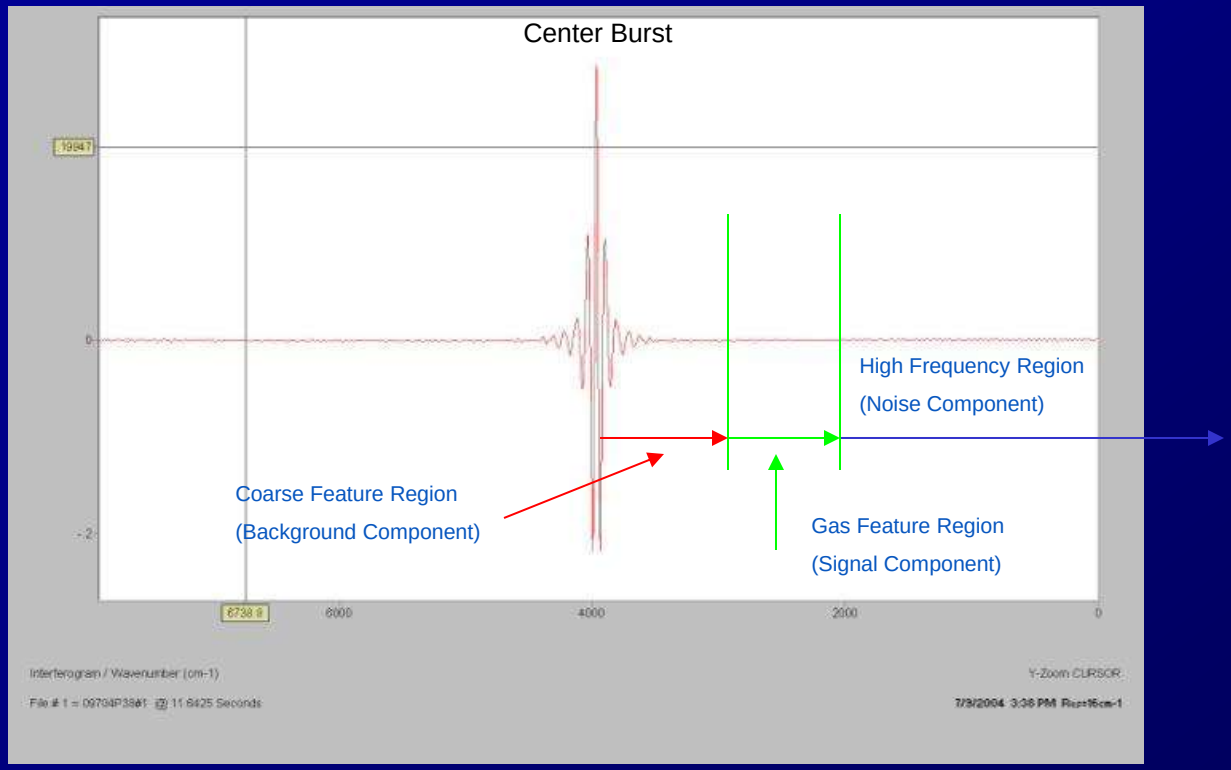
# Difficulty in Selecting Representative Backgrounds – Airborne Data




Tolar, Texas – Run 6, Random Scans

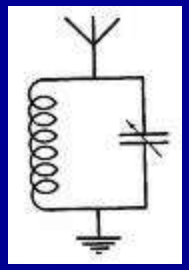
The normal radiometric variation from scan to scan is much higher than the signal magnitude or $\Delta R >> L$

# Dissecting an Interferogram

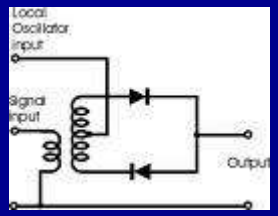



The fundamental shape of the interferogram has already largely separated the background, signal, and the noise. By using digital filtering, the signal can be passed while the background and noise are removed.

# Equivalent Signal Processing Steps Radio vs. Interferometer

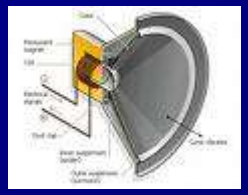


Tuner -- Interferogram Segmentation (Digital Band Pass Filtering)




Mixer (detector) -- Interferometer

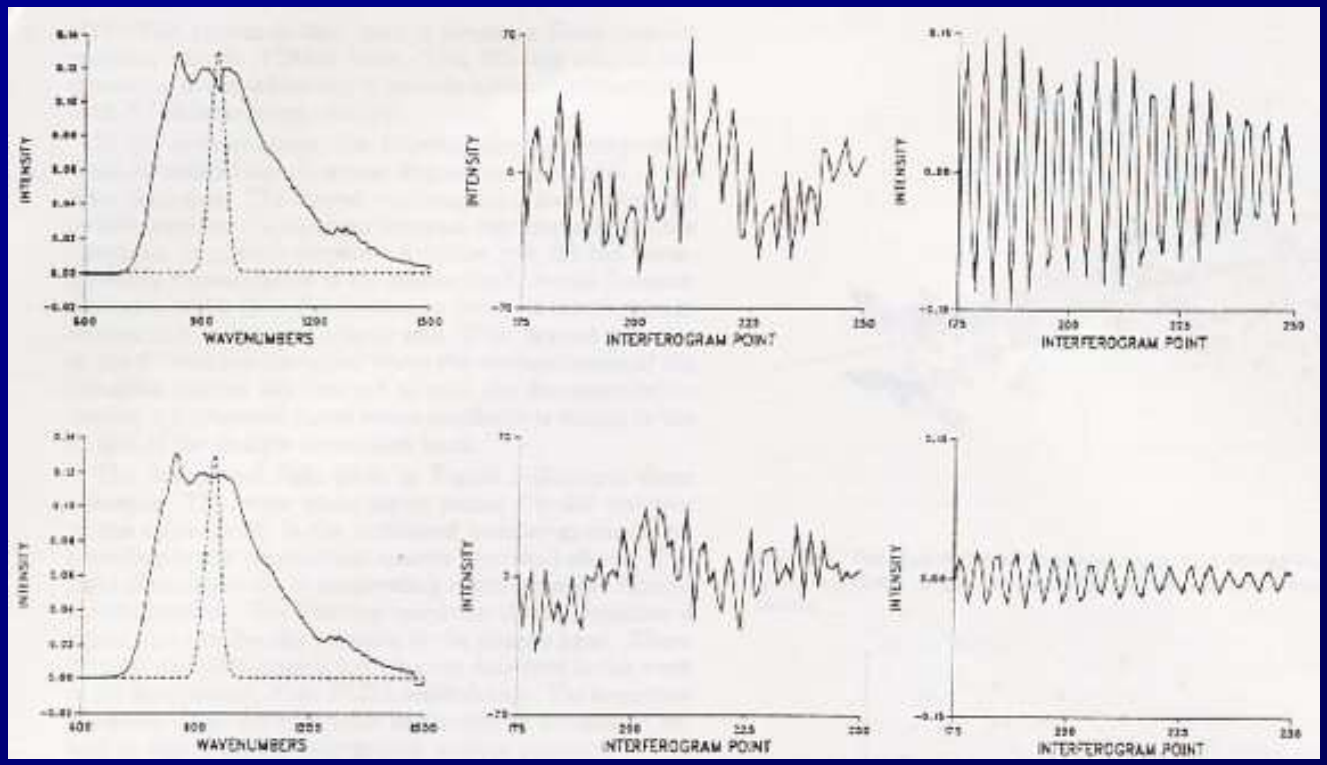
IF Amplifiers – Complex Digital Band pass Filtering (Not a Simple Response Filter)



Output/Ear – Pattern Recognition ≈ 100 Dimensions

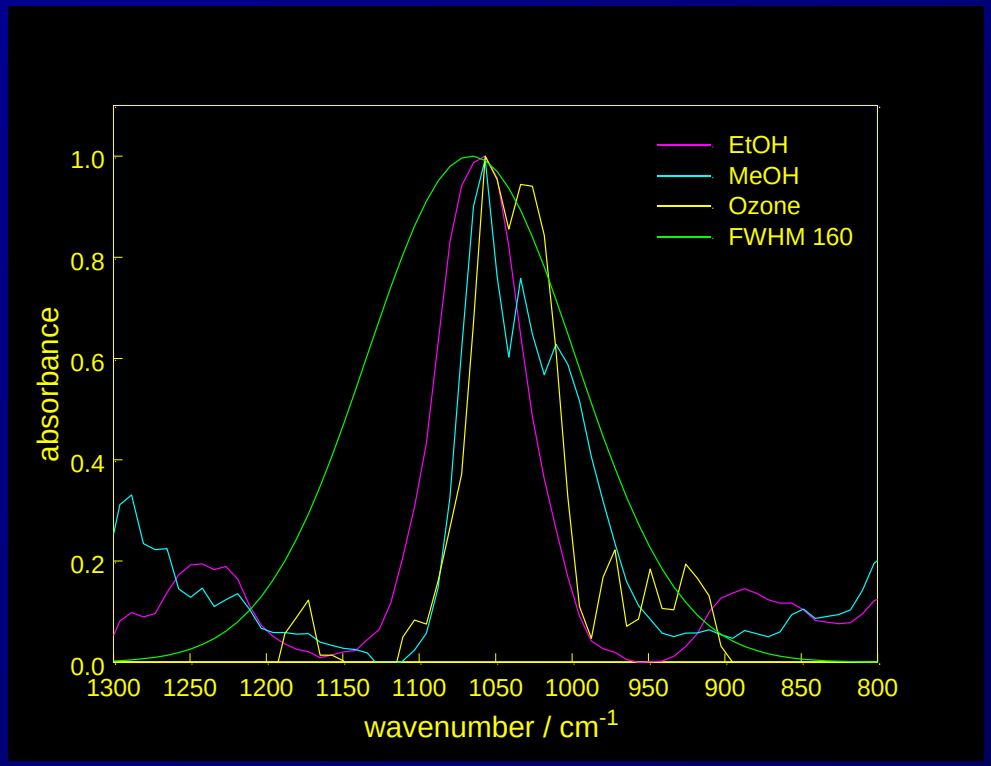
# Enhancing the Weak Signal Capability of Pattern Recognition

By applying a digital high pass filter followed by a multi-dimensional band pass filter to the interferogram, the background and noise can be suppressed, while the signal is passed. By using a “unique” band pass filter, a degree of pre-selection is applied to the signal thus generating a suitable input for pattern recognition.

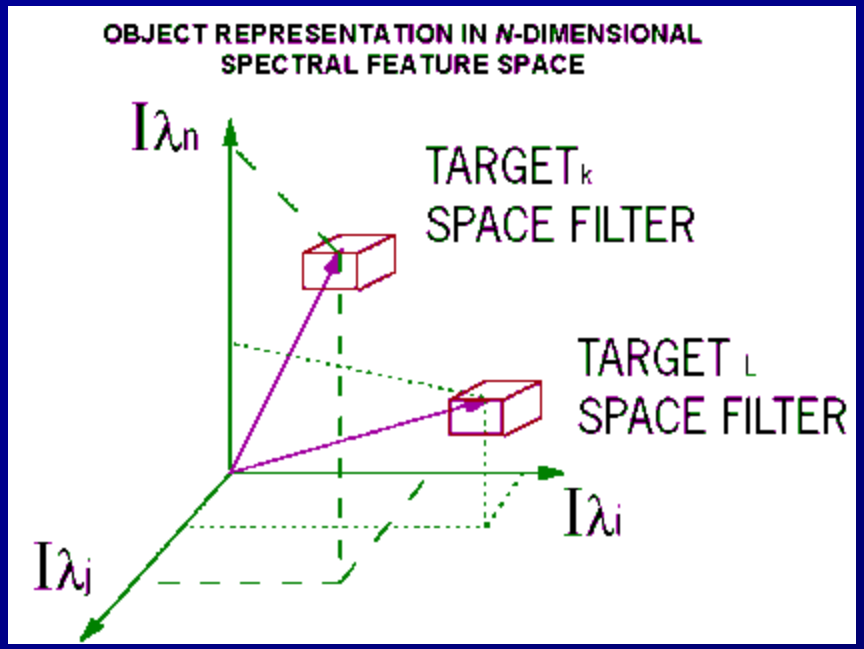


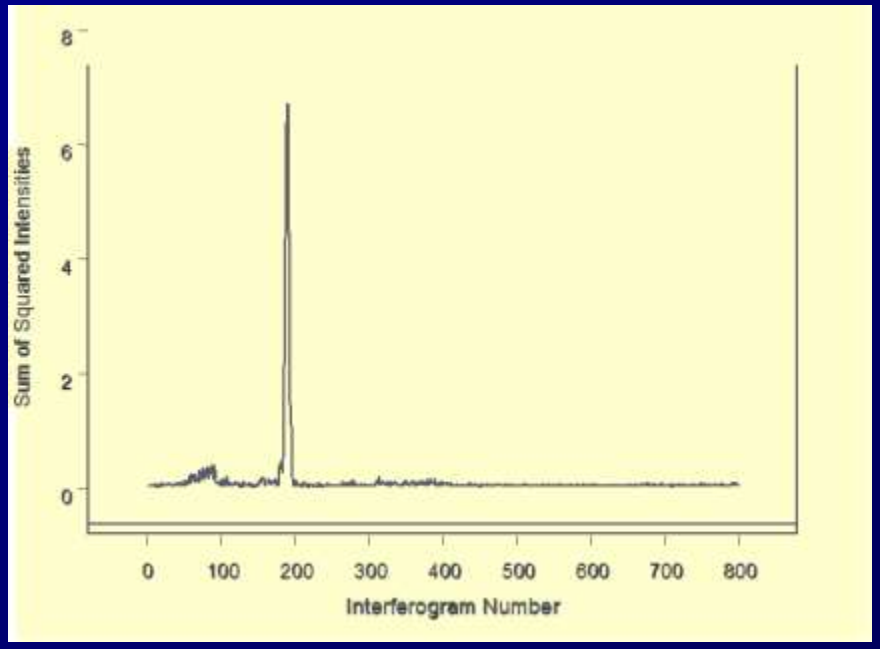
# Filter Design and Interference
# A Funnel Too Wide

A nice symmetrical band pass filter (or perhaps a matched) filter may work great for a given compound alone in the universe; such a filter typically fails in the real world for anything but very high concentrations of gas due to interference from other gases.



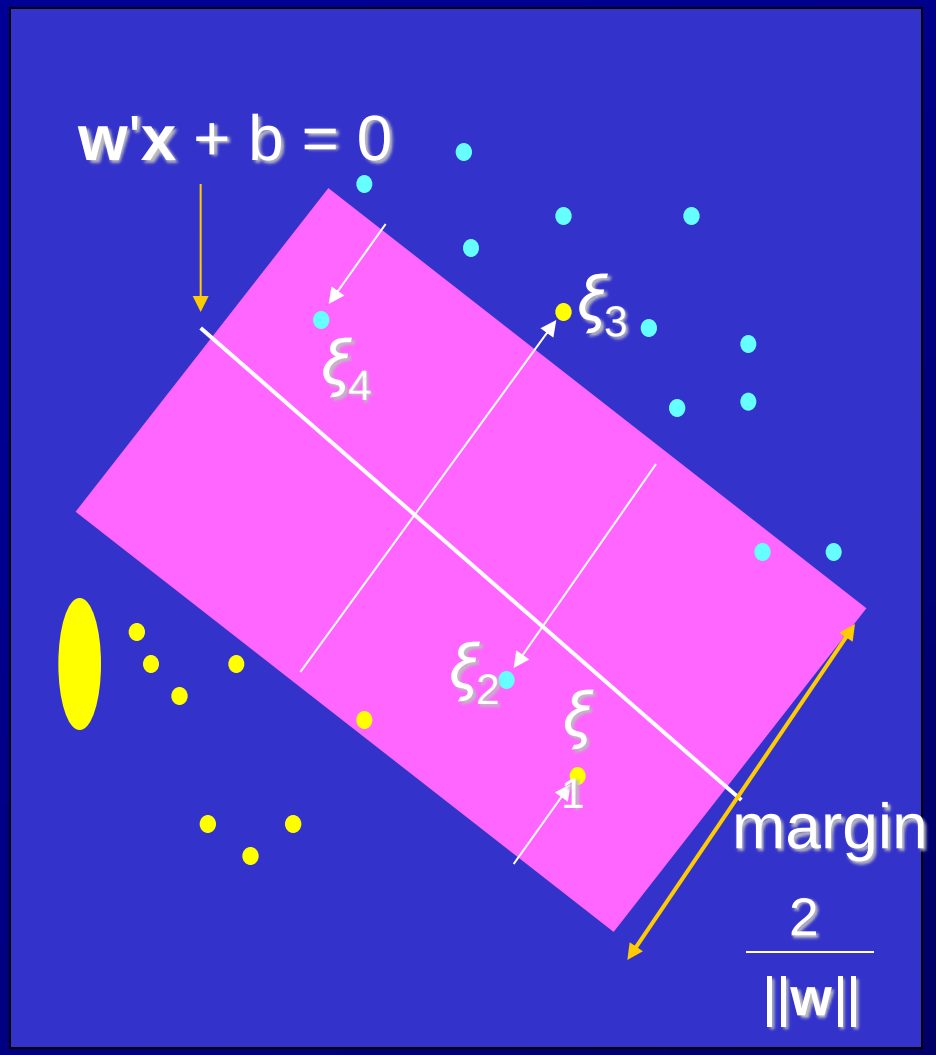
# Pattern Recognition
# Multi-Dimensional Space




Output from the digital filter process is input into a n-dimensional pattern recognition routine using either a piece wise linear discriminator or a support vector machine discriminator. These routines map the vector space (patterns) into similar dimensional space.

# Support Vector Classifier




minimize $||\mathbf{w}||^2 + C\Sigma\xi^2_i$

subject to $y_i(\mathbf{w}'\mathbf{x} + b) \geq 1 - \xi_i$

**w** : weight vector

$C$ : regularization parameter

$\xi_i$ : slack variable

$y_i$ : class label

# Chemical Detection Algorithms

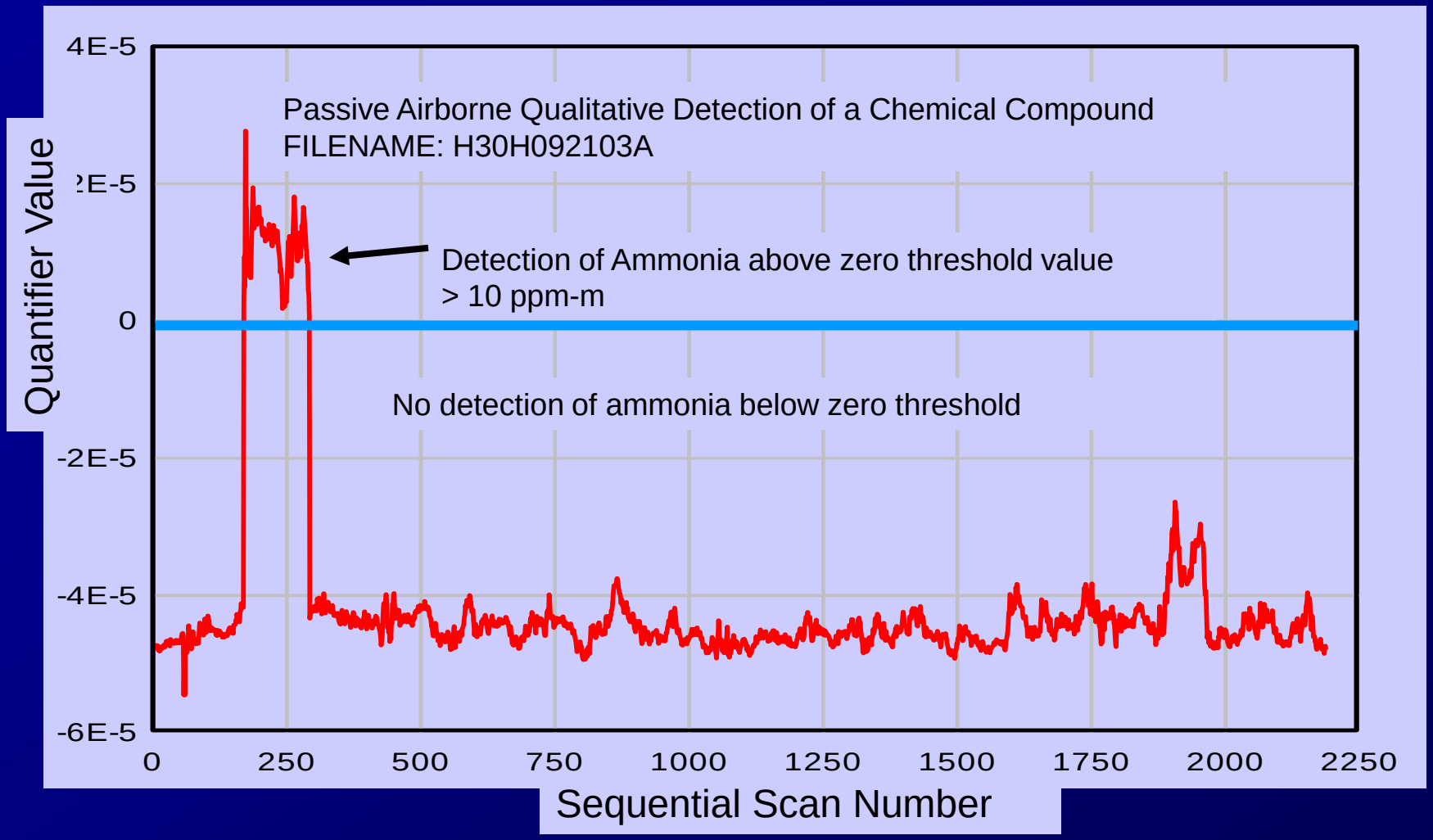
## 71 Automated

Detection limits (in ppm) referenced to a 10 meter path length

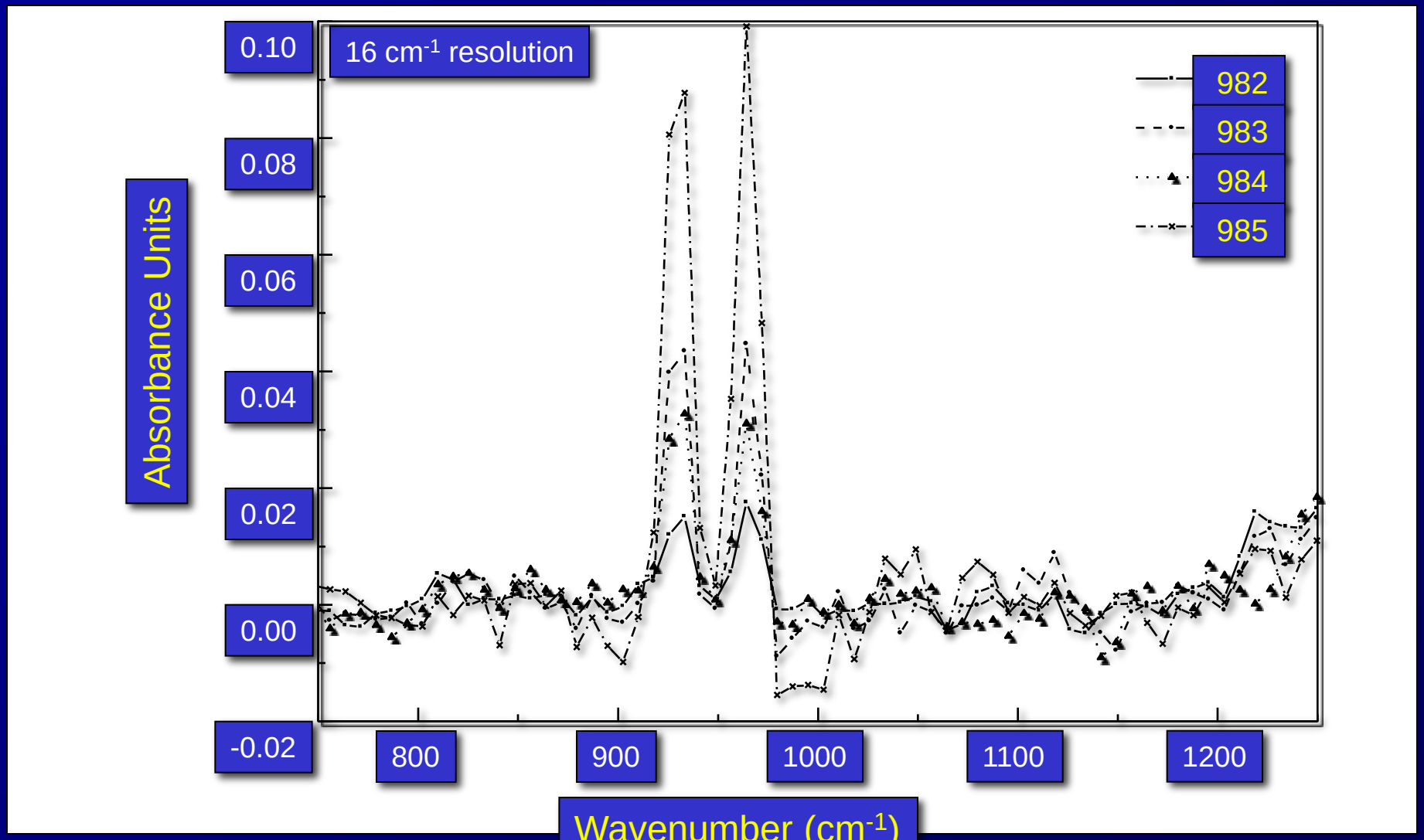
| | | | |
|---|---|---|---|
| Acetic Acid (2.0) | Cumene (23.1) | Isoprene (6.5) | Propylene Oxide (6.8) |
| Acetone (5.6) | Diborane (5.0) | Isopropanol (8.5) | Silicon Tetrafluoride (0.2) |
| Acrolein (8.8) | 1,1-Dichloroethene (3.7) | Isopropyl Acetate (0.7) | Sulfur Dioxide (15) |
| Acrylonitrile (12.5) | Dichloromethane (6.0) | MAPP (3.7) | Sulfur Hexafluoride (0.07) |
| Acrylic Acid (3.3) | Dichlorodifluoromethane (0.7) | Methyl Acetate (1.0) | Sulfur Mustard (6.0) |
| Allyl Alcohol (5.3) | 1,1-Difluoroethane (0.8) | Methyl Ethyl Ketone (7.5) | Nitrogen Mustard (2.5) |
| Ammonia (2.0) | Difluoromethane (0.8) | Methanol (5.4) | Phosgene (0.5) |
| Arsine (18.7) | Ethanol (6.3) | Methylbromide (60) | Phosphine (8.3) |
| Bis-Chloroethyl Ether (1.7) | Ethyl Acetate (0.8) | Methyl Methacrylate (1.1) | Tetrachloroethylene (10) |
| Boron Tribromide (0.2) | Ethyl Formate (1.0) | MTEB (3.0) | 1,1,1-Trichloroethane (1.9) |
| Boron Triflouride (5.6) | Ethylene (5.0) | Naphthalene (3.8) | Trichloroethylene (2.7) |
| 1,3-Butadiene (5.0) | Formic Acid (5.0) | n-Butyl Acetate (3.8) | Trichloromethane (0.7) |
| 1-Butene (12.0) | Freon 134a (0.8) | n-Butyl Alcohol (7.9) | Triethylamine (6.2) |
| 2-Butene (18.8) | GA (Tabun) (0.7) | Nitric Acid (5.0) | Triethylphosphate (0.3) |
| Carbon Tetrachloride (0.2) | GB (Sarin) (0.5) | Nitrogen Trifluoride (0.7) | Trimethylamine (9.3) |
| Carbonyl Flouride (0.8) | Germane (1.5) | Phosphorus Oxychloride (2.0) | Trimethyl Phosphite (0.4) |
| Carbon Tetraflouride (0.1) | Hexafluoroacetone (0.4) | Propyl Acetate (0.7) | Vinyl Acetate (0.6) |
| Chlorodifluoromethane (0.6) | Isobutylene (15) | Propylene (3.7) | |

Manual assessment of 500+ other chemical compounds

# Chemical Plume Cross-Cut

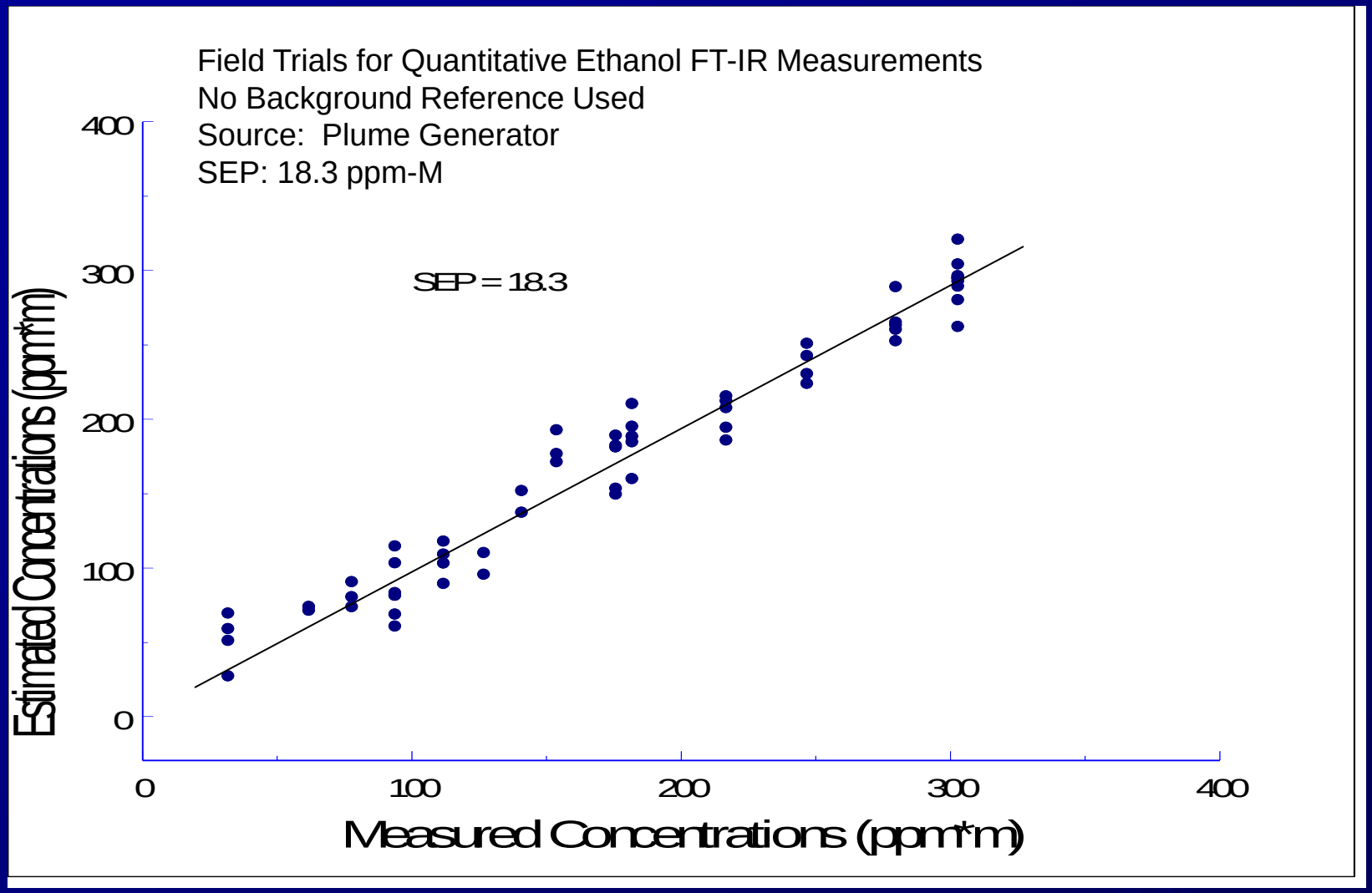


# Pattern Recogntion
# Ammonia Spectra QC

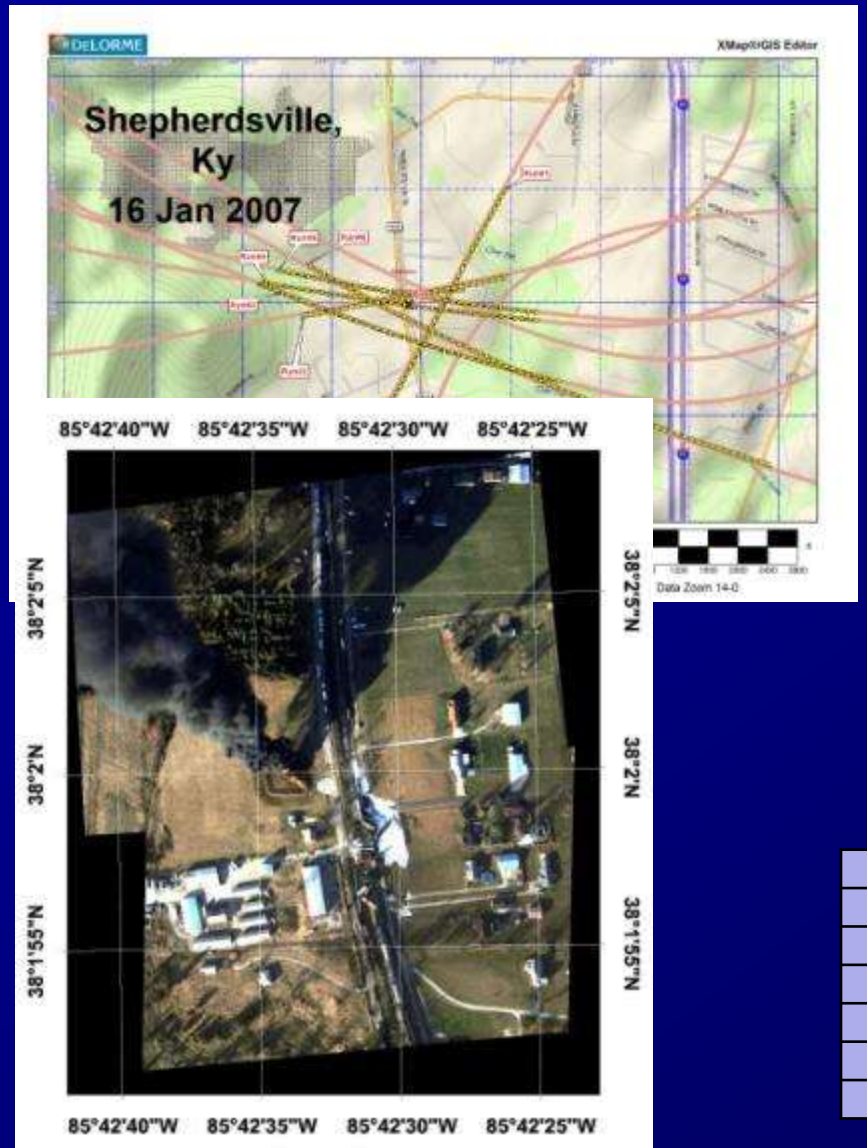


# Automated Compound Detection
# Ammonia Detection

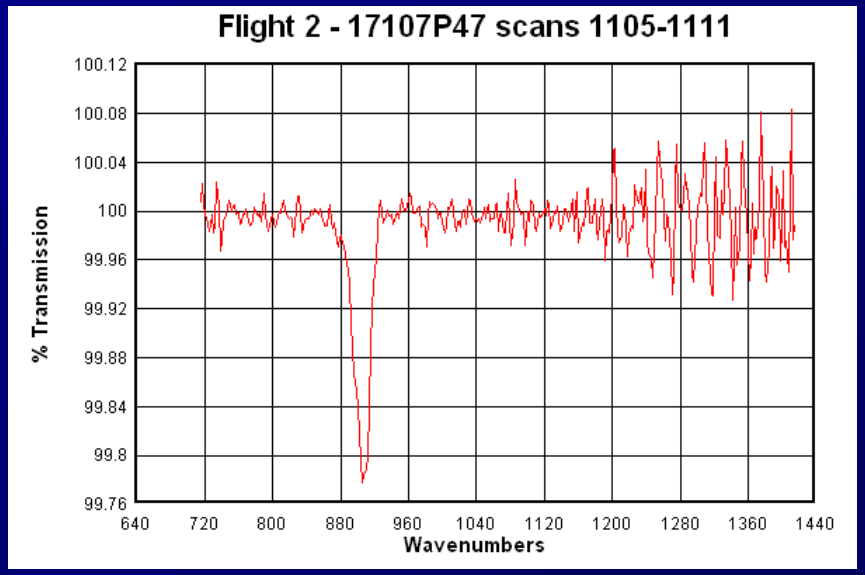
# Passive Quantitative Analysis
## Open Air Trials



# ASPECT Deployment
# Train Derailment in Sheperdsville, KY




1,3-Butadiene spectra from ASPECT flight over the fires




## Chemical Report

| Run | Compound |
|---|---|
| 1 | System Test |
| 2 | 1,3-butadiene 0 to 0.4 ppm |
| 3 | 1,3-butadiene 0 to 0.2 ppm |
| 4 | 1,3-butadiene 0 to 0.4 ppm |
| 5 | 1,3-butadiene 0 to 0.3 ppm |
| 6 | Awaiting data transmittal |

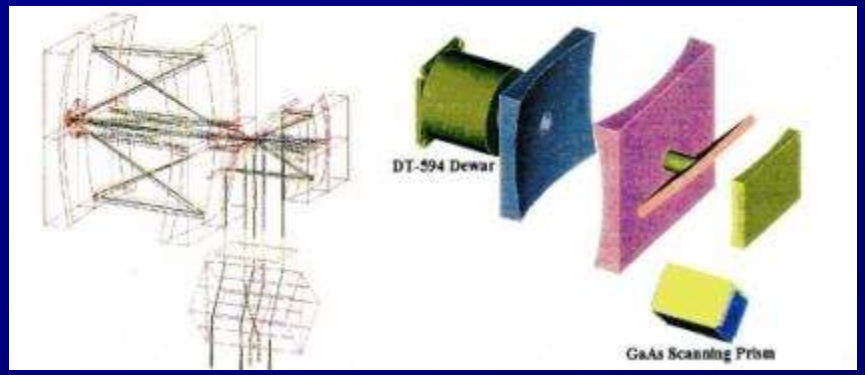
# Line Scanner RS-800MSIRLS

- Using a scanner speed of about 60 Hz and a field of view of 60$^{o}$ results in a linear infrared image approx ½ mile wide
- Approx 2.0 square miles can be imaged per minute
- Chemical discrimination is accomplished using a matrix of 16 cold optical filters having a bandwidth of approx 5 – 20 wave numbers
- Data collection status in approximately 12 minutes from start-up
- One step automated processing

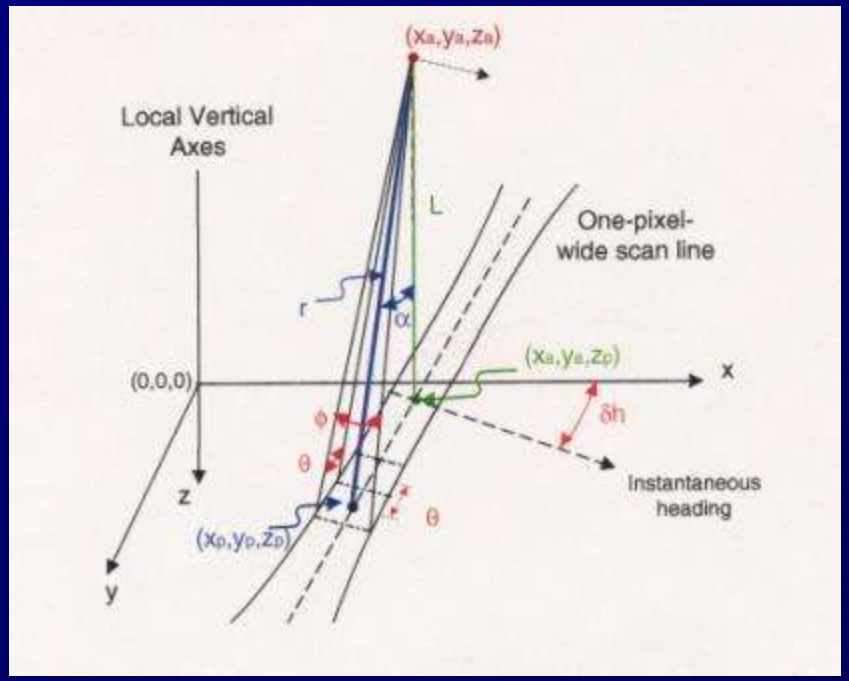
Aircraft Configuration

# RS-800MSIRLS Line Scanner Design

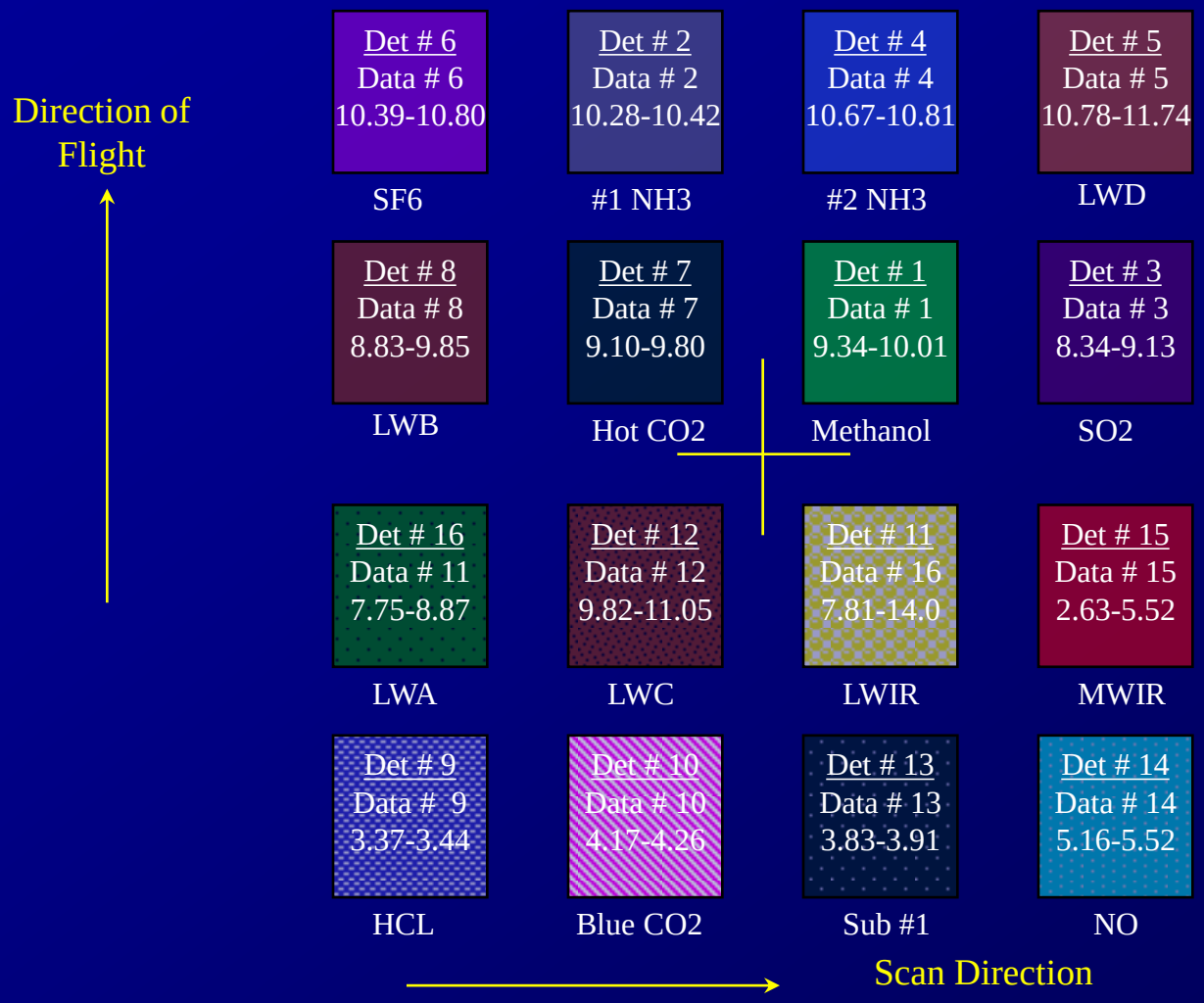
- GaAs Rotating Prism
- All Reflective Internal Optics
- f ≈ 1.1



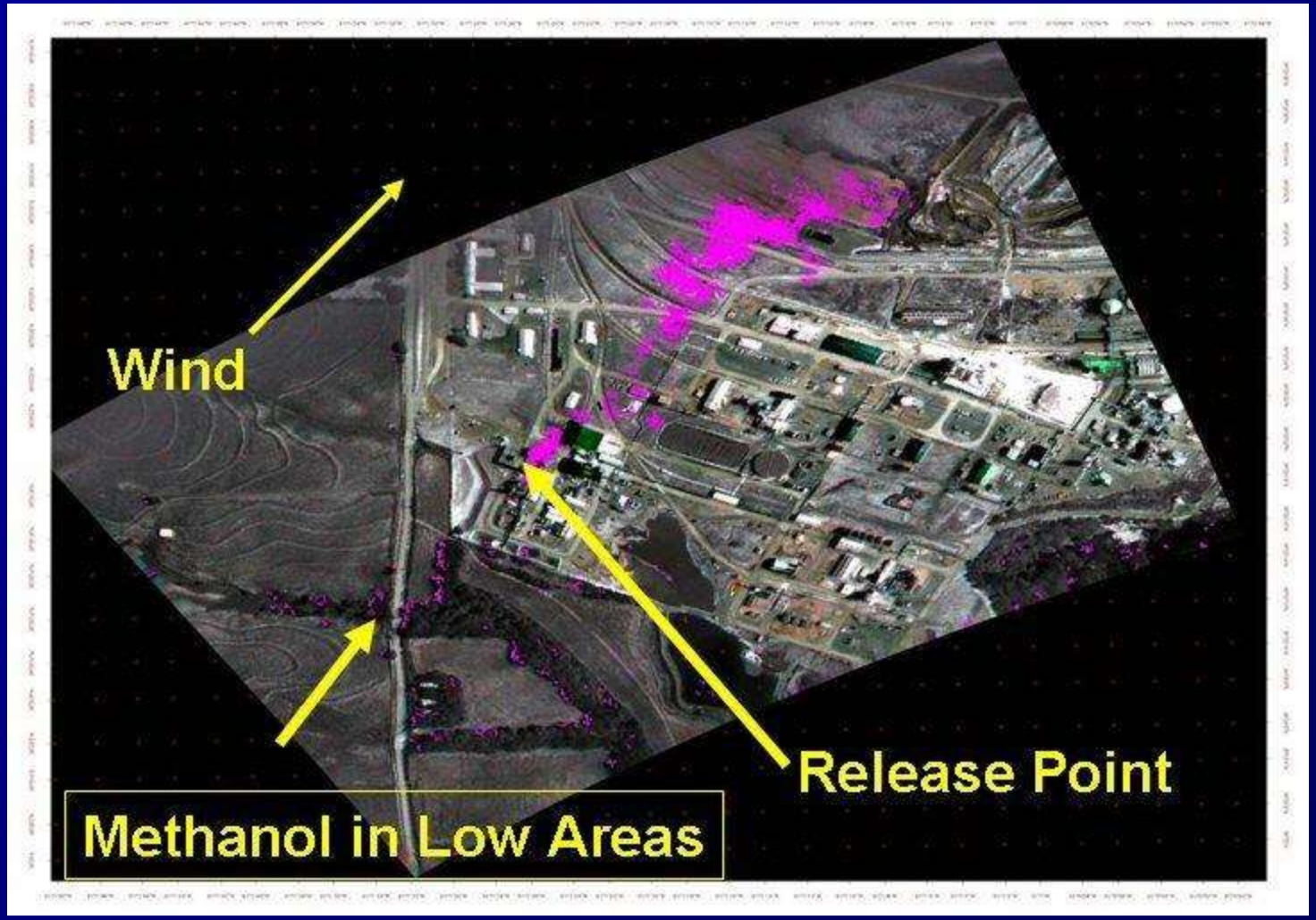

- Scan Rate 60 Hz
- Spatial Resolution 1 mrad
- Effective GSD 0.5 meter



# RS-800 Detector Layout



# Infrared Image of an Industrial Methanol Plume Release



# RADIATION DETECTION

# Radiation Detection Technology

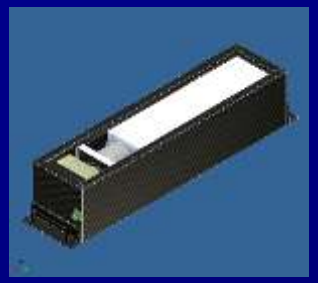
**Radiation Solutions Technology**

- **12** 2”x4”x16” Sodium Iodide
- **3** 3”x3” Lanthanum Bromide
- **4** Neutron Detection Tubes

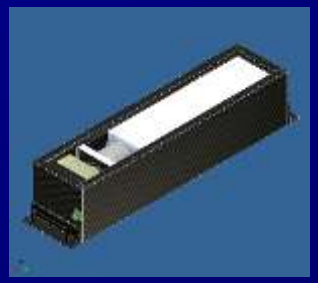
RSX5

RSX4

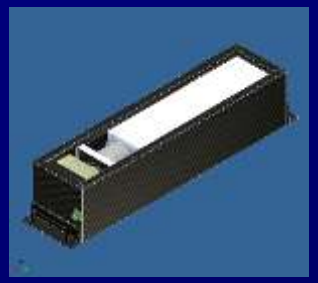
RSX4



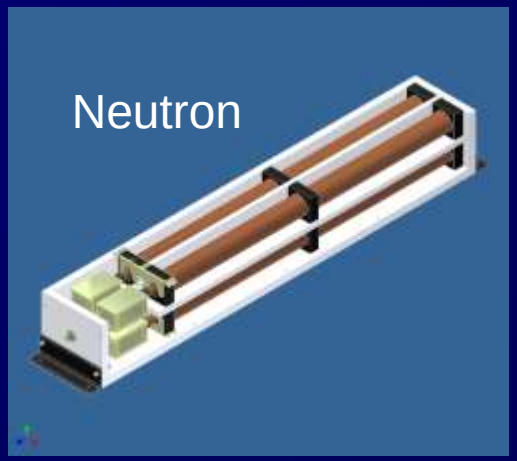
LaBr



LaBr



LaBr



# Calibrated Airborne System

## RadAssist Calibration Parameters

**Calibration Parameters**

ROI

| R.. | Active | Name | Start Ch | End Ch | Det.Bg | Cosmic | Alt. Beta | Sens.Coef | Unit |
|---|---|---|---|---|---|---|---|---|---|
| 01 | YES | TotCount | 137 | 937 | 14.55 | 1.0085 | 0.00702 | 1 | cps |
| 02 | YES | Tot Count (... | 9 | 937 | 41.961 | 3.9698 | 0.00665 | 1 | cps |
| 03 | YES | Potassium | 457 | 523 | 6.831 | 0.0541 | 0.00915 | 5.7578 | pCi/g |
| 04 | YES | Uranium (Bi-... | 553 | 620 | 0.8849 | 0.0442 | 0.00803 | 14.72853 | pCi/g |
| 05 | YES | Thorium(Tl-2... | 803 | 937 | -0.8314 | 0.0505 | 0.00689 | 23.7617 | pCi/g |
| 06 | YES | Cs-137 | 200 | 240 | 3.0329 | 0.1001 | 0 | 1 | cps |
| 07 | YES | Co-60 | 364 | 472 | 3.5458 | 0.1083 | 0 | 1 | cps |
| 08 | YES | Man-Made L... | 16 | 465 | 42.487 | 3.5095 | 0 | 1 | cps |
| 09 | YES | Man-Made H... | 466 | 937 | 0.0265 | 0.2592 | 0 | 1 | cps |
| 10 | YES | Cosmic | 1023 | 1023 | 0 | 0 | 0 | 1 | cps |

Calibration Coefficients Matrix

| * | TotCount | Tot Count (DOE) | Potassium | Uranium (Bi-214) | Thorium(Tl-208) | Cs-137 | Co- |
|---|---|---|---|---|---|---|---|
| TotCount | 1 | 0 | 0 | 0 | 0 | 0 | |
| Tot Count (DOE) | 0 | 1 | 0 | 0 | 0 | 0 | |
| Potassium | 0 | 0 | 1 | 1.07083 | 0.732874 | 0 | |
| Uranium (Bi-214) | 0 | 0 | -0.00767 | 1 | 0.532255 | 0 | |
| Thorium(Tl-208) | 0 | 0 | -0.0011 | 0.04125 | 1 | 0 | |
| Cs-137 | 0 | 0 | 0 | 0 | 0 | 1 | |
| Co-60 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Man-Made LOW | 0 | 0 | 0 | 0 | 0 | 0 | |
| Man-Made HIGH | 0 | 0 | 0 | 0 | 0 | 0 | |
| Cosmic | 0 | 0 | 0 | 0 | 0 | 0 | |

Dose Rate computation

Dose Calibration Factor: 0.043500

Dose Altitude Beta: 0.005000

☐ Scale to # xtals

Height Correction

☑ Enable Height Correction

Meters per unit of Altitude: 0.1506000

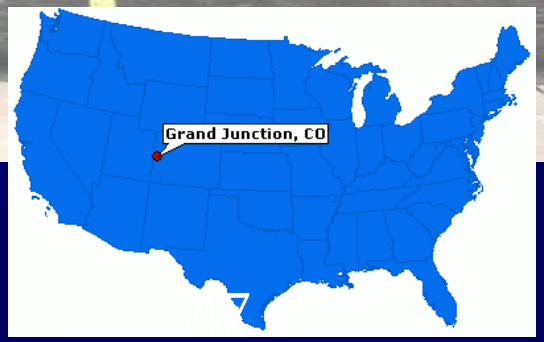
Reference Altitude: 136.1926 [m]

Altitude field: Analog Input 1 (ADC 1

Fixed Altitude: 0.0000 [m]

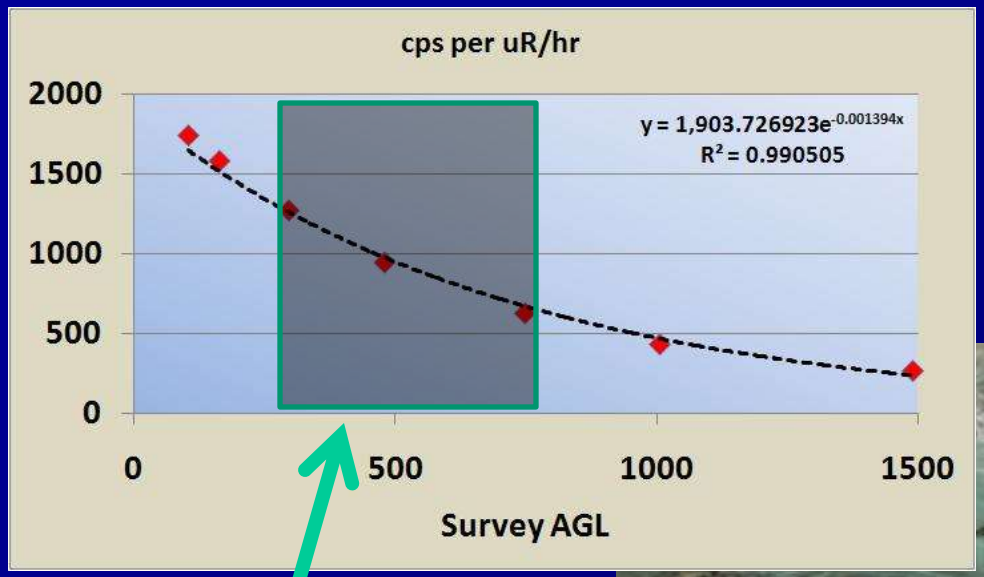
Cancel | OK

Grand Junction, Colorado
Calibration Pads

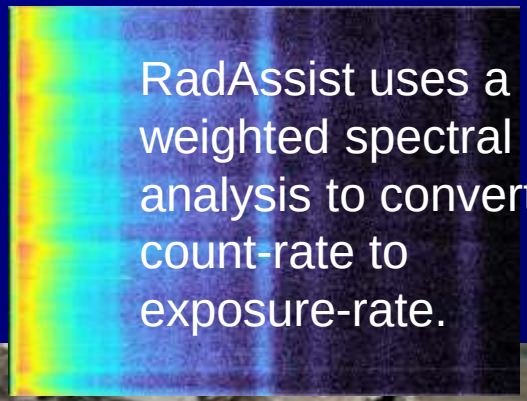



1. High Altitude Flights
2. Calibration Pads
3. Calibration Range Flights
4. Radon background calibration flights

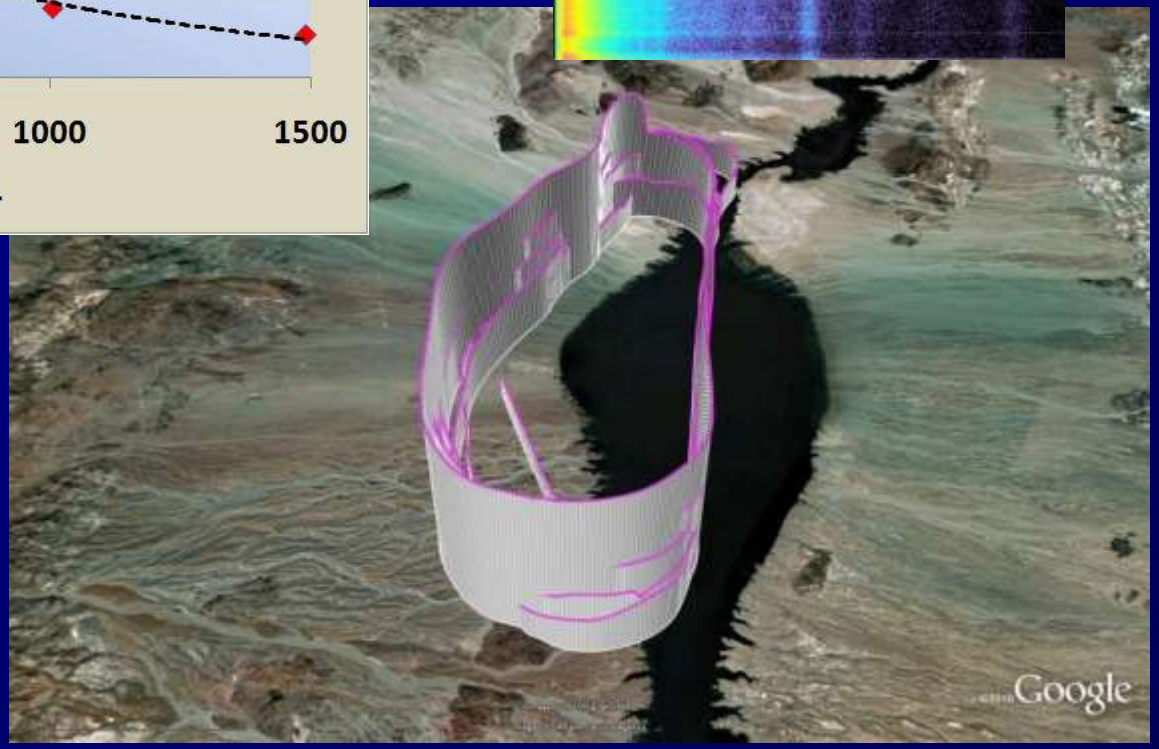
# Count-rate to exposure-rate calibration
## "DOE" method vs. RadAssist




Typical survey altitudes



RadAssist uses a weighted spectral analysis to convert count-rate to exposure-rate.

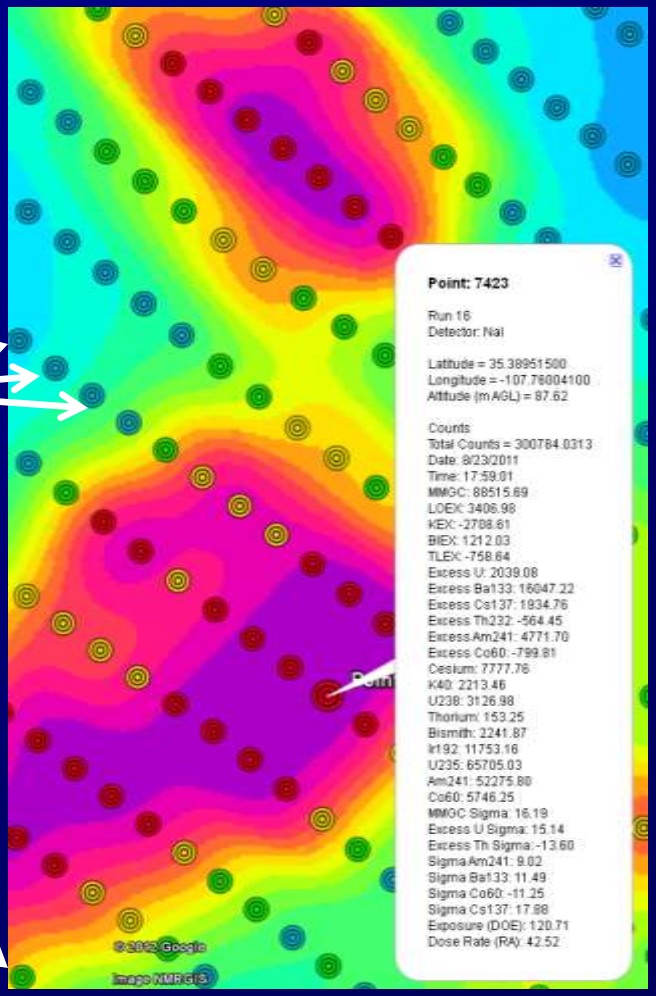


# ENVI Signal Processing Steps

11. Isotope Analyses
    a) Net = $(ROI_{ISO}) - K\ (ROI_{TOT})$
12. Minor adjustments
    a) GPS mid-point
    b) Polygon selection
    c) Altitude Filter
13. Standard Deviation Calcs.
    a) Sigma Plot
    b) Normality Test (QA)
14. Products
    a) Count rate
    b) Exposure rate
    c) Sigma Plot

Scans/ Points

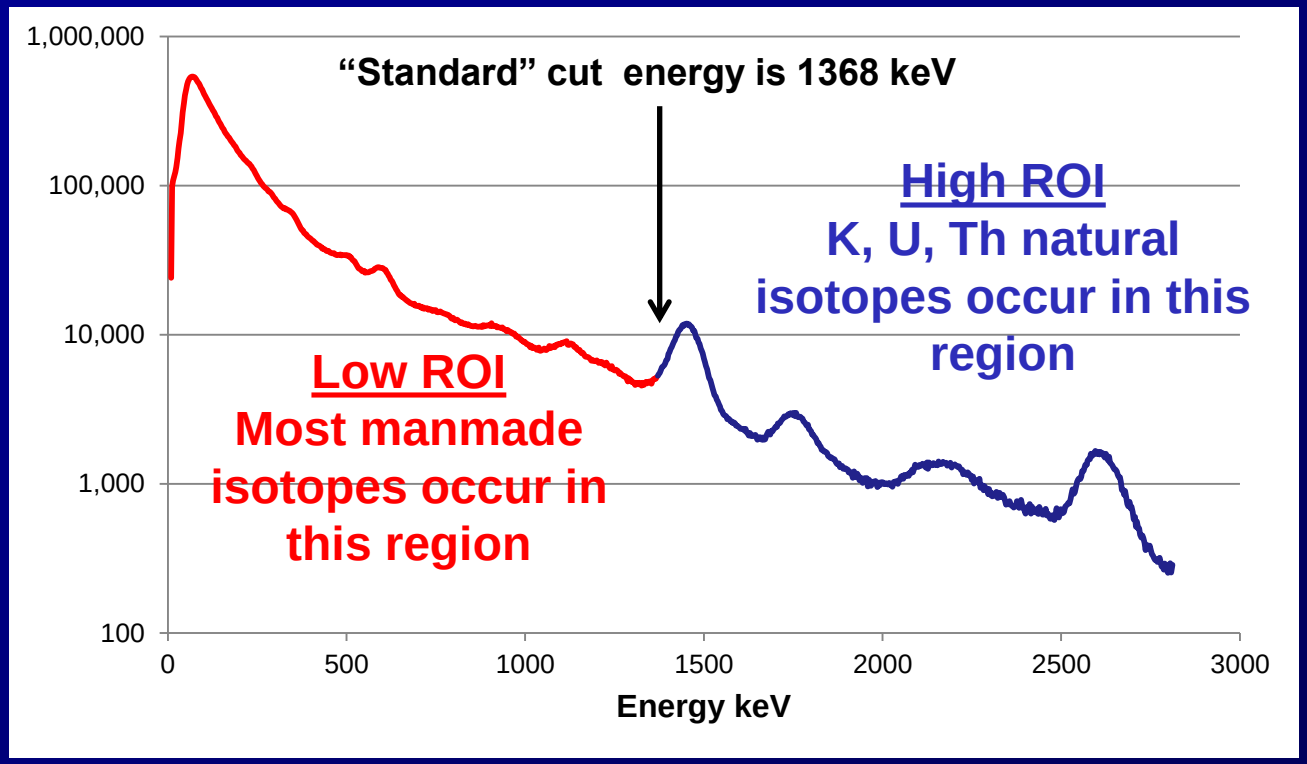
Runs



# Manmade Anomaly Detection

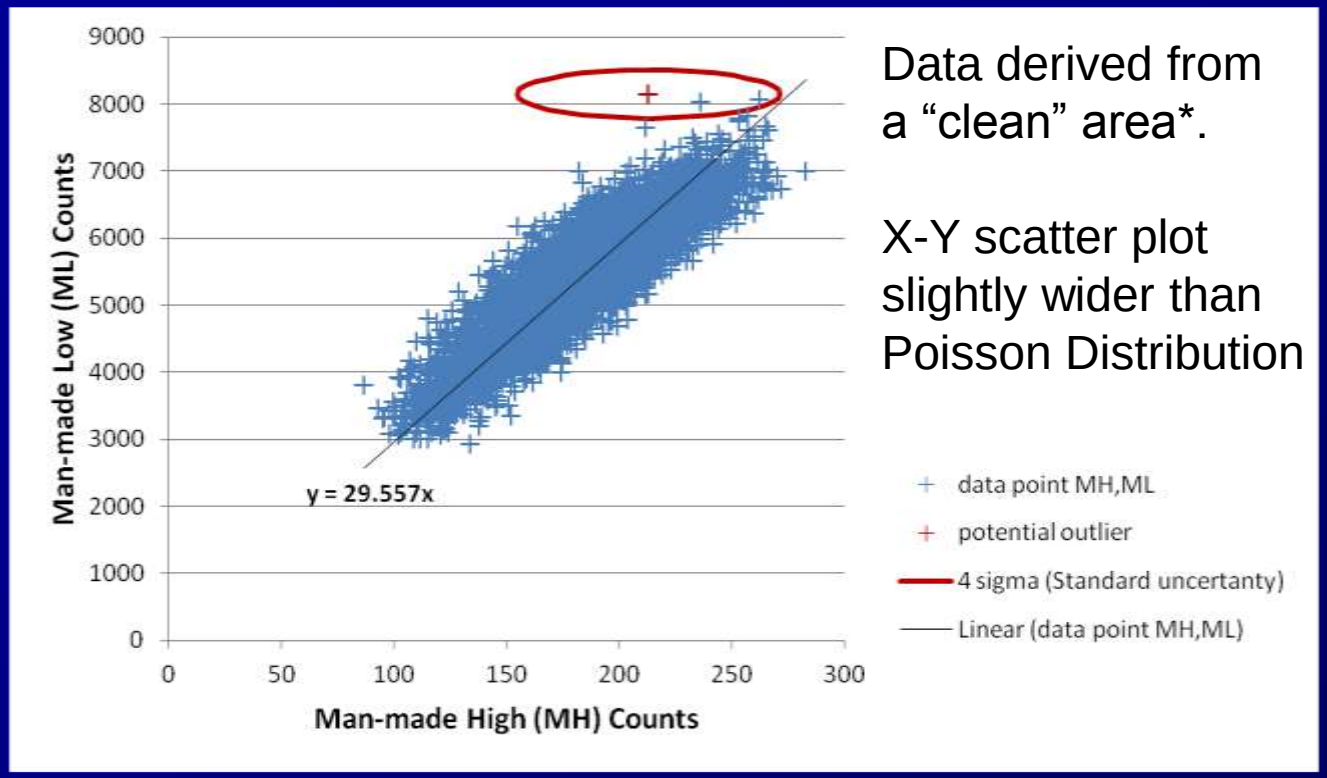
(Homeland Security Applications)

**Is there a man-made source present above a detection threshold that warrants ground investigation?**



# RadAssist Anomaly Detection

**Is a data point statistically different from the established liner relationship with the slope?**




Data derived from a “clean” area*.

X-Y scatter plot slightly wider than Poisson Distribution

Ratio Assumptions

1. Same for natural background K, U,Th
2. Independent of altitude

* Special reference survey not needed if searching for single outliers.

# Typical Cs-137 & Co-60 Sources/Applications

| Application | Isotope | Min Activity (mCi) 1mCi = 37MBq | Typical (mCi) | Max Activity (mCi) | IAEA Class |
|---|---|---|---|---|---|
| Moisture Density Gauge | Cs-137 | 8 | 10 | 11 | 5 |
| Fill-level, thickness gauges | Cs-137 | 50 | 60 | 65 | 4 |
| Brachytherapy - low dose rate | Cs-137 | 10 | 500 | 700 | |
| Well Logging | Cs-137 | 1,000 | 2,000 | 2,000 | |
| Spinning Pipe Gauges | Cs-137 | 2,000 | 2,000 | 5,000 | 3 |
| Dredger Gauges | Cs-137 | 200 | 2000 | 10,000 | |
| | Co-60 | 250 | 760 | 2,600 | |
| Blast Furnace Gauges | Co-137 | 1,000 | 1,000 | 2,000 | |
| Conveyor Gauges | Cs-137 | 100 | 3,000 | 40,000 | |
| Level Gauges | Cs-137 | 1,000 | 5,000 | 5,000 | |
| | Co-60 | 100 | 5,000 | 10,000 | |

# What's a Dangerous Source?

**1 mCi = 37 MBq**

| Radionuclide | Activity associated with a Dangerous Sources (mCi) |
|---|---|
| Co-60 | 800 |
| Cs-137 | 3,000 |
| Ir-192 | 2,000 |
| Ra-226 | 1,000 |
| Tc-99$^{m}$ | 2,100 |

A 'dangerous source' is defined by the IAEA as "a source that could, if not under control, give rise to exposure sufficient to cause severe deterministic effects."

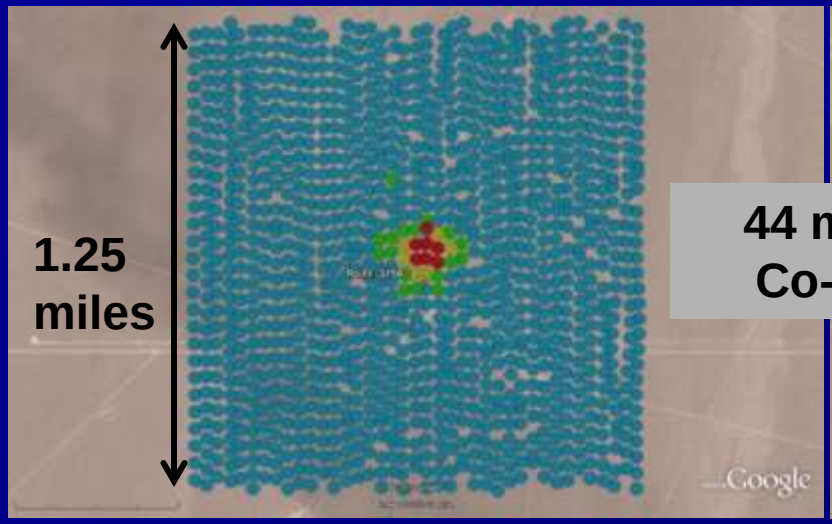
**Current ASPECT MDA @ 300 ft AGL**

| | |
|---|---|
| Cs-137 | 2 @ 3σ |
| Co-60 | 1 @ 3σ |

# DNDO Project Gyphon - ASPECT

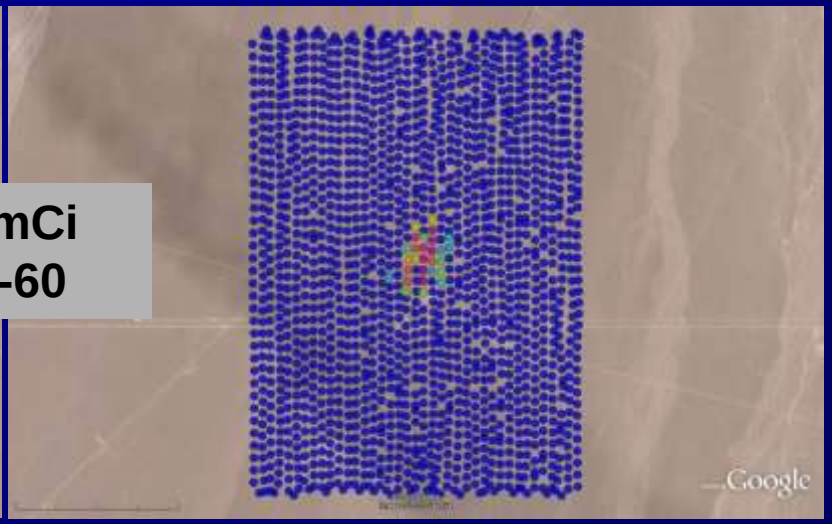
## 152 m AGL; 50 m line spacing

**Co-60 ROI Sigma Plot**




**44 mCi Co-60**

**RadAssist Anomaly Function**




**ENVI Code**
**(Requires Test Line)**

**Product produced within**
**SECONDS after Survey**

**RadAssist Anomaly Function**
**(No Test Line)**

**Product produced**
**REAL-TIME, while in flight.**

**Applied research application**

Survey time = 90 minutes; 39 survey lines

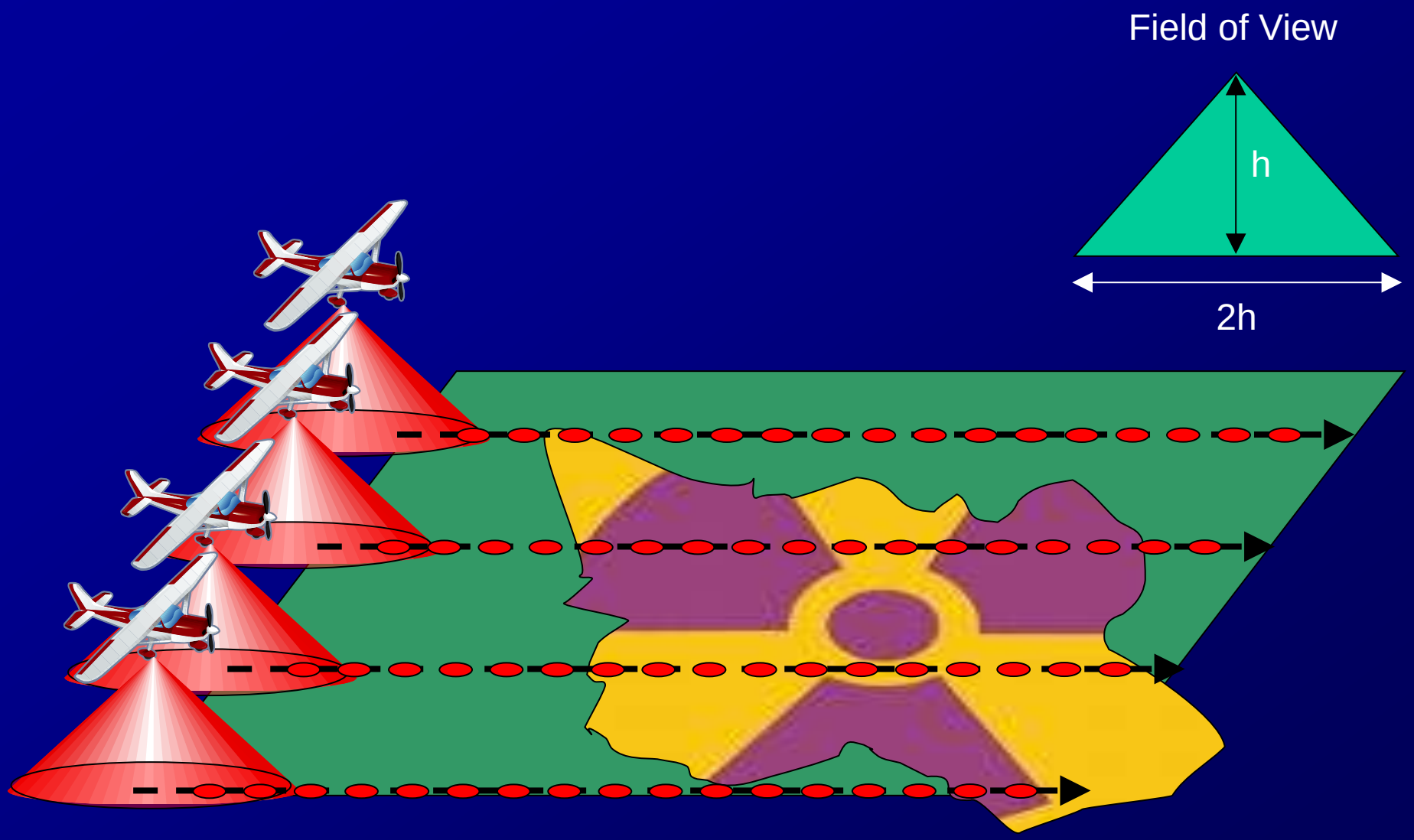
1.56 square mile area

# ASPECT Neutron Response

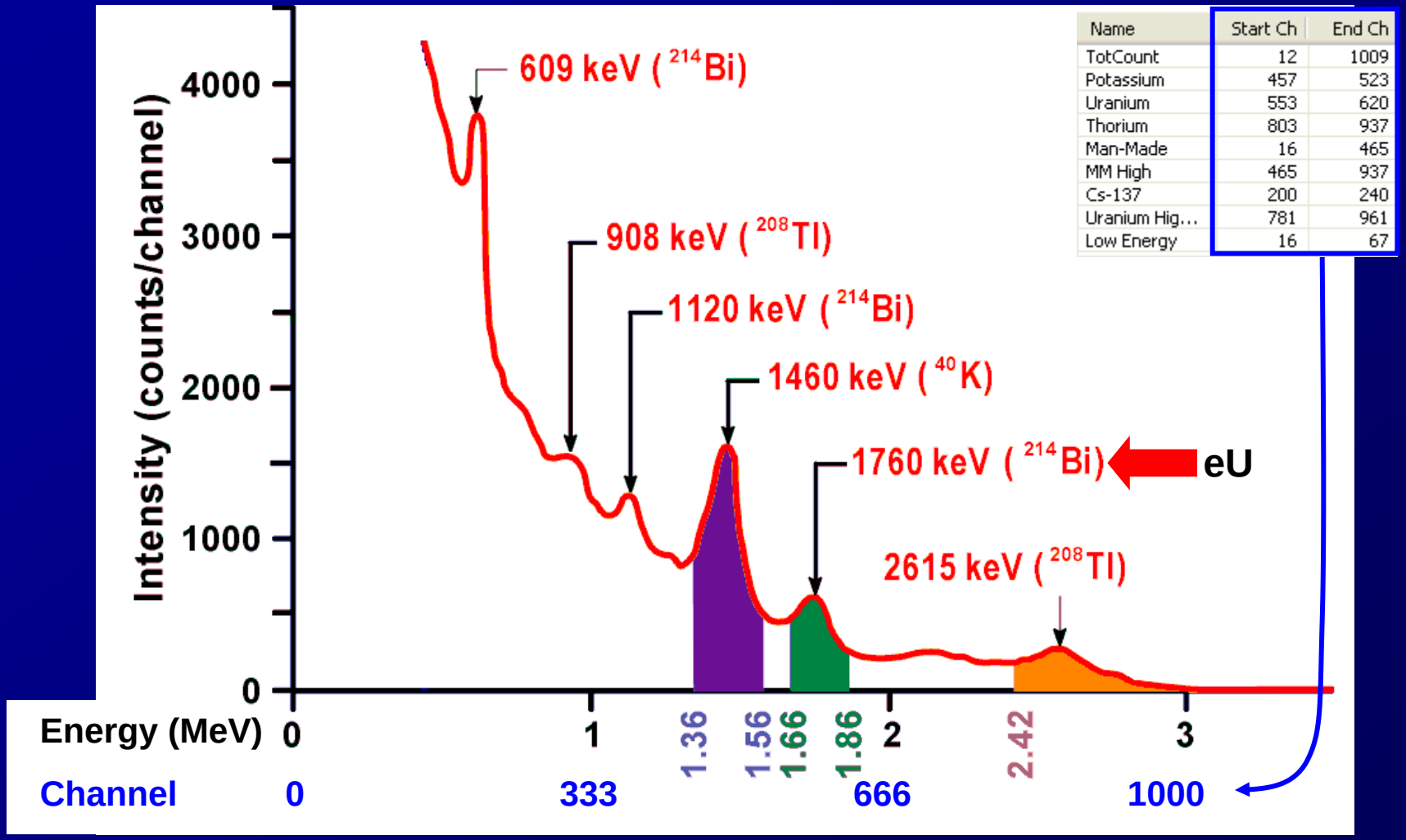
**<u>Identical Source</u>**
Multiple Altitudes
Multiple Off-sets
<u>Ideal flight Param</u>
200' AGL
Up to 600' off-set

- Identical control source detected and located
- 200' AGL
- 150 linear miles surveyed
- Real-Time Observation

# Typical Environmental Survey



# Typical Gamma-Ray Spectrum

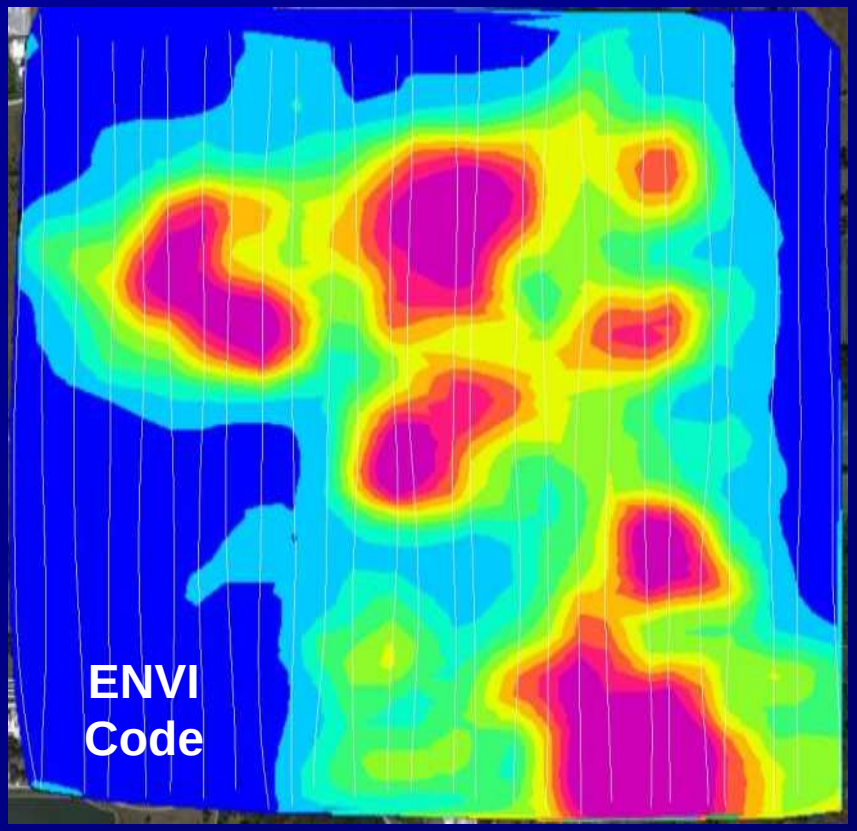



| Name | Start Ch | End Ch |
|---|---|---|
| TotCount | 12 | 1009 |
| Potassium | 457 | 523 |
| Uranium | 553 | 620 |
| Thorium | 803 | 937 |
| Man-Made | 16 | 465 |
| MM High | 465 | 937 |
| Cs-137 | 200 | 240 |
| Uranium Hig... | 781 | 961 |
| Low Energy | 16 | 67 |

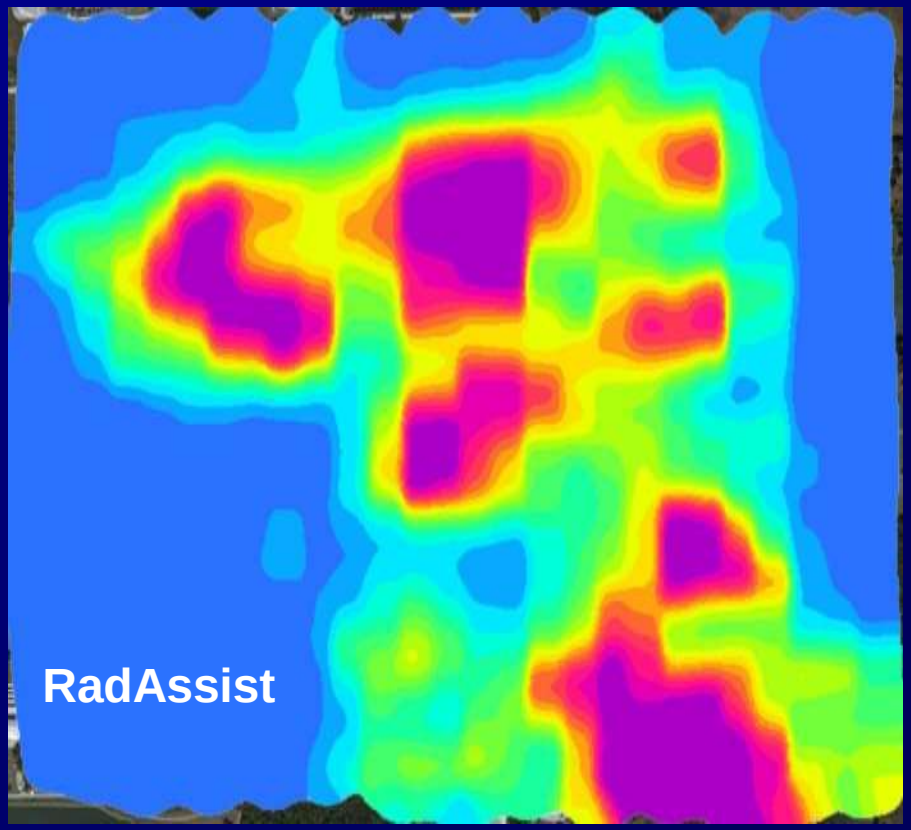
# Contouring Algorithms

**Triangulation** vs. **Point Spread Function**

300 ft AGL; 300 ft Line Spacing



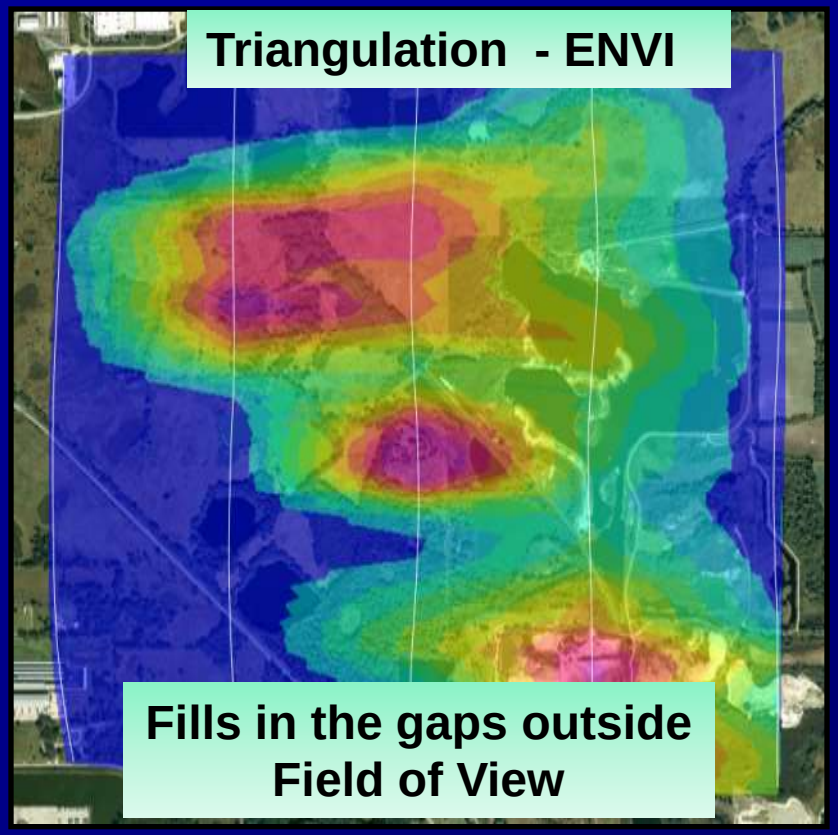

300 ft AGL, 300 ft Line Spacing



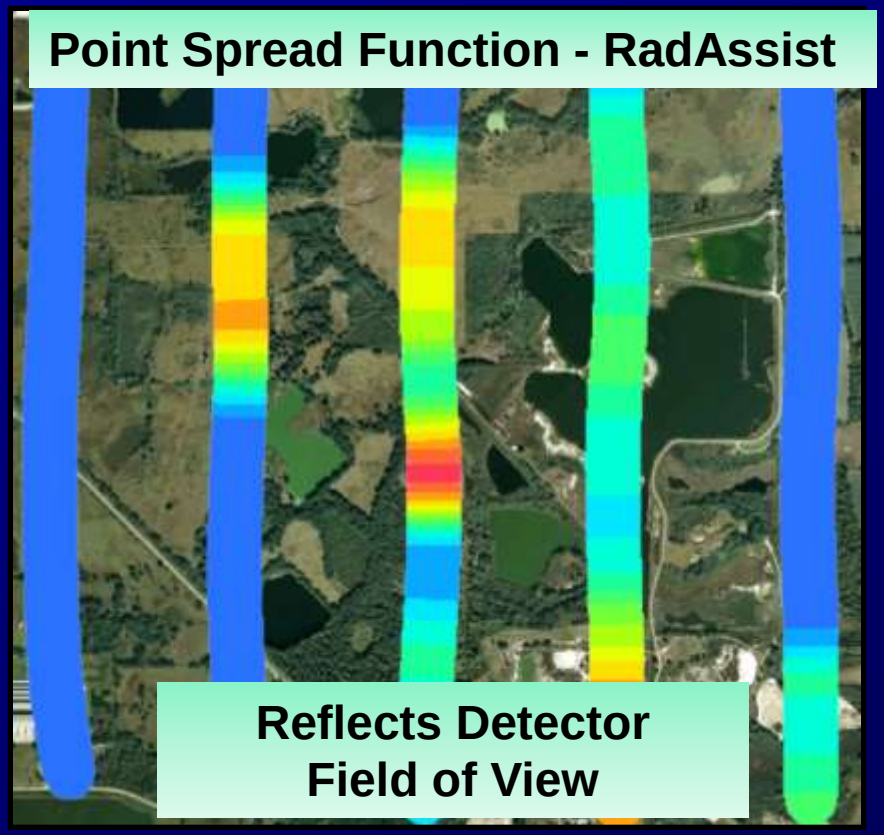


58

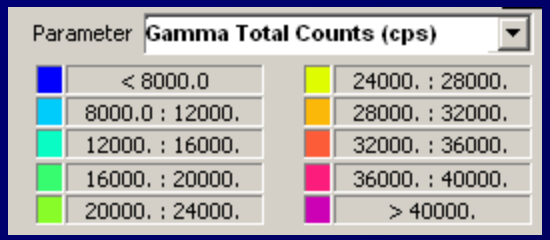
# Contouring Algorithms



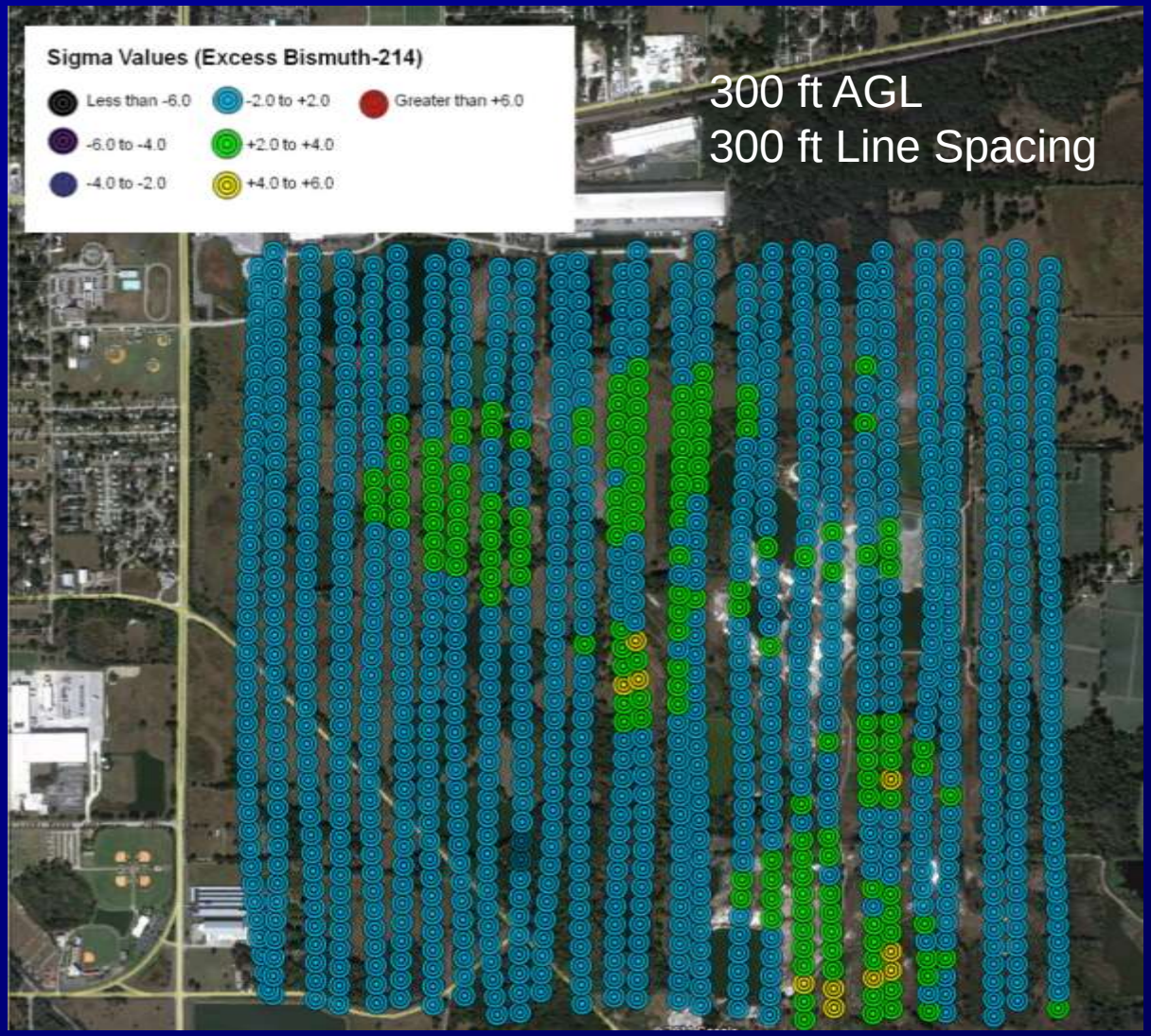

300 ft AGL
1800 ft Line Spacing




300 ft AGL
1800 ft Line Spacing



# Sigma Plot of eU conc.



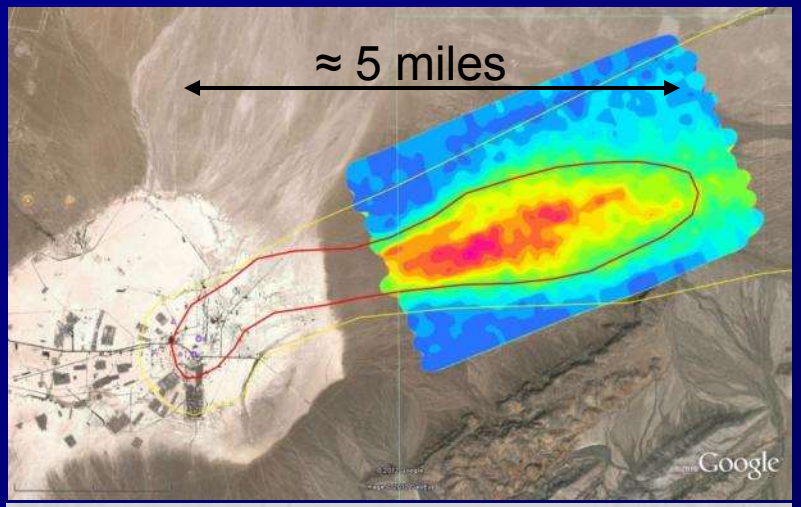
# Boston Count Rate Contour

# Boston Exposure Rate Contour

# ASPECT Survey

## (October 2010, 91 m AGL; line spacing 152 m)

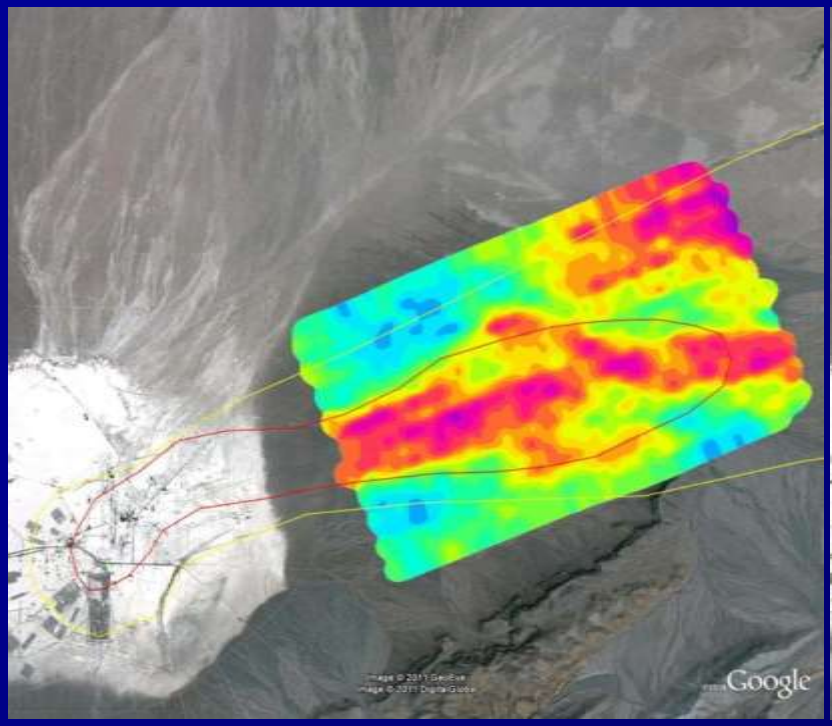
**Operation Sunbeam**



63

# Advanced Processing Algorithms
## (NNSS Survey; October 2010)

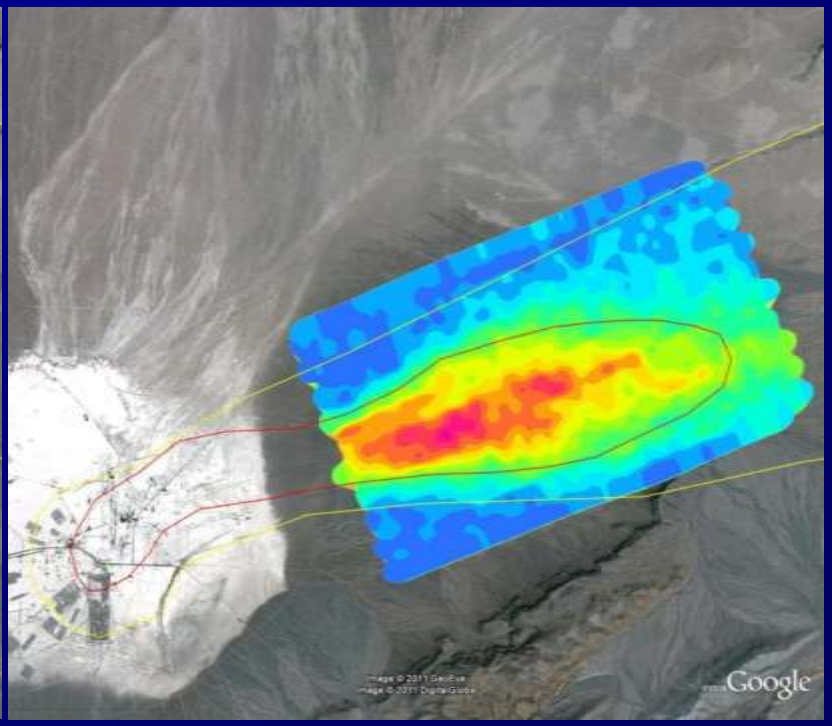
**Cs-137 ROI (uncorrected)**




**Total counts in ROI for specific isotopes**

**Product produced within SECONDS**

**NASVD : Cs-137 contour**




**Noise Adjusted Singular Value Decomposition**

**Product produced within HOURS**

# CBRN CMAT NRC License

Issued: March 2014

Authorized for:

- Several gamma emitting nuclides
- AmBe neutron source

Civil Defense Applications

- Training
- Exercises
- ASPECT algorithm development

Sources can be used anywhere in the United States

- CMAT handles all logistics

RSO : John Cardarelli (Cardarelli.john@epa.gov)

# OIL DETECTION

# Why ASPECT can detect oil

Radiance = $\epsilon T^4$

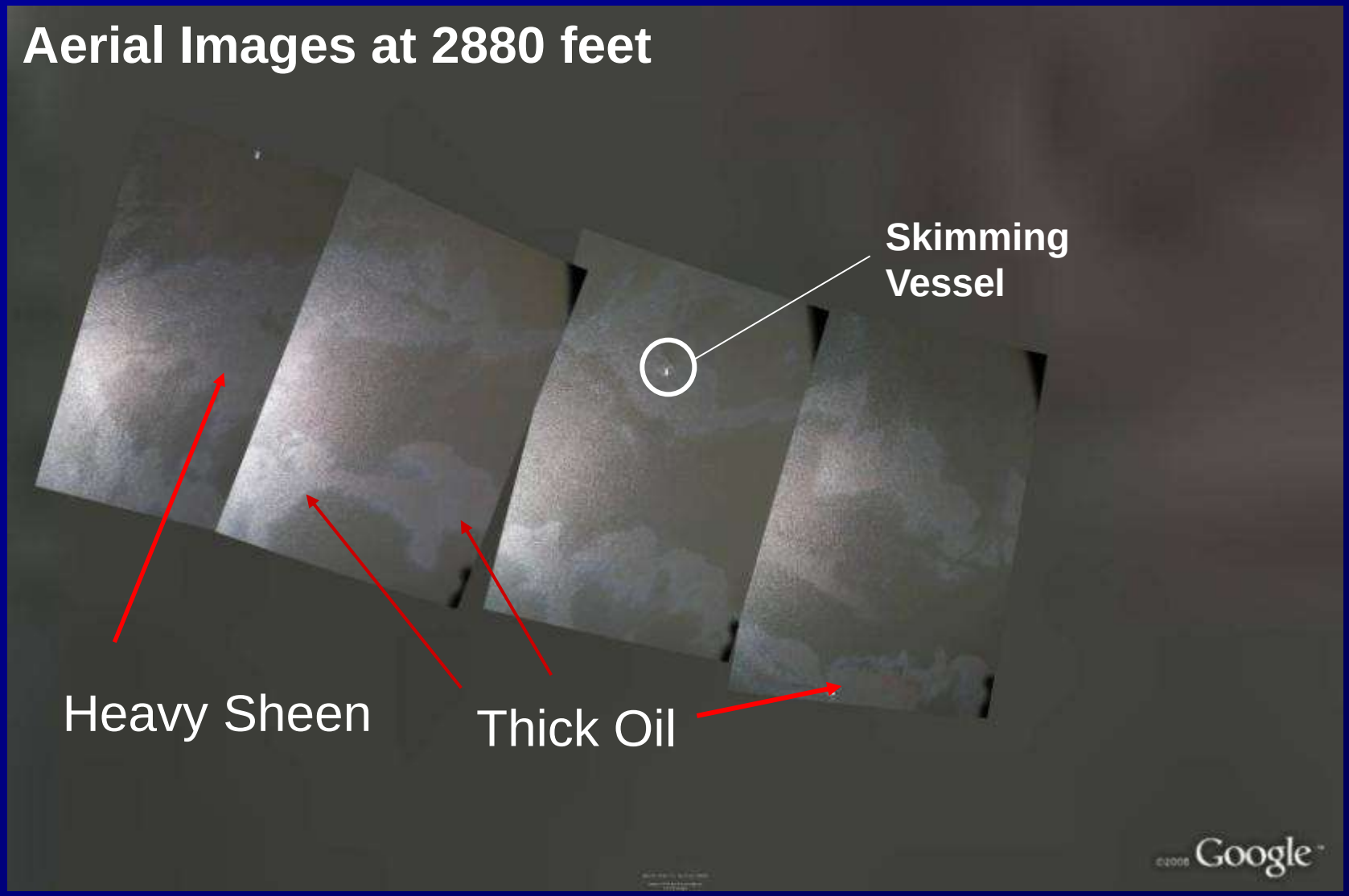
- $\epsilon$ = emissivity *(how efficient an object irradiates infrared energy)*
- $T$ = temperature
  - Oil and water have similar temperatures in open water ($\epsilon$ driven properties)
  - Oil on marshland has different temperatures ($T$ driven properties)

Oil $\epsilon \approx 0.75$ to $0.82$ depending on thickness of surface oil

Water $\epsilon \approx 0.93$

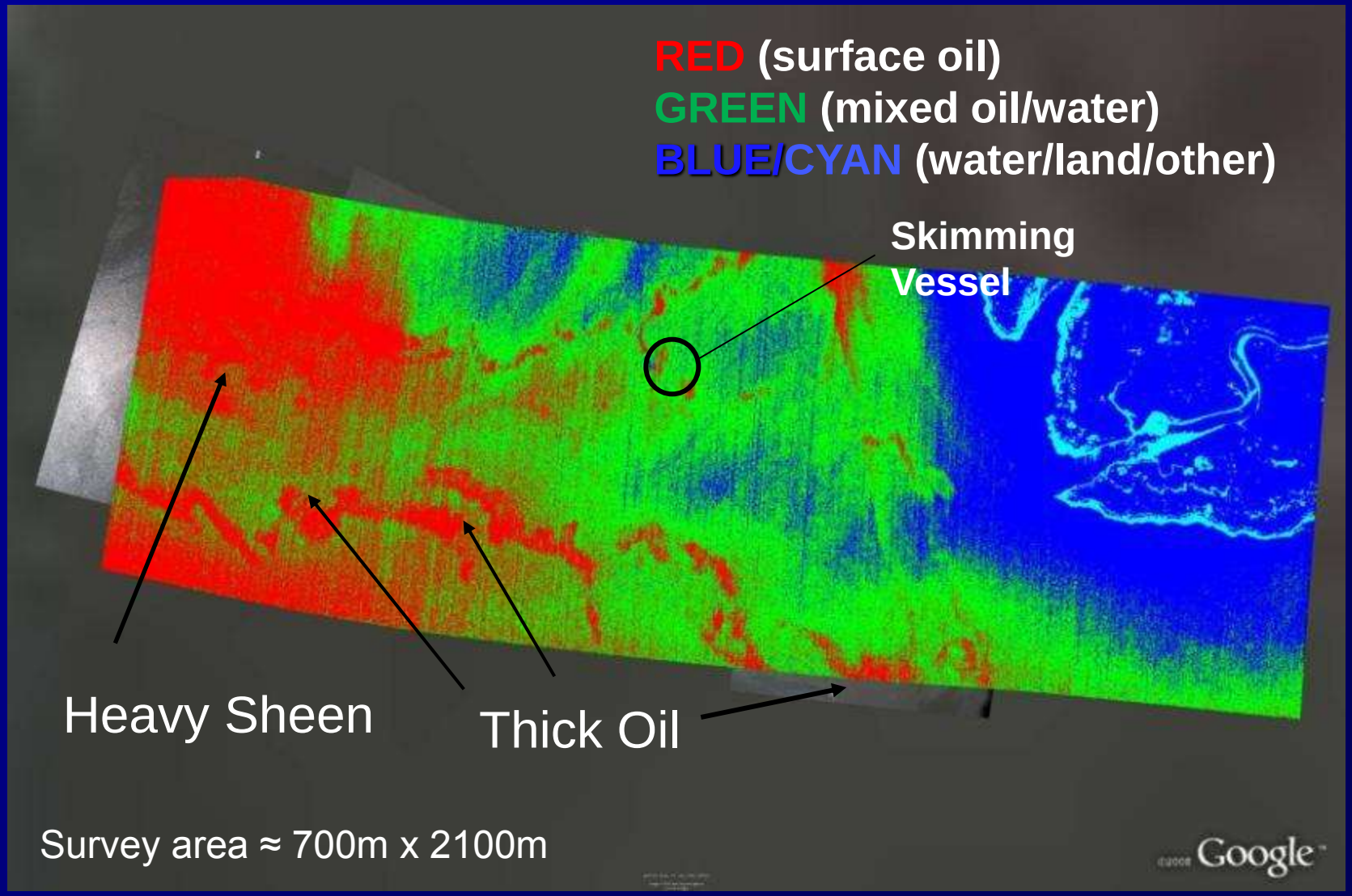
# Near Shore Oil Detection

## Aerial Imagery – Barataria Bay



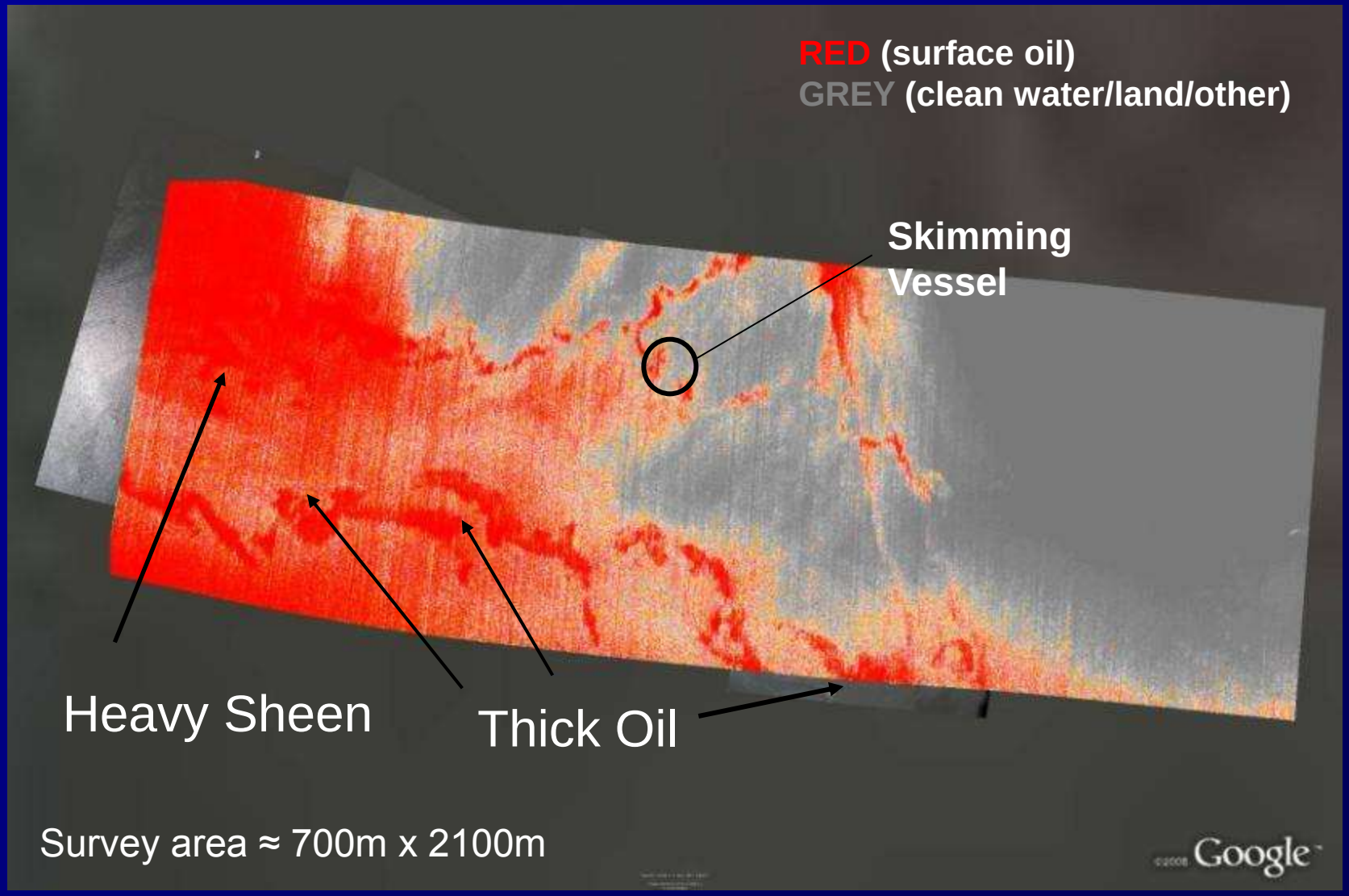
# Near Shore Oil Detection

## Unsupervised Classification Infrared Image



# Near Shore Oil Detection

## Supervised Pattern Recognition of IR Image

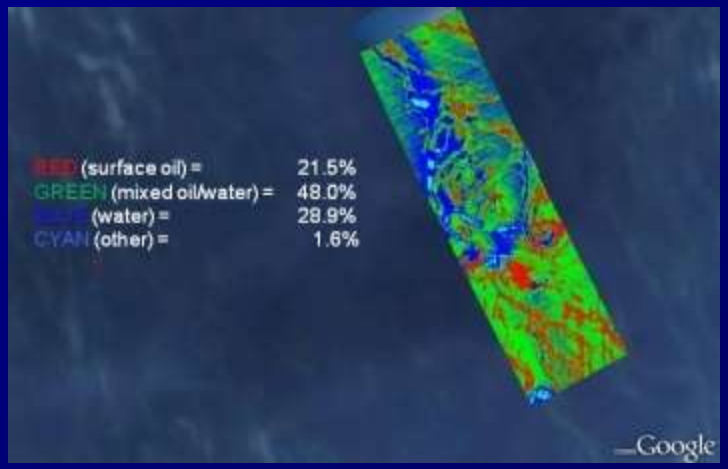


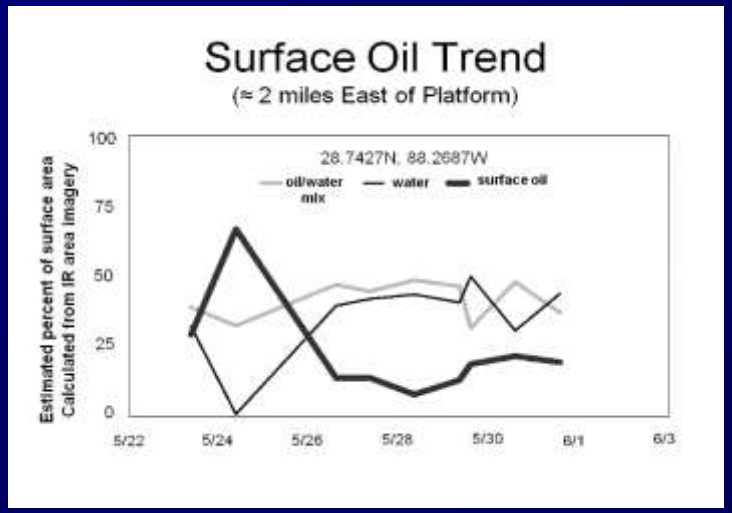
# Spectral Analysis of Oil

## Oil Coverage and Trend Analysis

- The ASPECT team developed a series of IR Spectral tools permitting the type and coverage of oil to be quantified

- Over a month period, ASPECT collected data approximately 2 miles east of the recovery site. A trend analysis indicated that between 24 May and 26 May the surface characteristic of the oil changed potentially due to dispersant operations



# Deep Water Horizon Mission Statistics

April 28 to August 3, 2010

- 86 survey flights
  - ✓3087 data collection runs
  - ✓294 flight hours
- 2,544,000 interferograms assessed
- Over 4.5TB processed data
- 14,972 digital photos
- 6,593 oblique photos
- 2,100 infrared images
- 372,000 unique users of the data
- 1.2 Million times data has been accessed

# IMAGERY

# Aerial Photography

**12.5 MPixel High Resolution Digital Camera**

**Automated Geo-Rectification/GIS Coded Images**

**Full Ortho-Rectification (Camera Model) Correction**

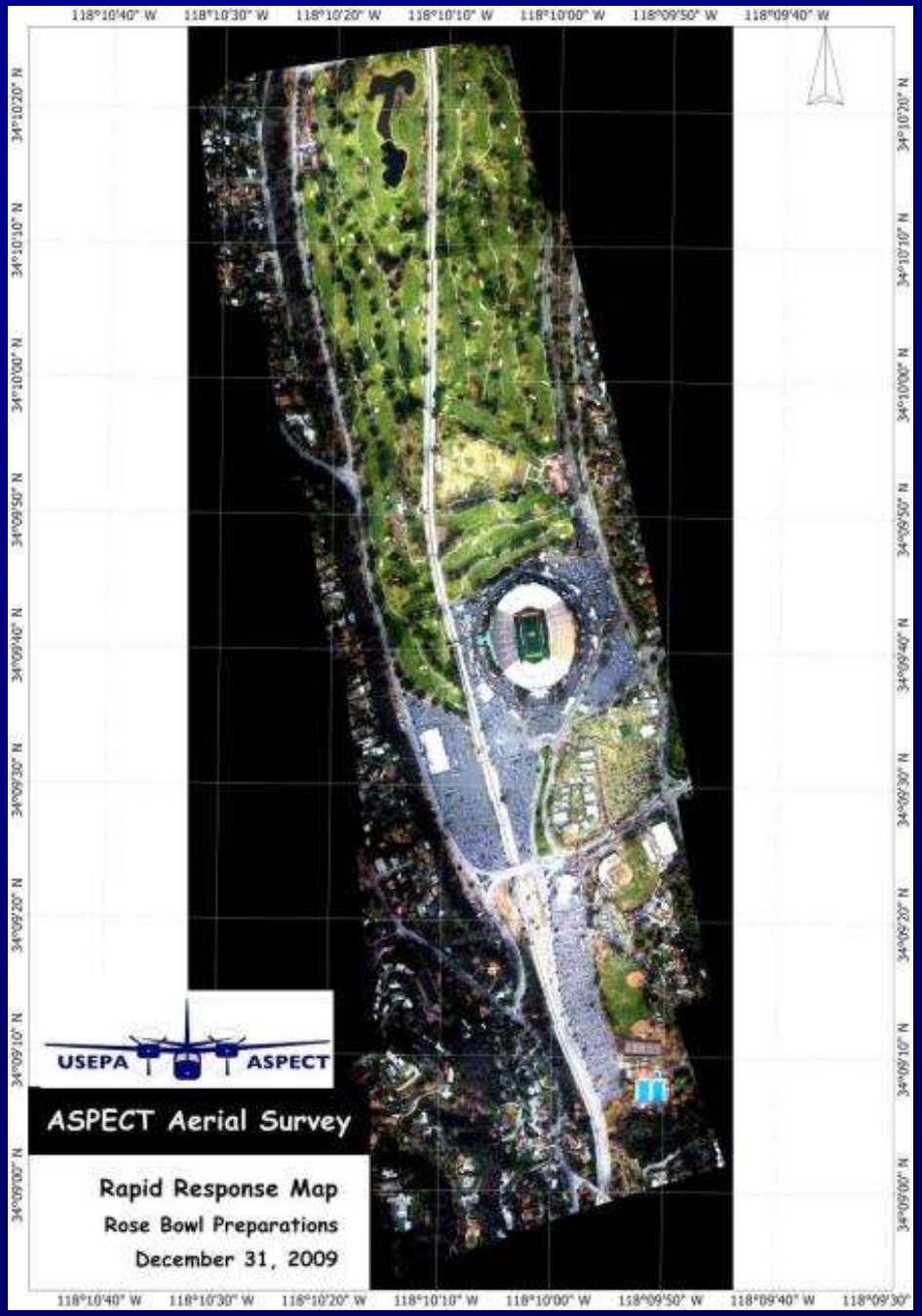
**Ability to Process in the Air-Approx 3 Minute Turn-Around**

**Compressed Transmission of Data Via SatCom**

**Fast Turn Around on Images – Approx 700 processed images per Hour**

**Product can be imported into:**

- **Google Earth,**
- **ESRI**
- **Generic Geospatial software packages**



# ASPECT Image Products

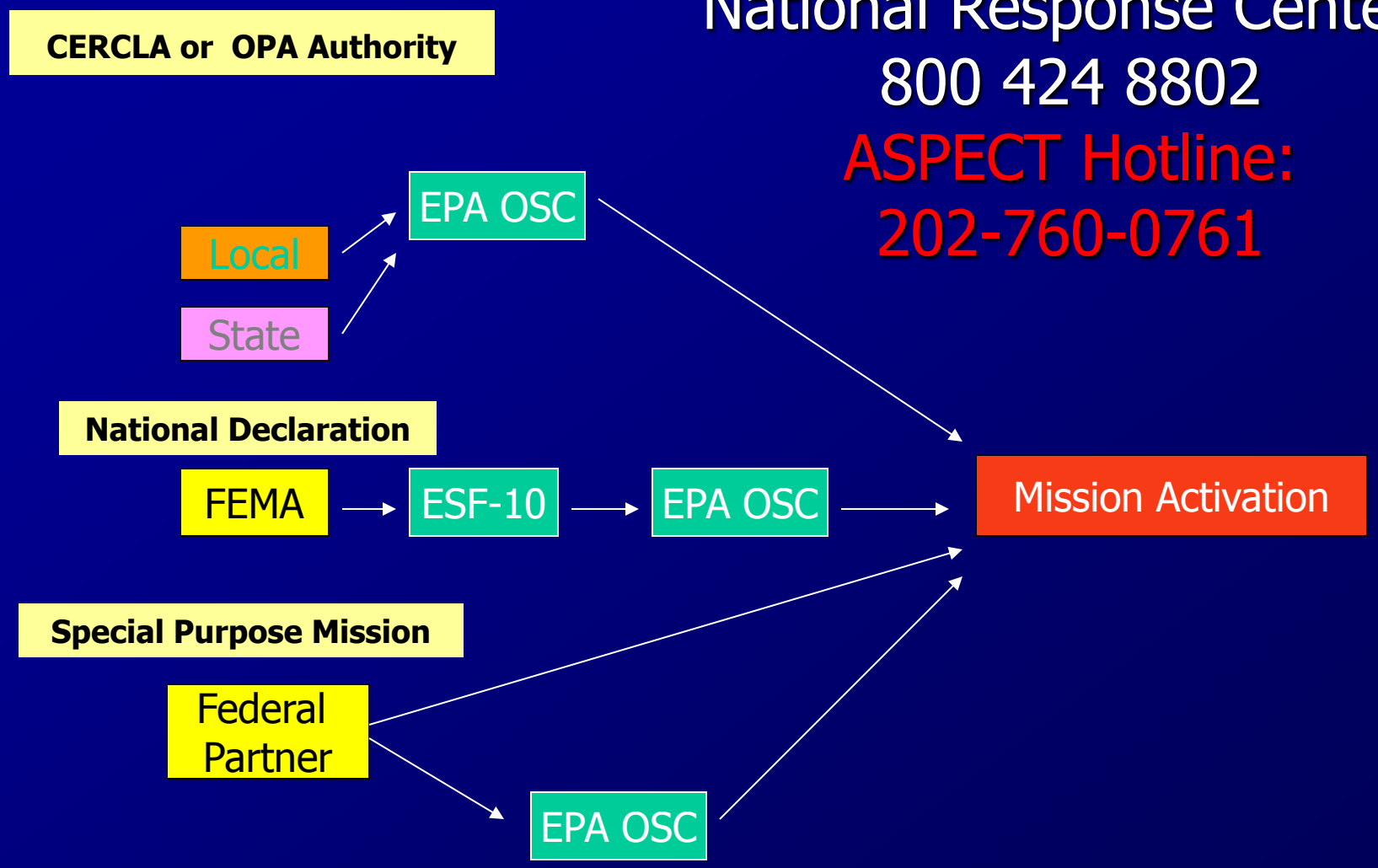
Aerial Image Mosaic,
Balloon Fiesta 2010

IR Image taken during the
same mission

# Logistics

# Methods of Activation

National Response Center:
800 424 8802
ASPECT Hotline:
202-760-0761



# Steps Needed For Activation

1. Call the ASPECT Hotline or one of the Team Contacts
2. Provide as much information as possible about the incident or proposed use
   - Location
   - Chem/Rad?
   - Any known air restrictions
3. Provide the contact person we will interface with.
4. If possible, provide the data contact individual who will receive the data

# Contact and Readiness

## Points of Contact

**Mark J Thomas**

Program Manager - 513-675-4753 - thomas.markj@epa.gov

**Tim Curry**

Deputy Program/Financial Manager - 816-718-4281 - curry.timothy@epa.gov

**John Cardarelli**

Radiation Program Manager – 513-487-2423 - cardarelli.john@epa.gov

**Paul Kudarauskas**

Logistics Manager & DC Liaison - 202-344-5382 - kudarauskas.paul@epa.gov

## Readiness

**24/7 On-Call number: 202-760-0761**

**< 1 Hour Departure (0700 – 1700)**

**< 1 ½ Hour Departure (After Hours)**

# Typical ASPECT Planning Numbers
## Mission Time and Products

- Chemical Response:
  - Flight Time ≈ 3 Hours
  - 40 Data Collection Passes
  - 40 Multi-Spectral IR Images
  - 120,000 FTIR Data Points
  - 200 Georectified Aerial Images
  - Initial Data Products in 5 Minutes, Report in 1 Hour

- Photographic/Chemical Survey (Assume 40 Square Miles)
  - Collection Rate: 23 Square Miles per Hour
  - Total Flight Time ≈ 3 Hours for the Survey
  - 120 Multi-Spectral IR Images
  - 360,000 FTIR Data Point
  - 600 Georectified Aerial Images (Full coverage)
  - Full Data Uploaded/Delivered in 24 Hours

- Radiological Survey/Response (Assume 40 Square Miles)
  - Collection Rate: 8.7 Square Miles per Hour
  - Total Flight Time ≈ 5.5 Hours (Full coverage) for the Survey
  - Data Products Available After the 2$^{nd}$ Flight Line and Updated For Each Line Thereafter.
  - Initial Survey Products Delivered in 10 Minutes, Full Data Uploaded with Preliminary Report in 24 Hours

# Typical ASPECT Planning Numbers Costs

- Chemical Response:
  - Flight Time ≈ 3 Hours
  - Typical Cost $5100 per Response

- Photographic/Chemical Survey (Assume 40 Square Miles)
  - Total Flight Time ≈ 3 Hours
  - Approximately $150 per Square Mile for Data Collection
  - Approximately $1500 per Day Ground Support
  - Typical Cost $7500 for the Survey

- Radiological Survey/Response (Assume 40 Square Miles)
  - Flight Time ≈ 5.5 Hours (Full coverage)
  - Approximately $200 per Square Mile for Data Collection
  - Approximately $1500 per Day Ground Support
  - Typical Cost $9500 For the Survey

- Long-term Deployment (BP Oil Response)
  - Flight Time ≈ 6 Hours per day(Full coverage)
  - Daily Cost ≈ $10000

# YouTube ASPECT Videos

Basic Intro

http://youtu.be/cGLKoGYZGWU

Flying for First Responders

http://youtu.be/f60r9sAozXs

Behind the Science

http://youtu.be/uVxy-jrcnos

# ASPECT Team

Mark Thomas, EPA
Timothy Curry, EPA
John Cardarelli, EPA
Paul Kudarauskas, EPA
Paul Lewis, NGA

Robert Kroutil, Kalman Co, Inc.
Jeff Stapleton, Kalman Co, Inc.
Dave Miller, Kalman Co, Inc.
Airborne ASPECT/ARRAE, Inc.
University of Iowa