

Airborne Spectral Photometric Environmental Collection Technology



*-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:

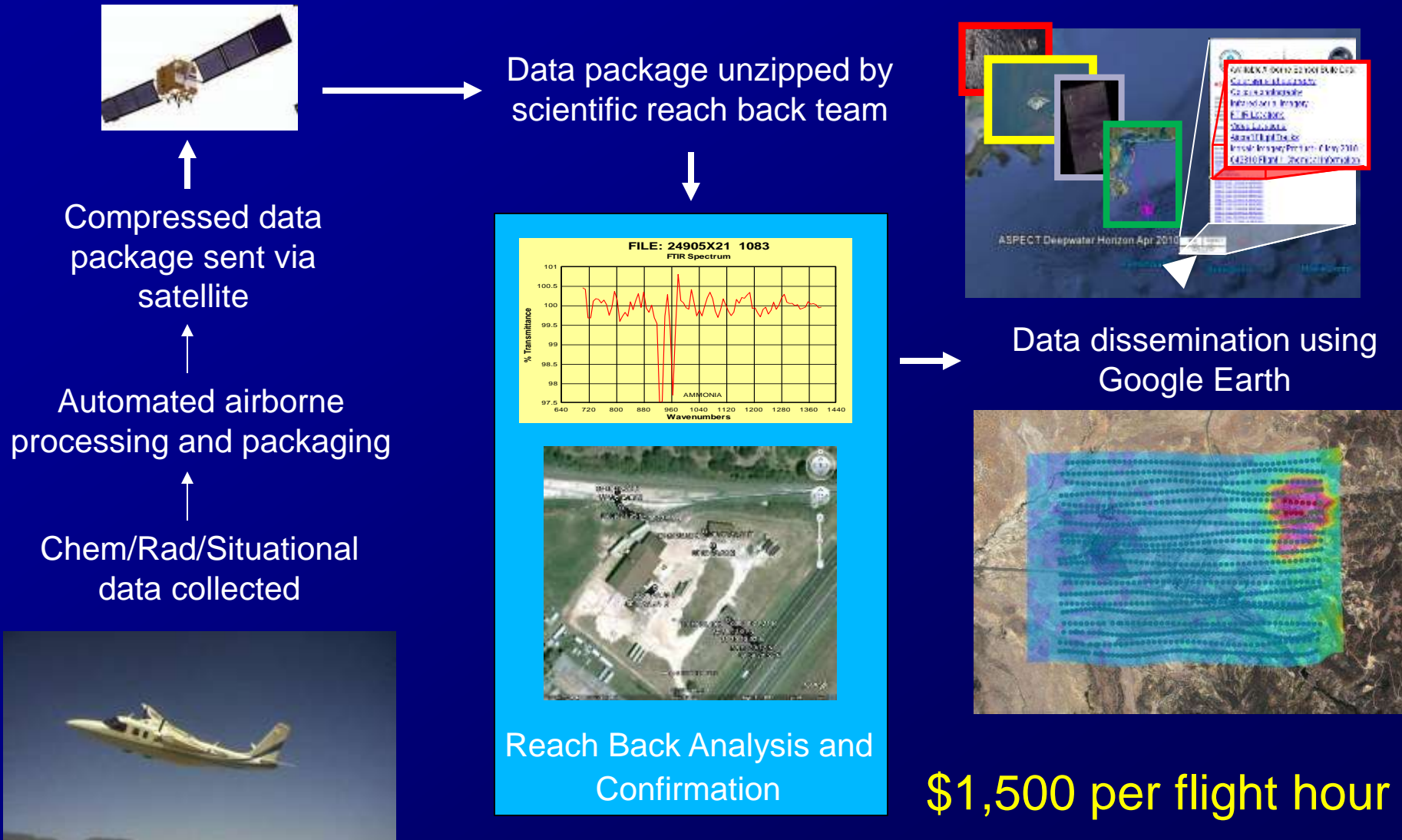
1. 1 hour prep
2. Refueling stop
3. >1 hour data collection

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

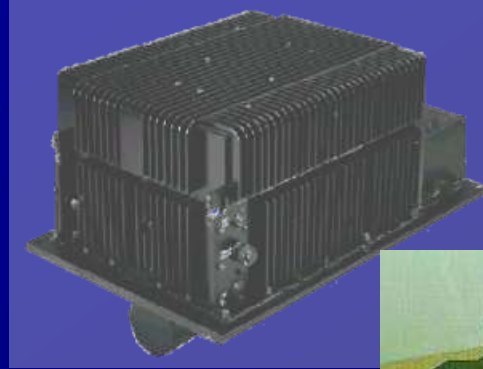
Performed in about 5 minutes



CURRENT SYSTEMS

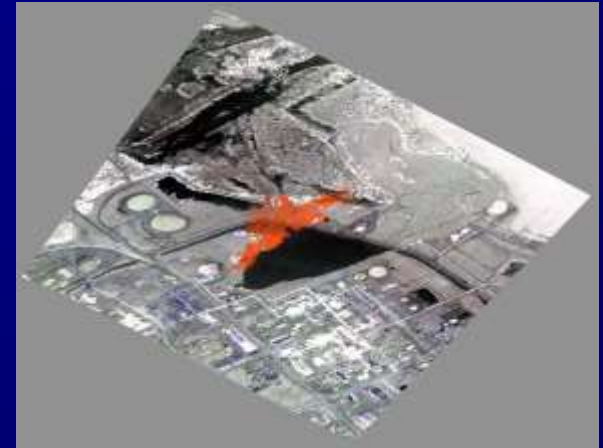
➤ ASPECT Uses Six Primary Sensors/Systems:

- ✓ 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

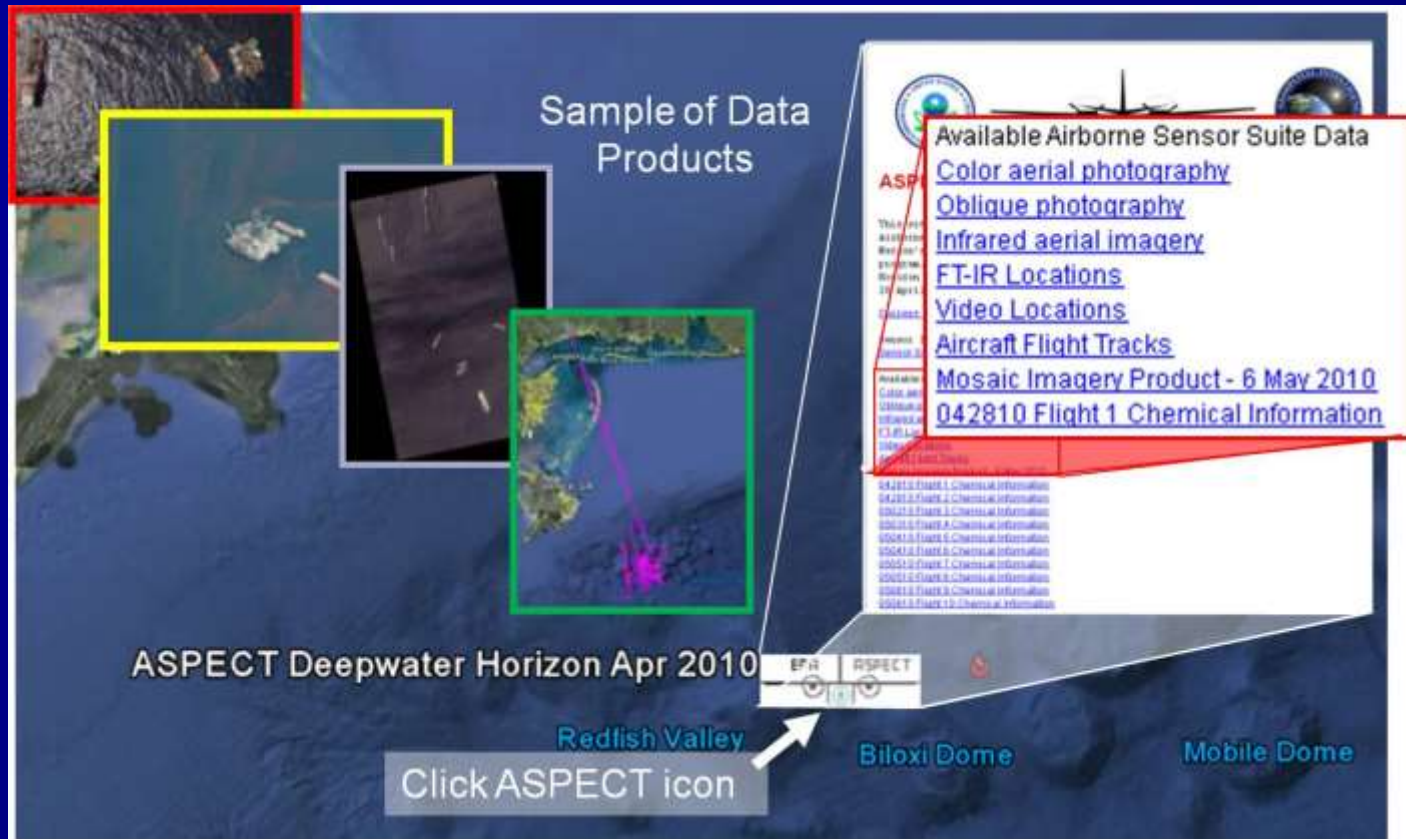
- Pre-Deployments to NSSEs/SERE (Presidential Inauguration, Rose Bowl, Super Bowl, 9/11 Anniversary)
- Hurricane Sandy
- West Texas Explosion
- Halliburton Lost Source
- Field Exercises with NGB WMD-CSTs & DOE
- Chem & Rad Urban Background Surveys



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

U.S. EPA ASPECT Program Gallery Go to 1 | 2 | 3



U.S. EPA ASPECT Program Gallery
This web page provide the links for word documents, powerpoint files, and PDF format files containing the processed data products for the West Virginia BSA Deployment.
Please click on the text below each icon to retrieve the pdf file, web link, or image.

West Virginia BSA Deployment - July 2013

 <p>BSA Deployment Plan</p>	 <p>Google Earth, Flex Viewer, Web APTs</p>	 <p>ASPECT Flight Path - 7/18/2013</p>	 <p>ASPECT MMGC Sigma - 7/14/2013</p>	 <p>ASPECT Flight Lines BSA</p>
 <p>ASPECT Flight to Overhead Image</p>	 <p>Image Caption</p>	 <p>Image Caption</p>	 <p>Image Caption</p>	 <p>Image Caption</p>



**U.S. EPA ASPECT Program
Data Display Site**



BSA Jamboree July 2013

Available Google Earth Data Products
Google Earth Products

Available Flex Viewer Data Products
Flex Viewer Products

Available Google Maps Data Products
Google Map Products

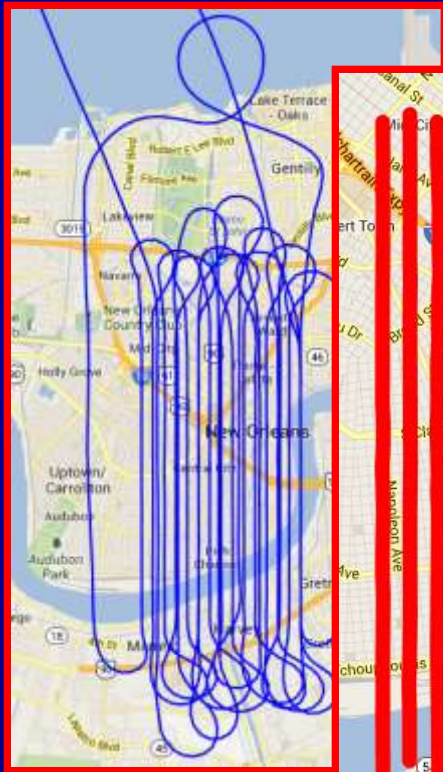
Available Google Earth API Data Products
Google Earth API Products

Available API Data Products
Other API Map Products

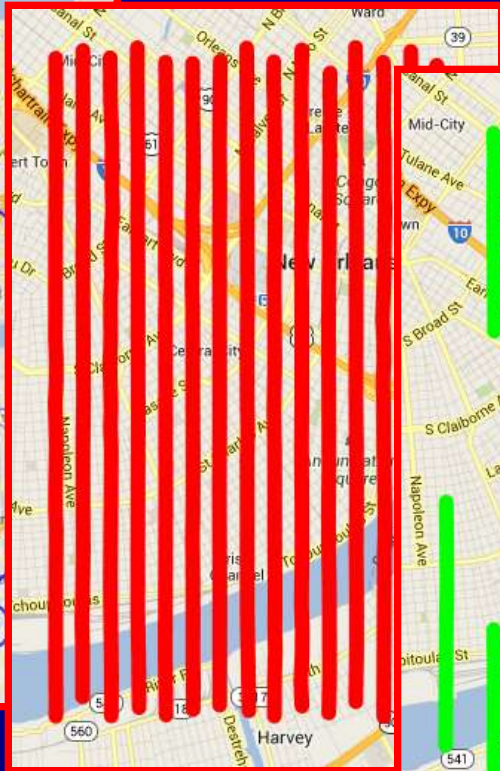
Available Mobile Data Products
Mobile Map Products

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

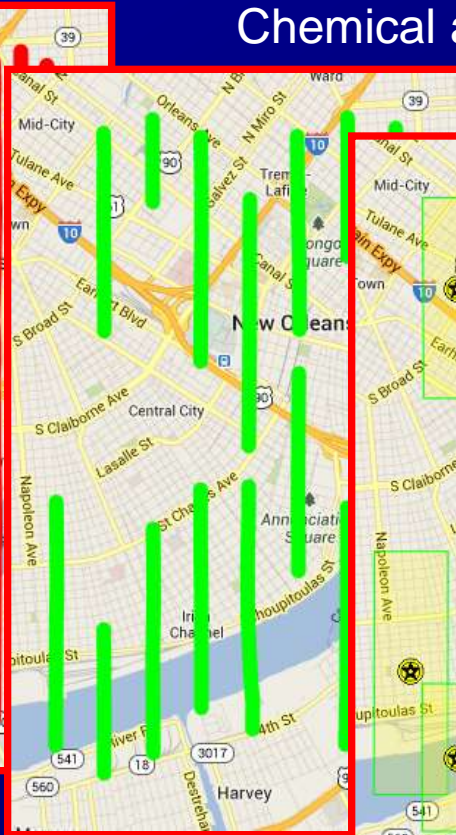
Sample ASPECT Google Maps Products



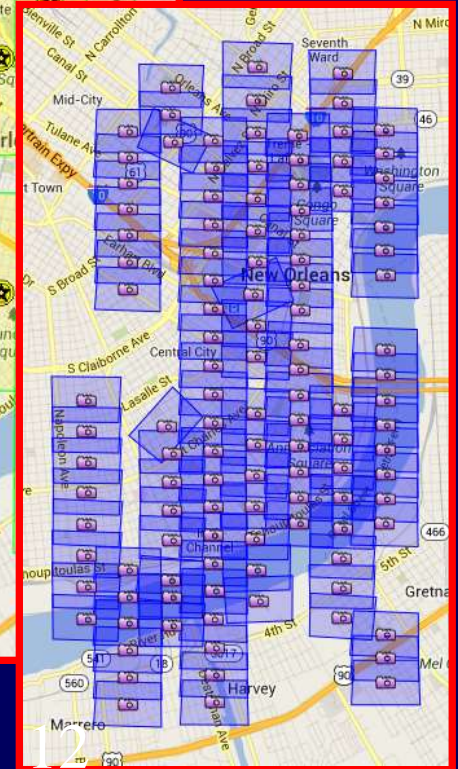
Flight Path



Rad
Sensors
Locations



Chemical and
IR Sensors Active



Photos

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



Image USDA Farm Service Agency
Image U.S. Geological Survey
Image NMRGIS
Image © 2011 DigitalGlobe

©2010 Google

**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

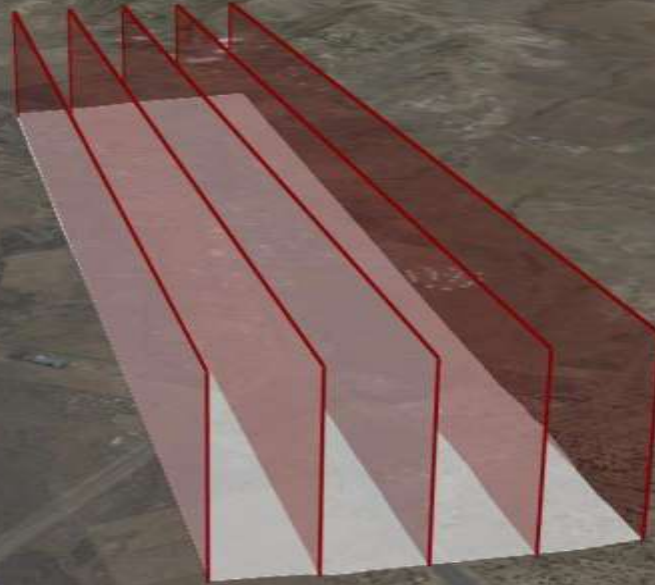


Image USDA Farm Service Agency
Image U.S. Geological Survey
Image NMRGIS
Image © 2011 DigitalGlobe

©2010 Google

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

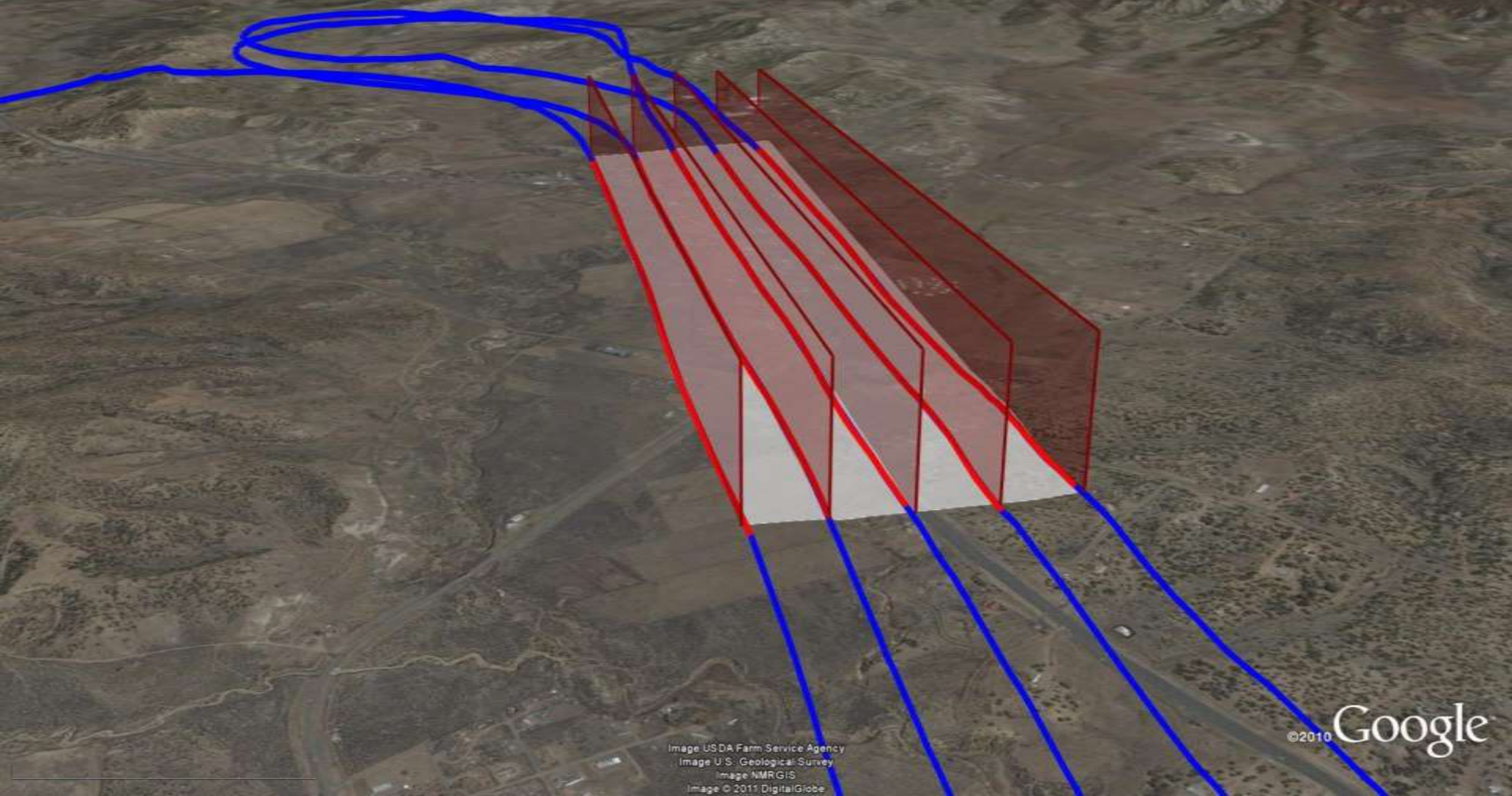


Image USDA Farm Service Agency
Image U.S. Geological Survey
Image NMRGIS
Image © 2011 DigitalGlobe

©2010 Google

ASPECT Team creates a **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)

Sigma Values (MMGC)

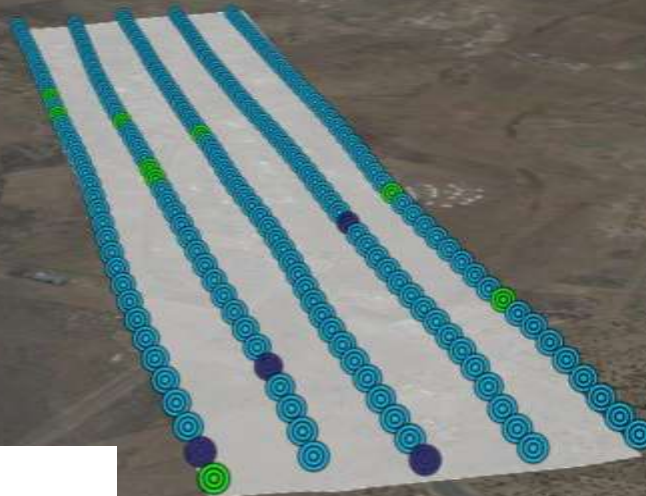


Image USDA Farm Service Agency
Image U.S. Geological Survey
Image NMRGIS
Image © 2011 DigitalGlobe

©2010 Google

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

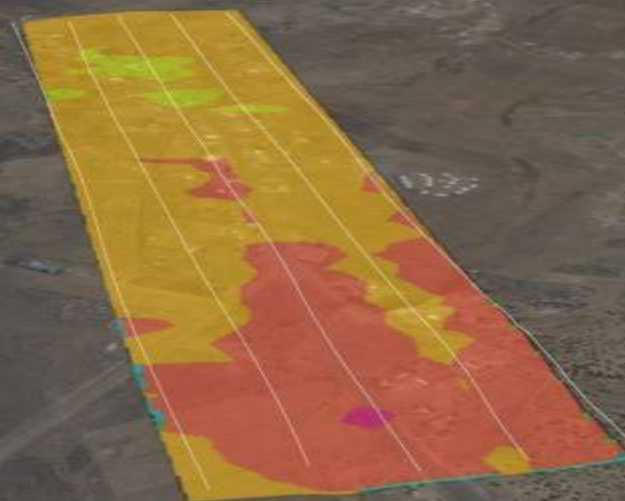
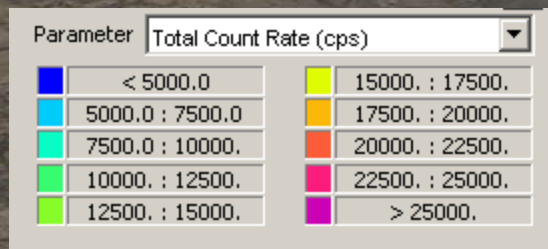












Image U.S. Geological Survey
Image NMRGIS
Image USDA Farm Service Agency
Image © 2011 DigitalGlobe

©2010 Google

ASPECT Team creates an **Exposure Rate** contour map to assist public health decisions (normal background ranges between 5 and 20 uR/hr).

Parameter **Exposure Rate (uR/hr)**

	< 5.0000		25.0000 ; 30.0000
	5.0000 ; 10.0000		30.0000 ; 35.0000
	10.0000 ; 15.0000		35.0000 ; 40.0000
	15.0000 ; 20.0000		40.0000 ; 45.0000
	20.0000 ; 25.0000		> 45.0000

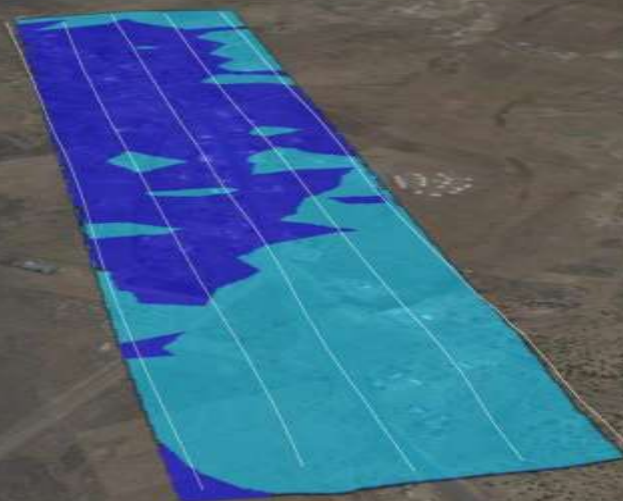
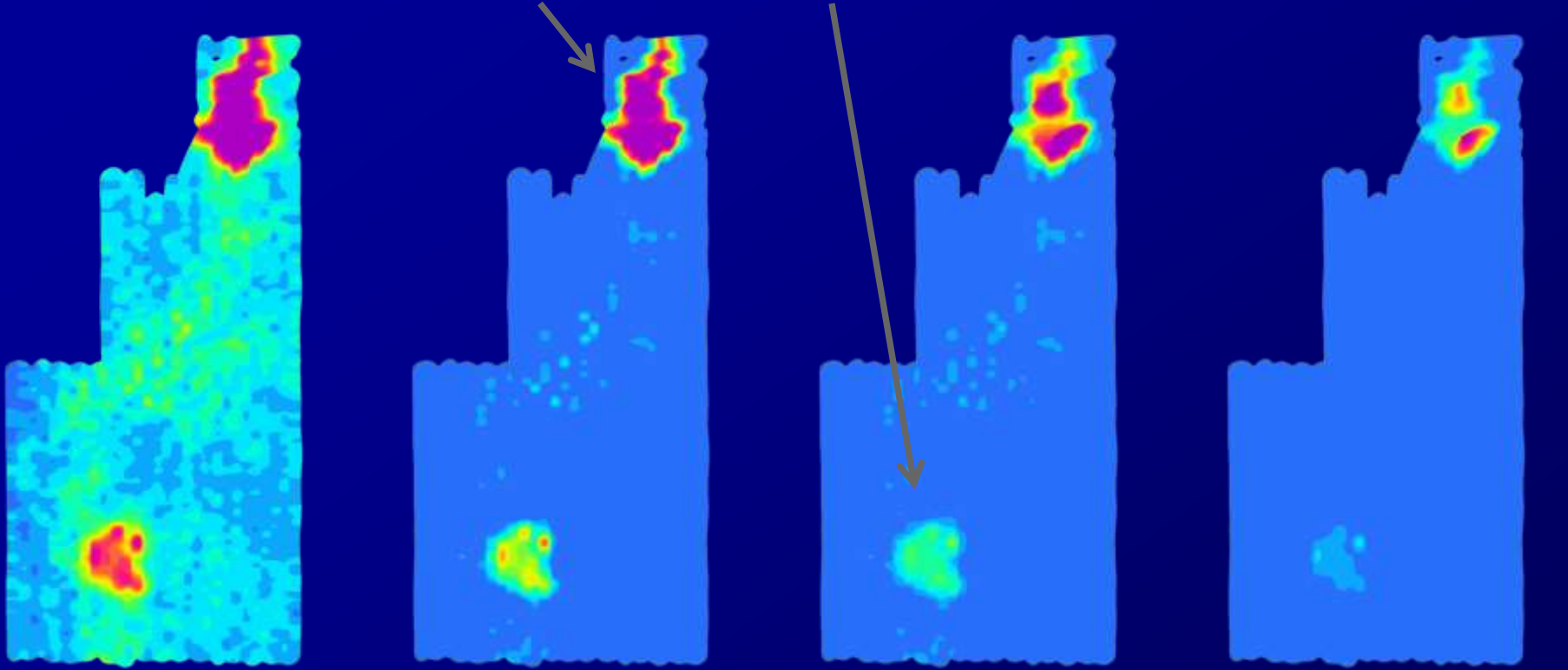


Image USDA Farm Service Agency
Image U.S. Geological Survey
Image NMRGIS
Image © 2011 DigitalGlobe

©2010 Google

Same Data – Different Scale

Midnite vs. Sherwood Mines



< 1,000	5,000 : 6,000
1,000 : 2,000	6,000 : 7,000
2,000 : 3,000	7,000 : 8,000
3,000 : 4,000	8,000 : 9,000
4,000 : 5,000	> 9,000

<1 to >9

< 4,000	8,000 : 9,000
4,000 : 5,000	9,000 : 10,000
5,000 : 6,000	10,000 : 11,000
6,000 : 7,000	11,000 : 12,000
7,000 : 8,000	> 12,000

<4 to >12

< 4,000	12,000 : 14,000
4,000 : 6,000	14,000 : 16,000
6,000 : 8,000	16,000 : 18,000
8,000 : 10,000	18,000 : 20,000
10,000 : 12,000	> 20,000

<4 to >20

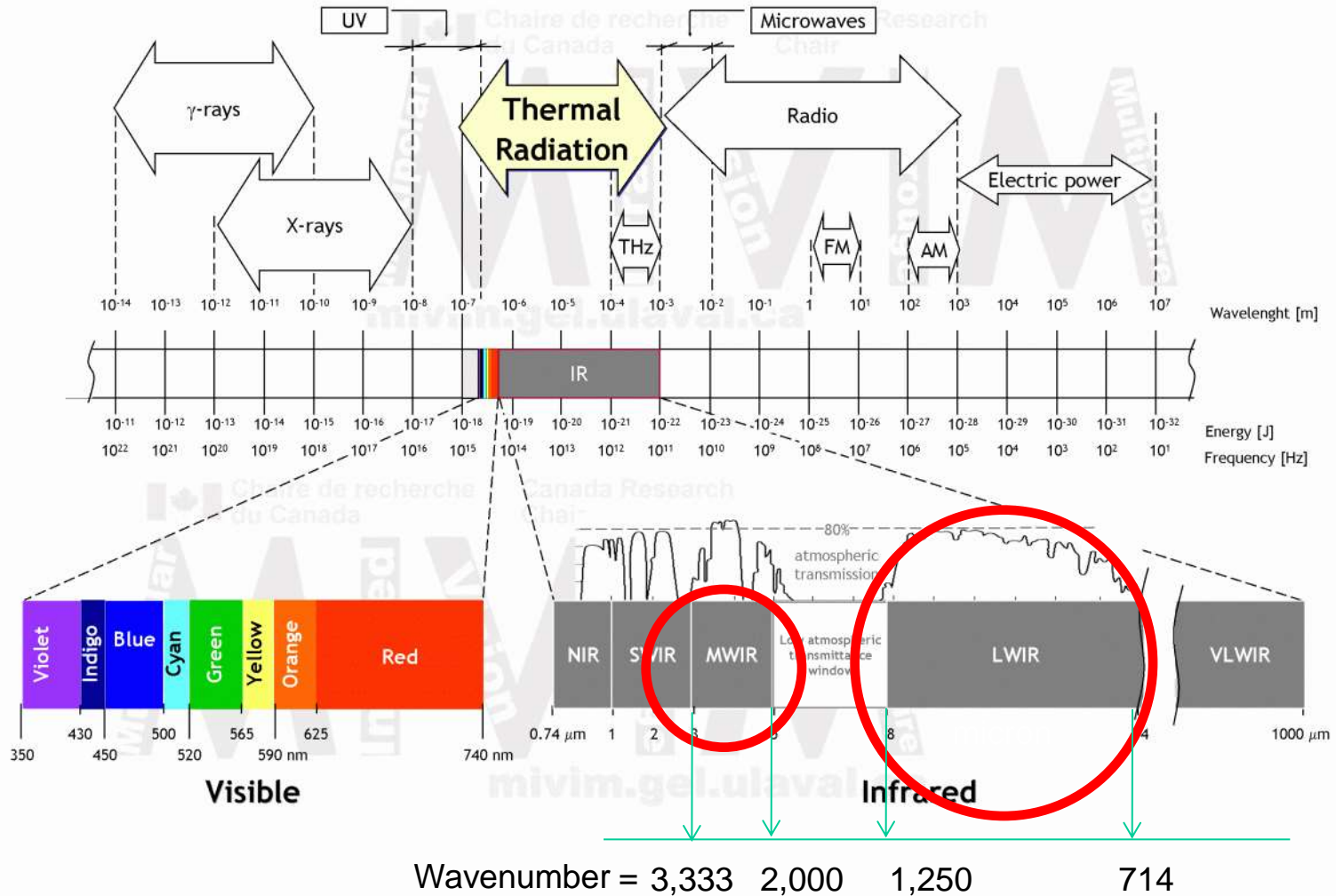
< 8,000	24,000 : 28,000
8,000 : 12,000	28,000 : 32,000
12,000 : 16,000	32,000 : 36,000
16,000 : 20,000	36,000 : 40,000
20,000 : 24,000	> 40,000

<8 to >40

Equivalent Uranium Concentration (pCi/g)

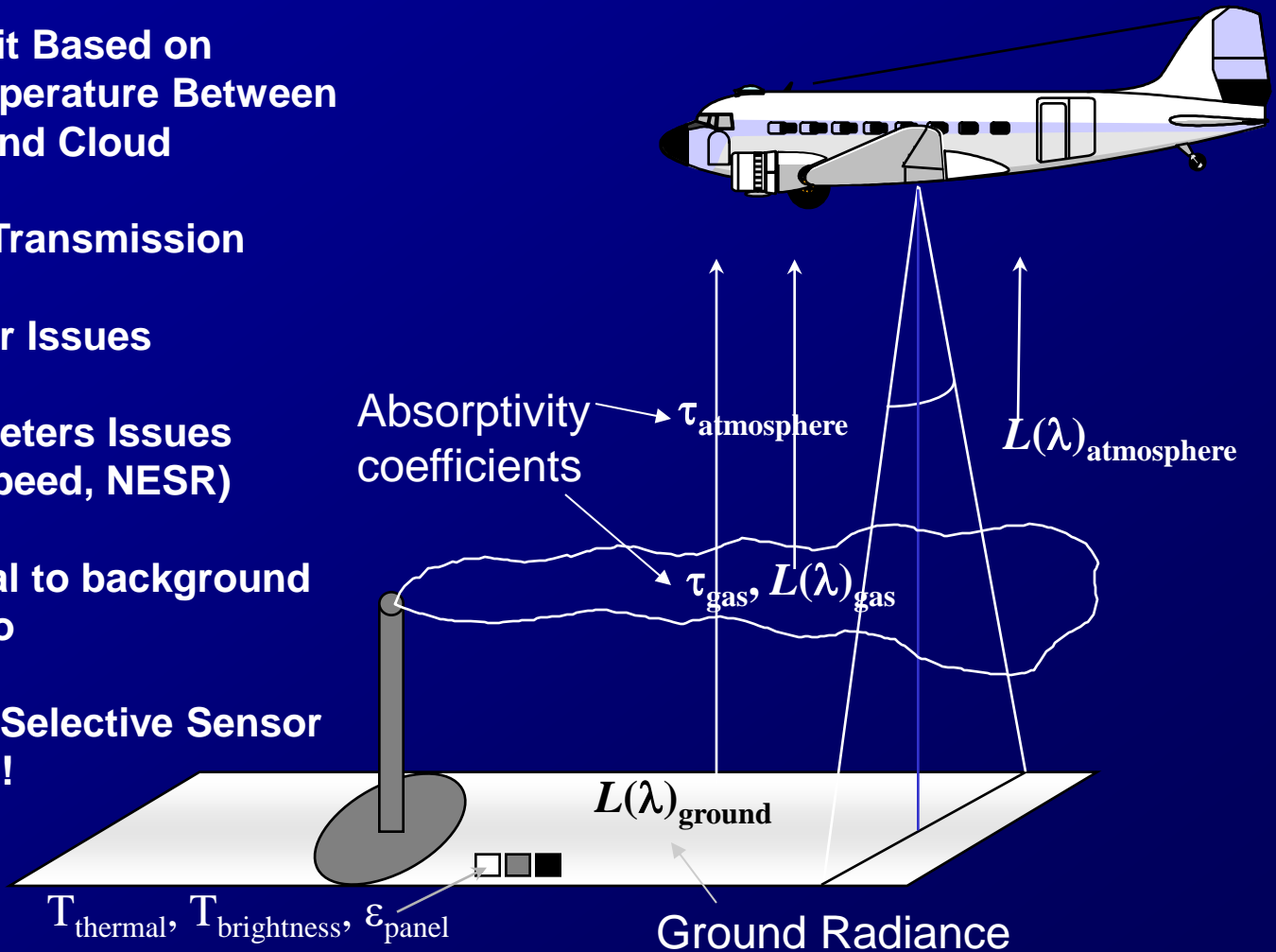
CHEMICAL DETECTION

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

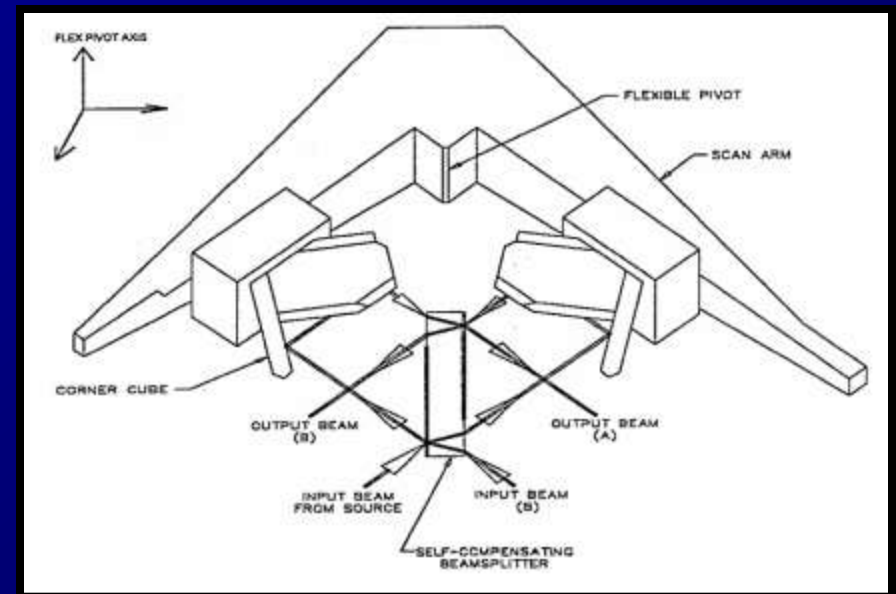
- The FTIR utilized by ASPECT consist of a modified MR-254; high temporal resolution (75 Hz) system
- Dual input design
- Signal port
- Cold source reference port
- Two detectors are utilized including a 3 –5 and 8 – 12 micron providing coverage in the atmospheric IR window
- Unit ready for operation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



Aircraft Configuration

FTS System

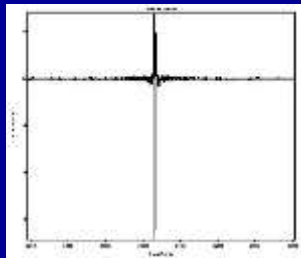
- Scan Speed - 70 scans/sec
- Telescope - 10" (0.2° FOV)
- Dual Scan Direction
- Throughput - 0.01 cm²*sr
- 1.0 to 32 cm⁻¹ resolution
- Channel 1 : 3 - 5 microns
6*10⁻⁹ W/cm²srcm⁻¹ NESR
- Channel 2 : 8-12 microns
1.8*10⁻⁸W/cm²srcm⁻¹ NESR



INTERFEROMETER DESIGN

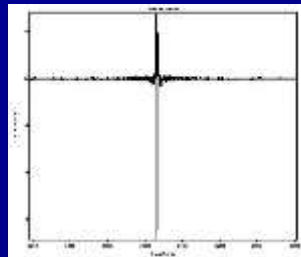
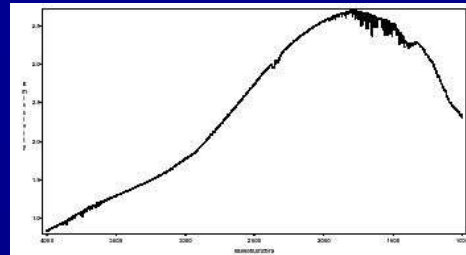
Signal Processing

Difficulty Using Traditional FTIR Methods



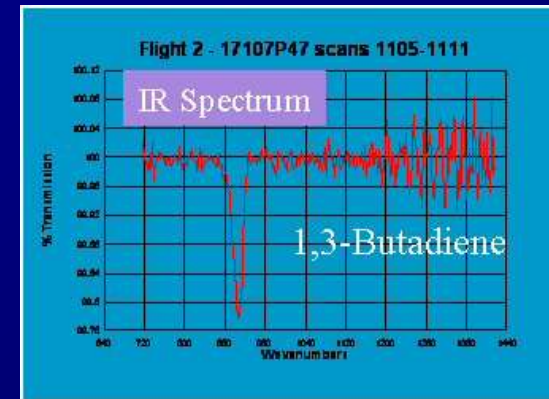
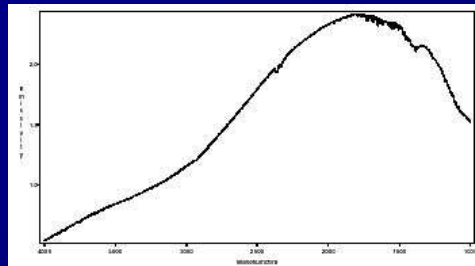
Sample Data

FFT



Background Data

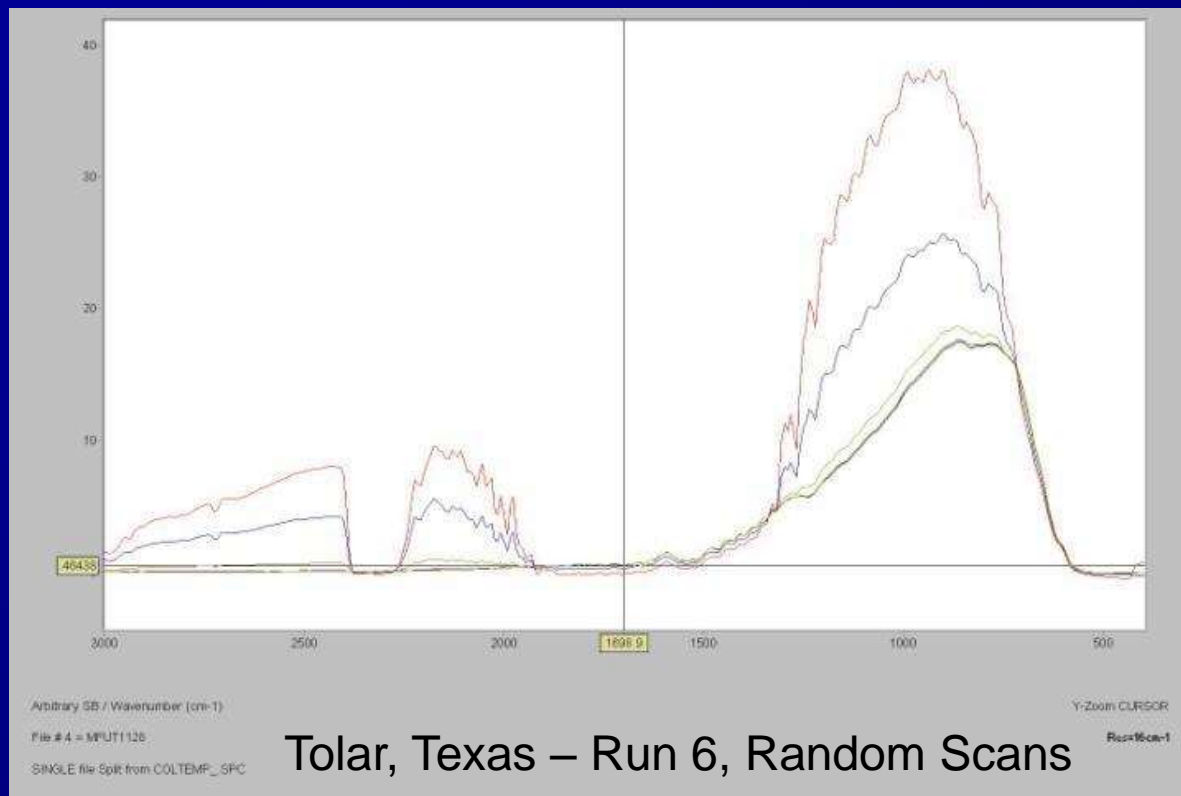
FFT



Sample – Background = Result

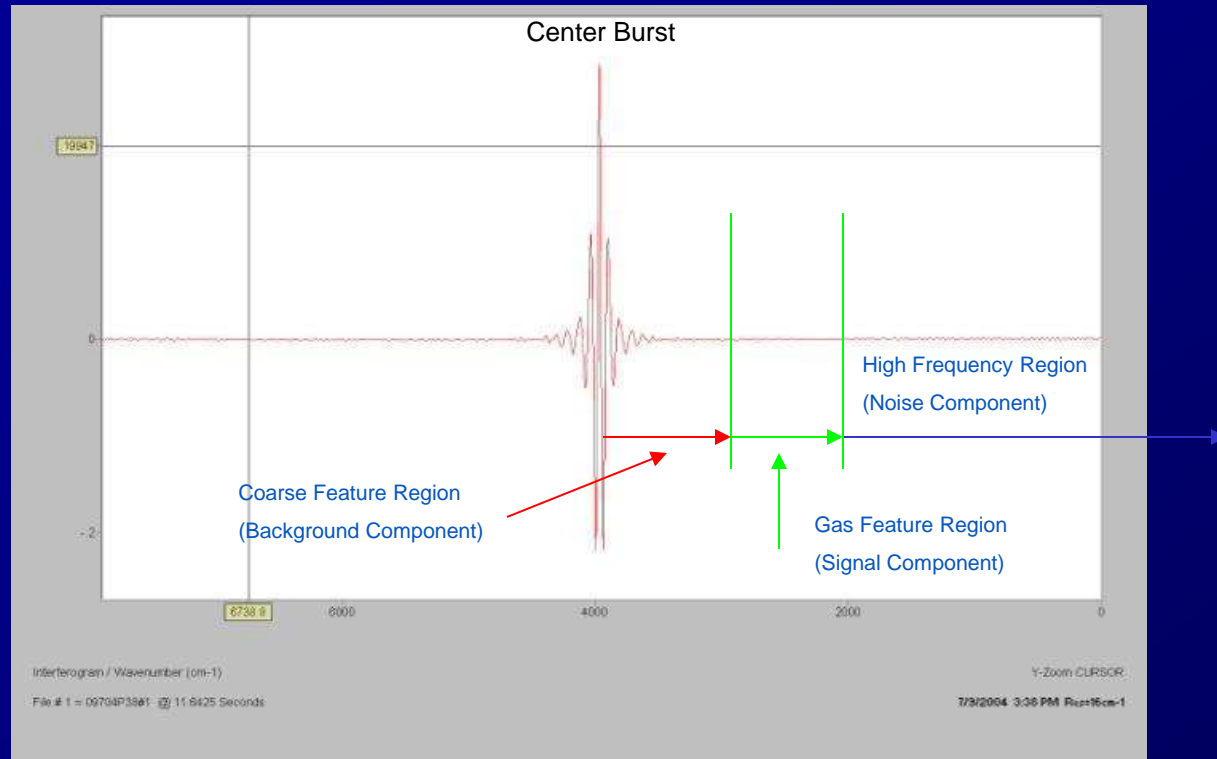
- This method effectively strips the signal from the background.
- Method requires a stable radiometric background $\Delta R \gg L$

Difficulty in Selecting Representative Backgrounds – Airborne Data



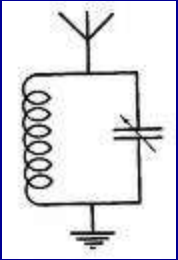
The normal radiometric variation from scan to scan is much higher than the signal magnitude or $\Delta R \gg L$

Dissecting an Interferogram

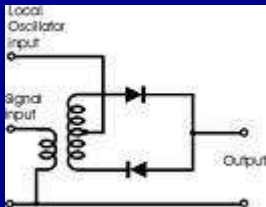


The fundamental shape of the interferogram has already largely separated the background, signal, and the noise. By using digital filtering, the signal can be passed while the background and noise are removed.

Equivalent Signal Processing Steps Radio vs. Interferometer



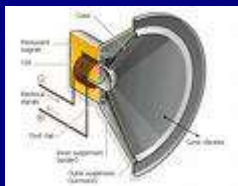
Tuner -- Interferogram Segmentation (Digital Band Pass Filtering)



Mixer (detector) -- Interferometer



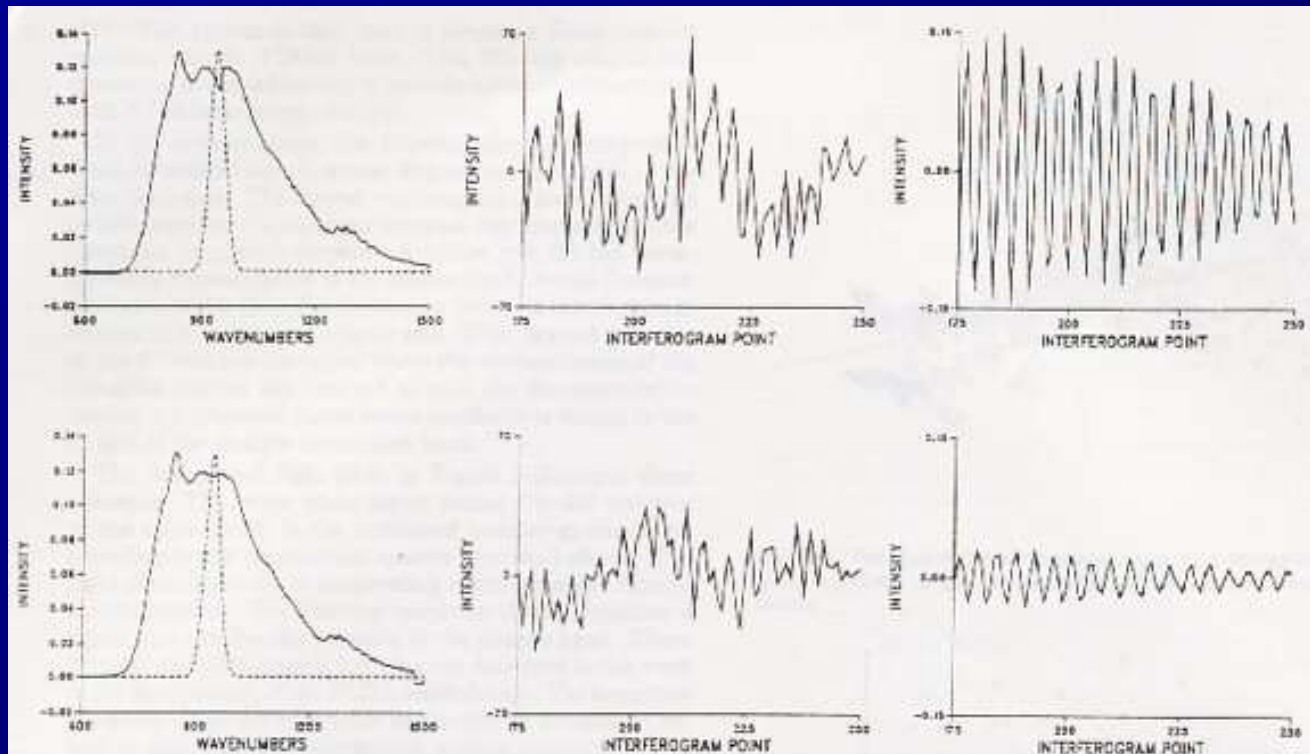
IF Amplifiers – Complex Digital Band pass Filtering (Not a Simple Response Filter)



Output/Ear – Pattern Recognition \approx 100 Dimensions

Enhancing the Weak Signal Capability of Pattern Recognition

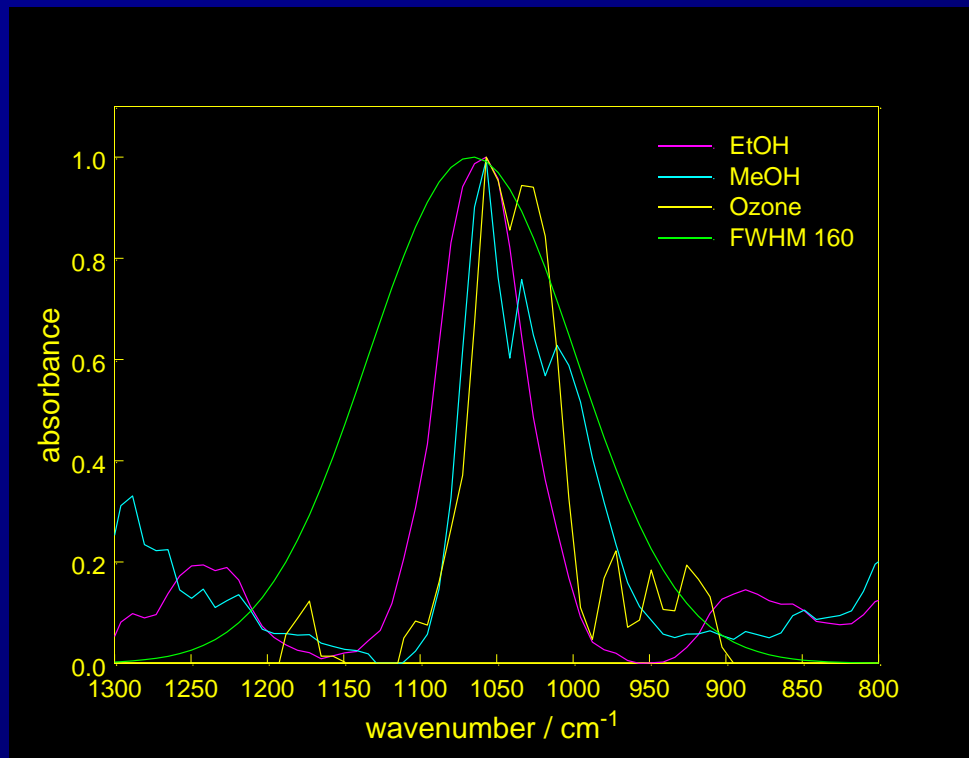
By applying a digital high pass filter followed by a multi-dimensional band pass filter to the interferogram, the background and noise can be suppressed, while the signal is passed. By using a “unique” band pass filter, a degree of pre-selection is applied to the signal thus generating a suitable input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



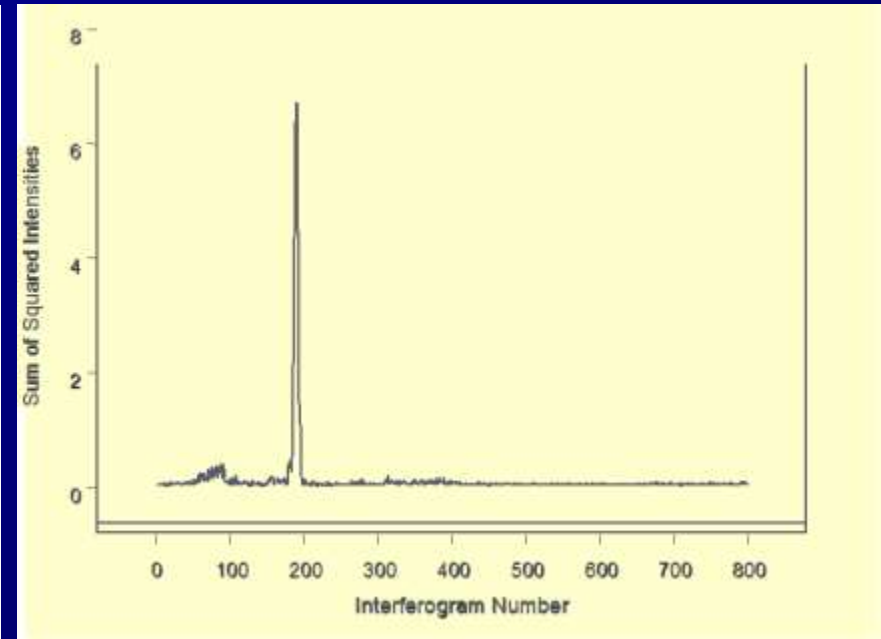
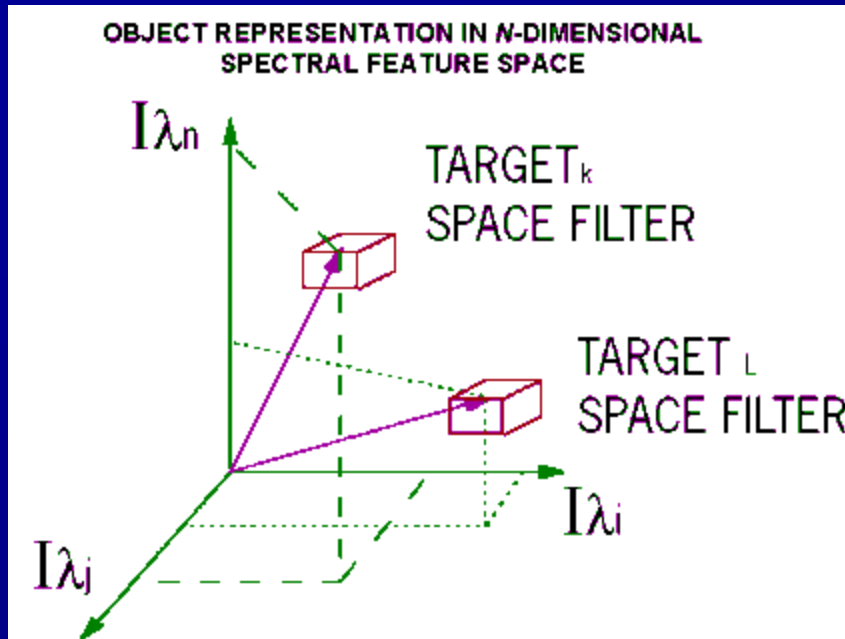
Filter Design and Interference

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.

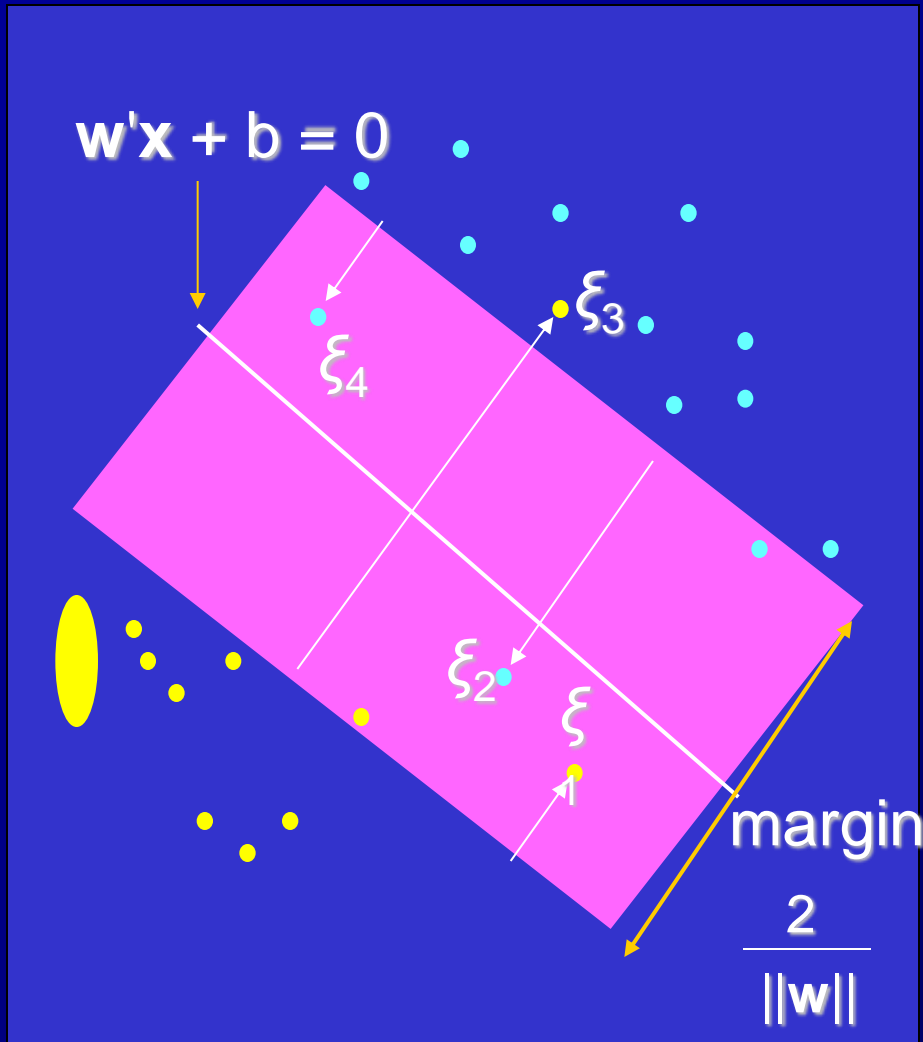


Pattern Recognition Multi-Dimensional Space



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 $\|w\|^2 + C\sum\xi_i^2$
subject to $y_i(w'x + b) \geq 1 - \xi_i$

w : weight vector
 C : regularization parameter
 ξ_i : slack variable
 y_i : class label

Chemical Detection Algorithms

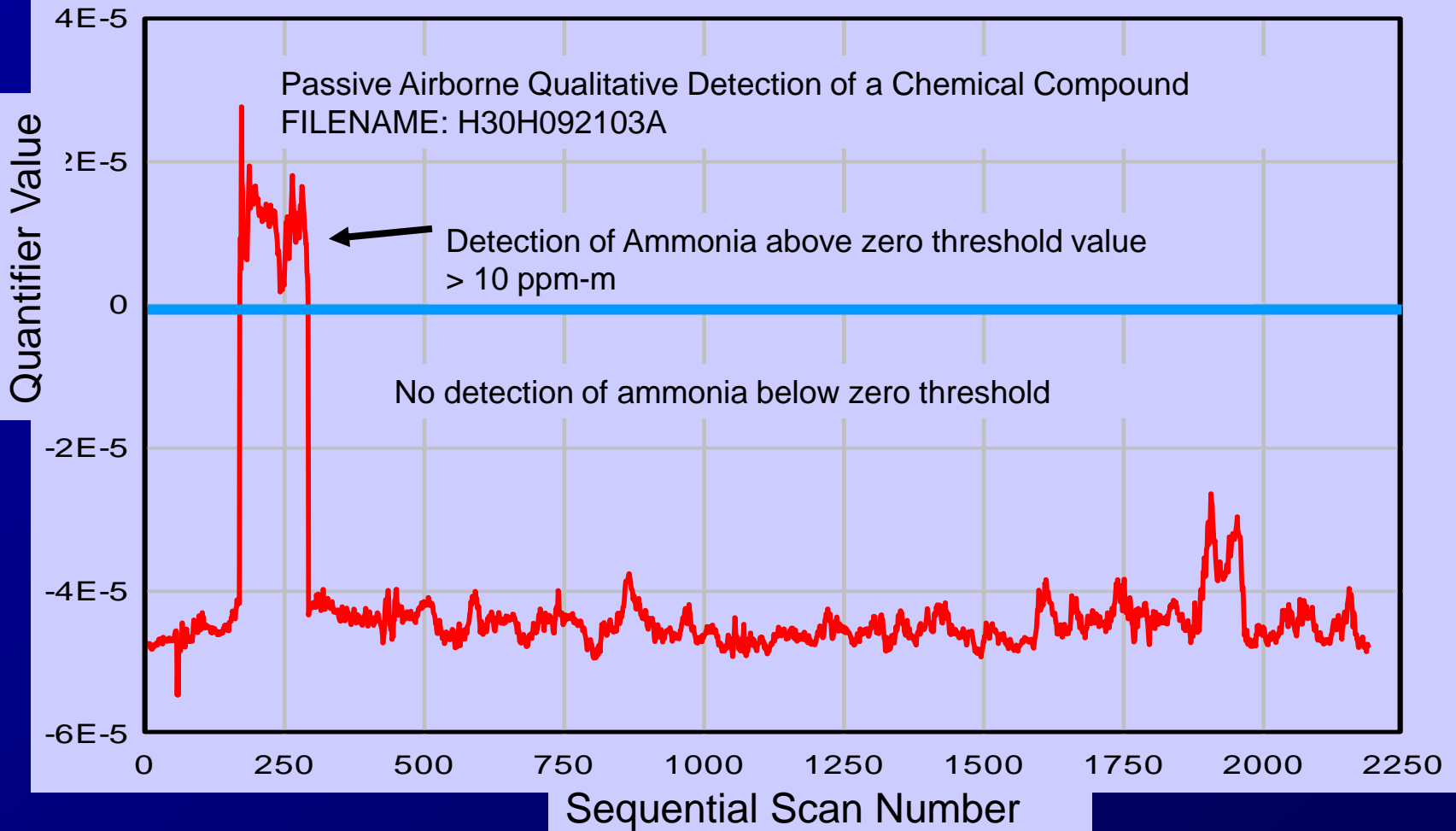
71 Automated

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

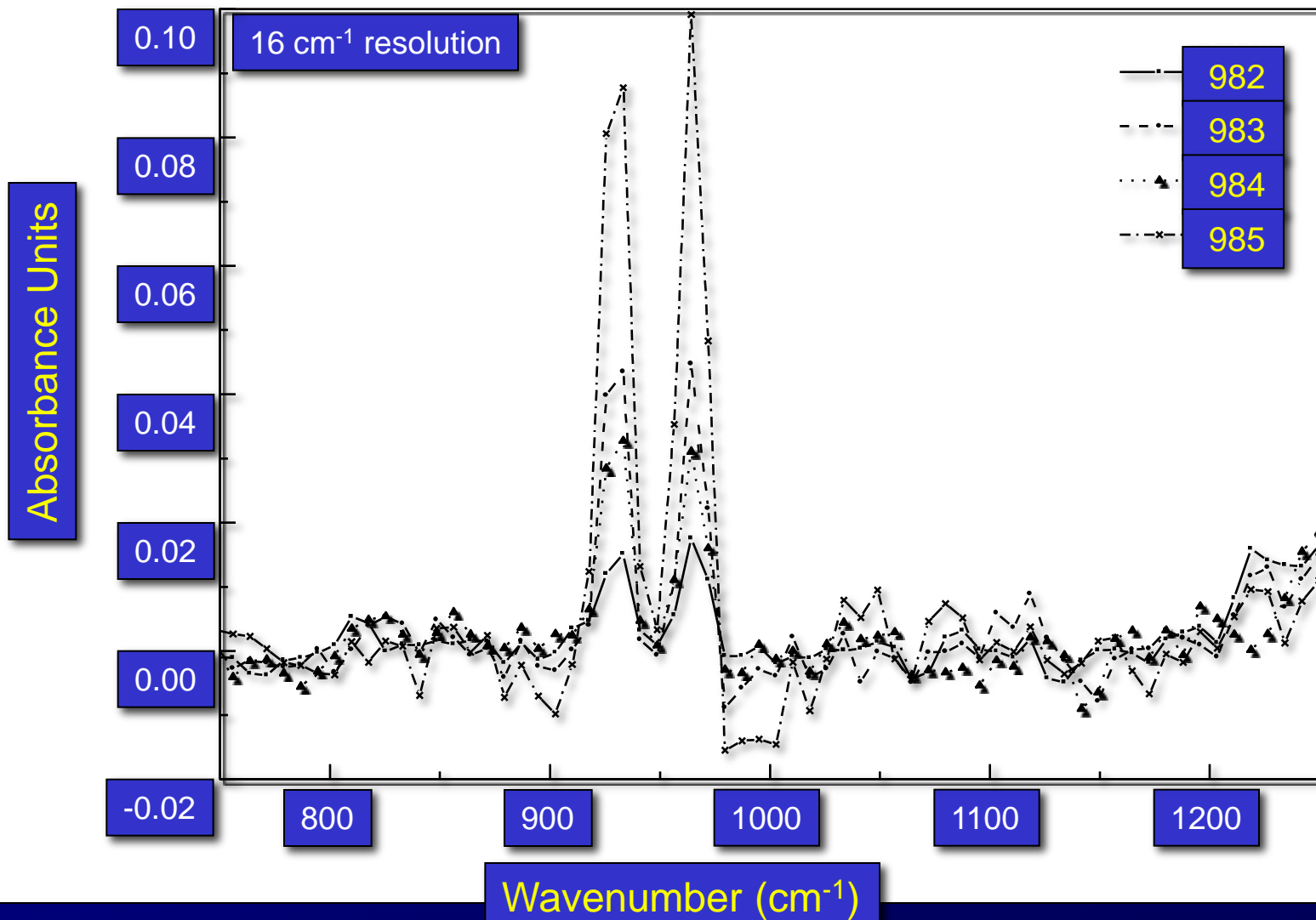
Acetic Acid (2.0)	Cumene (23.1)	Isoprene (6.5)	Propylene Oxide (6.8)
Acetone (5.6)	Diborane (5.0)	Isopropanol (8.5)	Silicon Tetrafluoride (0.2)
Acrolein (8.8)	1,1-Dichloroethene (3.7)	Isopropyl Acetate (0.7)	Sulfur Dioxide (15)
Acrylonitrile (12.5)	Dichloromethane (6.0)	MAPP (3.7)	Sulfur Hexafluoride (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 Trifluoride (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 Fluoride (0.8)	Germane (1.5)	Phosphorus Oxychloride (2.0)	Trimethyl Phosphite (0.4)
Carbon Tetrafluoride (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 Recognition Ammonia Spectra QC

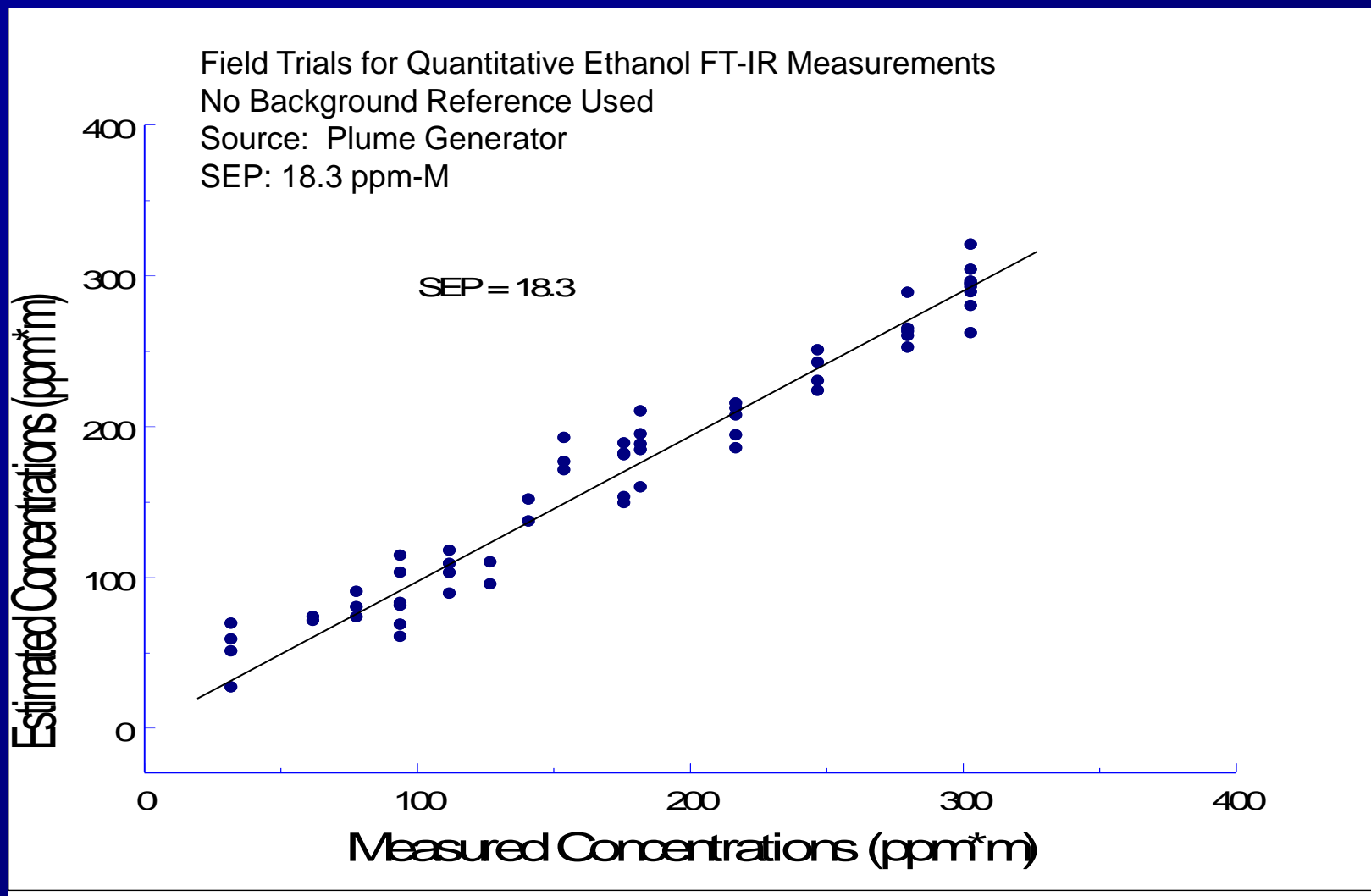


Automated Compound Detection

Ammonia Detection

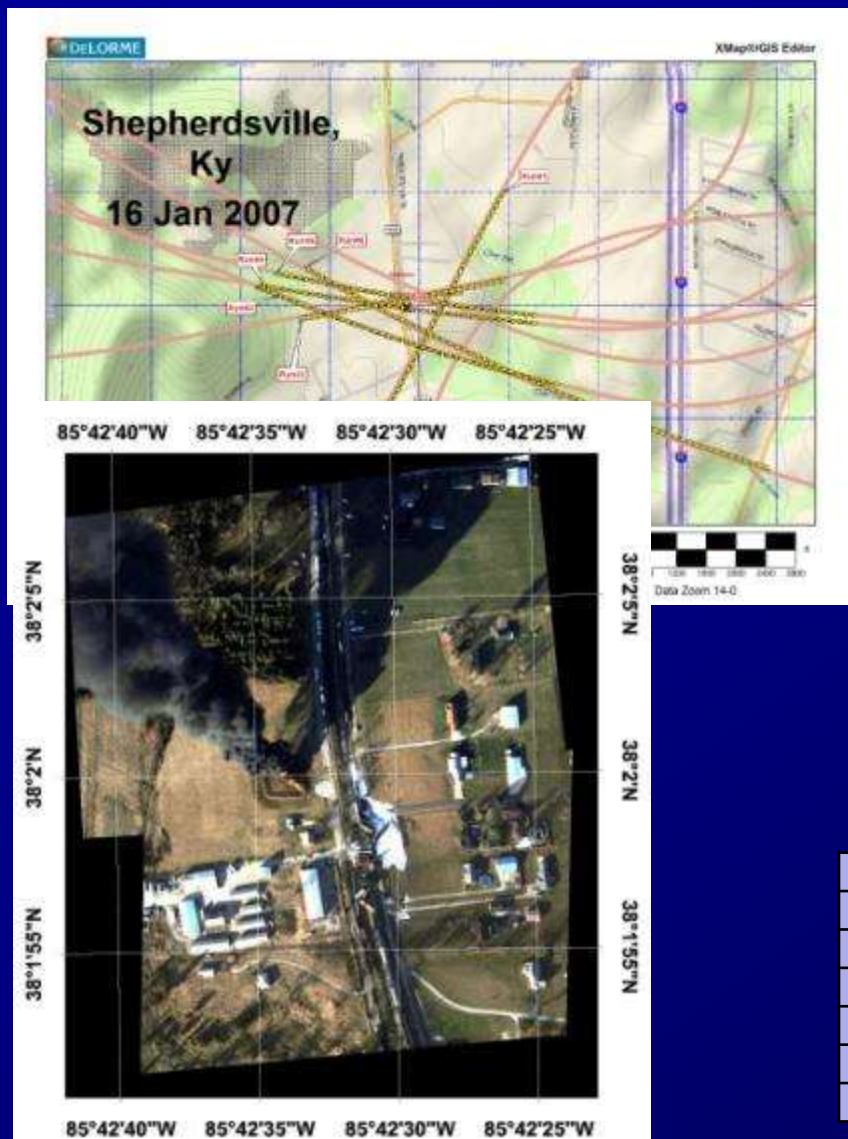


Passive Quantitative Analysis Open Air Trials

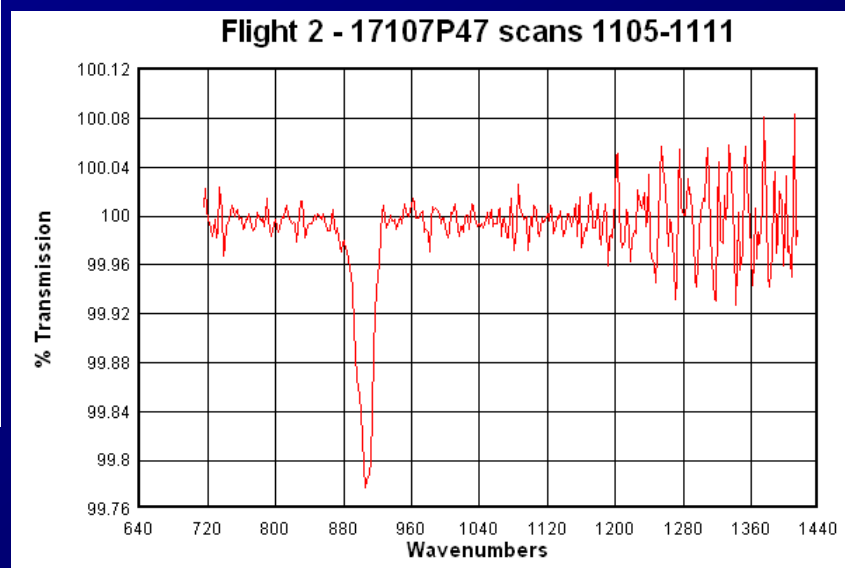


ASPECT Deployment

Train Derailment in Sheperdsville, KY



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

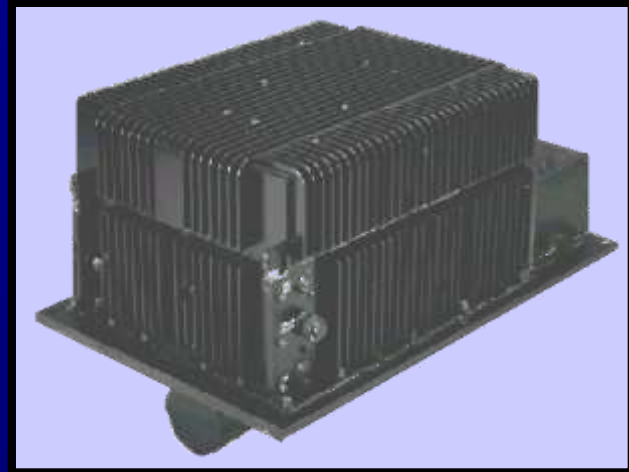


Chemical Report

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

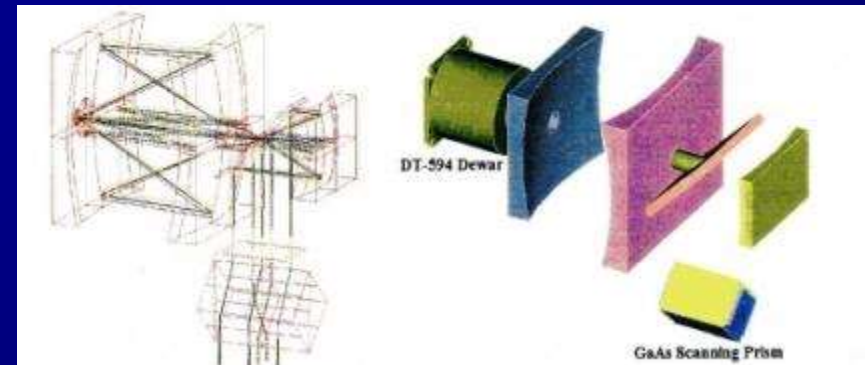
- Using a scanner speed of about 60 Hz and a field of view of 60° results in a linear infrared image approx ½ mile wide
- Approx 2.0 square miles can be imaged per minute
- Chemical discrimination is accomplished using a matrix of 16 cold optical filters having a bandwidth of approx 5 – 20 wave numbers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



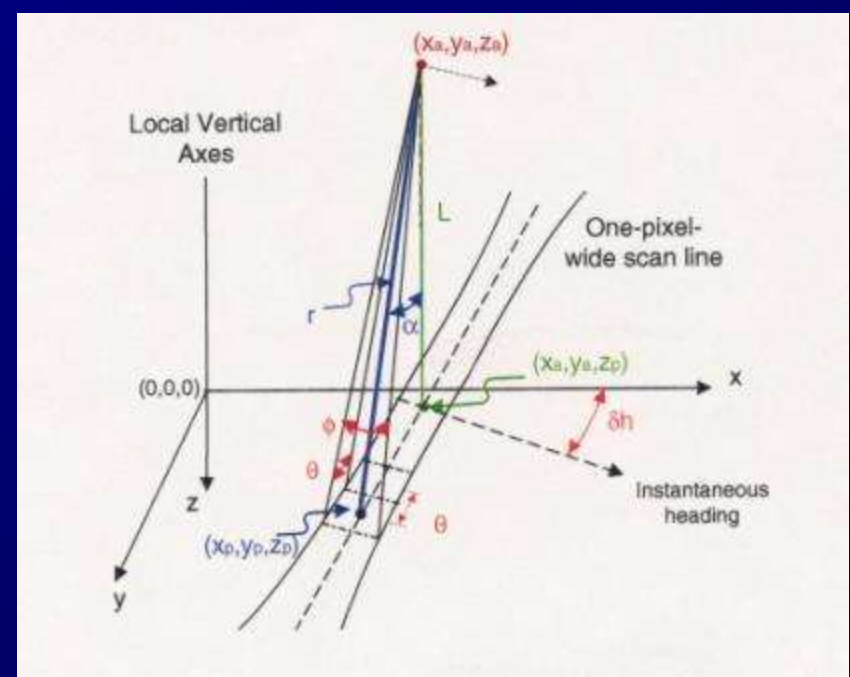
Aircraft Configuration

RS-800MSIRLS Line Scanner Design

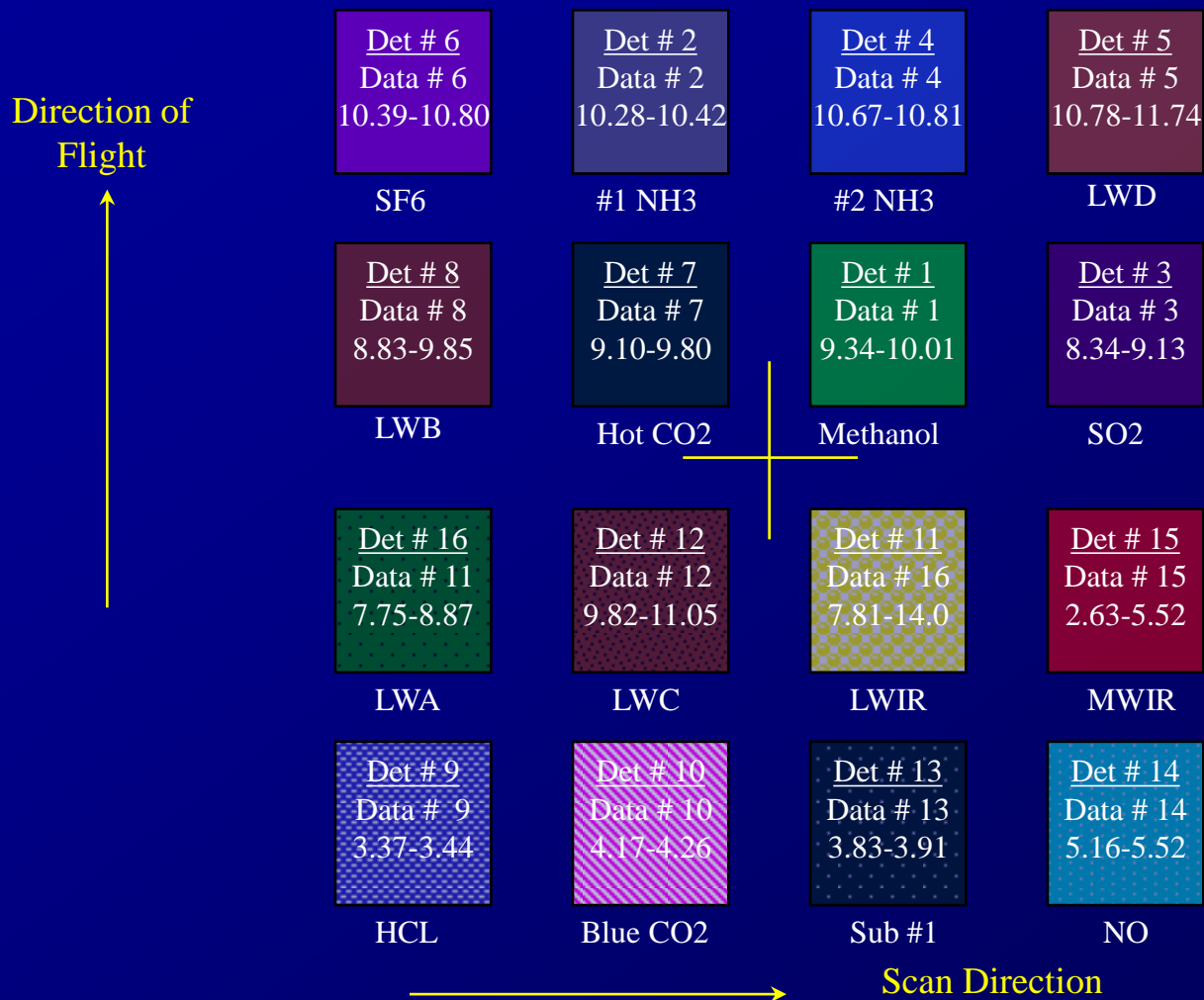
- GaAs Rotating Prism
- All Reflective Internal Optics
- $f \approx 1.1$



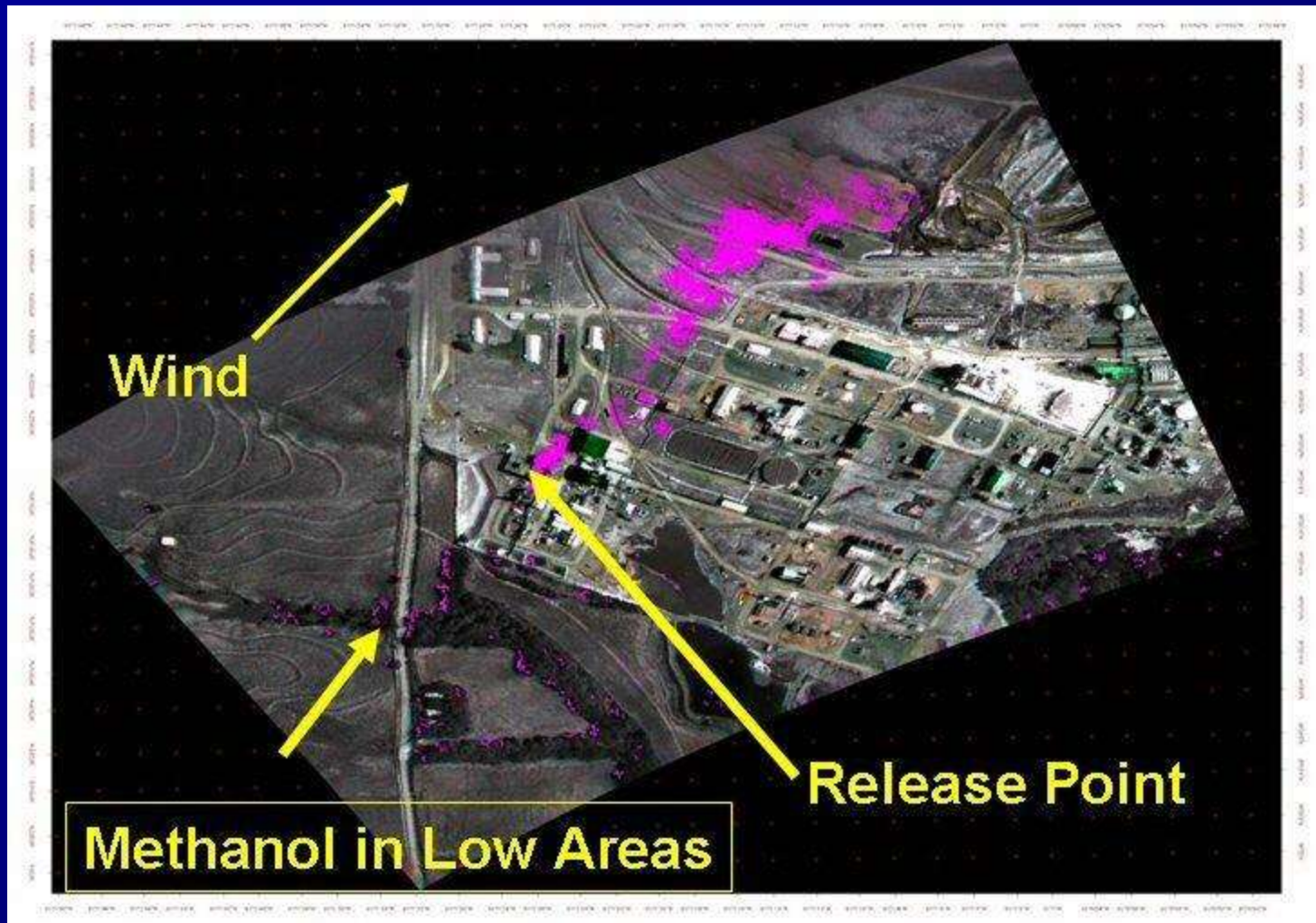
- Scan Rate 60 Hz
- Spatial Resolution 1 mrad
- Effective GSD 0.5 meter



RS-800 Detector Layout



Infrared Image of an Industrial Methanol Plume Release

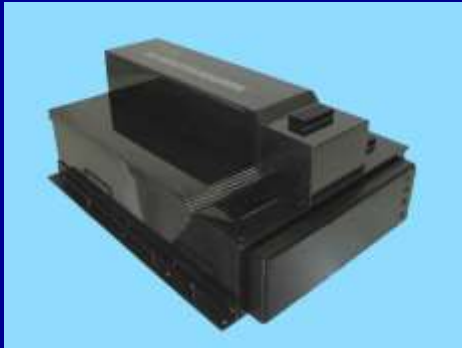


RADIATION DETECTION

Radiation Detection Technology

Radiation Solutions Technology

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



RSX5



RSX4



RSX4



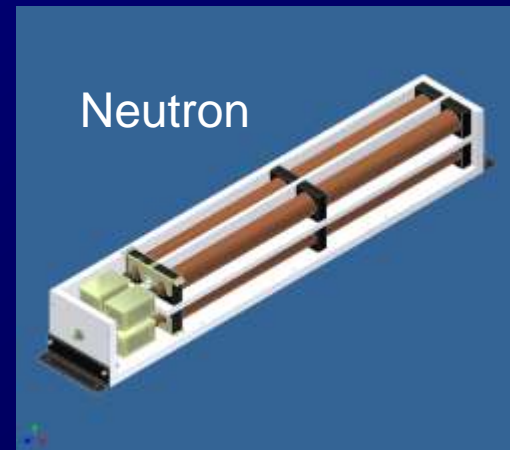
LaBr



LaBr



LaBr



Calibrated Airborne System

RadAssist Calibration Parameters

Calibration Parameters

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-214)	553	620	0.8849	0.0442	0.00803	14.72853	pCi/g
05	YES	Thorium(Tl-208)	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	0
Tot Count (DOE)	0	1	0	0	0	0	0
Potassium	0	0	1	1.07083	0.732874	0	0
Uranium (Bi-214)	0	0	-0.00767	1	0.532255	0	0
Thorium(Tl-208)	0	0	-0.0011	0.04125	1	0	0
Cs-137	0	0	0	0	0	1	0
Co-60	0	0	0	0	0	0	1
Man-Made LOW	0	0	0	0	0	0	0
Man-Made HIGH	0	0	0	0	0	0	0
Cosmic	0	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]

Buttons: Cancel, OK

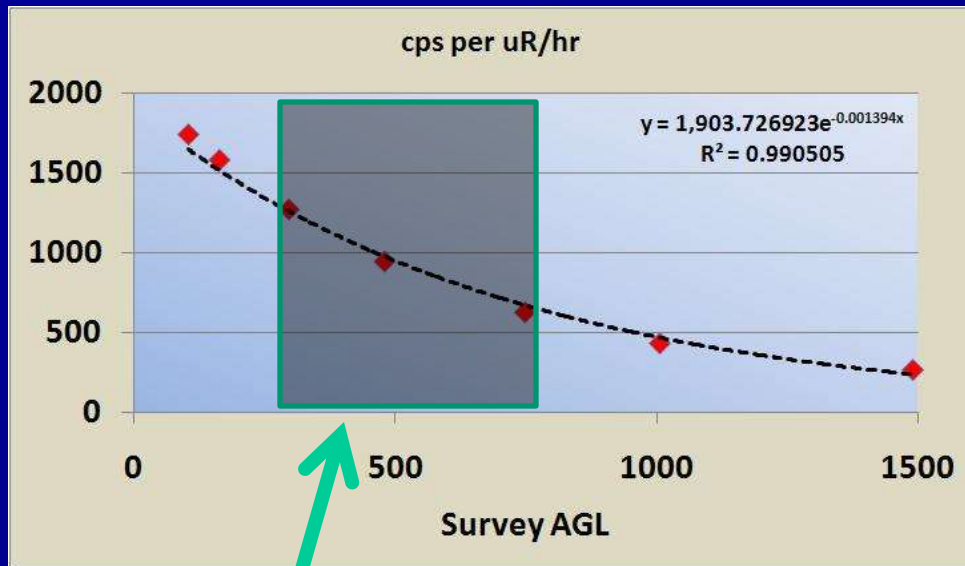
Grand Junction, Colorado
Calibration Pads



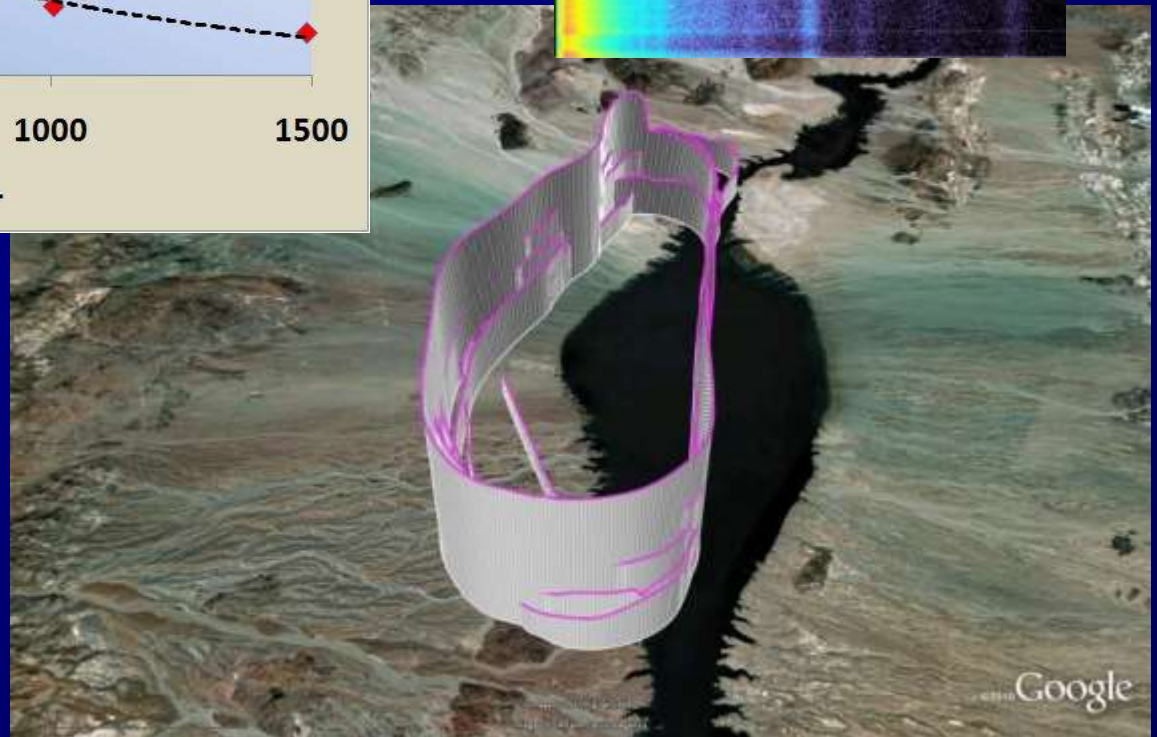
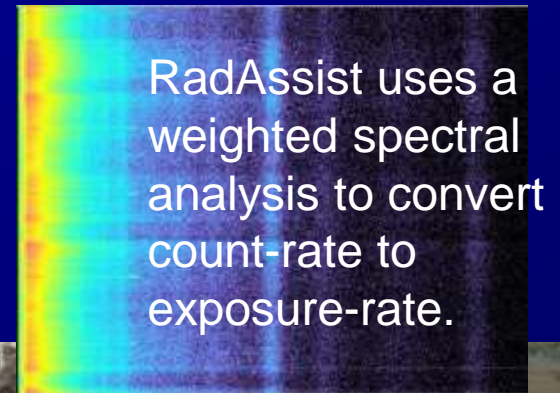
1. High Altitude Flights
2. Calibration Pads
3. Calibration Range Flights
4. Radon background calibration flights

Count-rate to exposure-rate calibration

“DOE” method vs. RadAssist



Typical survey altitudes



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

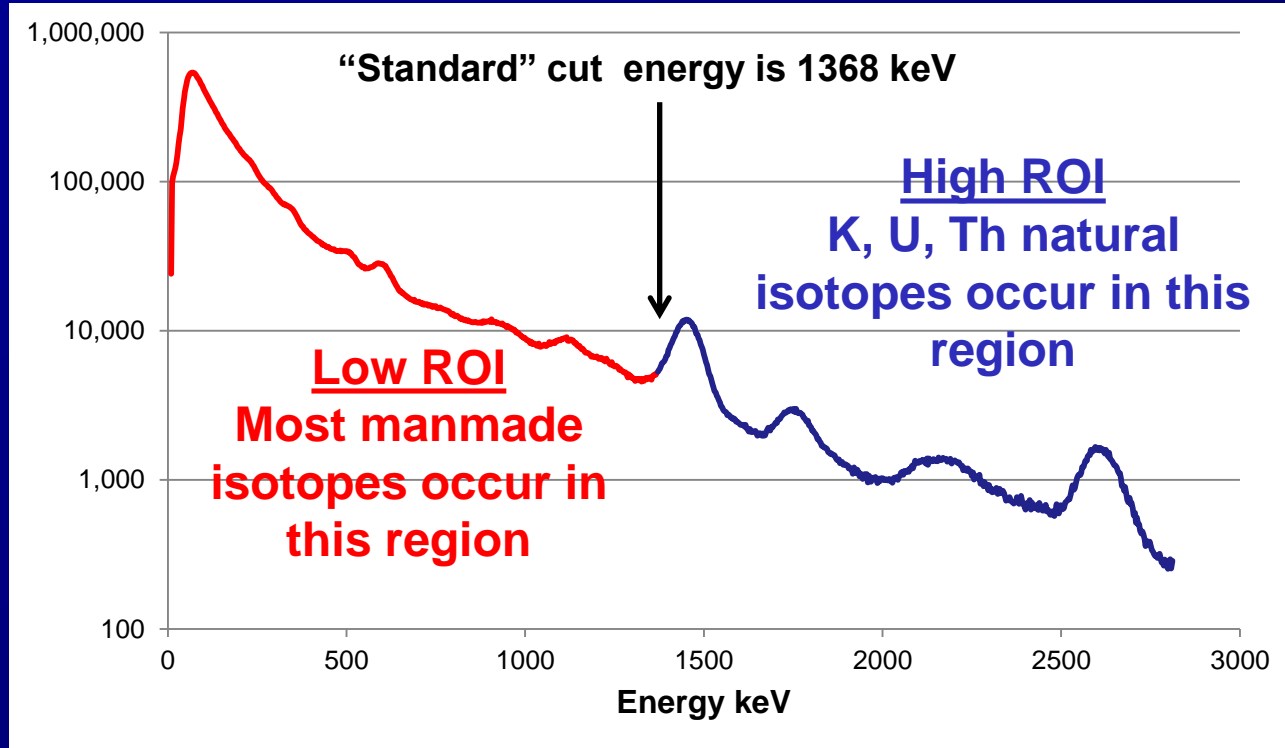
Runs



Manmade Anomaly Detection

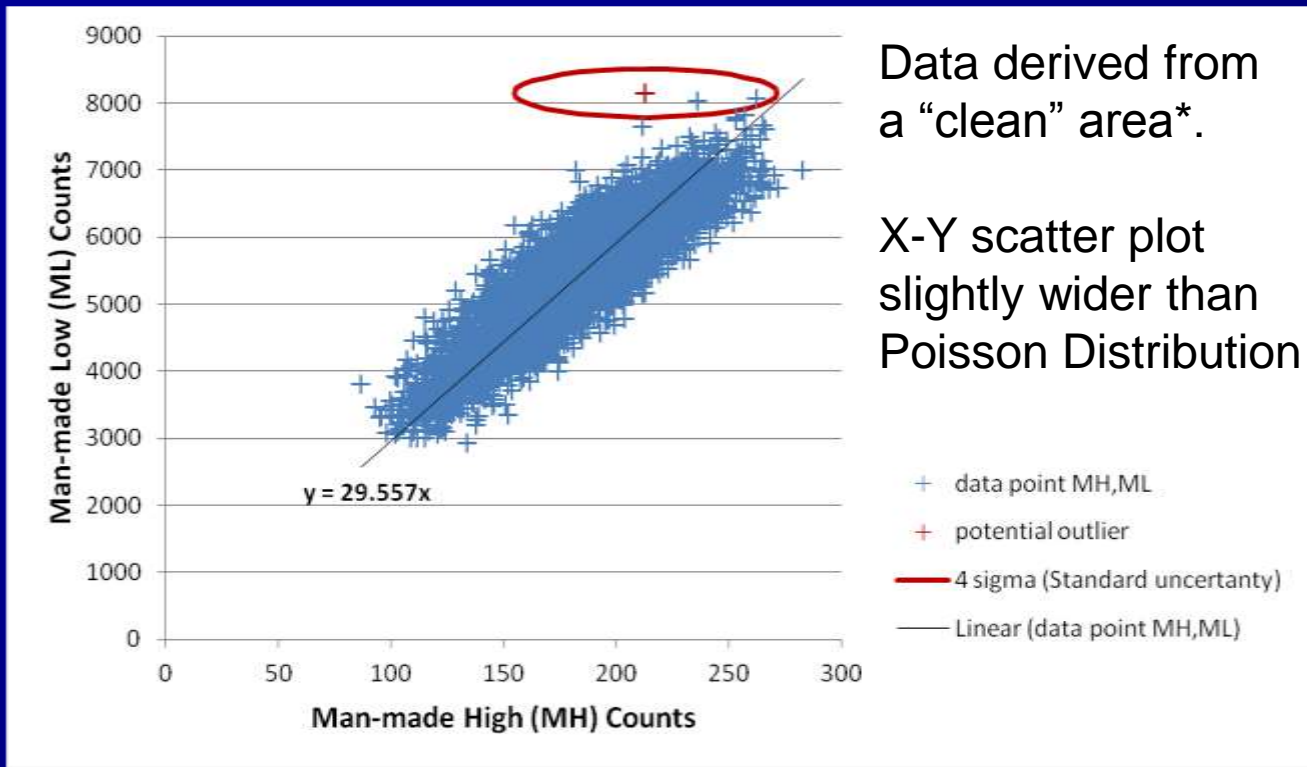
(Homeland Security Applications)

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 linear 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 @ 3 σ

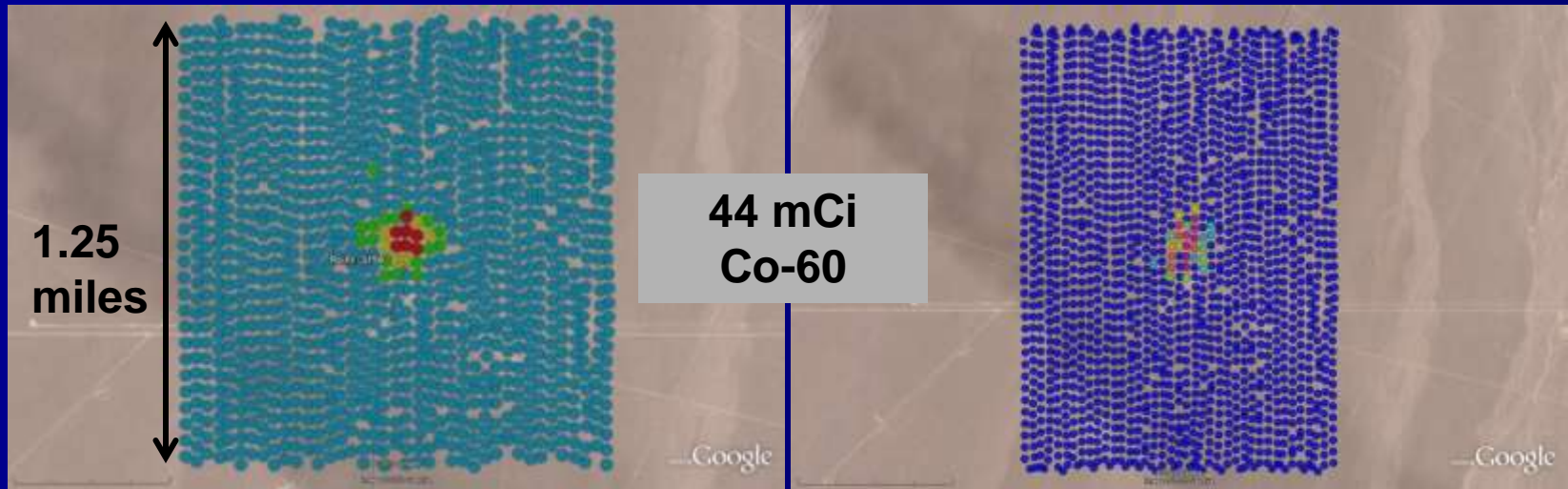
Co-60 1 @ 3 σ

DNDO Project Gyphon - ASPECT

152 m AGL; 50 m line spacing

Co-60 ROI Sigma Plot

RadAssist Anomaly Function



ENVI Code
(Requires Test Line)

RadAssist Anomaly Function
(No Test Line)

Product produced within
SECONDS after Survey

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

15 Ci AmBe Source in Shield



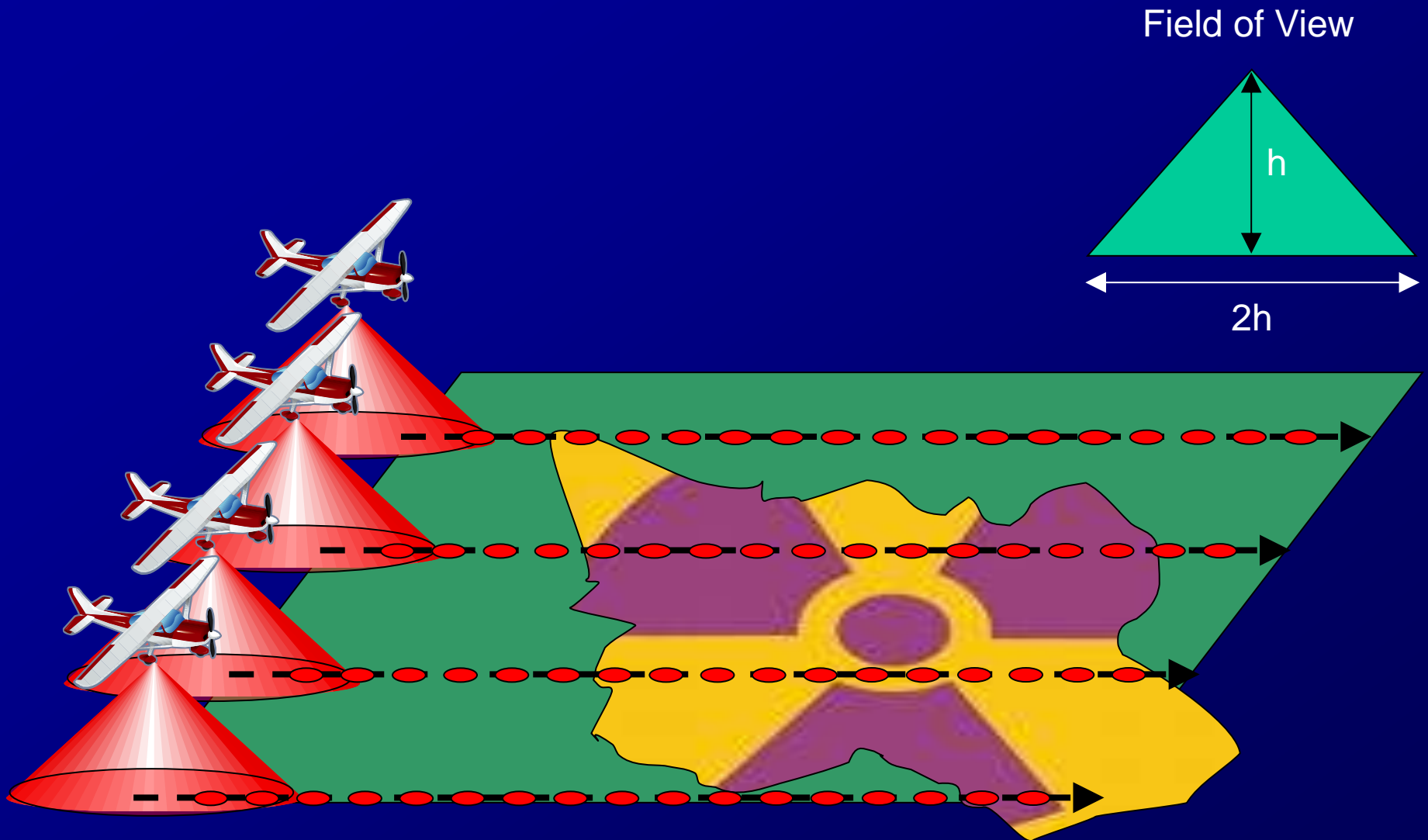
Identical Source
Multiple Altitudes
Multiple Off-sets
Ideal flight Param
200' AGL
Up to 600' off-set

ASPECT Calibration Flight

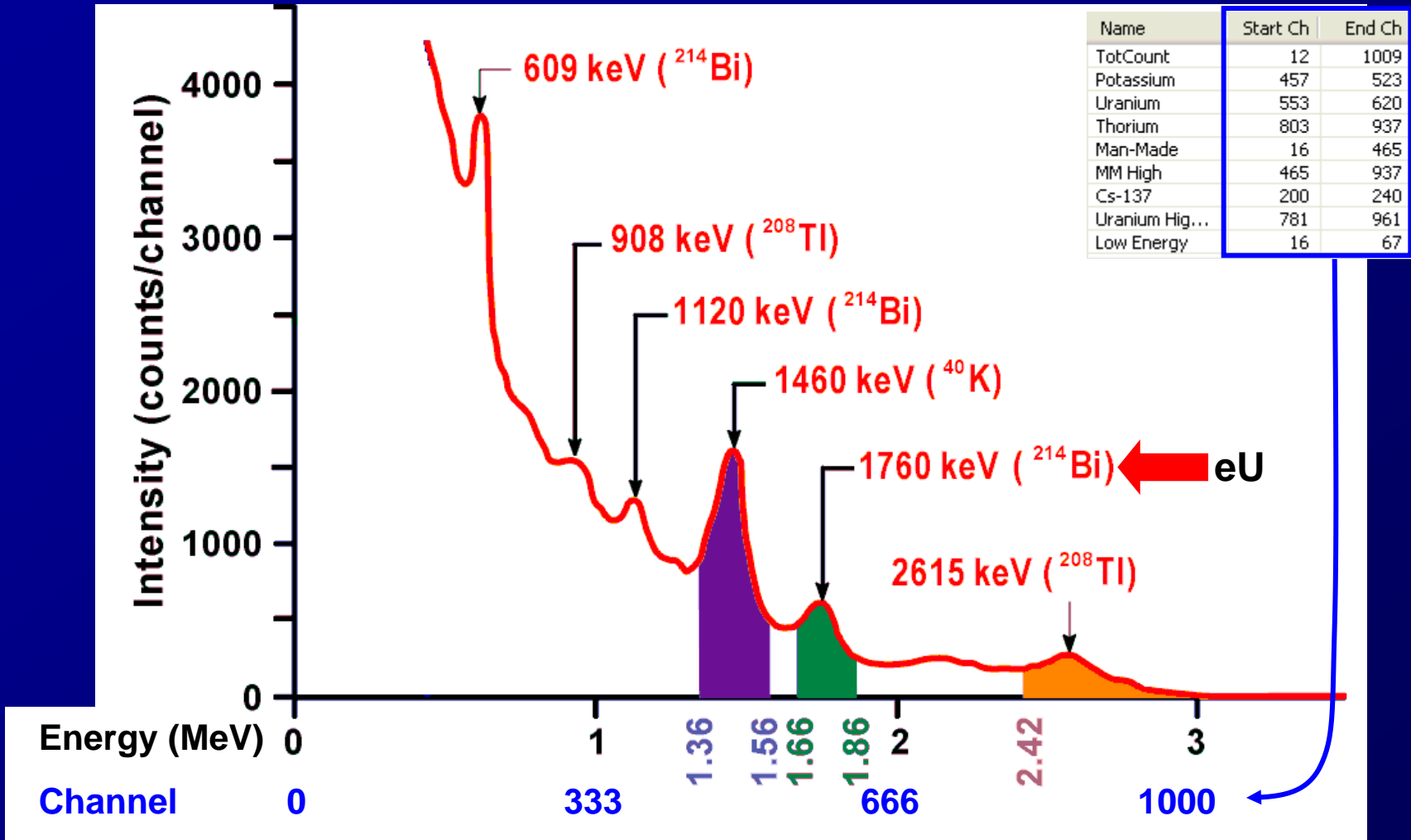


- Identical control source detected and located
- 200' AGL
- 150 linear miles surveyed
- Real-Time Observation

Typical Environmental Survey



Typical Gamma-Ray Spectrum



Contouring Algorithms

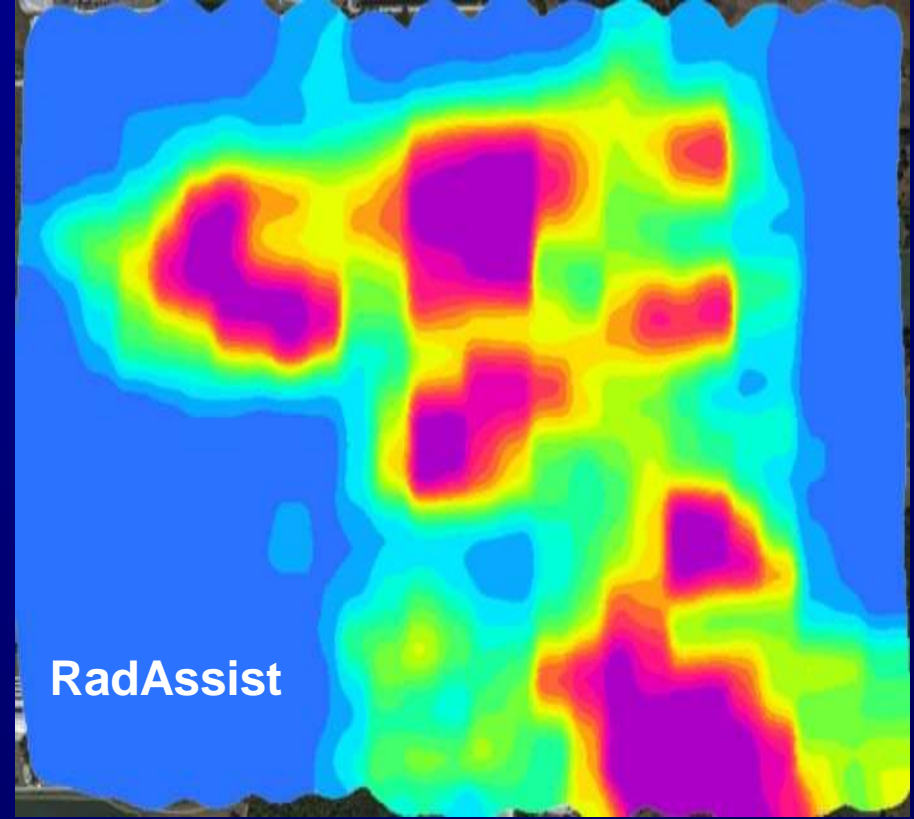
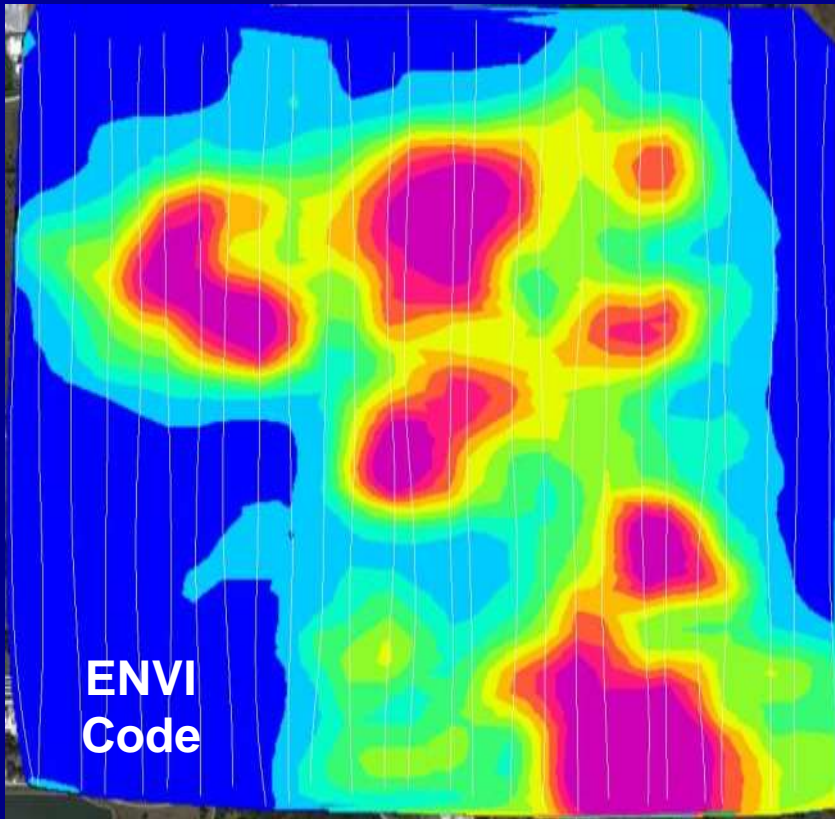
Triangulation

vs.

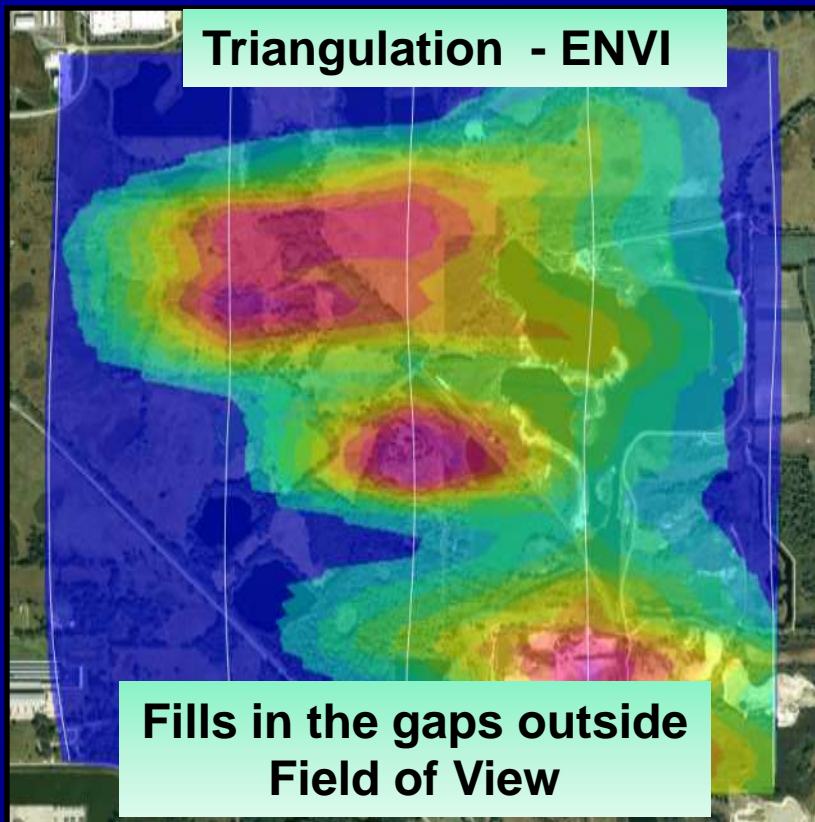
Point Spread Function

300 ft AGL; 300 ft Line Spacing

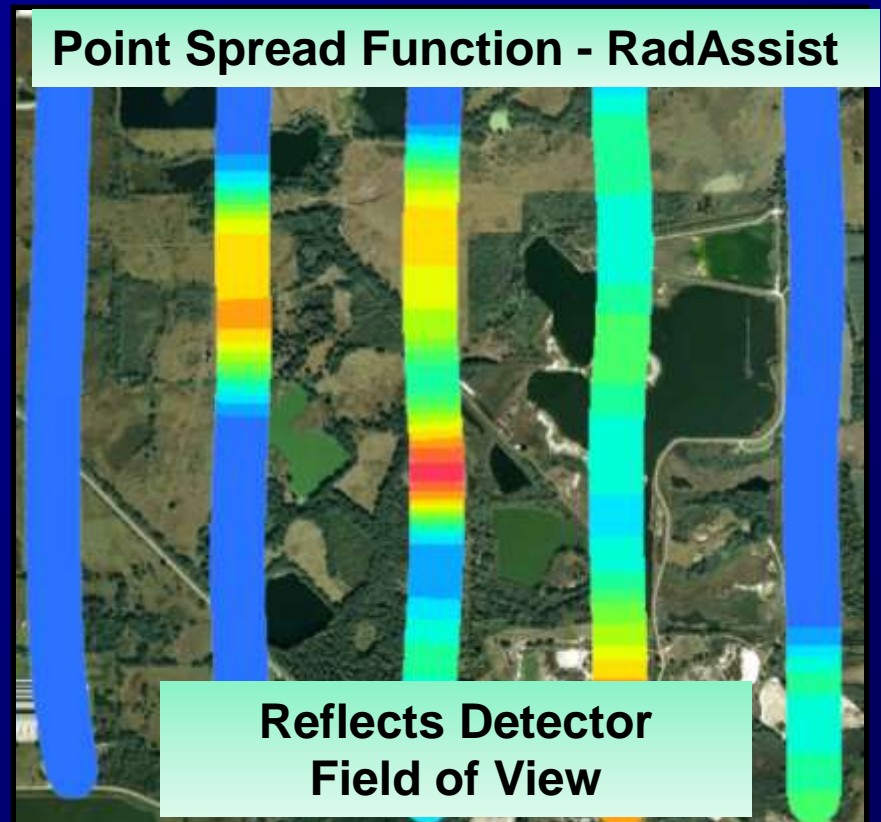
300 ft AGL, 300 ft Line Spacing













Contouring Algorithms



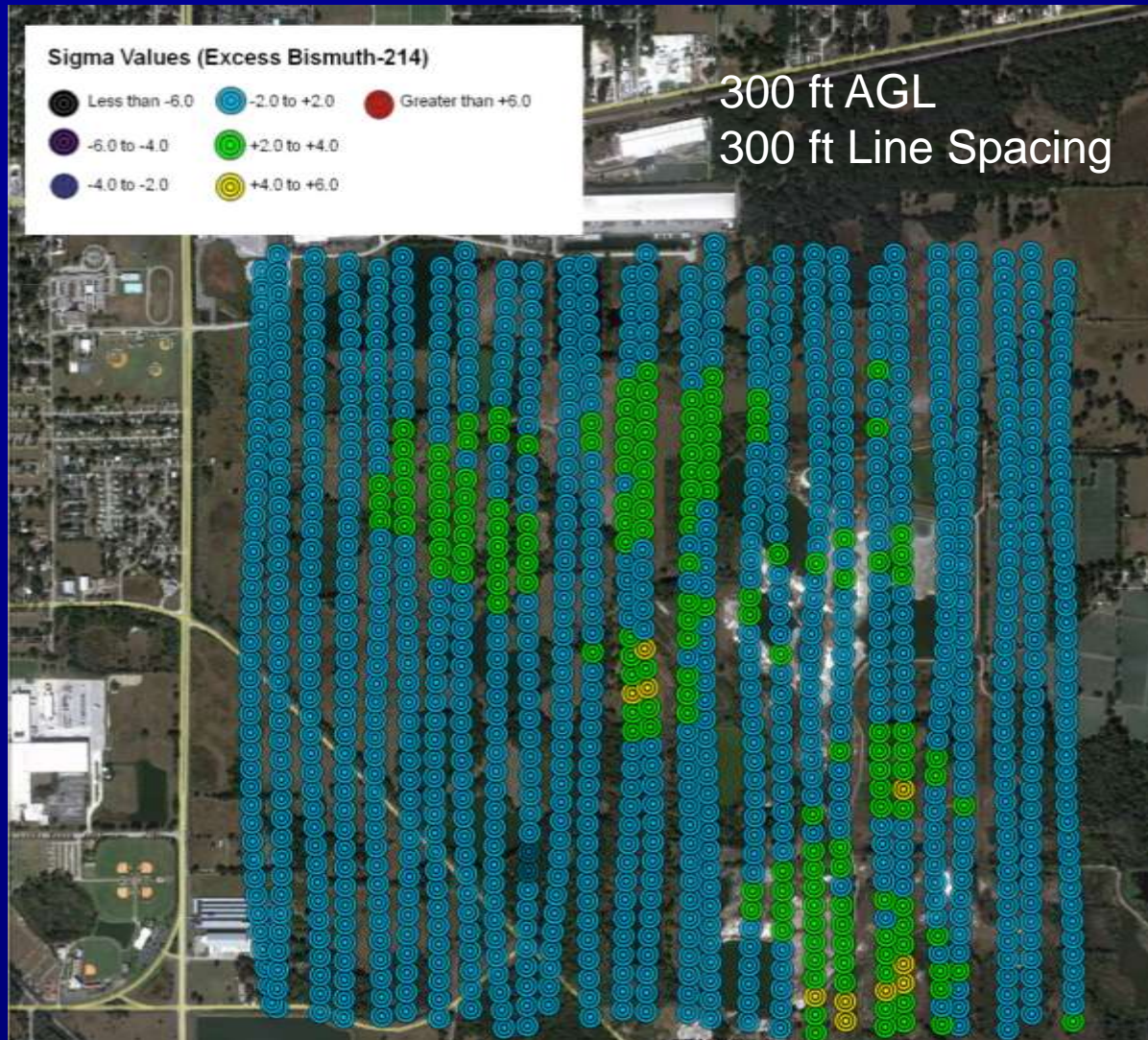
300 ft AGL
1800 ft Line Spacing



300 ft AGL
1800 ft Line Spacing

Parameter	Gamma Total Counts (cps)
	< 8000.0
	8000.0 : 12000.
	12000. : 16000.
	16000. : 20000.
	20000. : 24000.
	24000. : 28000.
	28000. : 32000.
	32000. : 36000.
	36000. : 40000.
	> 40000.

Sigma Plot of eU conc.



Boston Count Rate Contour



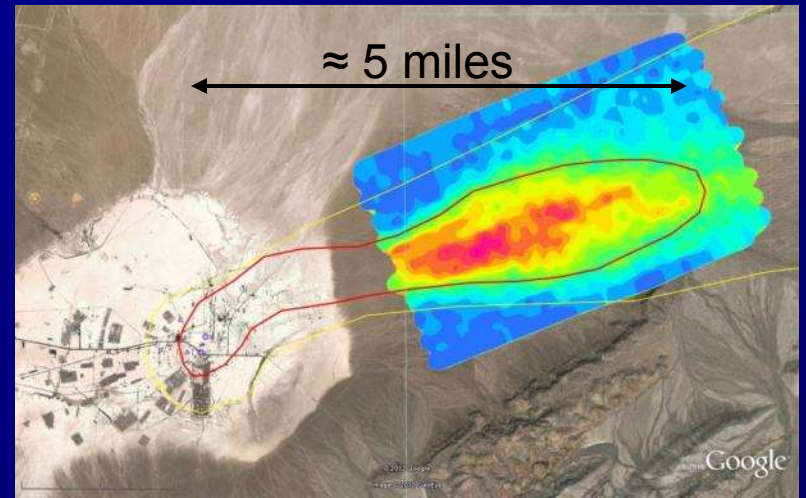
Boston Exposure Rate Contour



ASPECT Survey

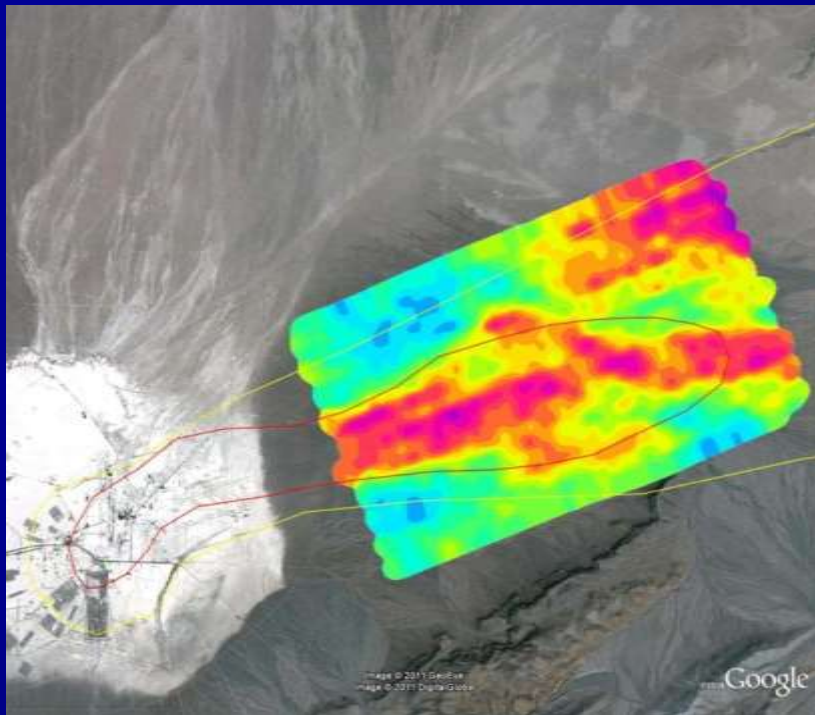
(October 2010, 91 m AGL; line spacing 152 m)

Operation Sunbeam



Advanced Processing Algorithms (NNS Survey; October 2010)

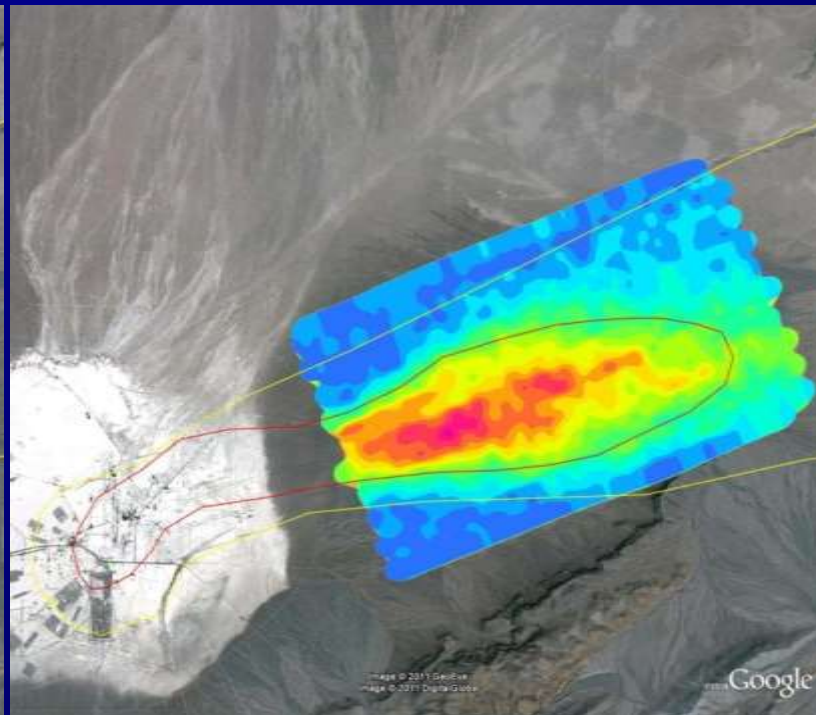
Cs-137 ROI (uncorrected)



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

$$\text{Radiance} = \epsilon T^4$$

ϵ = emissivity (*how efficient an object irradiates infrared energy*)

T = temperature

Oil and water have similar temperatures in open water (ϵ driven properties)

Oil on marshland has different temperatures (T driven properties)

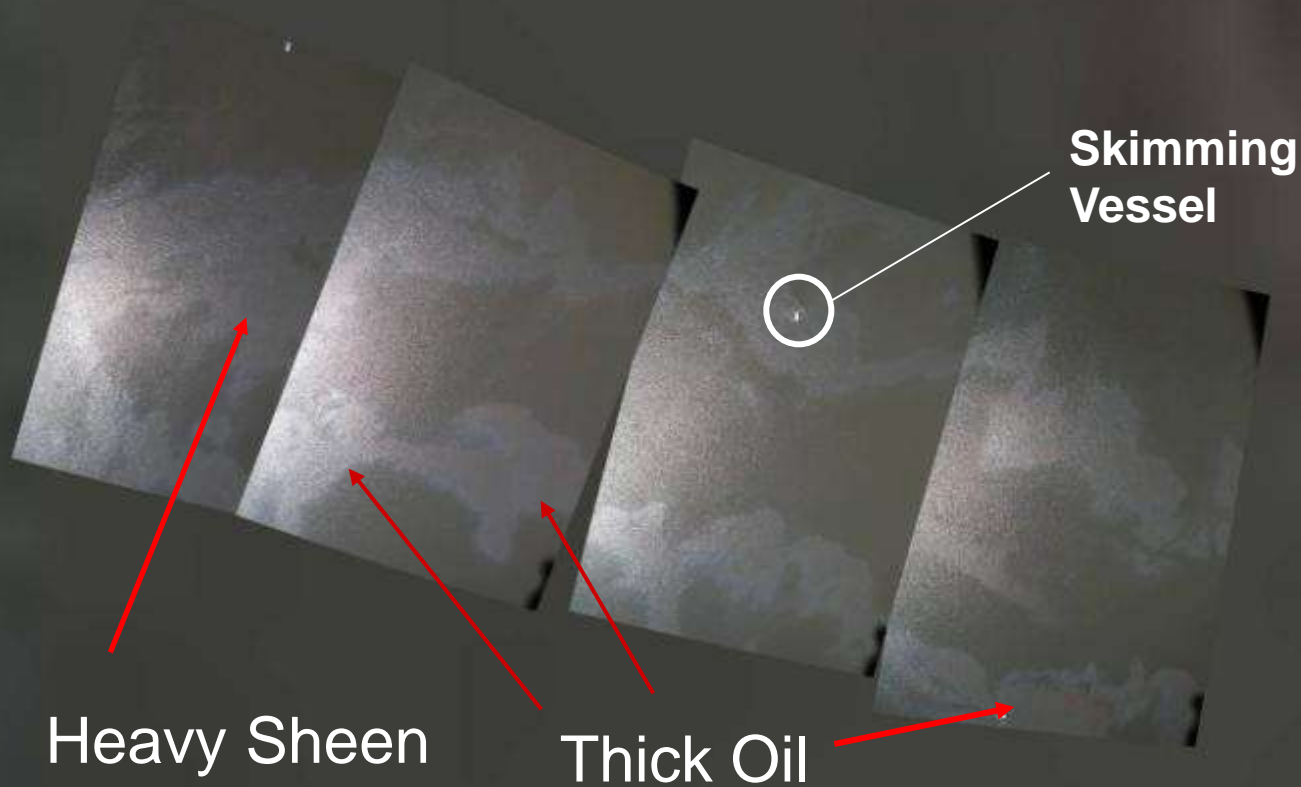
Oil $\epsilon \approx 0.75$ to 0.82 depending on thickness of surface oil

Water $\epsilon \approx 0.93$

Near Shore Oil Detection

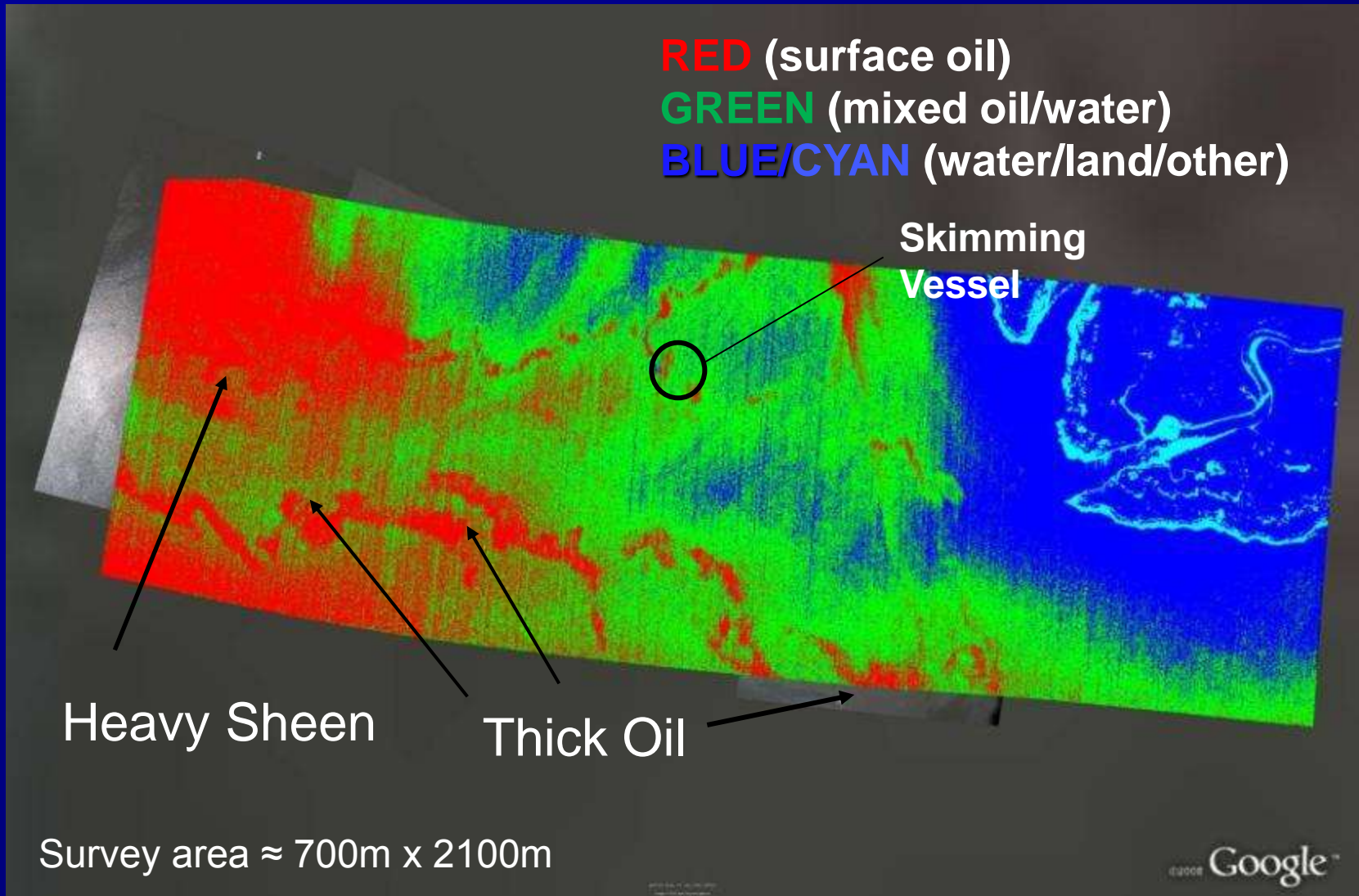
Aerial Imagery – Barataria Bay

Aerial Images at 2880 feet



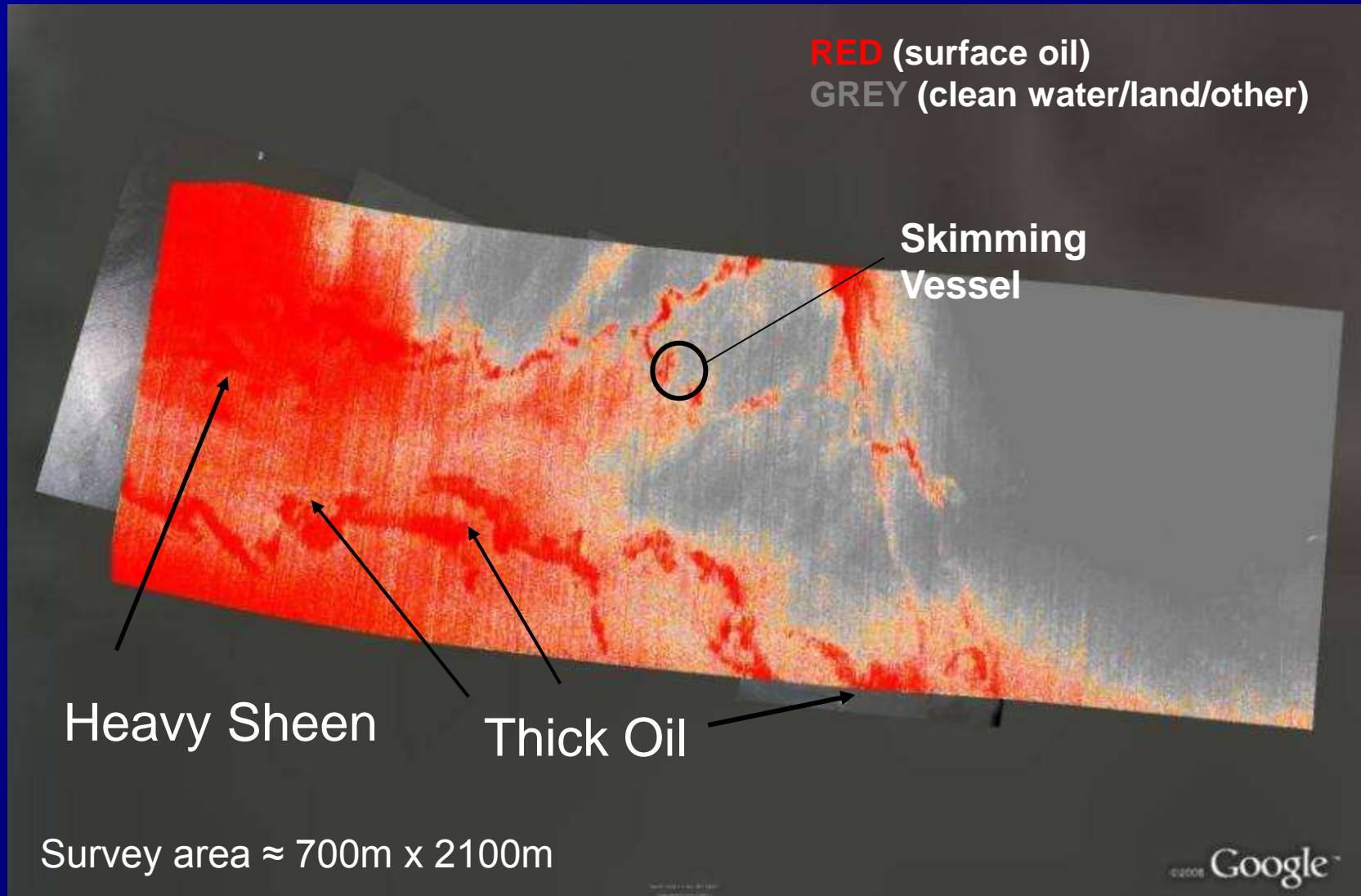
Near Shore Oil Detection

Unsupervised Classification Infrared Image



Near Shore Oil Detection

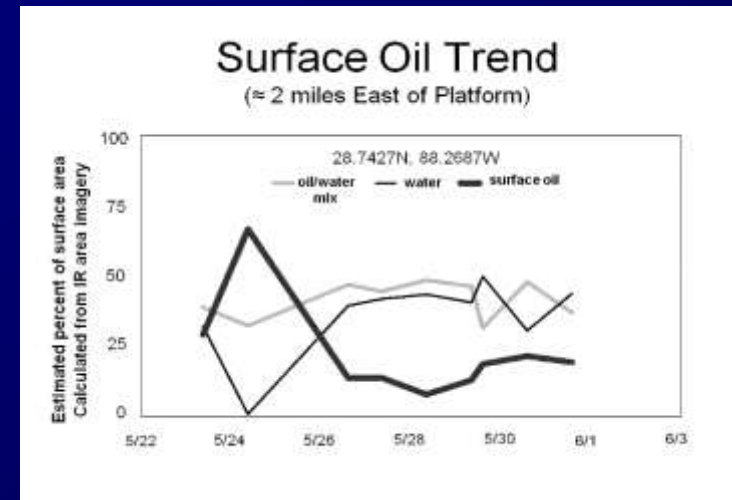
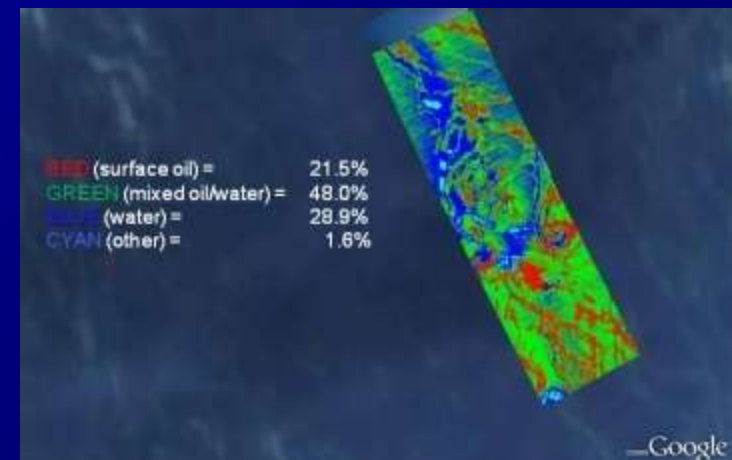
Supervised Pattern Recognition of IR Image



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

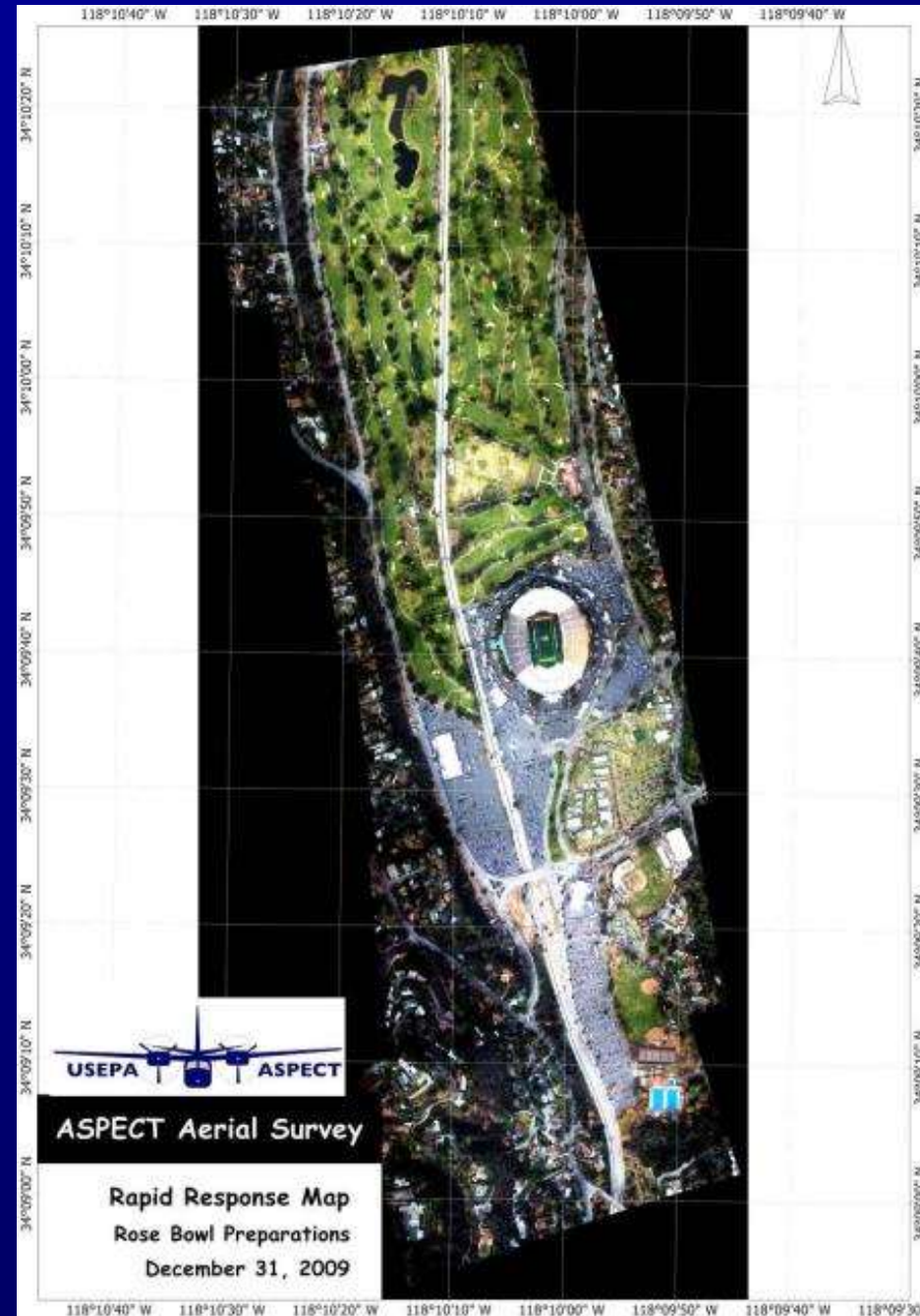
Fast Turn Around on Images – Approx 700
processed images per Hour

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

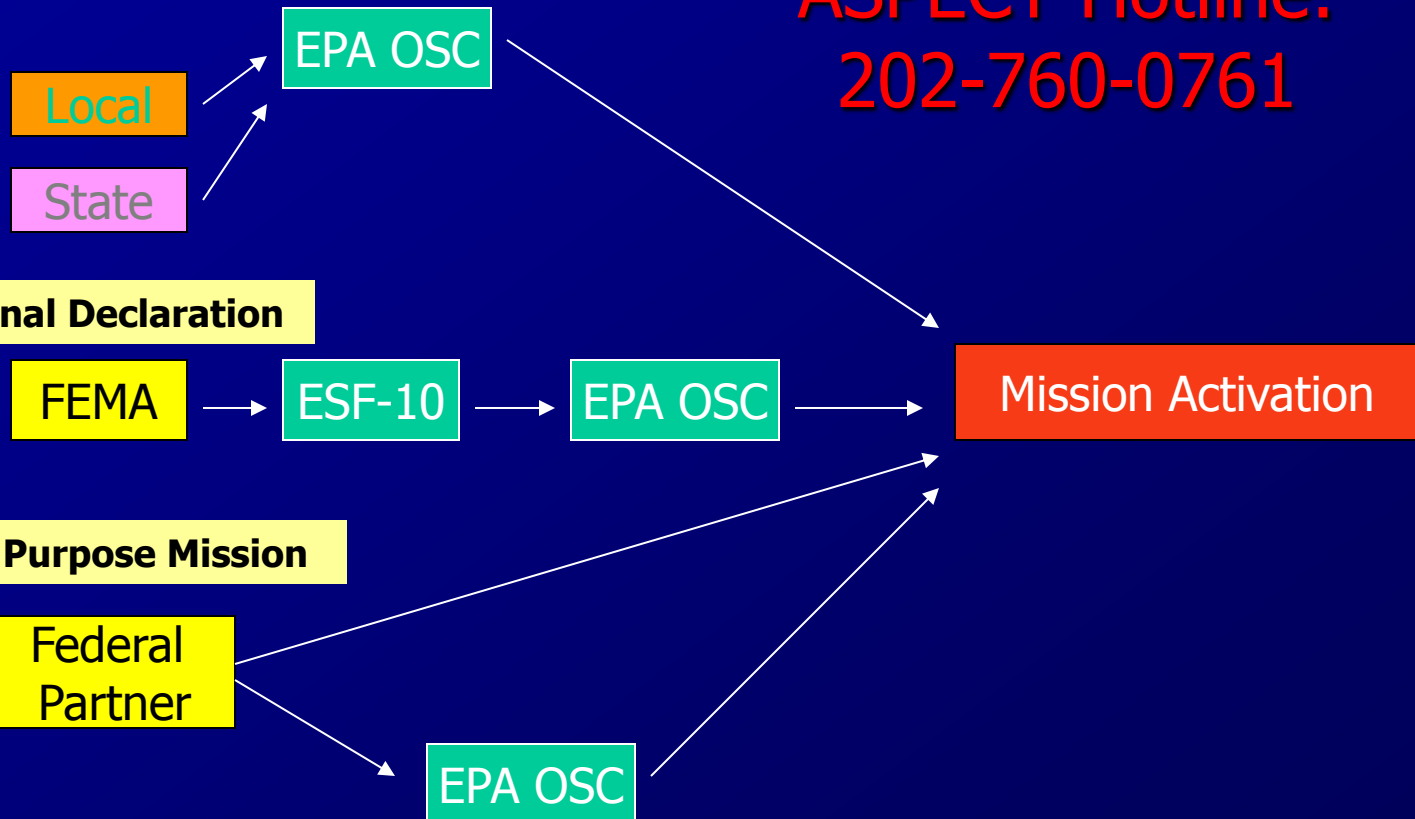
CERCLA or OPA Authority

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 \approx 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 \approx 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 \approx 5.5 Hours (Full coverage) for the Survey
 - Data Products Available After the 2nd 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 \approx 3 Hours
 - Typical Cost \$5100 per Response
- Photographic/Chemical Survey (Assume 40 Square Miles)
 - Total Flight Time \approx 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 \approx 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 \approx 6 Hours per day(Full coverage)
 - Daily Cost \approx \$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

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Paul Lewis, NGA

Robert Kroutil, Kalman Co, Inc.

Jeff Stapleton, Kalman Co, Inc.

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University of Iowa

