Spectral Calibration of the EO-1 Advanced Land Imager*

Jeffrey A. Mendenhall

Advanced Space Systems and Concepts Group

MIT/Lincoln Laboratory

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Outline

• Introduction
• Collimator
• Technique
• Results
• Summary
# EO-1 ALI MS/PAN

Spectral and Spatial Coverage

<table>
<thead>
<tr>
<th>Band</th>
<th>Wavelength ($\mu m$)</th>
<th>Detector Type</th>
<th>GSD (m)</th>
<th># of Detectors</th>
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<tbody>
<tr>
<td>Pan</td>
<td>0.480-0.690</td>
<td>Si Photodiode</td>
<td>10</td>
<td>3840</td>
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<tr>
<td>MS-1’</td>
<td>0.433-0.453</td>
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<td>MS-1</td>
<td>0.450-0.515</td>
<td>Si Photodiode</td>
<td>30</td>
<td>1280</td>
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<tr>
<td>MS-2</td>
<td>0.525-0.605</td>
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<td>MS-3</td>
<td>0.630-0.690</td>
<td>Si Photodiode</td>
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<td>1280</td>
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<td>MS-4</td>
<td>0.775-0.805</td>
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<td>MS-4’</td>
<td>0.845-0.890</td>
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<td>MS-5’</td>
<td>1.200-1.300</td>
<td>PV HgCdTe</td>
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<td>MS-5</td>
<td>1.550-1.750</td>
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<td>MS-7</td>
<td>2.080-2.350</td>
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</tbody>
</table>
MS/PAN Flight Module
Spectral Filters

- Beryllium Pedestal
- Ceramic Motherboard
- Readout IC
- HgCdTe Detector
- Pan 1p 2 3 4 4p 5p 5 7
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Spectral Collimator

• **Source**
  – Quartz tungsten halogen lamp
  – Oriel MS257 monochromator
  – 2” diameter (id) integrating sphere
    - 0.5” diameter exit port

• **Collimating Optics (0.5° field)**
  – 6” diameter Condensing lens
  – 17” diameter, 100” focal length off-axis parabola
  – 20” diameter turning flat

• Careful baffling to ensure proper stray light rejection
Spectral Collimator

- Beam Height = 140 mm
- Beam Height = 584 mm
- AOM110-6
- Lens: Melles Griot 01 LPX 245, F = 150 mm, D = 105 mm, BK-7
- Off Axis Parabola: R = 5100 mm, F = 2550 mm, CA = 394 mm
- Integrating "Sphere"
- Parabola Focus
- Oriel Monochrometer
- 4 x 10 Foot Bench
- Source
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Spectral Calibration Technique

- Measure spectral response of multispectral and panchromatic detectors from 0.4-2.5 μm

- Technique
  - Flood focal plane with 2 nm FWHM beam sequentially from 350 to 1000 nm in 2 nm intervals for VNIR
  - Flood focal plane with 4 nm FWHM beam sequentially from 1000 to 2500 nm in 4 nm intervals for SWIR
  - Record response of focal plane at each interval
  - Record response of spectrally calibrated silicon and lead sulfide detectors to monitor flux and stability of beam
Spectral Calibration Analysis

• A pixel’s spectral response is derived by normalizing its response as a function of wavelength to account for various artifacts
  – Dark current
  – Vacuum tank window transmission
  – Beam flux

\[
S_P(b, \lambda) = \frac{R_P(dn, \lambda) R_d(\lambda)}{T_W(\lambda) F(\lambda)}.
\]

• \(S_P(b, \lambda)\) is the derived spectral response for pixel P as a function of band b and wavelength \(\lambda\)
• \(R_P(dn, \lambda)\) is the ALI dark subtracted focal plane response for pixel P as a function of wavelength
• \(R_d(\lambda)\) is the spectral responsivity of the reference detector used to monitor the beam
• \(T_W(\lambda)\) is the spectral transmission of the vacuum tank window
• \(F(\lambda)\) is the measured flux of the beam as a function of wavelength
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Spectral Calibration Results:
Band 1p and 1
Spectral Calibration Results:
Bands 2 and 3
Spectral Calibration Results:
Bands 4 and 4p
Spectral Calibration Results:
Bands 5p, 5 , and 7
Spectral Calibration Results: Panchromatic Band
ALI Spectral Response Functions

VNIR Normalized Spectral Response

SWIR Normalized Spectral Response
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Summary

• We find excellent morphological agreement between system and subsystem level spectral calibration measurements.

• Based on system level measurements, the finer subsystem level calculations were adopted for the flight spectral response functions of the ALI.

• Characterization of a fully populated array would require substantial commitment at the system level and may be more appropriate at the subsystem level.