MAGI: A New High-Performance Airborne Thermal-Infrared Spectral Imaging Sensor for Earth Science Applications Jeffrey L. Hall¹*, Michael S. Ramsey², David M. Tratt¹, and the MAGI Team[†]

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 km² 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	Valu
Number of spectral channels	32
Wavelength coverage	7.1 – 12.
Instantaneous pixel FOV	0.53 m
Frame rate	955 H
Integration Time	280 µs
NEDT (single frame)	~0.12°C at
Number of along-track pixels	128
Maximum cross-track scan angle	± 42° (2800
Max. number of cross-track scans	unlimit
Detector	HgCdT
Detector Temperature	55 K
Optics Temperature	120 k
Calibration	Full apertu

¹ The Aerospace Corporation ² University of Pittsburgh

* Contact information: Tel: 310-336-7615; e-mail: Jeffrey.L.Hall@aero.org

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Cryostat



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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Camera Electronics

(roll/pitch)



Visible Camera Image

MAGI Thermal Data

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.





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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Spectral Retrievals

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.

