MAGI: A New High-Performance Airborne Thermal-Infrared Spectral Imaging Sensor for Earth Science Applications

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A new airborne sensor for Earth science applications is introduced. Developed by The Aerospace Corporation under the NASA Instrument Incubator Program, the Mineral and Gas Identifier (MAGI) is a wide-swath moderate spectral resolution thermal-infrared (TIR) imaging spectrometer that spans the 7.1-12.7 µm spectral window in 32 uniform and contiguous channels. Its spectral resolution enables improved discrimination of rock types, greatly expanded gas-detection capability, and more accurate land-surface temperature retrievals. Its whiskbroom scanning is enabled by a novel Dyson spectrometer design, providing coverage rates of up to 20 km^2 per minute at 2-meter ground sampling distance.

The conceptual design of MAGI was established by a parametric trade analysis, which was carried out primarily to ascertain the optimum TIR spectral resolution for achieving a majority of the canonical science objectives associated with TIR imaging sensors (Hall *et al.*, 2008). The outcome of this exercise was a 32-channel TIR design that is intermediate between that of coarse resolution multispectral airborne TIR imagers and the “hyperspectral” TIR imager family, such as the legacy Spatially Enhanced Broadband Array Spectrograph System (SEBASS; Hackwell *et al.*, 1996) and the current *Mako* (Warren *et al.*, 2010; Hall *et al.*, 2011) and HyTES (Johnson *et al.*, 2011) sensors. The MAGI design concept is also extendable to Earth orbit (Hall *et al.*, 2008), where it would provide an option for enhanced performance TIR imaging capability for future missions beyond Landsat 8 and HyspIRI.

Parameter	Value
Number of spectral channels	32
Wavelength coverage	7.1 – 12.7 µm
Instantaneous pixel FOV	0.53 mrad
Frame rate	955 Hz
Integration Time	280 µsec
NEDT (single frame)	~0.12°C at 10 µm
Number of along-track pixels	128
Maximum cross-track scan angle	± 42° (2800 pixels)
Max. number of cross-track scans	unlimited
Detector	HgCdTe
Detector Temperature	55 K
Optics Temperature	120 K
Calibration	Full aperture BB

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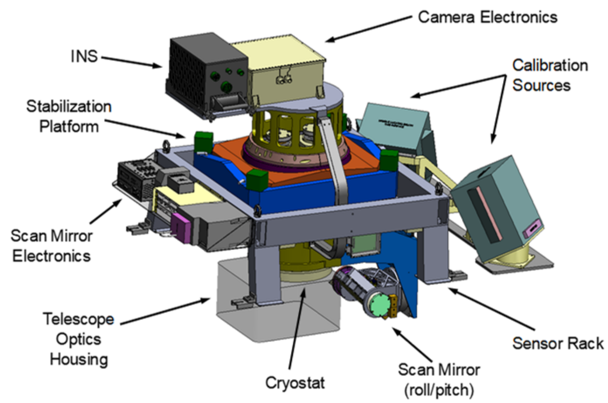

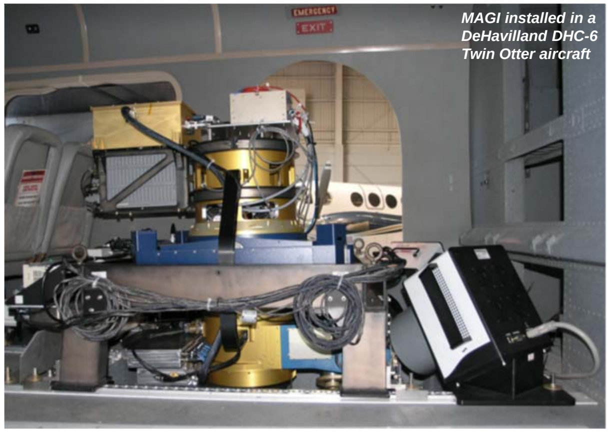

Radiometric calibration uses two high-emissivity blackbody calibration sources operated at different known temperatures and which calibrate the complete optical path.

The inaugural MAGI flight trials were conducted in December 2011 and the sensor performed nominally during these flights. Targets were selected in order to sample a representative cross-section of geologic, urban, and agricultural environments. The sensor was flown over these targets at altitudes up to 12,500 ft (3.8 km) above Mean Sea Level (MSL).

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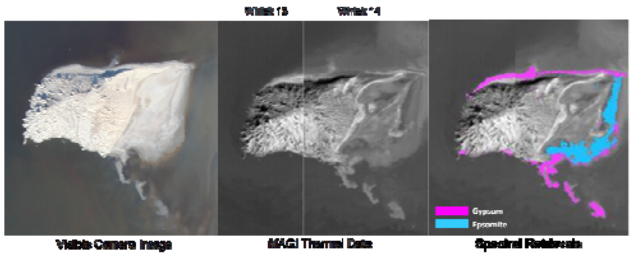
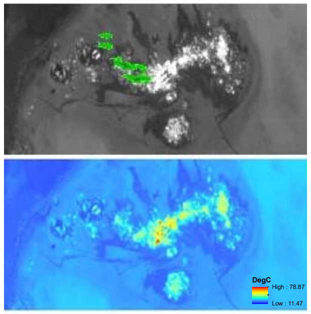


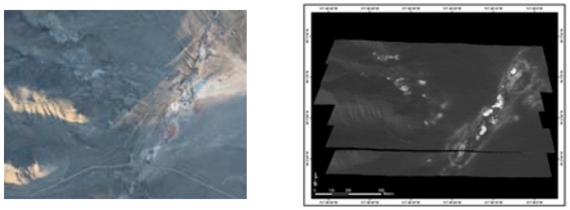
Airborne imagery of Mullet Island, Salton Sea, CA acquired at 10,000 ft (3 km) AGL. **Left:** True-color visible image acquired by a boresighted DSLR camera. **Center:** MAGI 10-µm thermal radiance image. **Right:** Spectral analysis indicating presence of evaporite minerals. Ground sample distance: 1.6 m.



10-µm radiance image of geothermal vents near the SE edge of the Salton Sea, CA, with a detected ammonia emission superimposed in green.

Corresponding brightness temperature map.

Altitude: 10,000 ft (3 km) AGL. Ground sample distance: 1.6 m.



Airborne imagery of geothermal hot spots in Coso, CA acquired at 7,000 ft (2.1 km) AGL. **Left:** True-color visible image acquired by the boresighted DSLR camera. **Right:** MAGI 10-µm thermal radiance image. The brightest pixels in this image are ~80°C.

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