

Maturing HiMAP (High-resolution Multiple-species Atmospheric Profiler) to TRL 6

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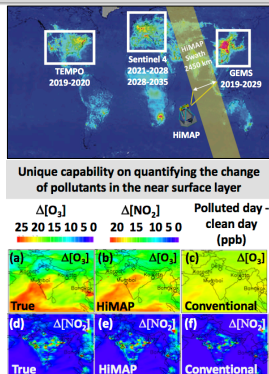
Program: Strategic Initiative R&D

Introduction

Global, high-resolution, vertical profile measurements of aerosols and gaseous pollutants (O_3 , NO_2) have been identified as NASA priorities by the 2017 Earth Sciences Decadal Survey.

Existing systems lack the capability to meet all these requirements, resulting in a compelling need to develop HiMAP, a new generation global Earth Observing System (EOS) with the unique capability of quantifying these three targeted observables in the near surface layer (0-2 km).

HiMAP combines wide swath, high accuracy linear polarization, broad spectral range, high spectral resolution, and multiple along-track viewing angles to meet the precision, accuracy, and spatial resolution requirements specified by the 2017 ESDS within a compact system.



Characteristics of HiMAP

HiMAP is a wide swath, push broom, imaging spectropolarimeter with two independent modules.

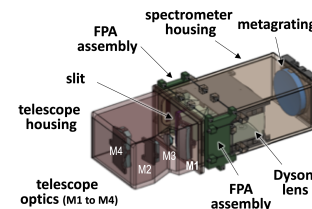
- UV-Vis: 300-500 nm for O_3 and NO_2 profiling
- NIR: 680-780 nm for aerosols profiling

Its UV-Vis modular

- Form factor: $17.0 \times 11.1 \times 30.0$ cm³ and ~10 kg
- Field of view across track: 50°
- Degree of linear polarization: 0.005
- Spectral resolution: 0.50 nm
- Mapping capability

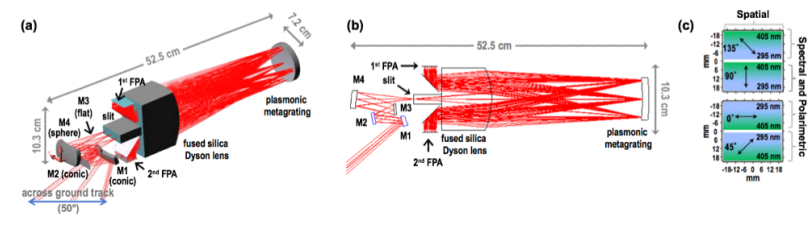
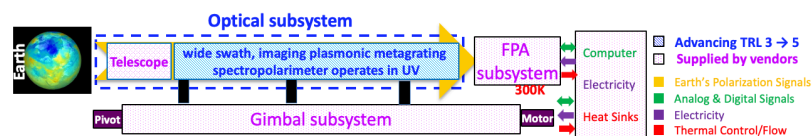
Platform	Swath Width	Resolution at Nadir
Aircraft	35 km	85×85 m ²
Satellite	800	Global survey
		Megacities

The technical approach of UV-Vis modular is scalable to the near infrared (680–780 nm) to enable aerosol profiling.



Technical Approach and Innovation

HiMAP enables the quantification of near-surface aerosols and gaseous pollutants by using a combination of high-spectral resolution, multi-angular viewing, high-accuracy linear polarimetry over a continuous spectral region to finely sample these pollutants' concentration in the vertical dimension.

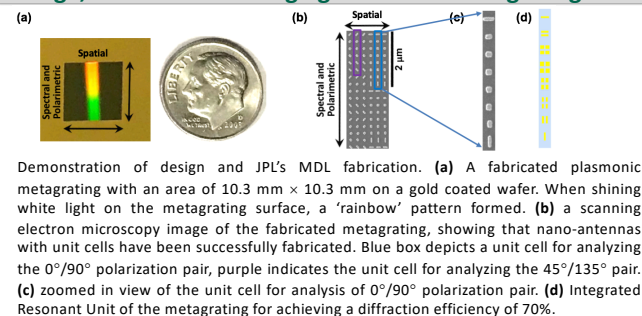


The technology innovations mainly reside in the plasmonic metagrating and the Dyson imaging spectropolarimeter. These enable three functionalities including wide field of view imaging, simultaneous quantification of linear polarization states, and spectral light dispersion within a single device, without employing multiple entrance slits, moving parts, high frequency modulation, or complex coating design and engineering, thus enhancing measurement efficiency and reducing engineering risks and costs, in comparison to conventional technologies.

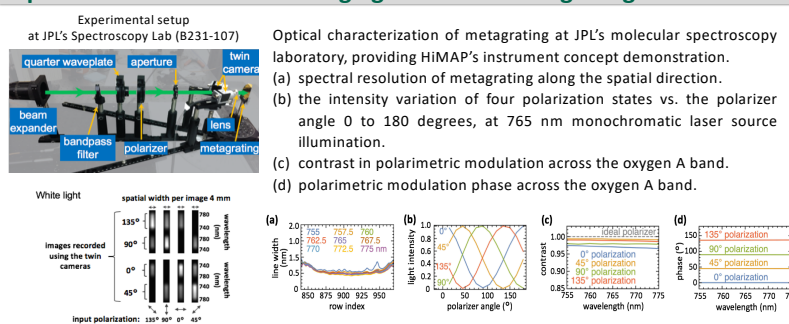
The optical subsystem delivers the polarization spectra of atmospheric constituents with a concave, plasmonic metagrating, which forms four spectral images on the twin imaging FPAs (panel c of the Figure), for simultaneously analyzing linear polarization states of 0° , 90° , 45° , and 135° .

- f/4 with a $36 \mu\text{m}$ wide slit, optics transmission of ~55%
- nominal spot diameter is less than $\frac{1}{2}$ of a pixel
- $1/400^{\text{th}}$ of a pixel of spectral 'smile' and keystone geometrical distortions

Design, Fabrication of Imaging Plasmonic Metagrating



Optical Characterization of Imaging Plasmonic Metagrating



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