

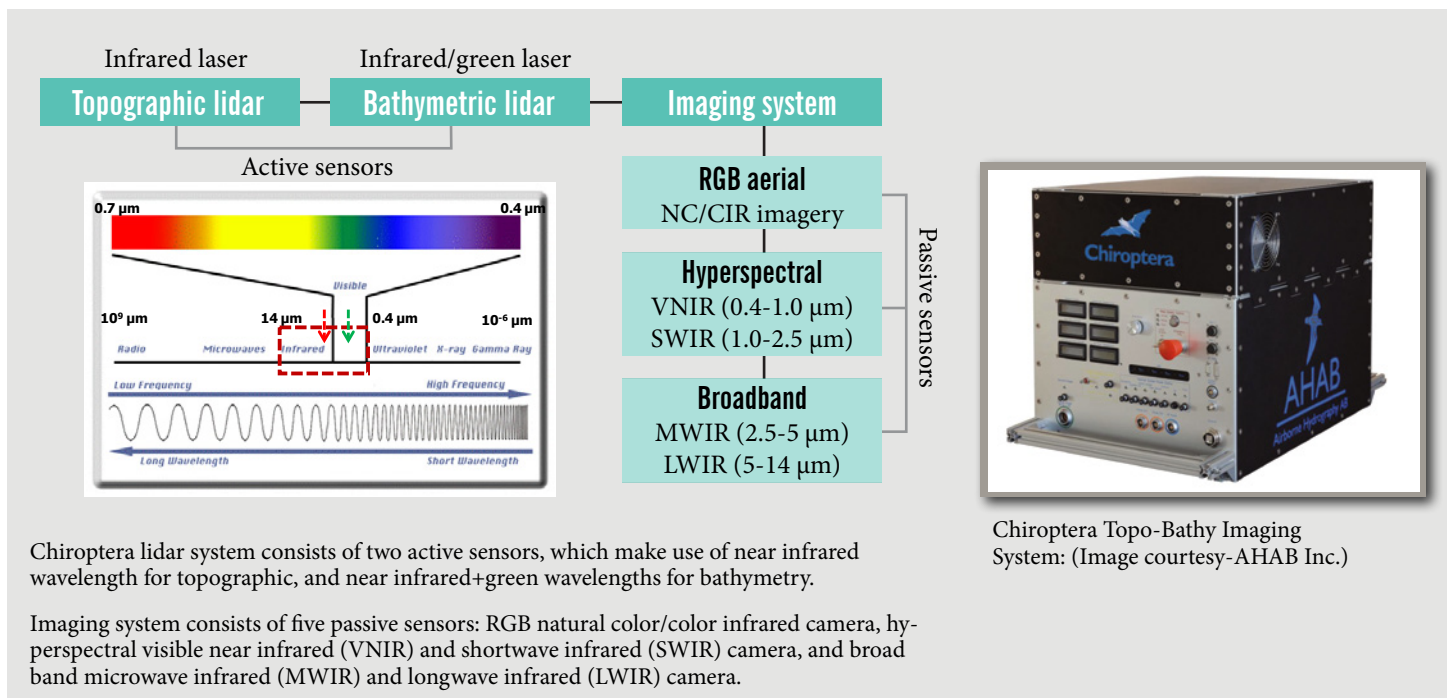
# An Overview of New Earth Surface Imaging Capabilities at the Bureau of Economic Geology



The Bureau of Economic Geology (BEG) in the Jackson School of Geosciences at UT-Austin has purchased a new airborne instrument system that includes topographic lidar, bathymetric lidar, color/infrared imaging, and hyperspectral scanning. This new system enhances our ability to collect research-grade, high-resolution topographic (land-surface) and shallow bathymetric (lake, river, or seafloor) data. Bathymetric lidar and color/infrared and hyperspectral imaging capabilities significantly expand applications into fluvial, lacustrine, and shallow-marine settings and land, water, and vegetation imaging applications across the geosciences. The new system is manufactured by Airborne Hydrography AB (AHAB), under the instrument name Chiroptera. In addition to Chiroptera, which forms the backbone of our capabilities, BEG operates an older topographic lidar system (Optech 1225) that will continue to be available for use, as well as two ground-based systems (including a recently purchased Optech model ILRIS-LR) that are used for high-resolution mapping of outcrops and that allow us to create point-cloud outputs of any object with range capabilities of about 3 km.

BEG has a long history of conducting research-quality lidar surveys along the Texas Gulf Coast, including projects for monitoring Texas coastal (gulf and bay) environments, determining susceptibility of coastal lands to tropical-storm flooding and overwash, and quantifying hurricane impact and subsequent coastal recovery. BEG intends to continue working in this area of Texas but expand into terrestrial environments as well. We see substantial opportunities for expanding this data collection and analysis using the new system with its bathymetric and imaging capabilities and providing services to internal and external research communities and multiple State and Federal agencies interested in the geosciences. Other potential applications include (but are not limited to)

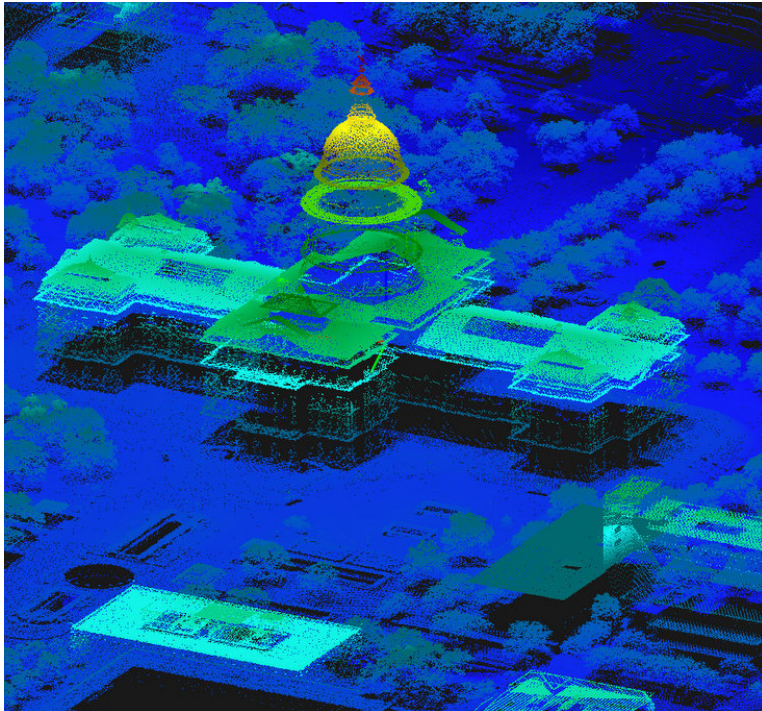
- Creating detailed watershed topographic models,
- Characterizing dynamic Earth systems and change over time,
- Studying modern analogs of ancient carbonate and clastic sedimentary rocks,
- Determining uplift and down-drop rates in tectonically active areas,
- Conducting rapid-response surveys where detailed topographic data are critical to hazard assessment, and
- Quantifying vegetation assemblages, invasion of nonnative species through aquatic and terrestrial ecosystems, and estimates of evapotranspiration rates.



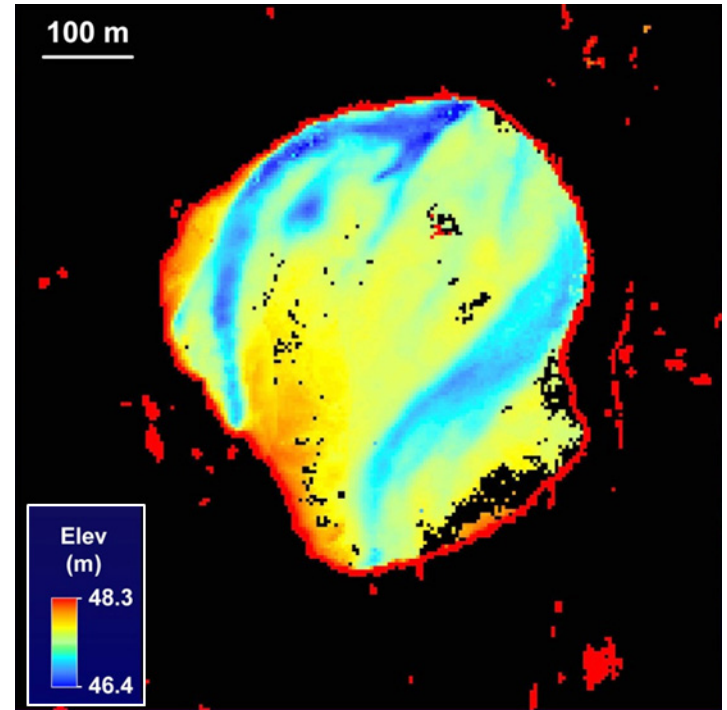
Chiroptera Topo-Bathy Imaging System: (Image courtesy-AHAB Inc.)

# Example Applications of the New System

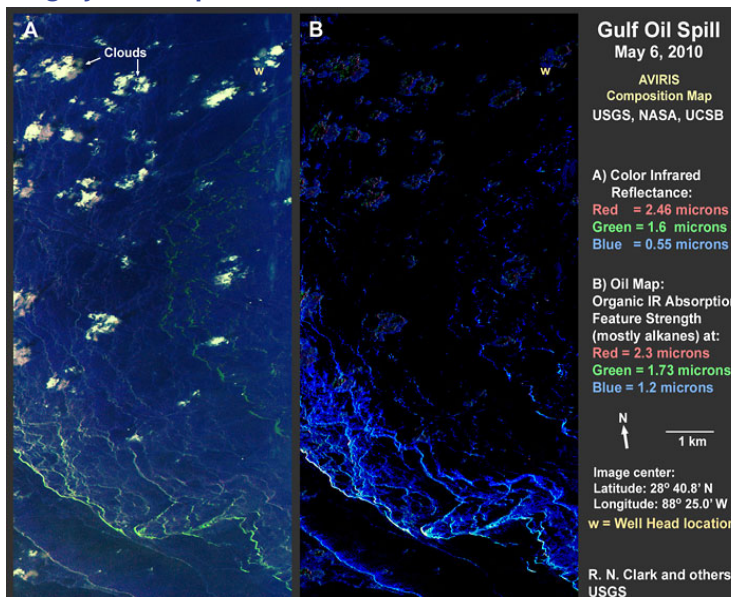
Image of Texas State Capitol, 2012



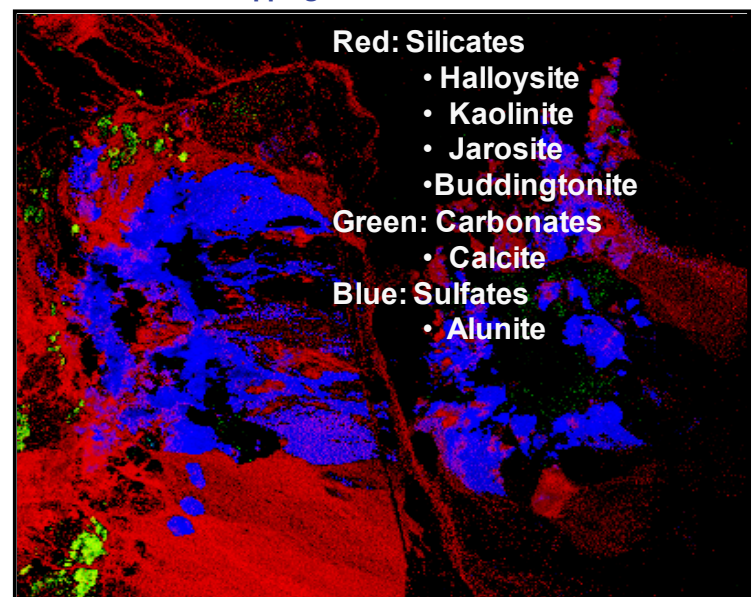
Lake bottom elevation using bathymetric laser, Alaska 2012



Applications of hyperspectral VNIR/SWIR imagery for oil spill detection



Applications of Hyperspectral SWIR for surface material mapping



(Data courtesy: <http://photojournal.jpl.nasa.gov>)

## Spectral regions determined by the detector spectral ranges and its applications

Electromagnetic radiation	Spectral range	Applications
Ultraviolet	200 to 400 nm	Oil spill fluorescence, explosives detection using UV resonant raman, phytoplankton
Visible near infrared	400-1000 nm	Plant physiology: classification and health for oceanography, forestry, and agriculture
Near infrared	850-1700	Plant physiology: classification and health
Shortwave infrared	850-2500	Mineral prospecting
Midwave infrared	3 to 5 microns	Hot gas plumes, volcanology, wildfires
Longwave infrared	7 to 14 microns	Volcanology, disturbed soil, wildfires, geologic carbon sequestration leak detection.



# System Specifications

Imaging system consists of 50 Megapixel natural color/color infrared DigiCAM camera; Hyperspectral camera-HyperScan VNIR-micro 16, which covers spectral range from visible (0.4  $\mu\text{m}$ ) to near infrared (1  $\mu\text{m}$ ) with 255 spectral bands; HyperScan SWIR-2500 sensor, which covers spectral range from 1  $\mu\text{m}$  to 2.5  $\mu\text{m}$  with 300 spectral bands; Broadband MWIR sensor, which covers spectral range from 3 to 5  $\mu\text{m}$ ; and Microbolometer longwave infrared (LWIR) sensor, which covers spectral range from 7 to 15  $\mu\text{m}$ .

## Chiroptera system (Topographic)

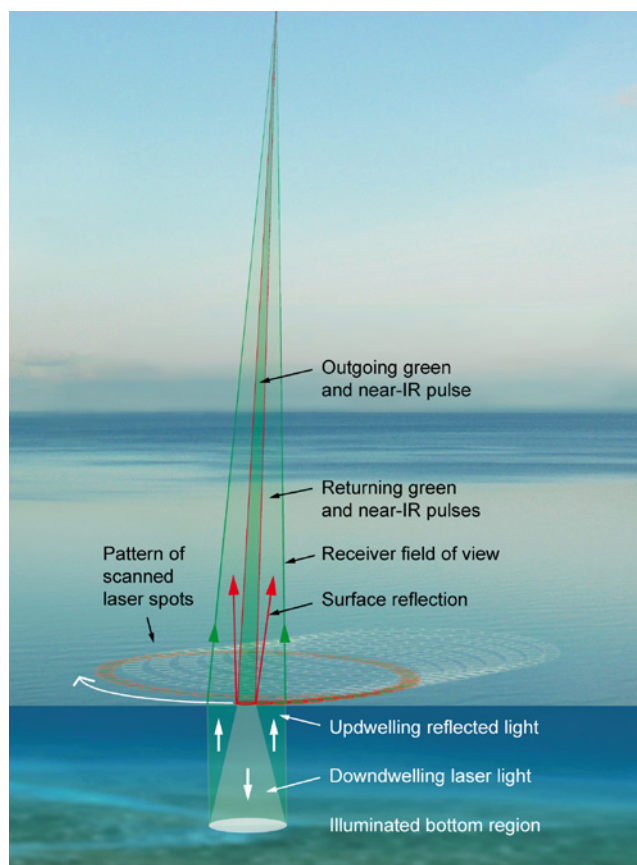
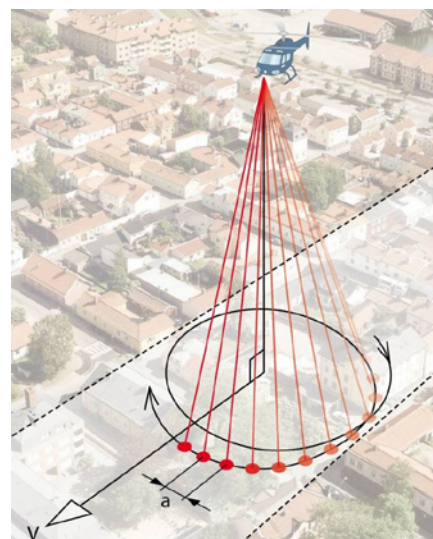
Topographic lidar scanner	
Wavelength	1 $\mu\text{m}$
Pulse length	4 $\pm$ ns
Laser pulse repetition rate (PRR)	Up to 400 kHz (flight altitude dependent)
Operating altitude	Up to 1500 m AGL (PRR dependent)
Range accuracy	2 cm RMS flat target
Pointing accuracy	20 cm RMS @ 400 m AGL
Beam divergence	0.5 mrad
Laser classification	Class IV (FDA CFRA 21)
Spot distribution	Palmer scanner, Ellipsoidal scanner pattern, degree of incident 14 ° to 20 °
Scan frequency	Programmable up to 70 RPS = 140 scans per second
Scan angle	$\pm$ 20 ° side ways

## Chiroptera system (bathymetric)

Bathymetric lidar scanner	
Wavelength	0.5 $\mu\text{m}$
Pulse length	2.5 $\pm$ 1 ns
Laser pulse repetition rate (PRR)	36 kHz
Operating altitude	250 – 400 m ASL
Depth range, flat sea bed K = 0.15, K = 0.2, K = 0.25	kD < 1.5 @ 10% sea bed reflectivity D = 10 m, D = 7.5 m, D = 6 m
Depth accuracy	15 cm RMS flat sea bed
Horizontal accuracy	75 cm RMS spot center
Beam divergence	3 mrad
Laser classification	Class IV (FDA CFRA 21)
Spot distribution	Palmer scanner, Ellipsoidal scanner pattern, degree of incident 10 ° to 20 °
Scan frequency	Programmable up to 50 RPS = 100 scans per second
Scan angle	$\pm$ 20 ° side ways

## Hyperspectral Imaging system

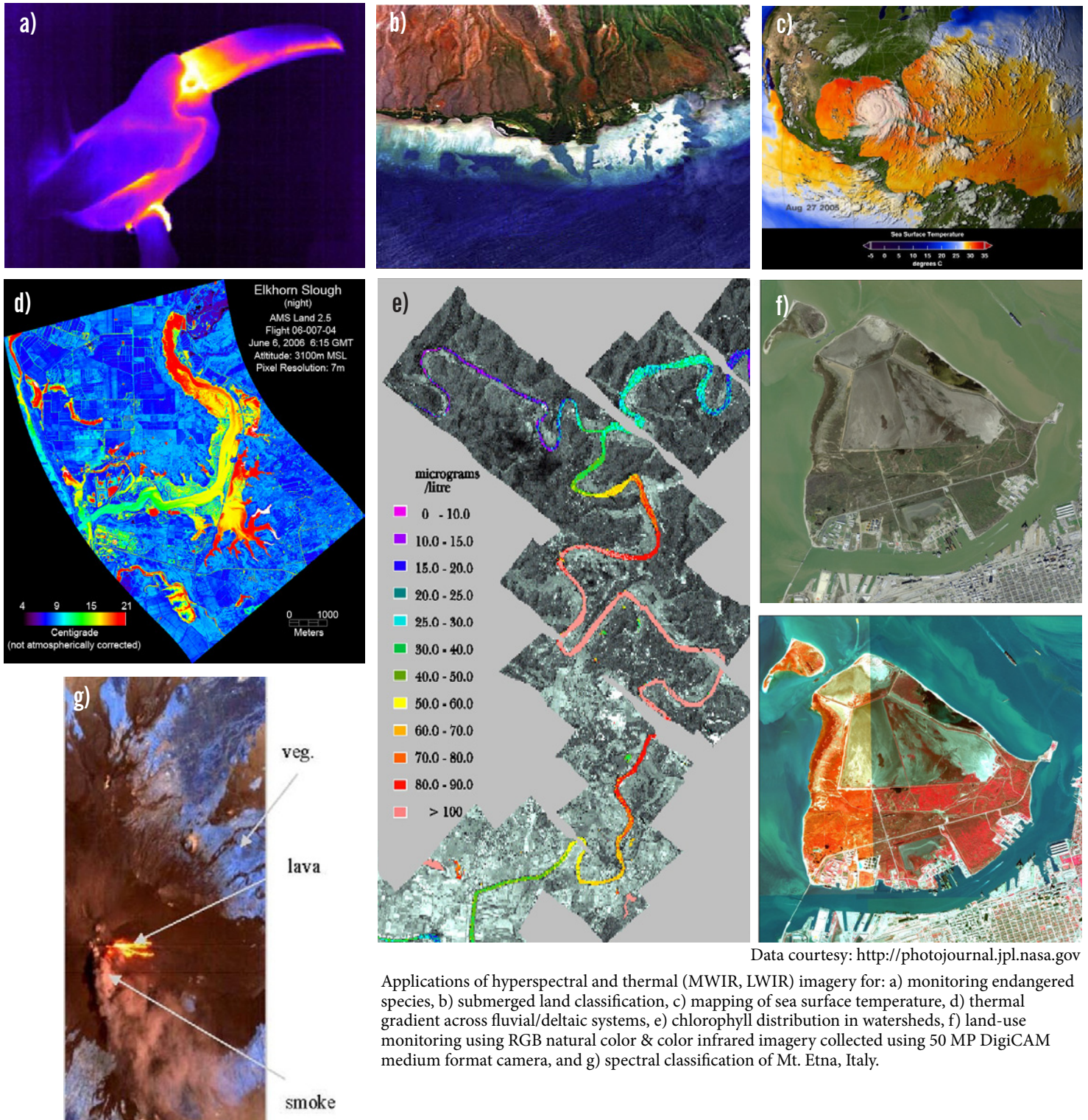
Model	Description
DigiCAM	DigiCAM 50 Megapixel RGB natural color/color infrared medium format camera. Detector size: 36.792 x 49.056 mm; Pixel size: 6 $\mu\text{m}$ ; Image size: 8176 x 6132 pixels; Focal length: 50 mm; Maximum frame rate: 1.6 sec; Storage unit SSD: 3480 images (250 GB).
HyperScan VNIR-micro 16	HyperScan-VNIR-micro (16 bits camera). Detector size: 2400 x 2400 spatial pixels, HyperVision software: ENVI-IDL + flight data capture system with SSD; spectral range: 0.4 to 0.1 $\mu\text{m}$ .
HyperScan SWIR-2500	HyperScan-SWIR 2500. Detector size: 1024 x 1024 spatial pixels; HyperVision software, ENVI-IDL+ flight data capture system with SSD; spectral range: 0.9-2.5 $\mu\text{m}$ .
Broadband MWIR Sensor	Flight configured InSb camera with Stirling Cryocooler. Detector size of 1280 x 1024, Pixel size: 12 $\mu\text{m}$ , Spectral range: 3 to 5 $\mu\text{m}$ ; Frame rate up to 100 fps; frame grabber, data capture with time stamping, flight data capture system with SSD.
Broadband Micro bolometer	High sensitivity Micro bolometer . Detector size: 1074 x 768; Zoon lens 25 mm to 225 mm, f/1.5; Flight data capture system with SSD; Spectral range: 7-14 $\mu\text{m}$ .



The Chiroptera lidar system uses ellipsoidal scanner pattern for topographic surveys using near infrared laser, and a combination of near infrared & green lasers for bathymetric surveys.



# Other Applications



Data courtesy: <http://photojournal.jpl.nasa.gov>

Applications of hyperspectral and thermal (MWIR, LWIR) imagery for: a) monitoring endangered species, b) submerged land classification, c) mapping of sea surface temperature, d) thermal gradient across fluvial/deltaic systems, e) chlorophyll distribution in watersheds, f) land-use monitoring using RGB natural color & color infrared imagery collected using 50 MP DigiCAM medium format camera, and g) spectral classification of Mt. Etna, Italy.

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