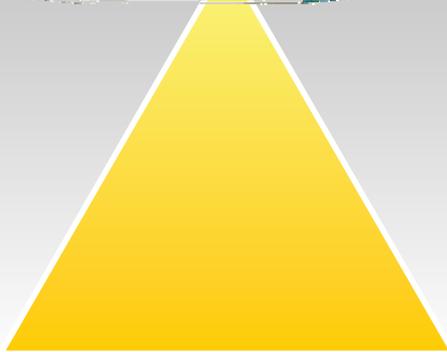
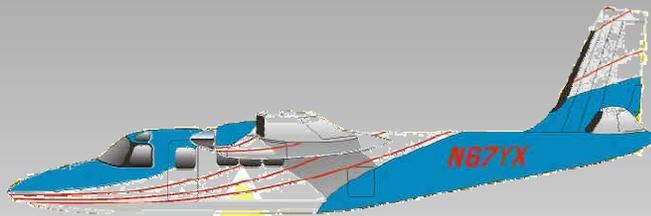




An Introduction to the EPA **ASPECT** Spectral Remote Sensing Project





What is ASPECT?

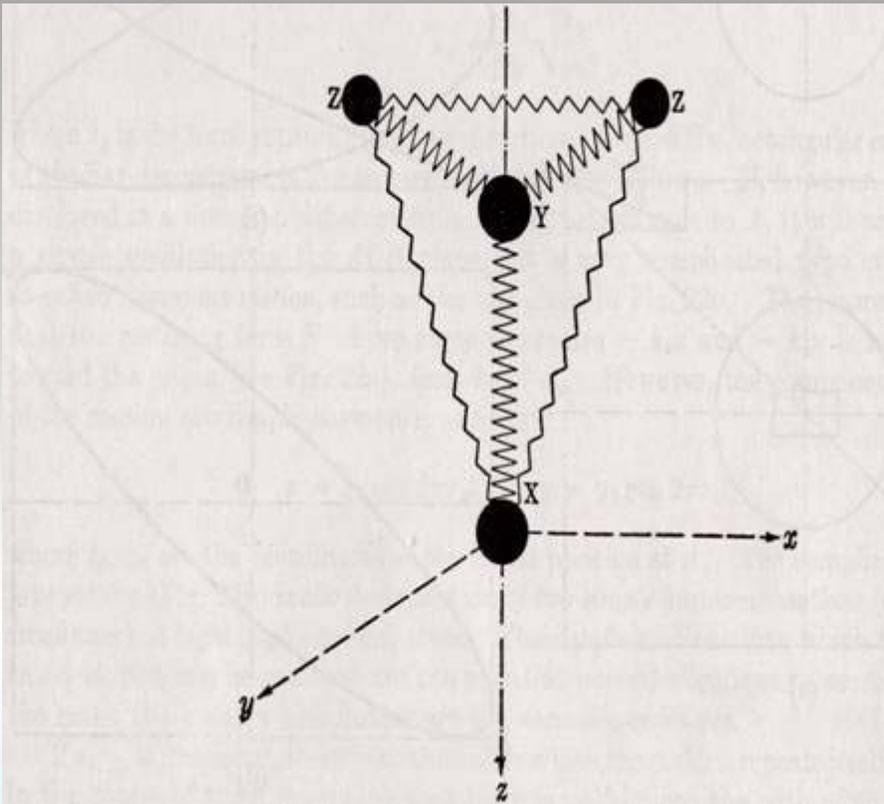
(Airborne Spectral Photometric
Environmental Collection Technology)



- An Airborne Standoff Hazard Detection and Reporting System Intended Primarily to **Directly Support the First Responder**
- ASPECT is the **Only Operational National Asset** Providing Responders with **Remote Chemical/Radiological** Detection
- ASPECT produces Geo-Registered Wide-Area Images of Chemical Plumes, Cross-Sectional Plots of the Plume, Thermal and Radioactivity Contouring of the Scene, and Digital Photography/Video of the Scene
- This Information is provided in near **Real-Time** Fashion to the First Responder on the Ground

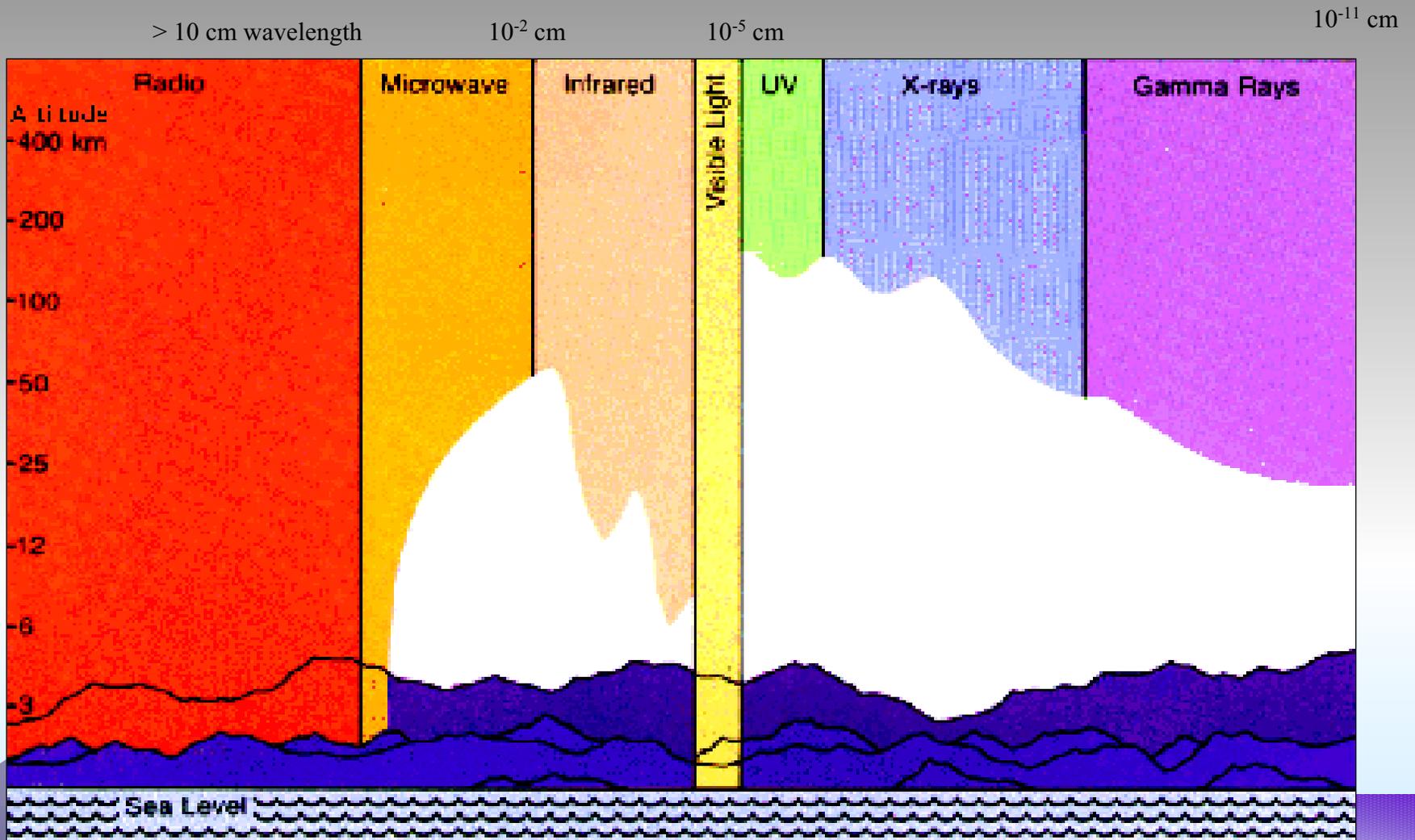


Passive Molecular/Electromagnetic Energy Interactions



- Consider molecules as mass (**atoms**) suspended by springs (**chemical bonds**)
- These bonds (**springs**) can stretch, bend, and/or rotate
- The mass and springs interact with photons of light at the same wavelength

Electromagnetic (Photons) Energy Reaching Earth's Surface



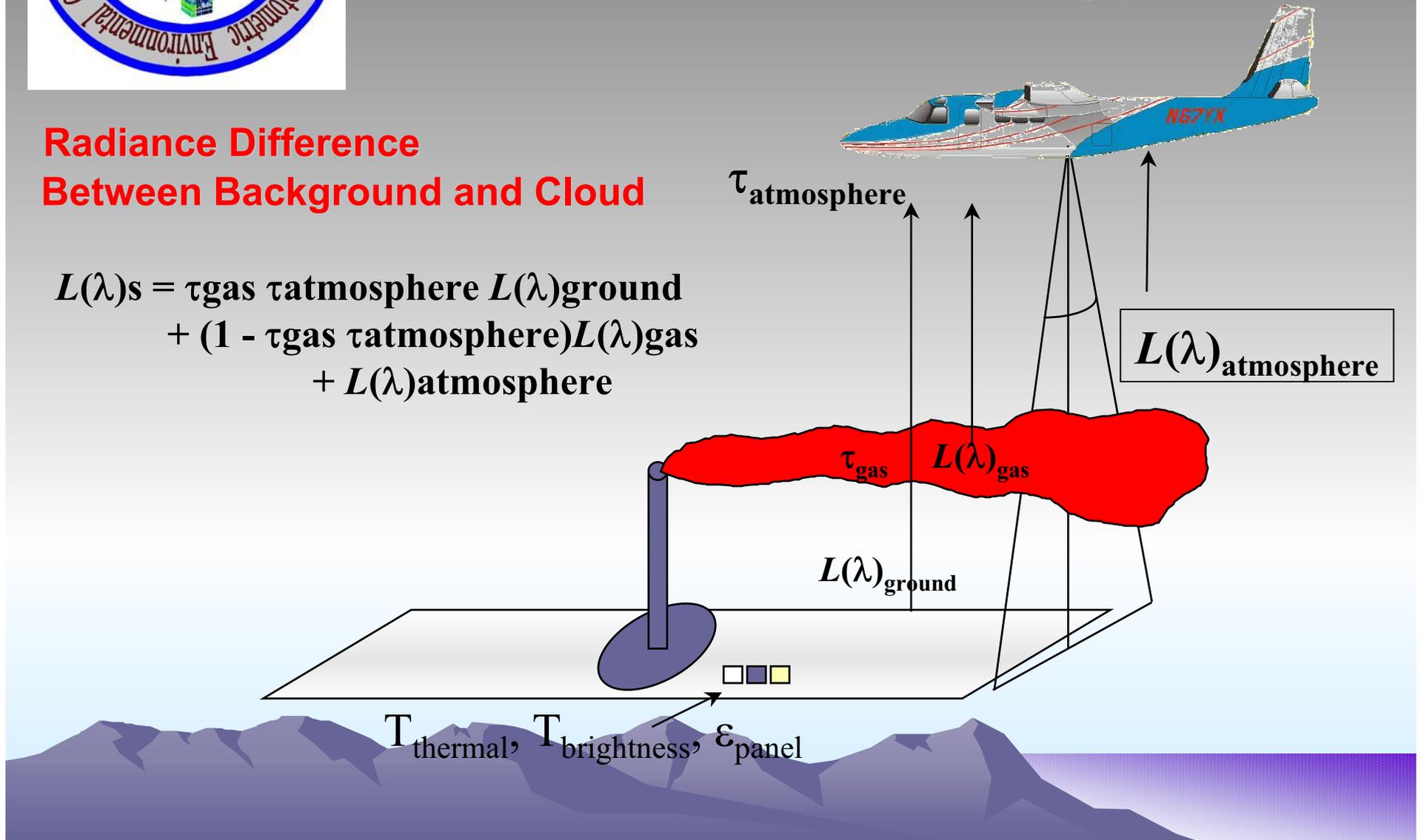


Program ASPECT

Passive IR Technology

Radiance Difference Between Background and Cloud

$$L(\lambda)_s = \tau_{\text{gas}} \tau_{\text{atmosphere}} L(\lambda)_{\text{ground}} + (1 - \tau_{\text{gas}} \tau_{\text{atmosphere}}) L(\lambda)_{\text{gas}} + L(\lambda)_{\text{atmosphere}}$$



Program ASPECT

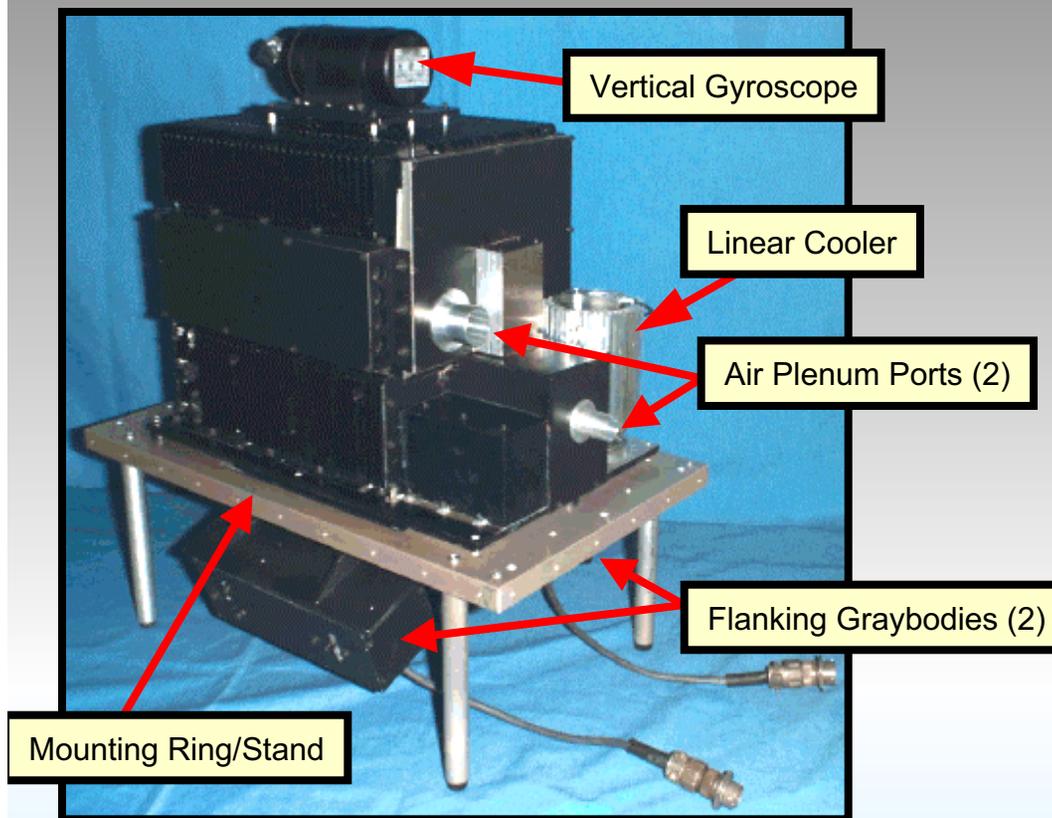
Spectral Sensing Systems

- ASPECT Uses Three Primary Sensors:
 - RS-800 Infrared Line Scanning Imager (Multi-Spectral Sensor)
 - A High Speed Spectrometer (Hyper-Spectral Sensor)
 - A Gamma-Ray Spectrometer (Hyper-Spectral Sensor)
 - All Data Streams GPS Registered





Method:



ASPECT MODIFIED RS-800SG MSIRLS

Current RTIS RS-800 SG/MSIRLS Configuration

Scanning Parameters

Scanner Type	Rotating Double-Dove Prism
Stabilization Roll	+/- 10 degrees
Recorded FOV	60 degrees
Scan Rate	60.0 scans/sec
Scans/Revolution	2
Samples / Scan	1500 (1400 over 60° FOV)

Spectral Parameters

Spectral Filters	14
Channels/Filter	1
Calibration	2 Internal Graybody Sources
NET (LWIR)	0.06 deg C
NET (MMR)	~0.1 deg C

Optics Parameters

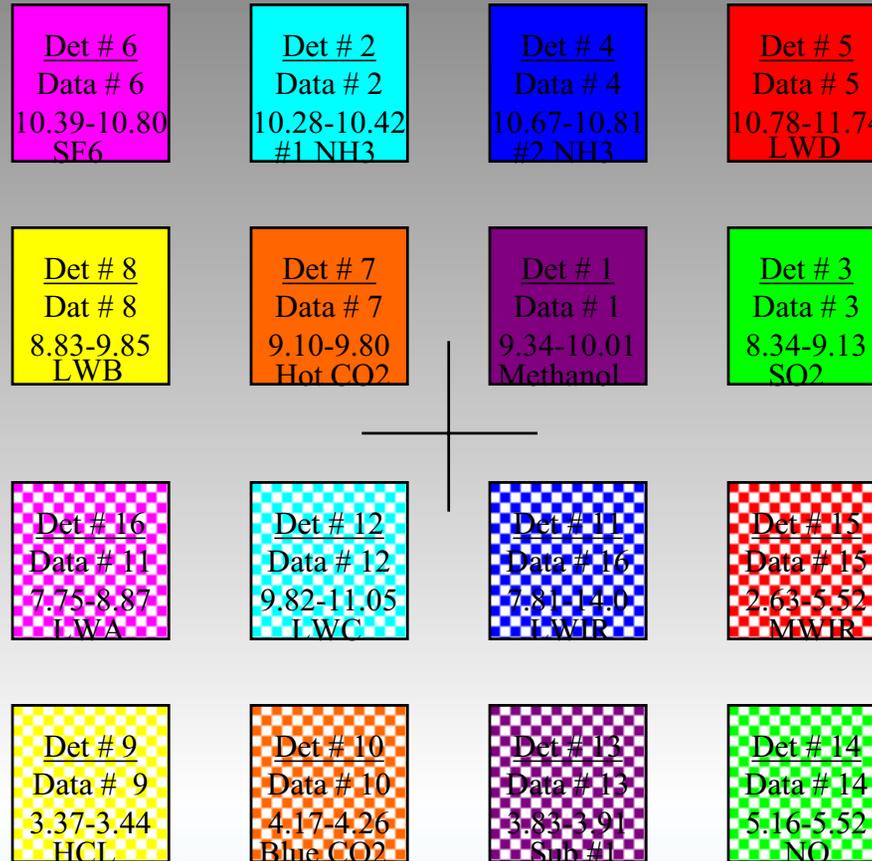
F-Number	1.18
Focal Length	2.00 inches
Resolution	1.0 mrad

Operational Characteristics

Nominal Air Speed	90 kts
Nominal Altitude	2000 ft

RS-800 Detector Layout

Direction of Flight
↑



→ Scan Direction



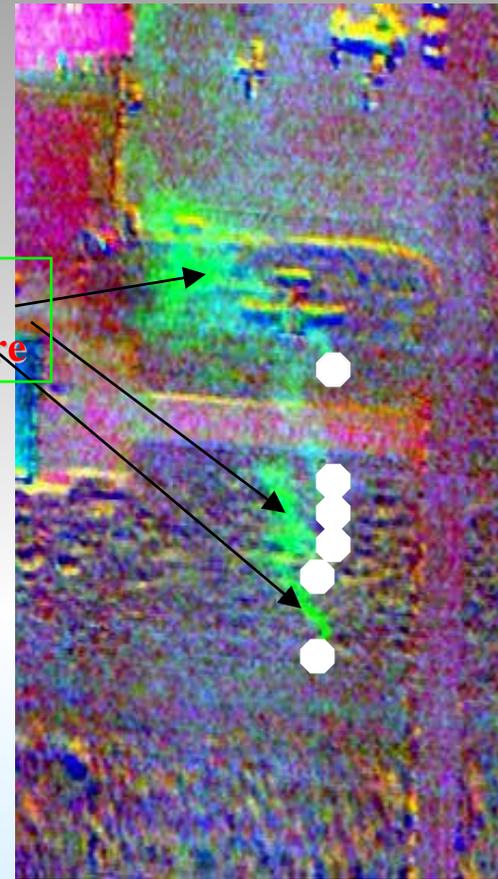


Open Containers with Small Surface Areas Test

Digital Photo with Plastic Pools Containing Various Concentrations of Methanol Circled in Black



Plume Signature



Line Scanner Image of the Same Plastic Pools Circled in White

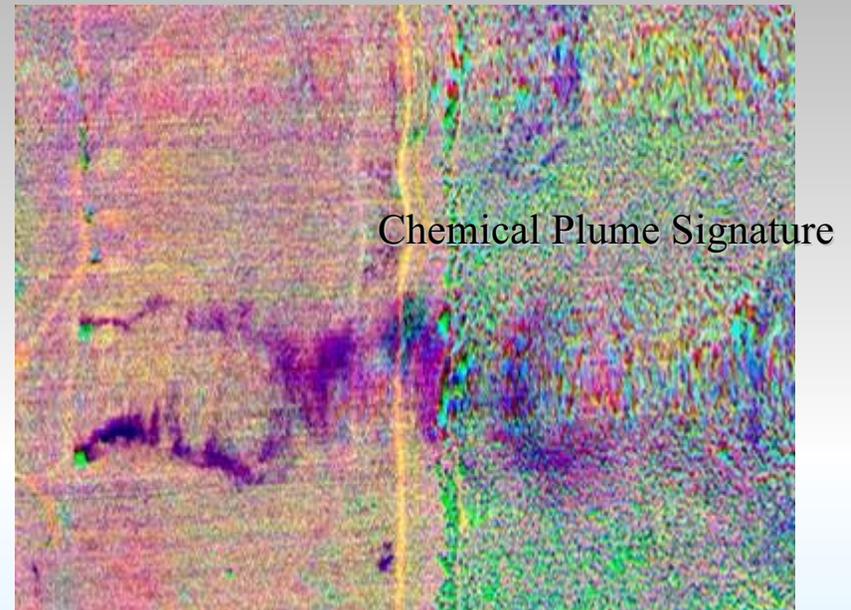


Simulated Chemical Spills Methanol and N-Butanol in 10 x 10 Foot Square Pools

Georectified Digital Photograph

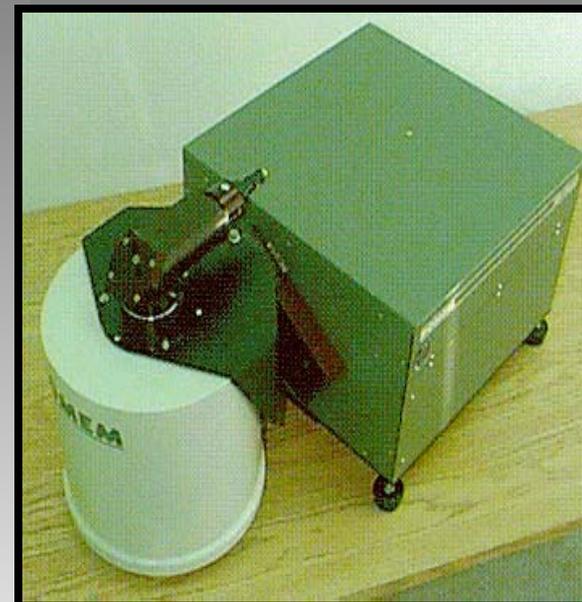
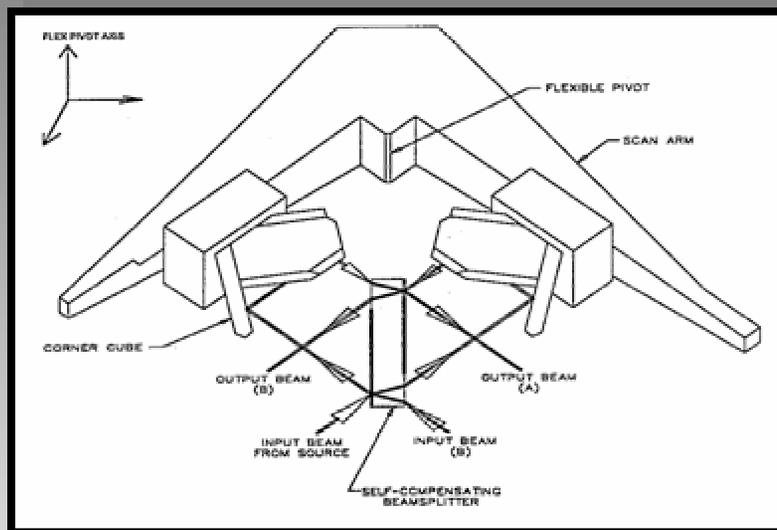


Line Scanner Image of Plume





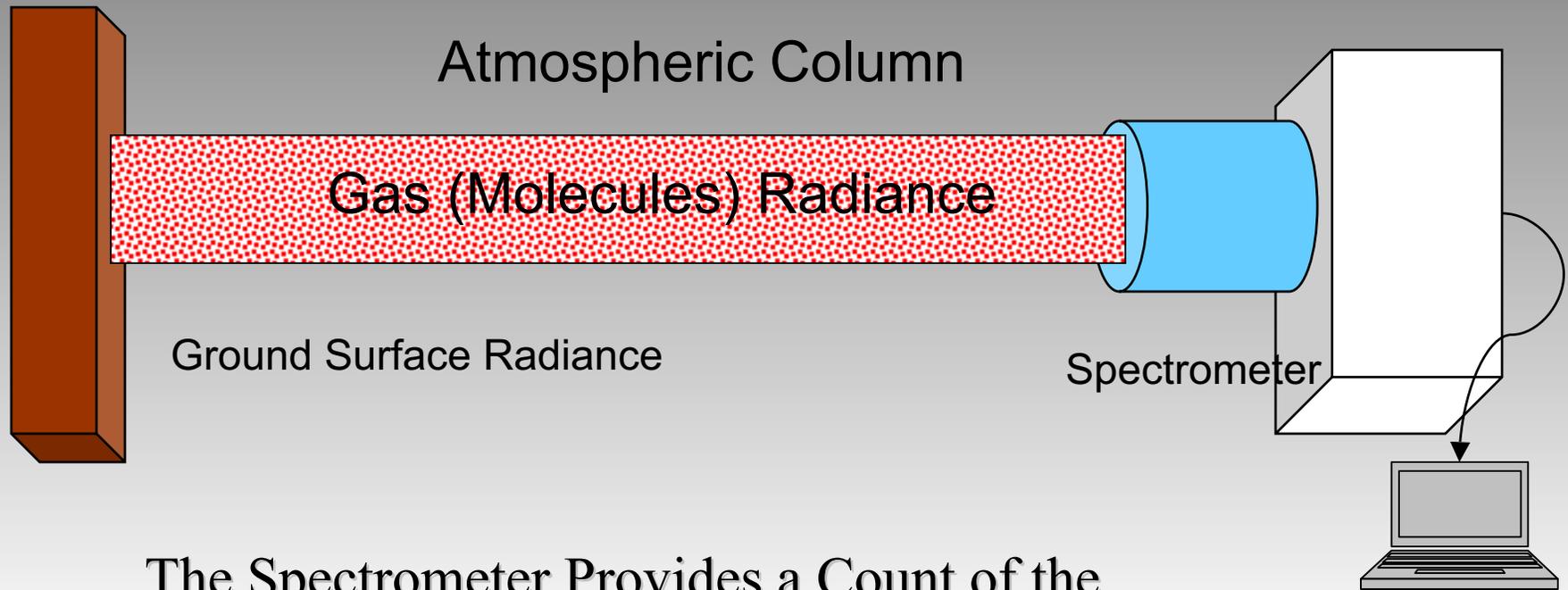
FTIR Spectral Data Collection Method:



INTERFEROMETER OPERATION

- **Telescope Focuses A Column of Spectral Energy into a Beam**
- **The Beam is Split and One Path Length is Varied**
- **When the Beams are Combined it Produces a Waveform**
- **The Waveform can be Fast Fourier Transformed (FFT)**
- **Transformation Separates the Waveform into a Spectral Graph**
- **Each Chemical Compound has a Unique Spectral Signature**

Passive Infrared Detection



The Spectrometer Provides a Count of the Moles of Chemical within the Field of View

FTIR Data Reporting

- Data Generated by the FTIR Spectrometer is Reported as ppm*M (parts per million times meter)
- By Using an Estimate of the Plume Thickness a Volumetric Concentration can be Calculated
 - Volumetric Concentration = (ppm*M Value)/Plume Thickness
- ASPECT is currently Generating Data Referenced to:
 - 1 Meter Standard
 - 10 Meter Thick Plume
 - 30 Meter Thick Plume



Relationship of Concentration (ppm) to ppm*M

All Results inside the Boxes Represent a FTIR Date Value Reported at 10 ppm*M

10 ppm



If Plume is 1 Meter Thick

5 ppm



If Plume is 2 Meters Thick

3.33 ppm



If Plume is 3 Meters Thick

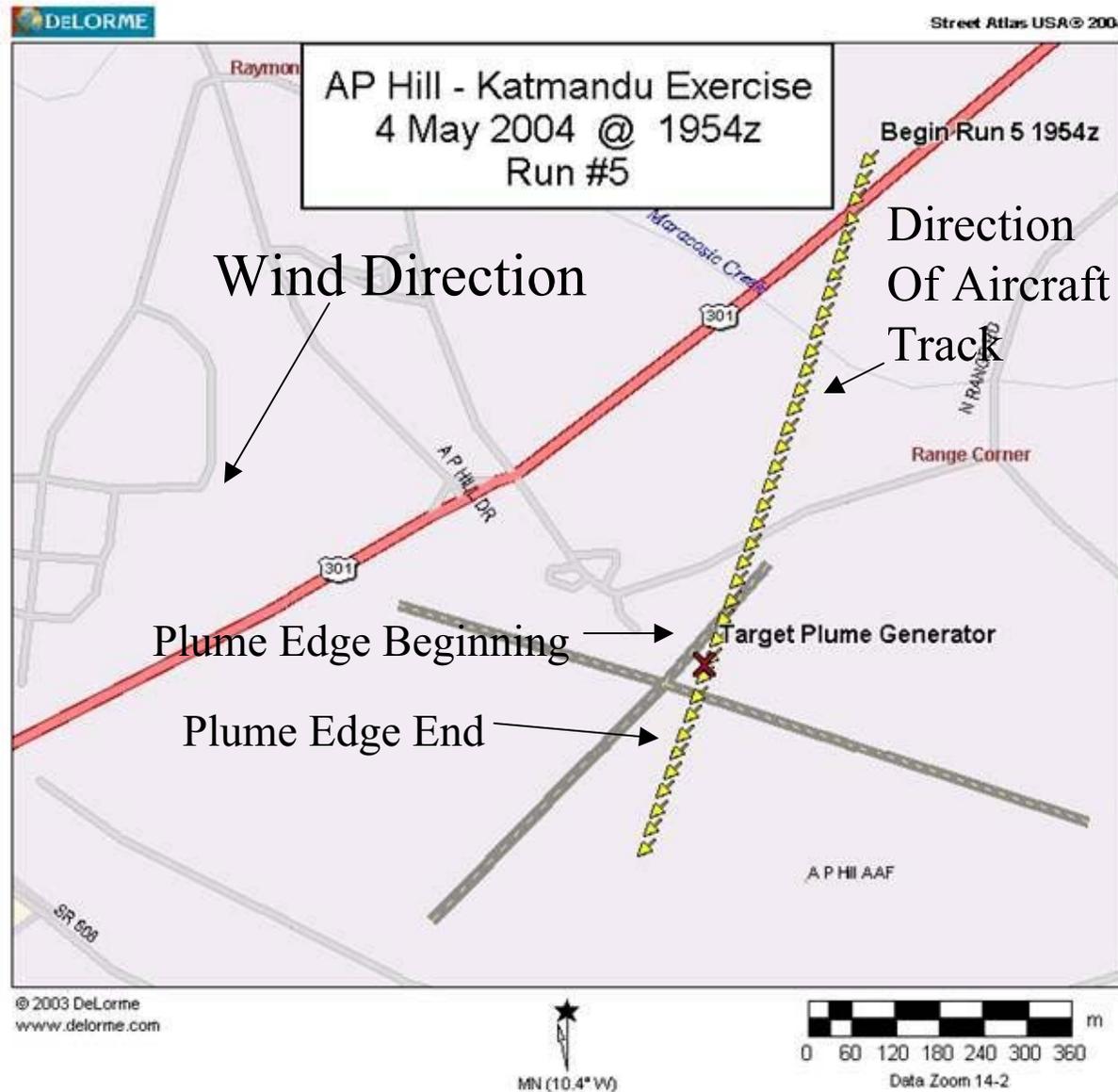
1.0 ppm



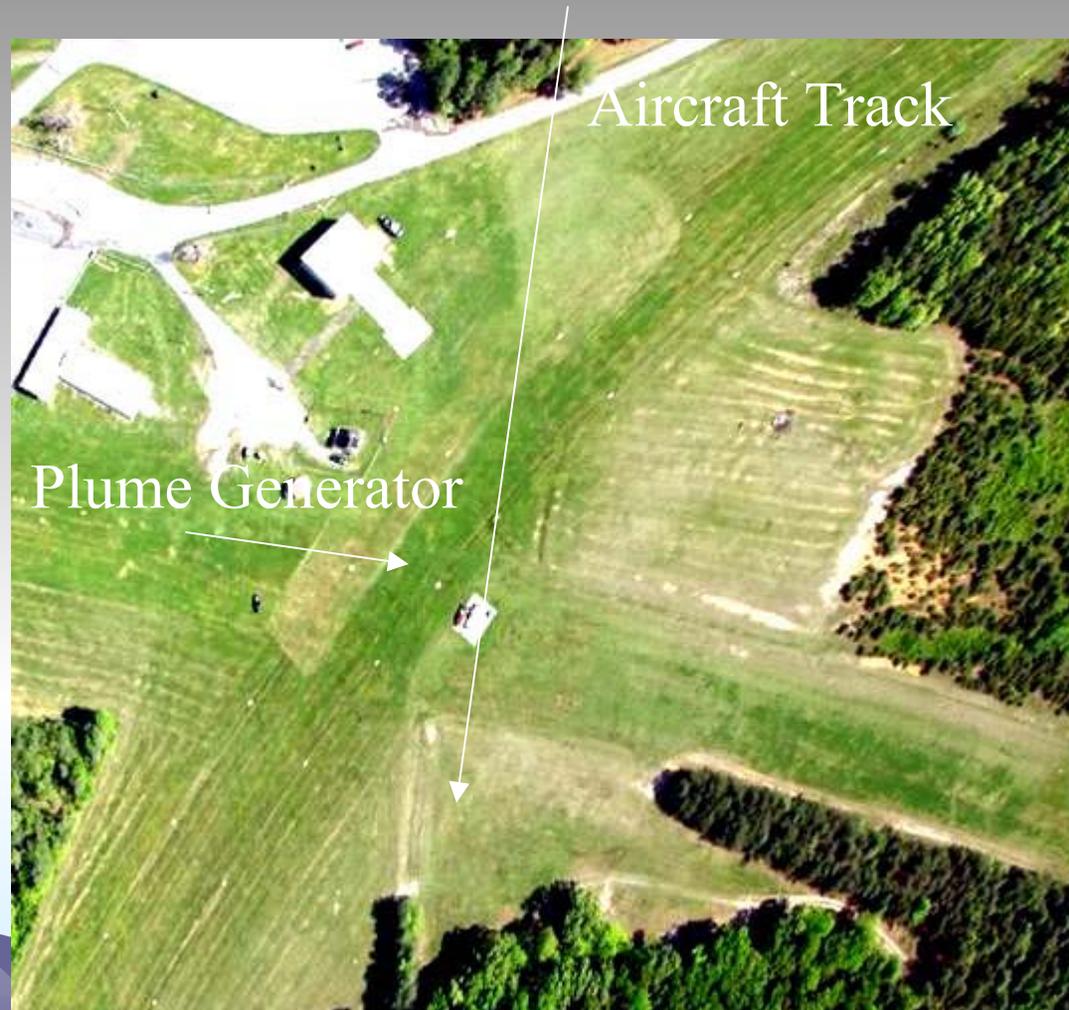
If Plume is 10 Meters Thick



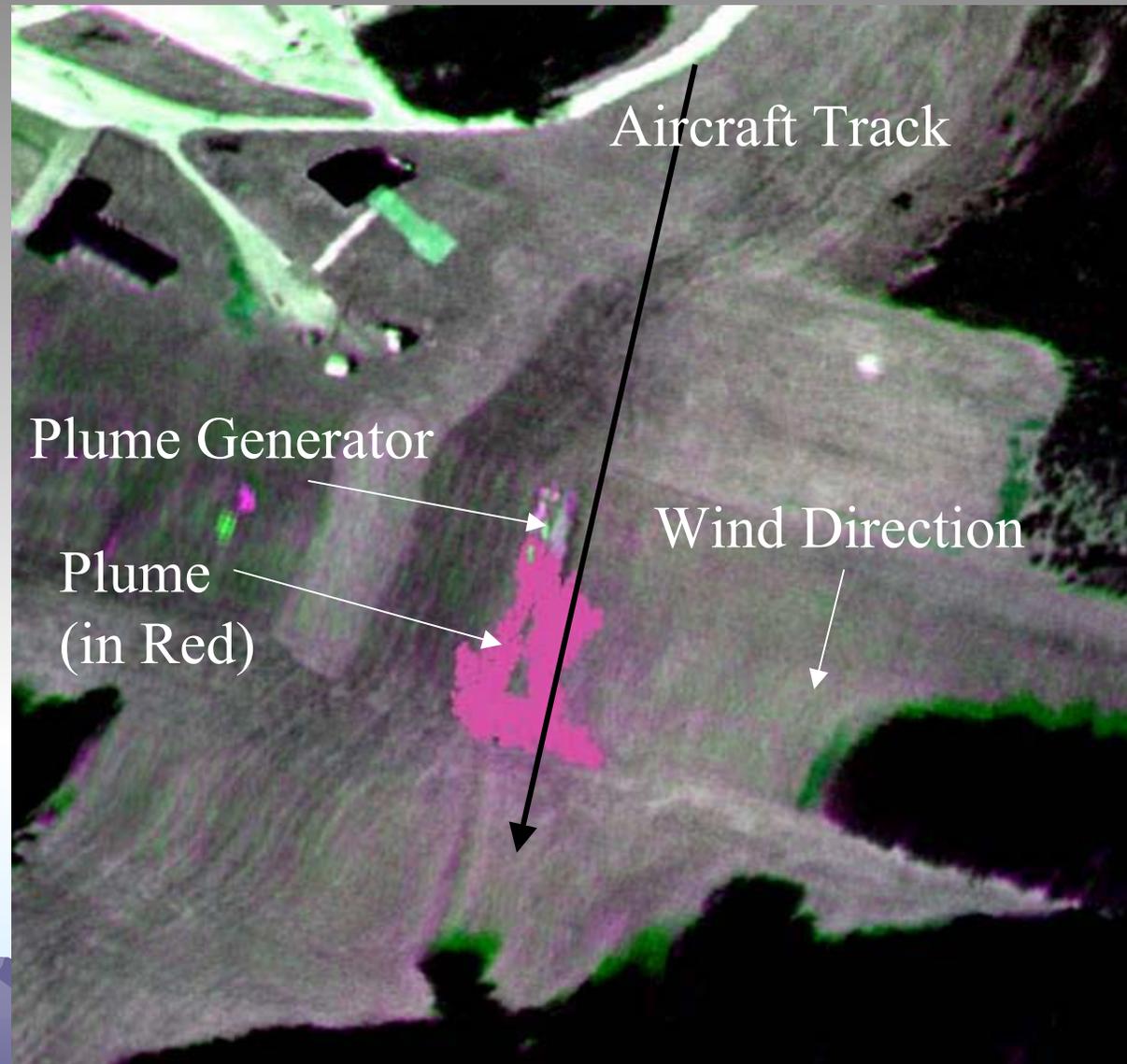
Mapping of FTIR Data Point Locations



Example of a Geo-rectified Digital Image collected from
Aircraft on **4 May 2004 19:54 Zulu at Ft. AP Hill**

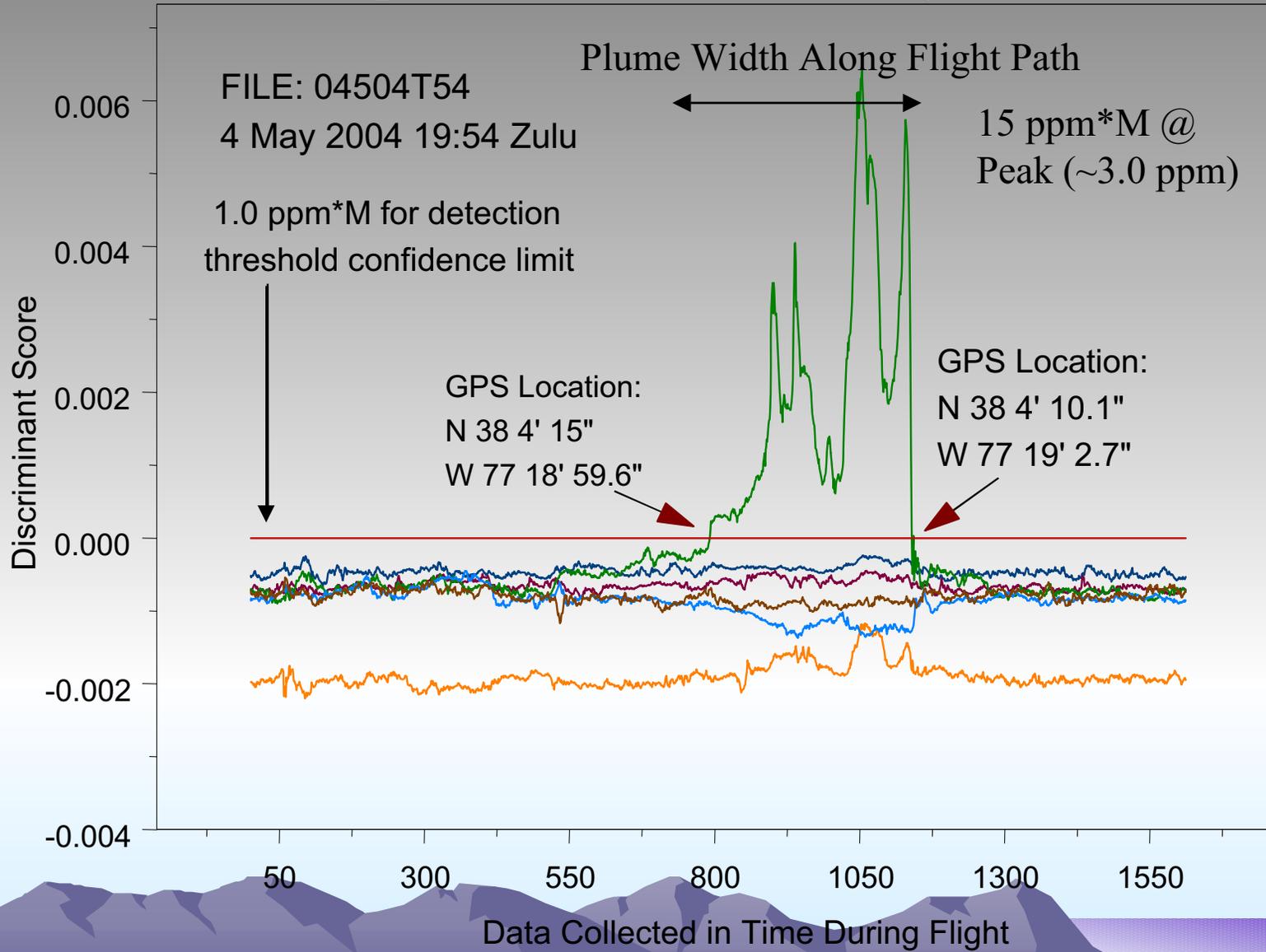


Processed Line Scanner Infrared Image of SF6 Plume
AP Hill - 4 May 2004 19:54 Zulu Ft. AP Hill



EPA ASPECT

FT-IR Spectrometer Plume Density Cross-Cut





ASPECT Gamma Ray Spectrometer

- Berkely Nucleonics SAM 935 Gamma Ray Spectrometer
- 4" by 4" by 16" NaI Crystal Lattice Detector
- Approximately 85 Isotopes in Library





Program ASPECT

Equipment View

Sensor Station View



RS-800SG
Chemical Infrared Imager

MR-254AB FTIR Spectrometer

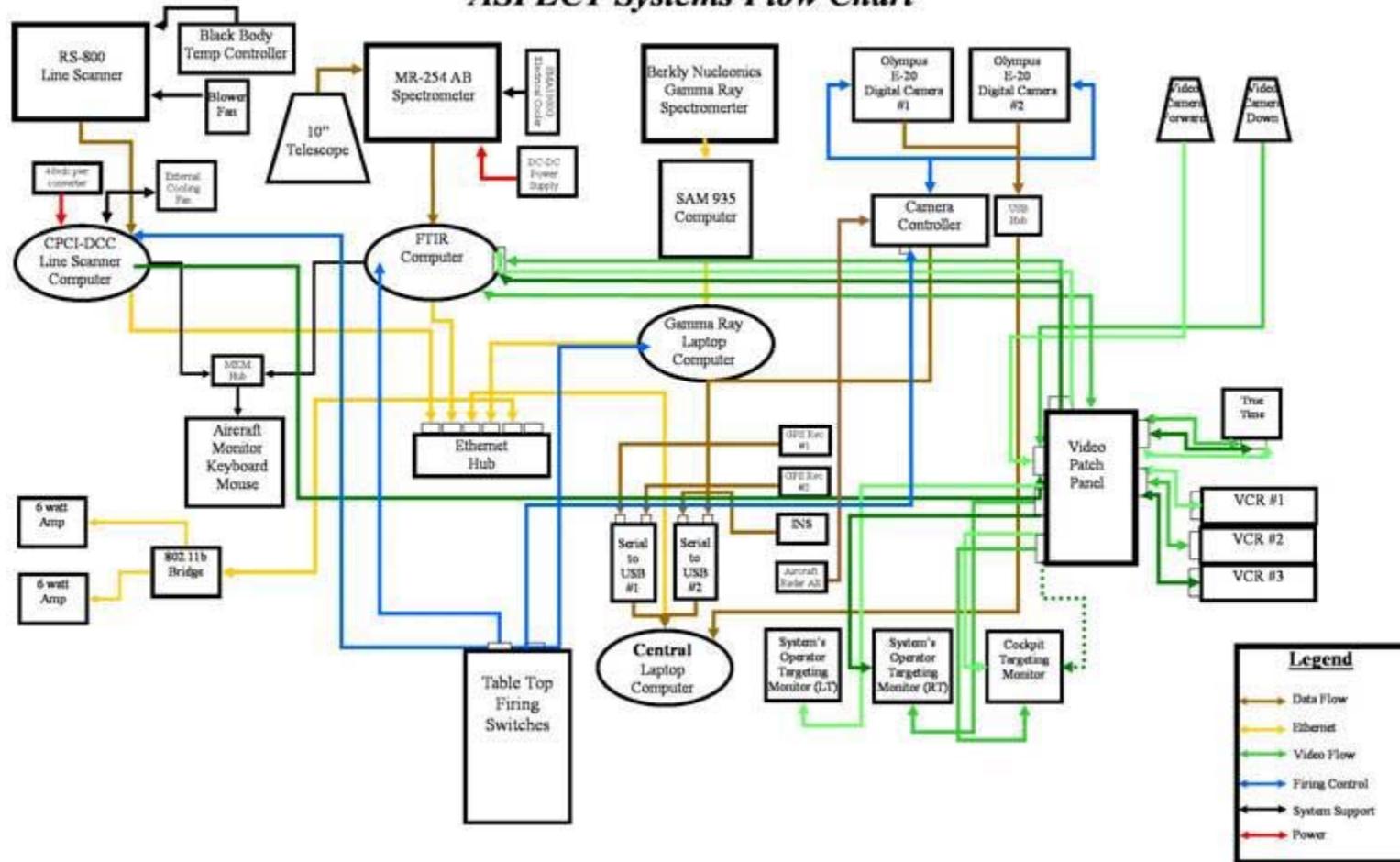
Operator Station:

- Correlation of chemical and radiological image and spectral data with GPS
- Transmit data to Incident Commander on the ground



Integrated System Diagram

ASPECT Systems Flow Chart



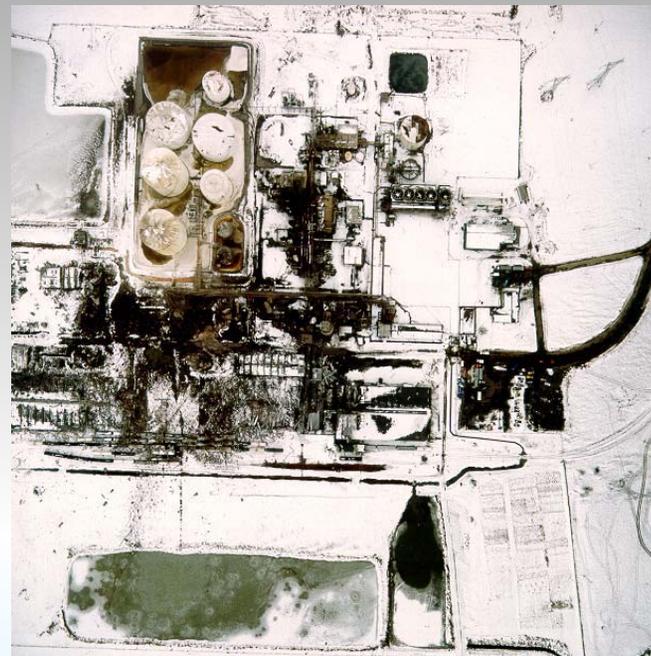


ASPECT Program

Core Emergency Response Requirements



- Rapid Response—Wheels Up in Under 1 Hour
- Direct Integration into the Local Incident Commander
- Compatibility with Common Data Systems
- Remote Detection of Chemical Plumes
- Automated Data Processing and Transmission
- Aerial Photography Capability
- Radiological Detection Capability

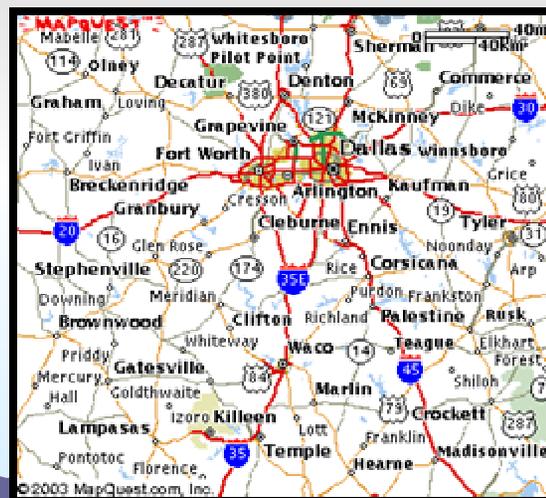




Program ASPECT

AIRCRAFT PLATFORM

- AeroCommander Platform
 - Base of Operation: Waxahachie, Texas
 - IFR/GPS Equipped
 - High Quality Filtered Power
 - STC Camera Holes in the floor
- Crew: Two Pilots, One Operator, All Commercial/ATP Rated
- Speeds:
 - Data Collection at 100 kts
 - Cruise at 180 – 200 kts
- Range/Aloft Time:
 - Range 1100 NM
 - Aloft Time 4 – 6 hours
- Service Altitude:
 - Data Collection at 2000 Ft AGL
 - Cruise at 20000 Ft (with Supplemental Oxygen)





3hr, 6hr & 9hr Response Coverage





Air Drop of the Data and Radio Communications Case

