Infrared Imaging Solutions

May 2015

Outline

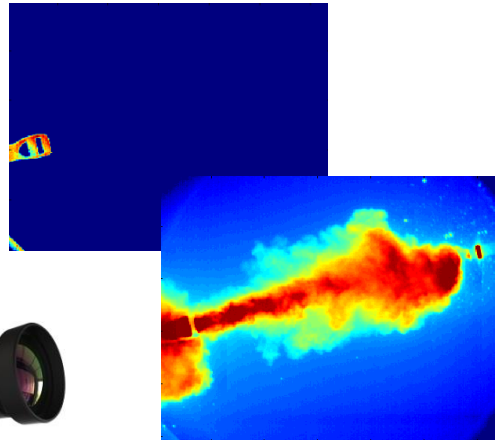
- Telops Corporate Presentation
- Infrared Cameras
- Hyperspectral Infrared Cameras

Corporate

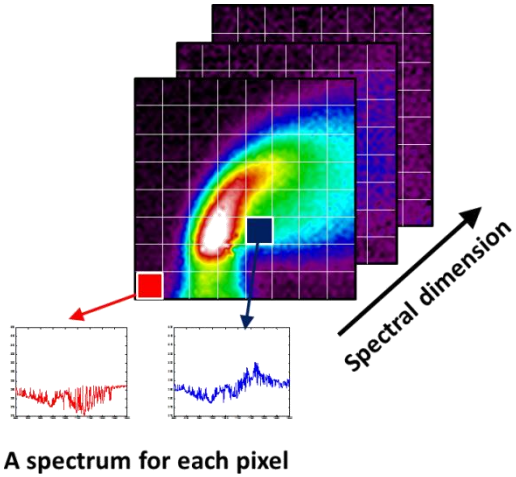
- Headquarters in Quebec, Canada
- Founded in 2000
- Established as a world leader in thermal infrared imaging solutions

Telops Infrared Imaging Offer

- **High Performance IR Cameras**
  - Cooled Detectors
  - MW, MWE, LW, VLW
  - High-Speed
  - High Definition
  - High Dynamic Range
  - Multispectral



- **Hyper-Cam: Infrared Hyperspectral Camera**
  - Cooled Detectors
  - MW, MWE, LW, VLW
  - High-Speed version
  - High Dynamic Range



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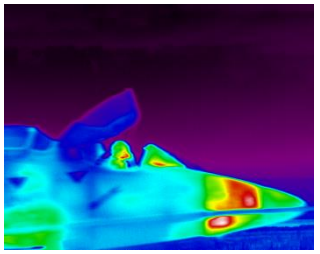
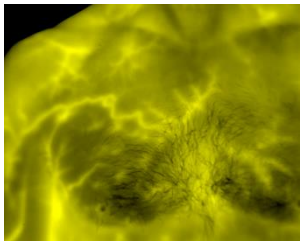
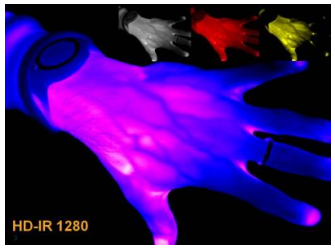
Infrared Cameras

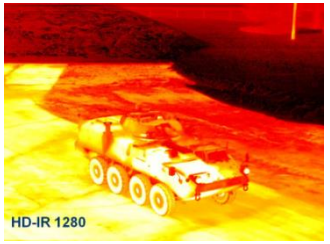
New IR Camera Families

- High Definition Cameras (HD-IR)
- High Dynamic Range Cameras (HDR-IR)
- Multispectral Cameras (MS-IS)
- Thermal Scientific Measurement Cameras (TS-IR)



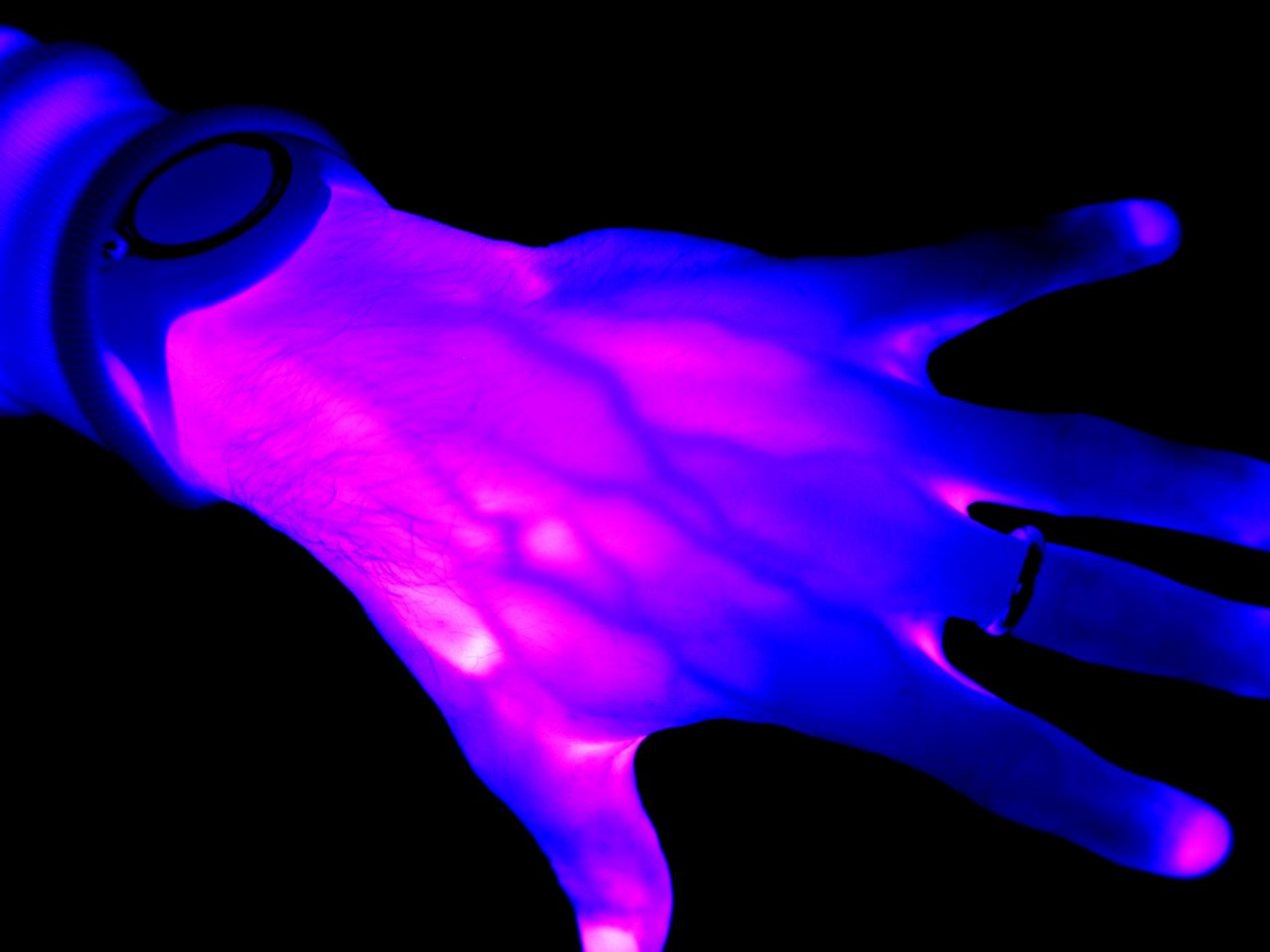






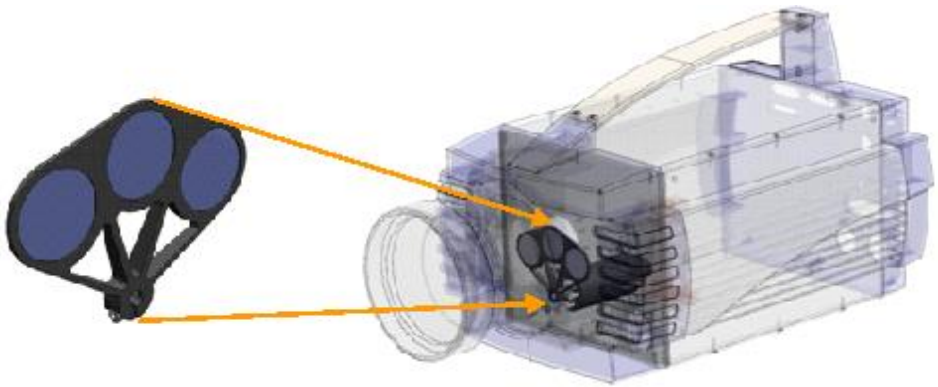
Thermography Cameras for Research

- Sensitive MWIR and LWIR cameras, offering the full range of flexible combinations of:
  - Resolution
  - frame rate
  - dynamic range and
  - multispectral capability
- High performance cameras to meet the most demanding research applications
- Customization is available to meet specific needs



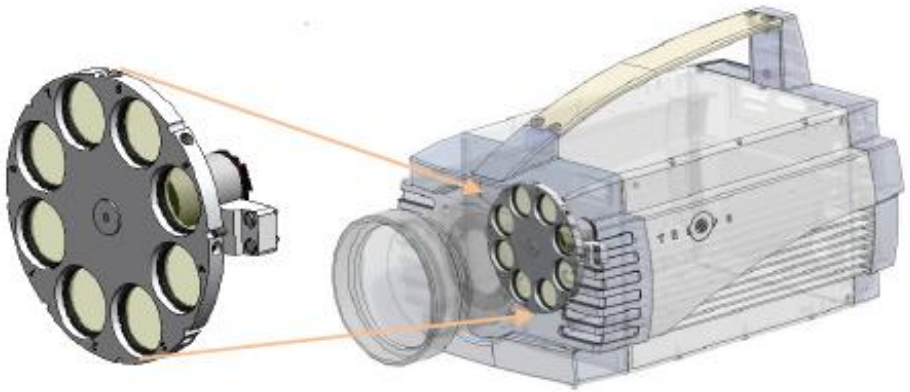
High Dynamic Range Imaging

- Automatic exposure control self adjusts exposure time to follow a scene with temperature variations
- 3 different attenuation filter positions mechanism is included, with fast motorized automated switching capability
- Allows the camera to self adjust to very large scene temperature variations

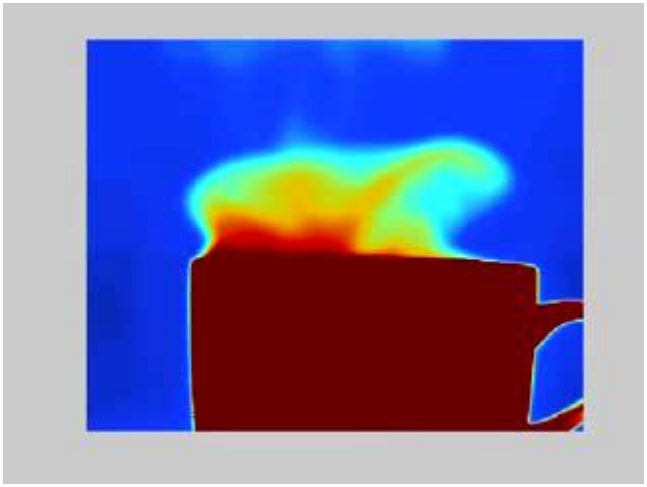


High-Speed Multispectral Imaging

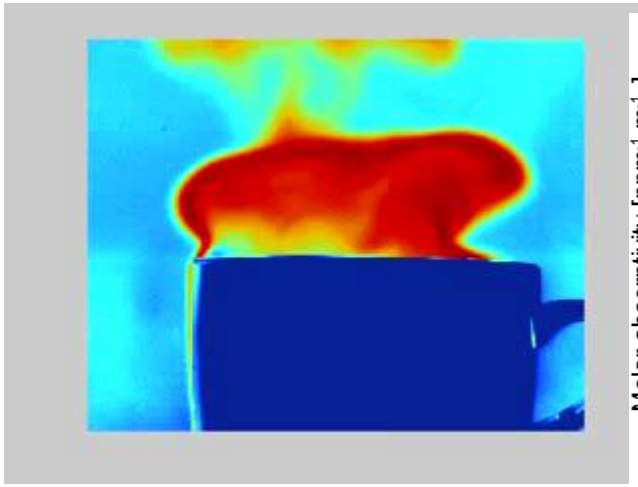
- Real-Time Multispectral Imaging with up to 8 Spectral Bands
- Up to 100 Revolutions per Second (800 frames per second)
- Detect Chemicals based on Spectral Signature



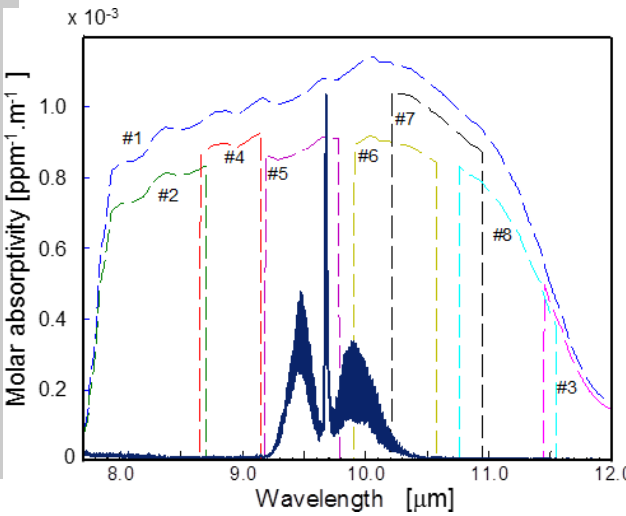
Detection of Methanol using 8-12µm Multispectral Camera

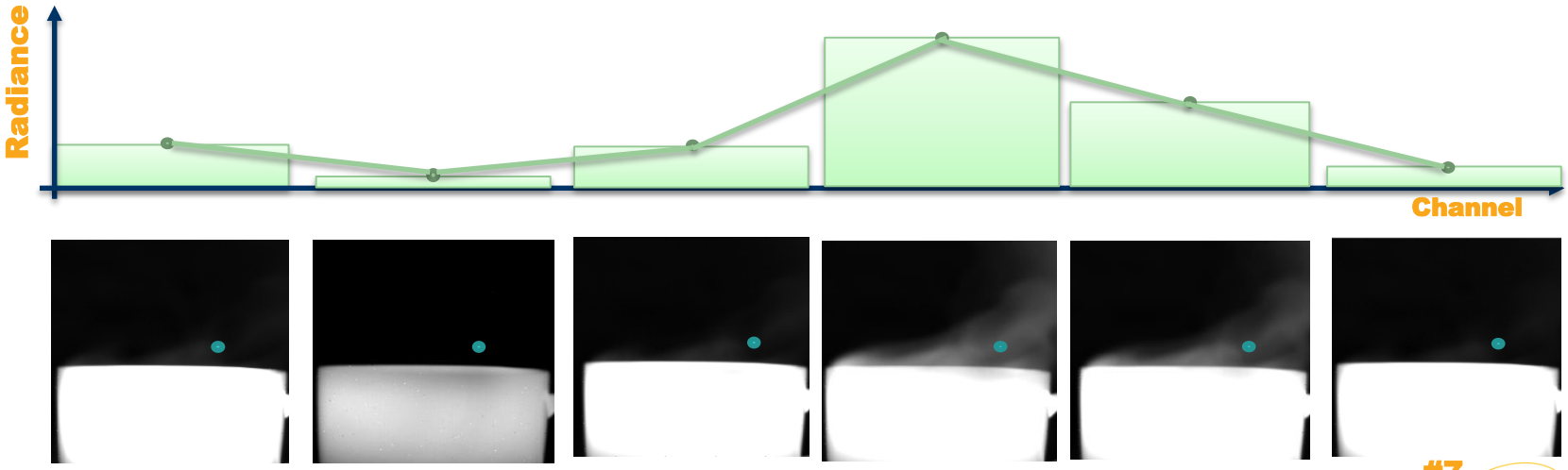


Broadband Video



Multispectral correlation Video





New TS-IR Capabilities

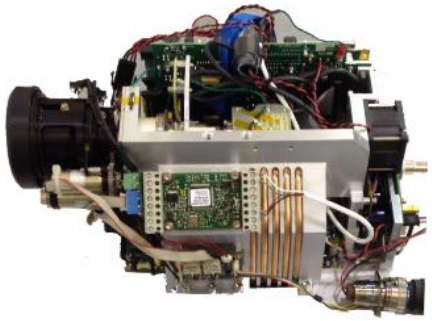
- Rugged enclosure handles harsh environmental conditions (IP67 certified)
- 1/16 GB internal high-speed memory
- Real-Time Temperature / Radiance Calibration
  - Valid for any camera temperature
  - Valid for any exposure time
- Ideal for autonomous operation

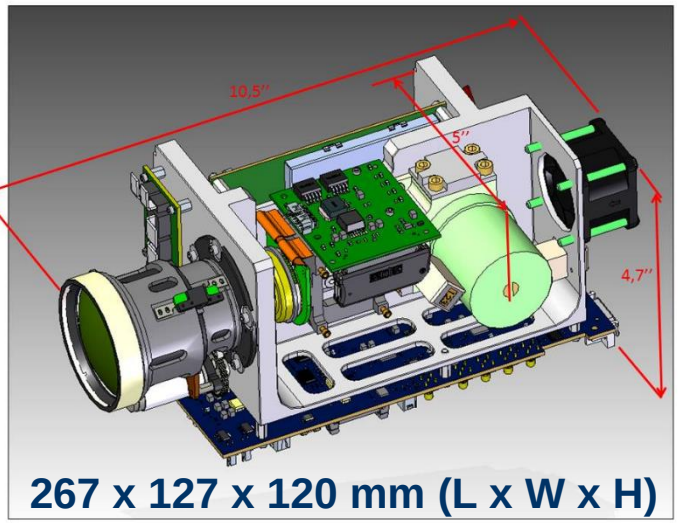
IR Camera Models

HD-IR	SPECTRAL RANGE (µm)	FPA FRAME SIZE (pixels)	FRAME RATE (Hz)	FILTER WHEEL	INTERFACE
HD-IR MCT	3.7 - 4.8	1280 x 1024	50	no	Camera Link, RS232, HD-SDI
HDR-IR					
HDR-IR MW	3 - 4.9	640 x 512	115	no	Camera Link, RS232, HD-SDI
HDR-IR VLW	7.7 - 11.8	320 x 256	300	no	Camera Link, RS232, HD-SDI
HDR-IR MW HD MCT	3.7 - 4.8	1280 x 1024	50	no	Camera Link, RS232, HD-SDI
MS-IR					
MS-IR MW MCT	3 - 4.9	640 x 512	115	yes, 8 filter pos.	Camera Link, RS232, HD-SDI
MS-IR VLW	7.7 - 11.8	320 x 256	300	yes, 8 filter pos.	Camera Link, RS232, HD-SDI
MS-IR MW HD MCT	3.7 - 4.8	1280 x 1024	50	yes, 8 filter pos.	Camera Link, RS232, HD-SDI
TS-IR					
TS-IR MW MCT HS	3 - 5	640 x 512	115	yes, 4 filter pos.	GigE, Camera Link, RS232, HD-SDI
TS-IR MW MCT MC	3 - 5	640 x 512	115	yes, 4 filter pos.	GigE, Camera Link, RS232, HD-SDI
TS-IR LW	8 - 10	640 x 512	115	yes, 4 filter pos.	GigE, Camera Link, RS232, HD-SDI
TS-IR LW HT	8 - 10	640 x 512	230	yes, 4 filter pos.	GigE, Camera Link, RS232, HD-SDI
TS-IR VLW	7.7 - 11.8	320 x 256	300	yes, 4 filter pos.	GigE, Camera Link, RS232, HD-SDI

Camera Cores

- Cameras can be supplied as cores, with or without lens, for OEM or custom integration
- Various lens options available, including motorized zoom and motorized focus lenses

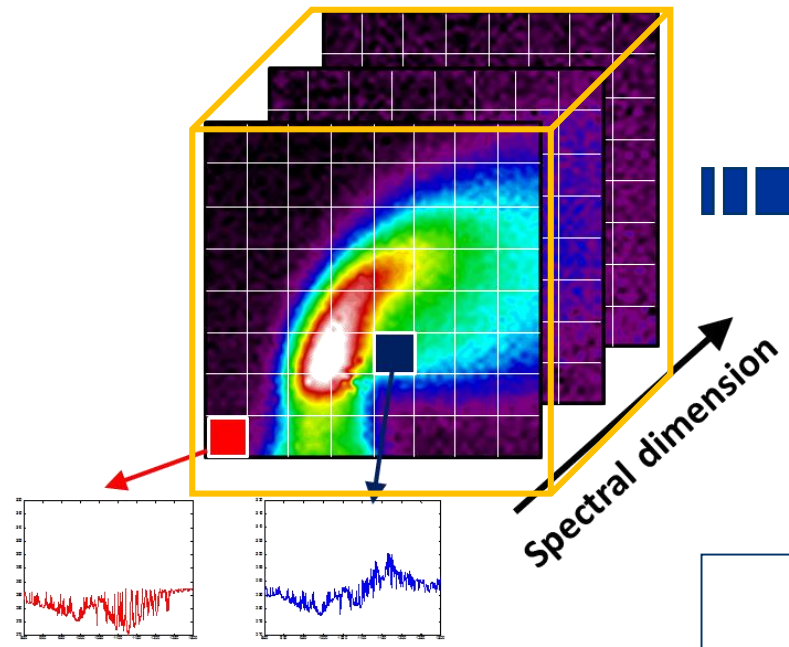




267 x 127 x 120 mm (L x W x H)

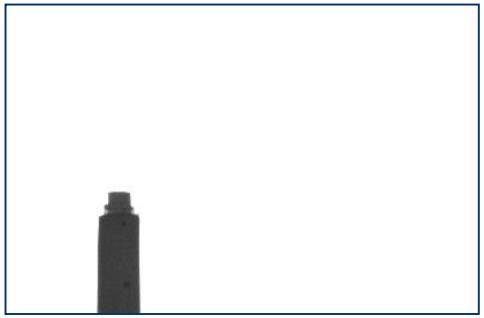
Hyperspectral Infrared Cameras

Infrared Hyperspectral Imaging



A spectrum for each pixel

- Each chemical has a unique infrared spectral signature.
- Spectral discrimination is done for each pixel in the datacube (scene).
- The spatial distribution of each chemical in the scene is then determined.



Visible image

Infrared image

(SO_2 contribution)

Hyper-Cam Specifications

- Commercial off-the-shelf imaging spectrometer using Fourier-transform technology (FT-IR)
  - LWIR: 7.7-11.8 µm
  - LWIR Narrow-Band: 7.7-9.3 µm
  - Methane
  - MWIR: 3-5 µm
  - MWIR-E: 1.5-5 µm
- Adjustable spectral resolution:
  - 0.25 to 150 cm^{-1}
    - Up to 1,400 bands in LWIR
- 320 x 256 pixels cooled detector
- Standard fields-of-view
  - 25 x 20 degrees
  - 6.4 x 5.1 degrees
  - 1.8 x 1.4 degrees
- Target dynamic range capabilities from ambient to 2,000°C
- Real-time calibrated spectral and chemical imaging
- Motorized polarizer accessory available
- Boresight visible camera
- Portable Weatherproof Enclosure (30kg)

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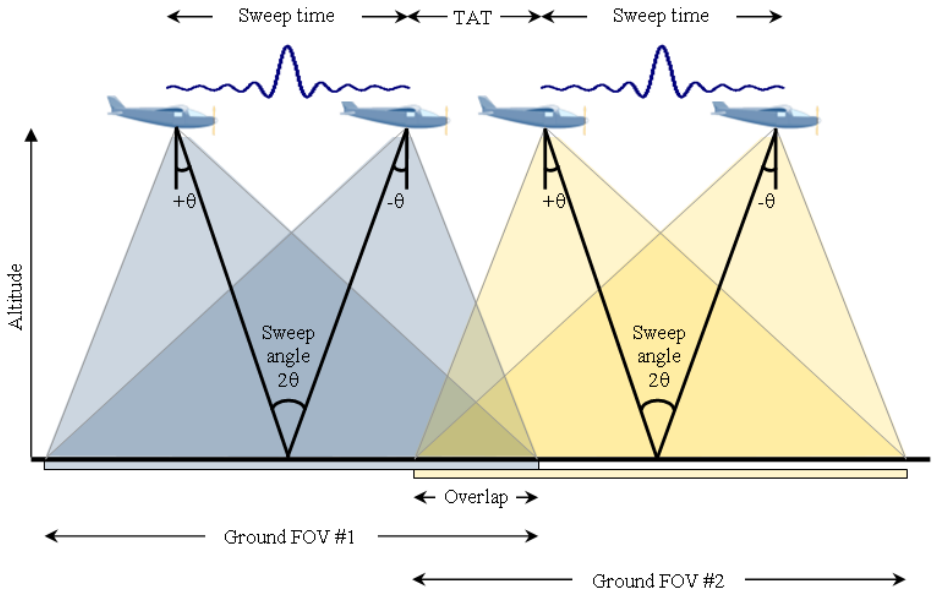
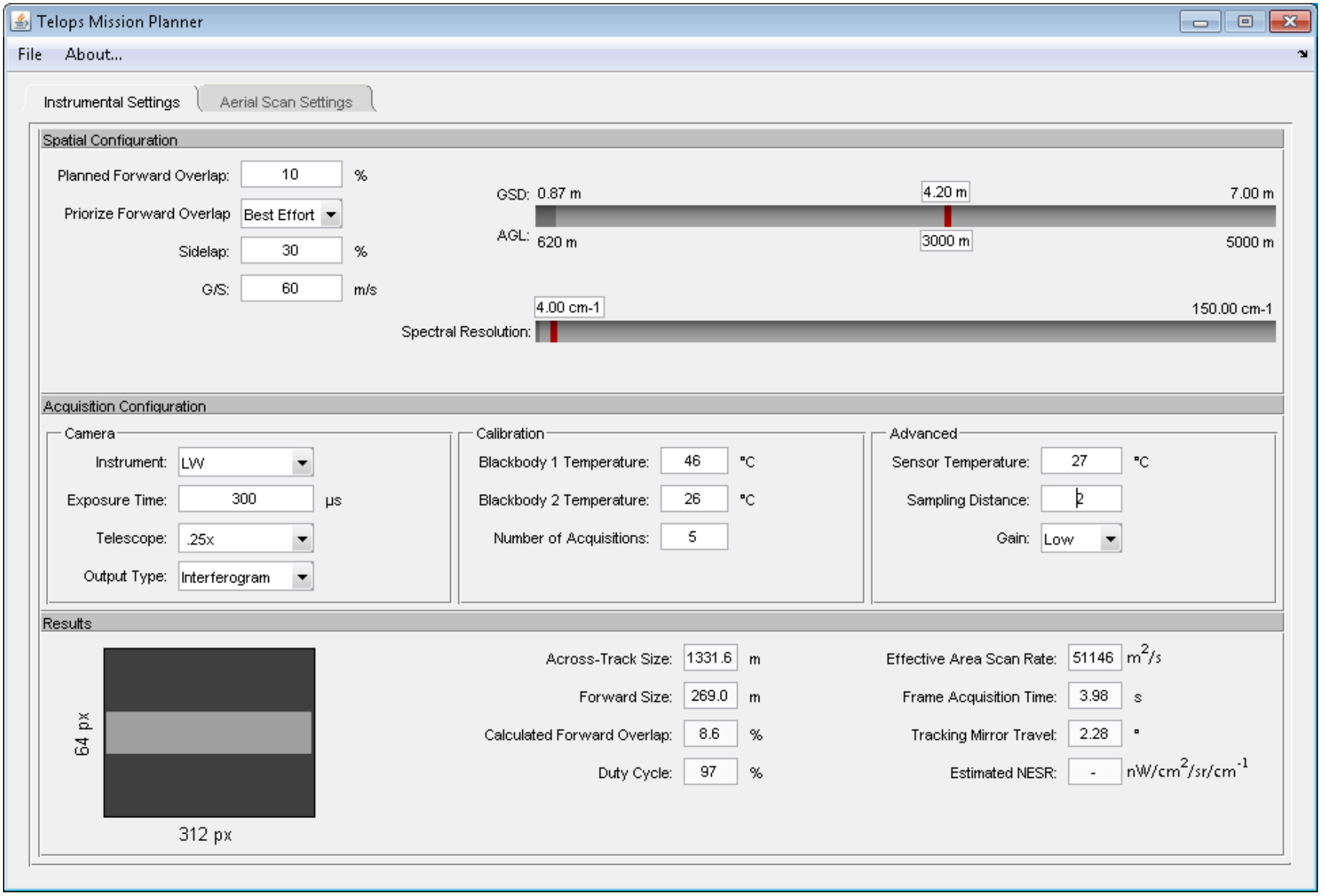
Airborne Mapping Operation

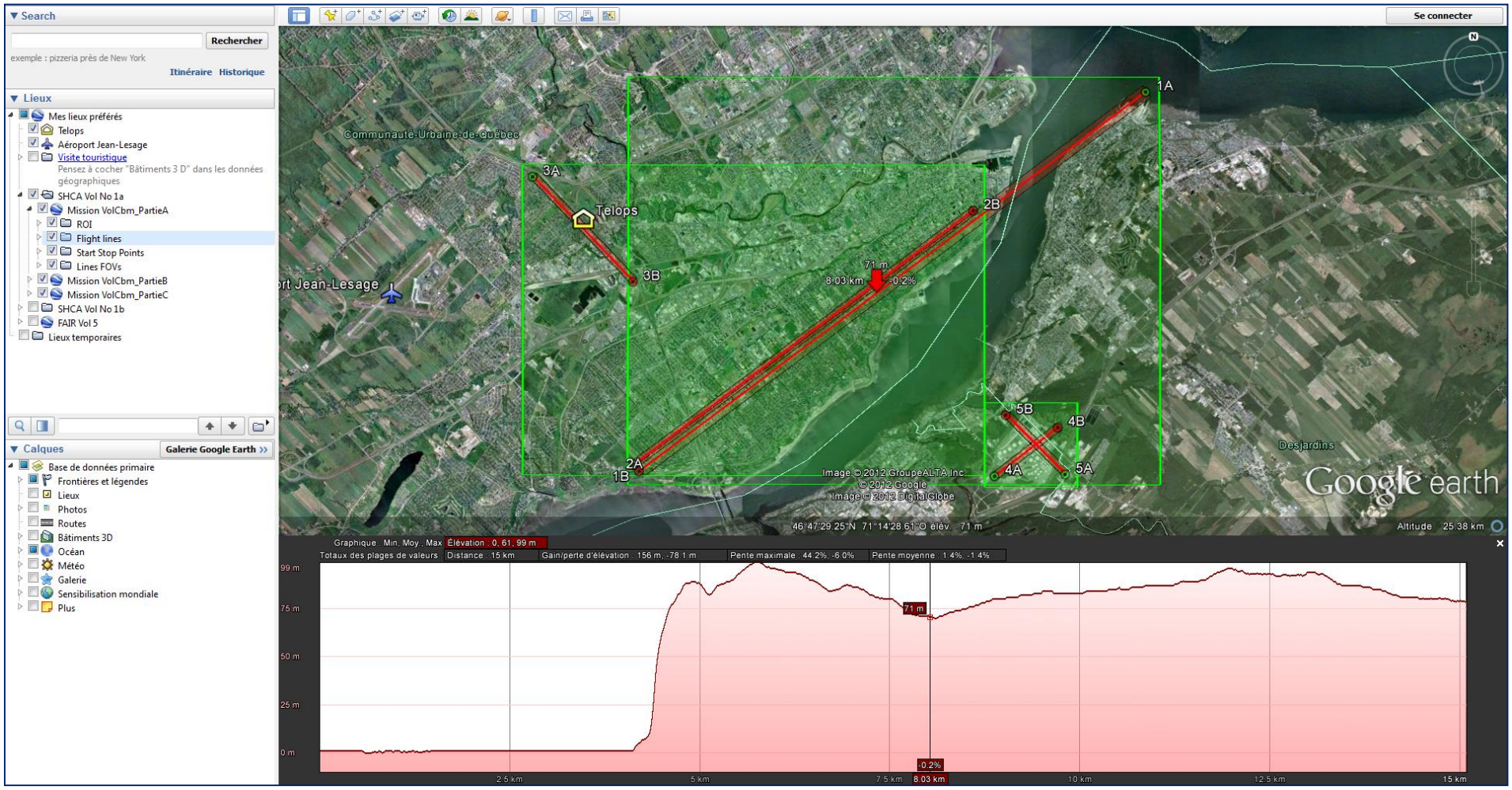
- Standard Hyper-Cam connects to the platform in minutes
- INS/GPS provides geolocation, attitude and timestamp information
- Laser range finder provides altitude relative to ground level
- Image motion compensation (IMC) mirror compensates for aircraft forward motion, pitch and roll
- Rotation stage compensates for aircraft yaw
- 6 degrees or 25 degrees swath widths available with interchangeable optics



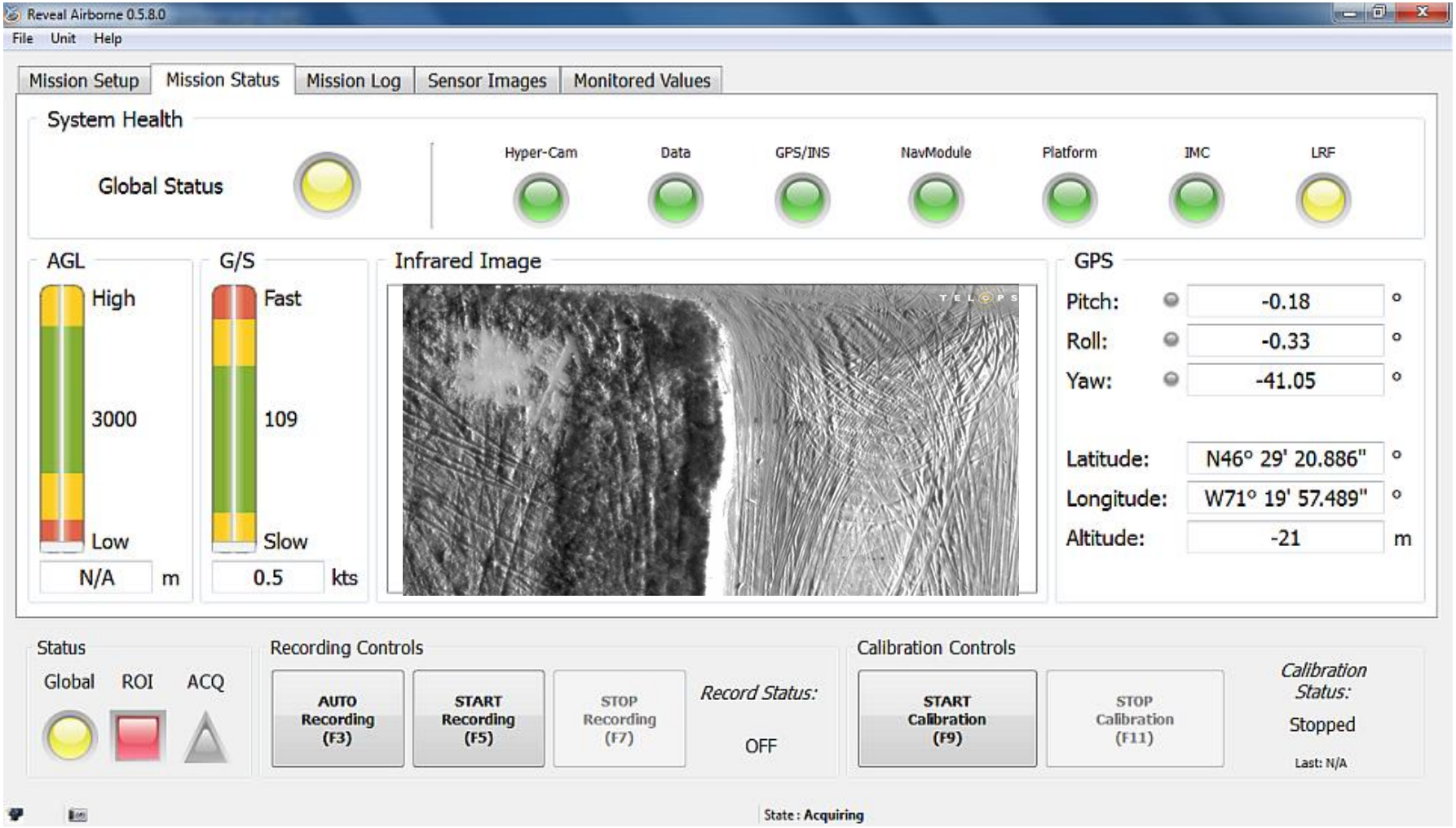
Mission Planner – Optimize Operation



Mission Planning Tools



Reveal Airborne – Mission Monitoring



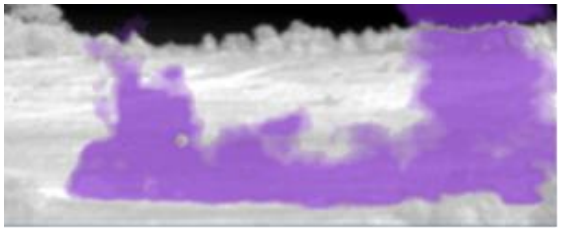
Chemical Imaging

- Reveal D&I: Real-time Chemical Detection & Identification software now available for chemical imaging using Hyper-Cam

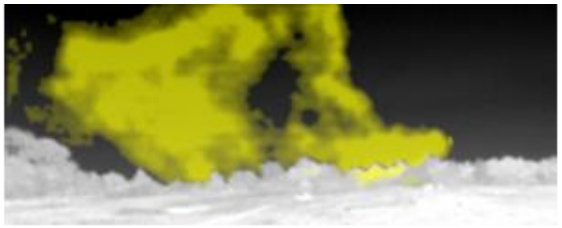

Telops Reveal D&I
File View Scenario Tools Window Help
Open Scenario
Start
Standby
Background
Detection View
System Status
Hardware diagnostic
Detector cooling
Standby
Background
Realtime detection
Current scenario:
Primary target
Available space on disk:
20,005 GB
Next frame in:
2s
Target
Detection
Detection sensitivity
6
Search
Target
Formula
Colour
Sens
Sulfur hexafluoride
SF6
3
Sulfur dioxide
SO2
6
Methane
CH4
6
Benzene
C6H6
4
Ammonia
NH3
2
Ethylene
C2H4
5
Propylene
C3H6
10
Propane
C3H8
2
History and Log
D:\Test5\Release1\
Spectrum
Date and Time
Source
Event ID
Scenario
21/08/2012 20h02 : 10
User
Comment added
Primary Target
21/08/2012 19h58:12
Sensor
RT Detection
Primary Target
21/08/2012 19h37:52
Sensor
Calibration
Primary Target
Save comment
Save with capture
Link comment to selected detection
Release of mixture B, 1kg/h, windy conditions.

Chemical Imaging

- **Chemical agent detection and identification**
  - Different colors for each gas
  - Transparency level indicates concentration and temperature contrast

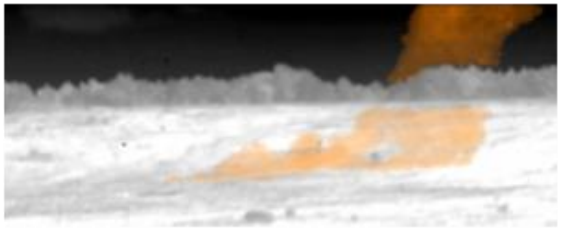


SF_6

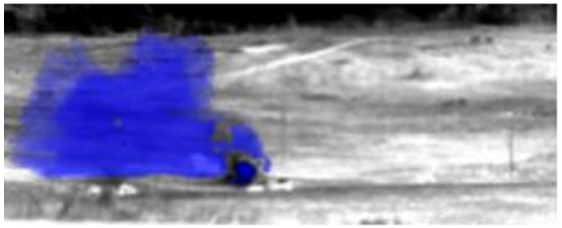


NH_3

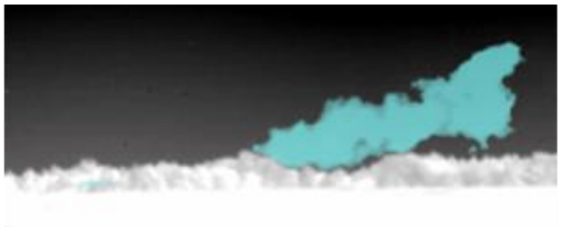
Mix SF_6 and NH_3



Phosgene

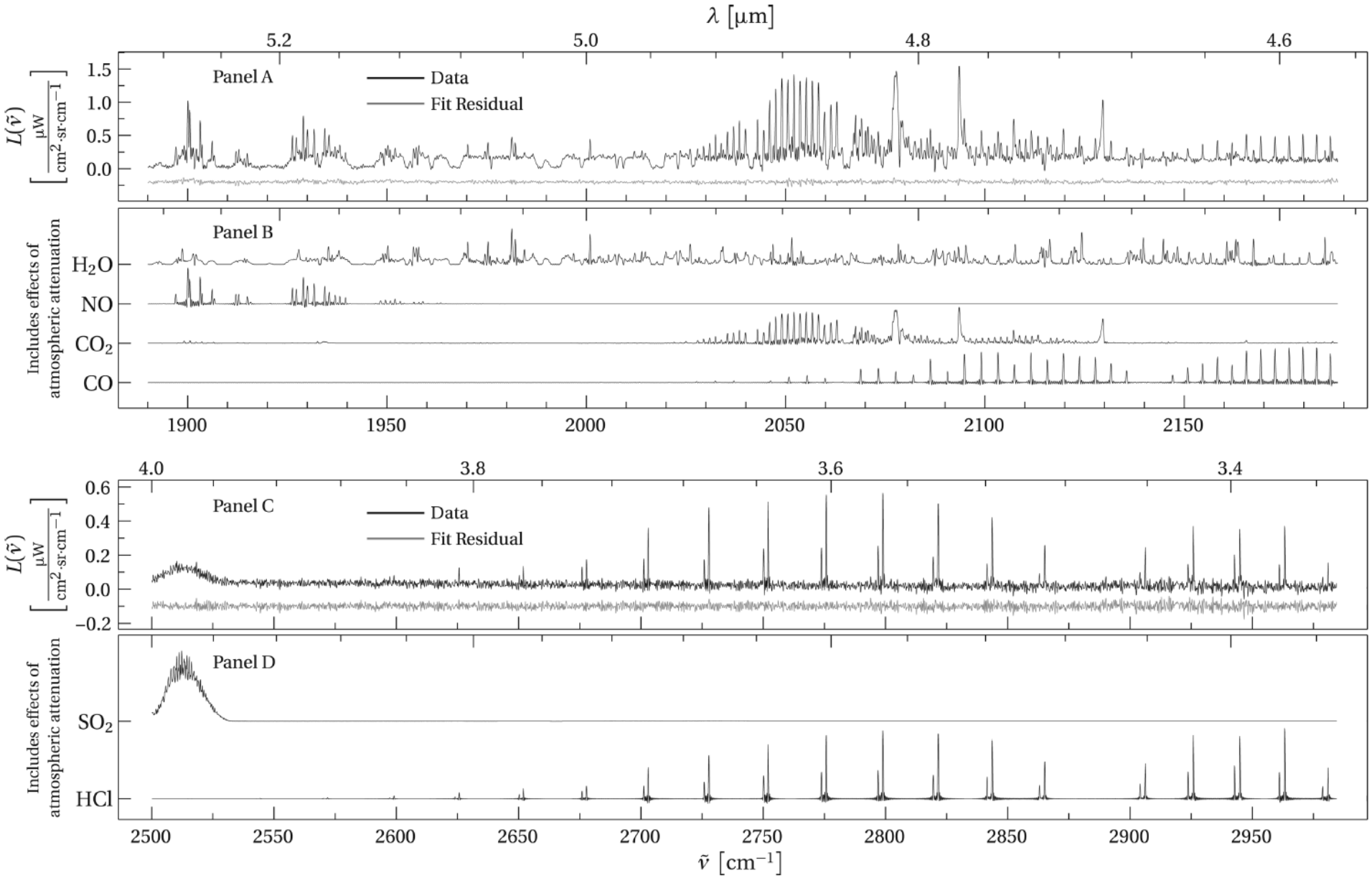


TEP



DMMP

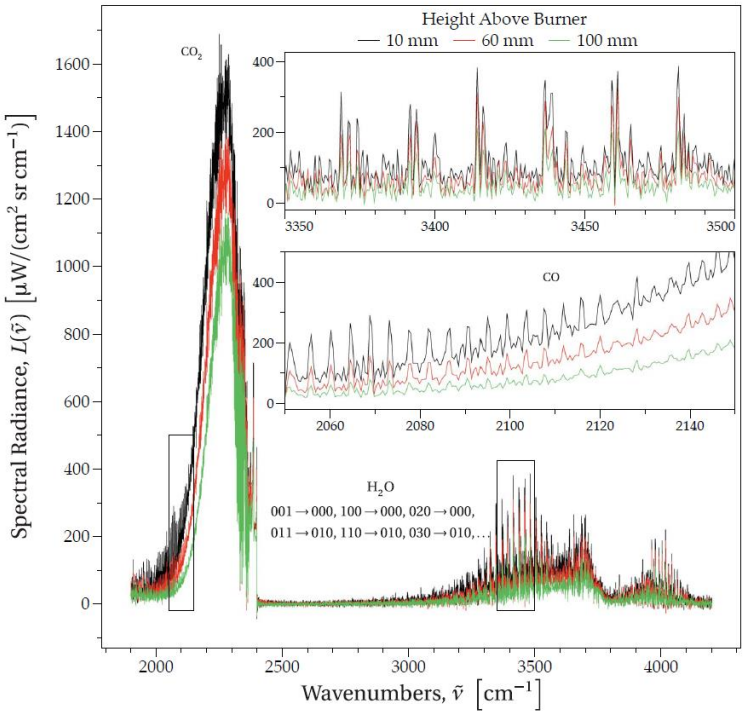
Coal Power Plant Gaseous Emissions

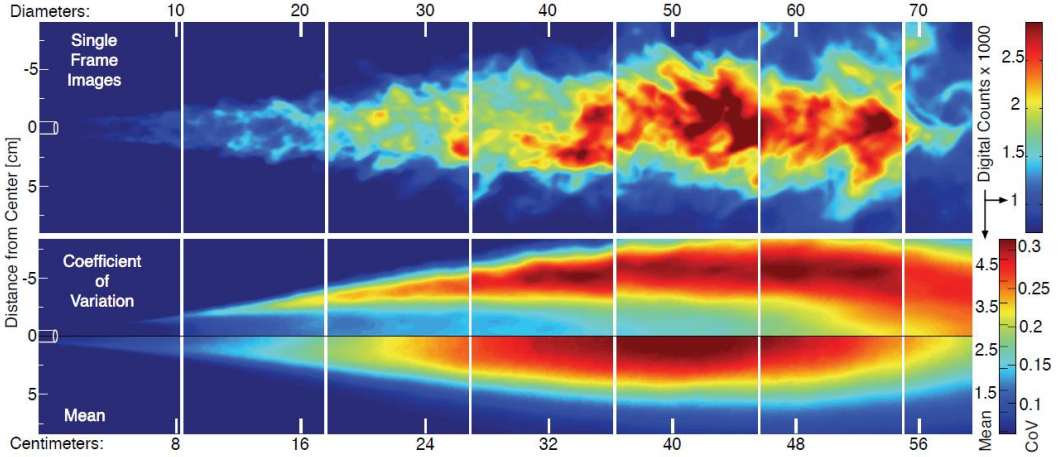


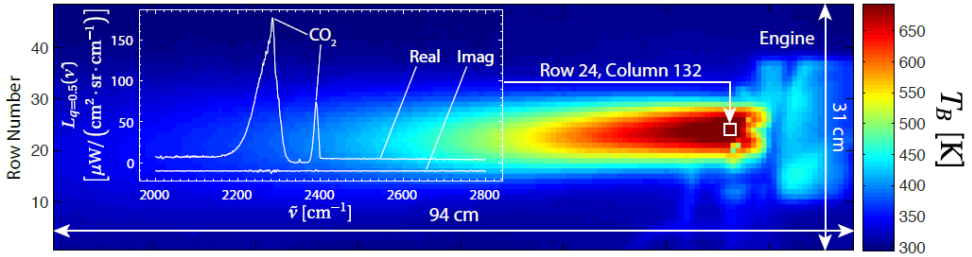
K. C. Gross, K. C. Bradley, G. P. Perram, "Remote Identification and Quantification of Industrial Smokestack Effluents via Imaging Fourier-Transform Spectroscopy," *Environmental Science & Technology* 2010 *44* (24), 9390-9397.

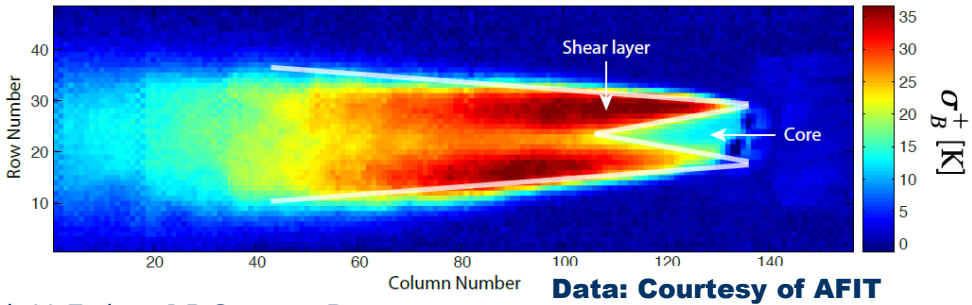
Data: Courtesy of AFIT

Characterization of Combustion Events







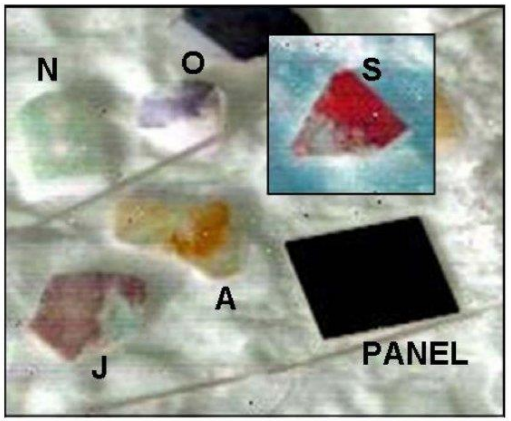


Data: Courtesy of AFIT

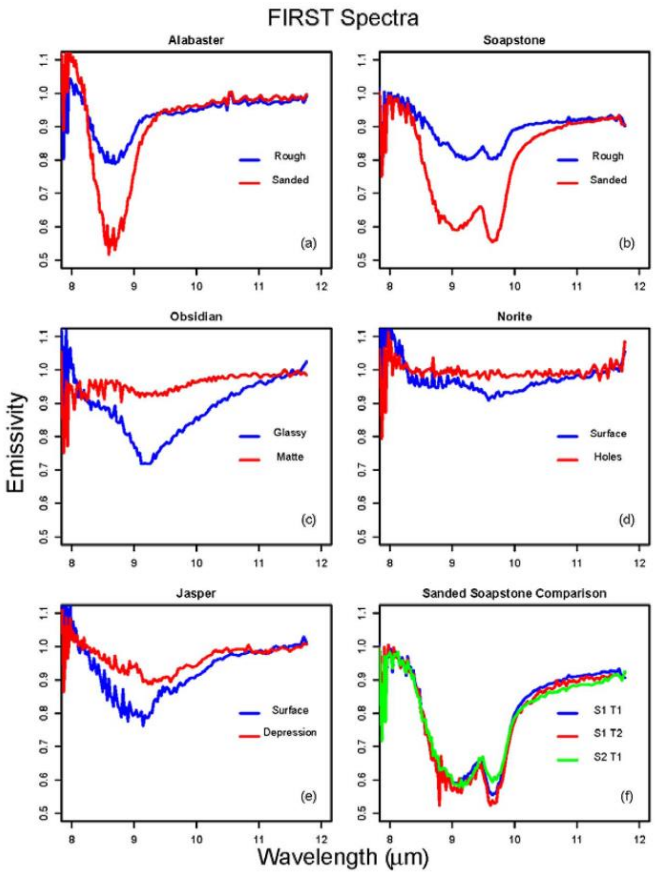
E. Moore ; K. C. Gross ; S. Bowen ; G. P. Perram ; M. Chamberland ; V. Farley ; J-P Gagnon ; P. Lagueux ; A. Villemaire; Characterizing and overcoming spectral artifacts in imaging Fourier-transform spectroscopy of turbulent exhaust plumes. Proc. SPIE 7304 (2009).

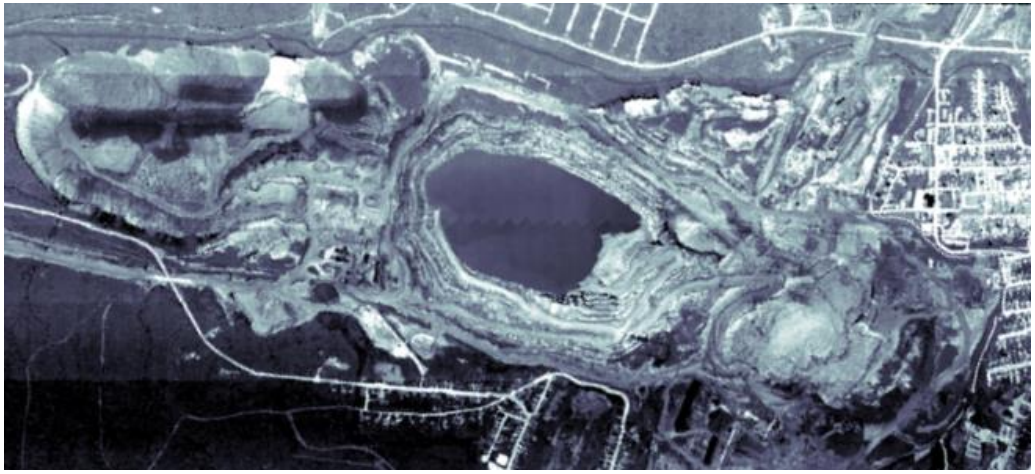
TELOPS

Mineral Detection and Classification



Lee Balick, et al., Longwave Thermal Infrared Spectral Variability in Individual Rocks, IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, VOL. 6, NO. 1, JANUARY 2009



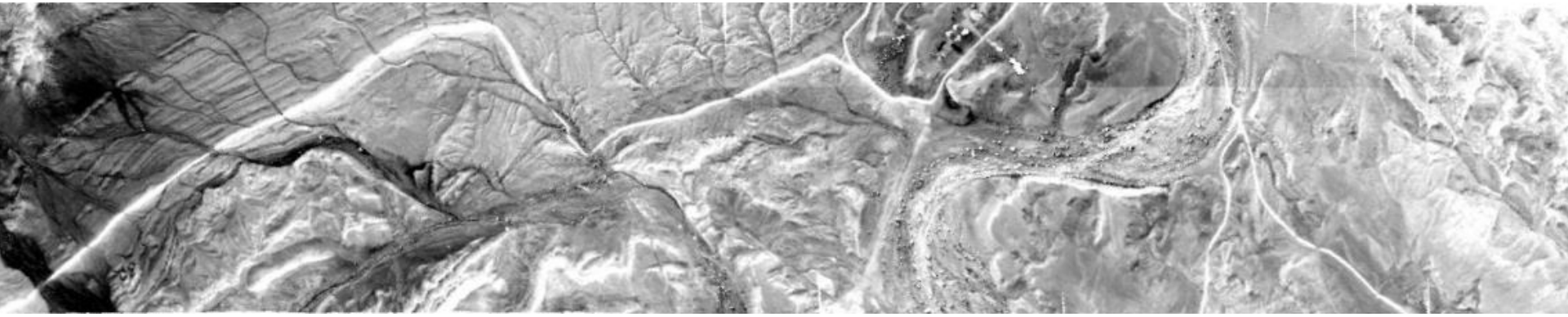


Open pit Asbestos mine mapping in LWIR

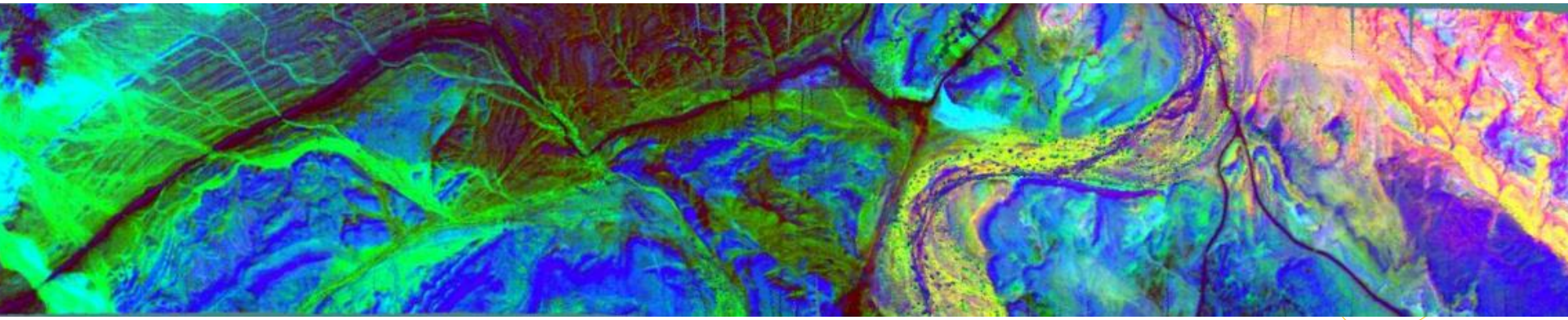
Mineral Mapping

Data: Courtesy of Dimap

Visible



Broadband LWIR (8-12 µm)



Conclusion

- High performance infrared broadband / multispectral / hyperpsectral imagers
- High quality remote sensing measurements with best combination of:
  - Spatial resolution
  - Spectral resolution
  - Temporal resolution
  - Sensitivity
- Customization available for specific requirements

Questions?