

Assessment of AVIRIS Laboratory and In-flight Uniformity

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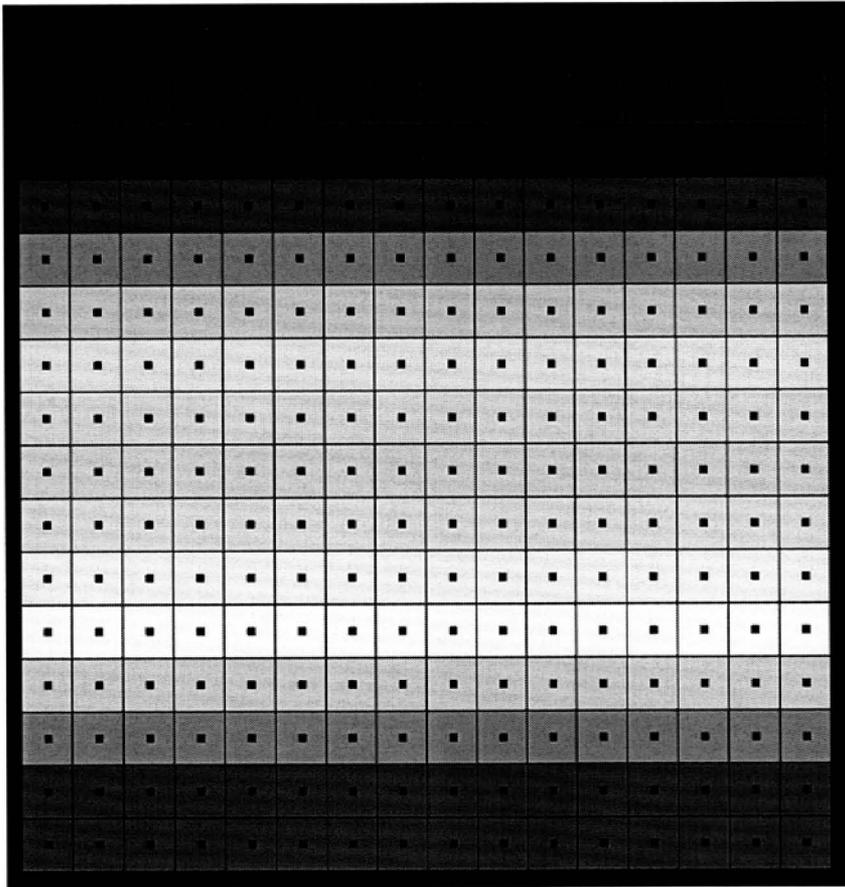
AVIRIS Workshop 24-27 May 2004

Overview

- What Uniformity?
- Spectral Cross-Track Uniformity
- Hyperion Example
- AVIRIS Example
- Spectral-IFOV Uniformity
- Summary and Conclusions

A Uniform System

Cross Track Sample



Depiction

- Grids are the detectors
- Spots are the IFOV centers
- Colors are the wavelengths

Every spectrum is
intercomparable to every
other spectrum

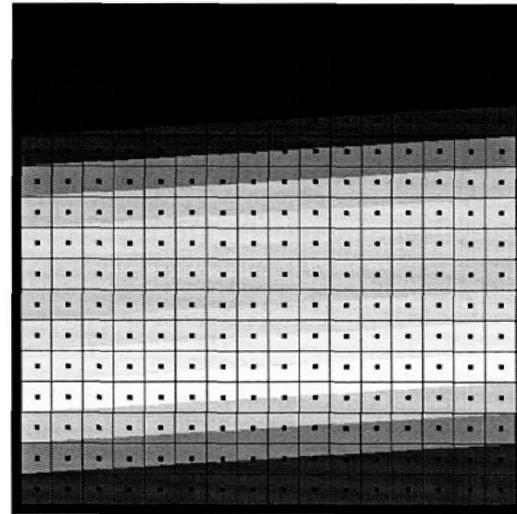
This is what is desired.

Spectral Cross-Track Spectral Non-Uniformity

Depiction

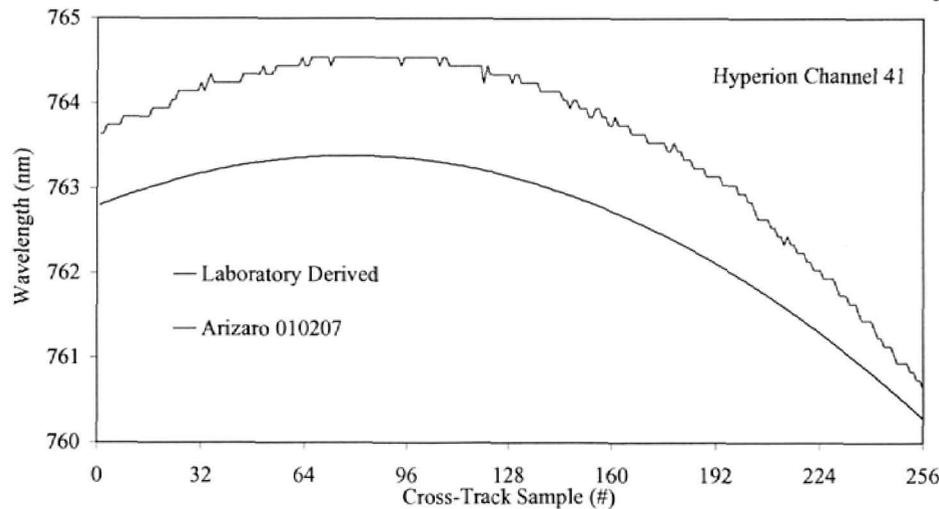
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Cross Track Sample



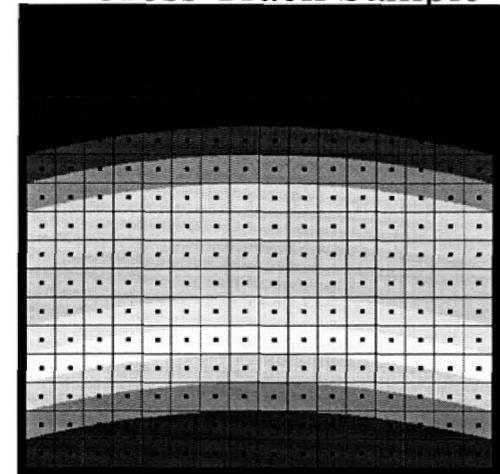
Wavelength

Hyperion 40% non-uniform



Failure by Twist

Cross Track Sample



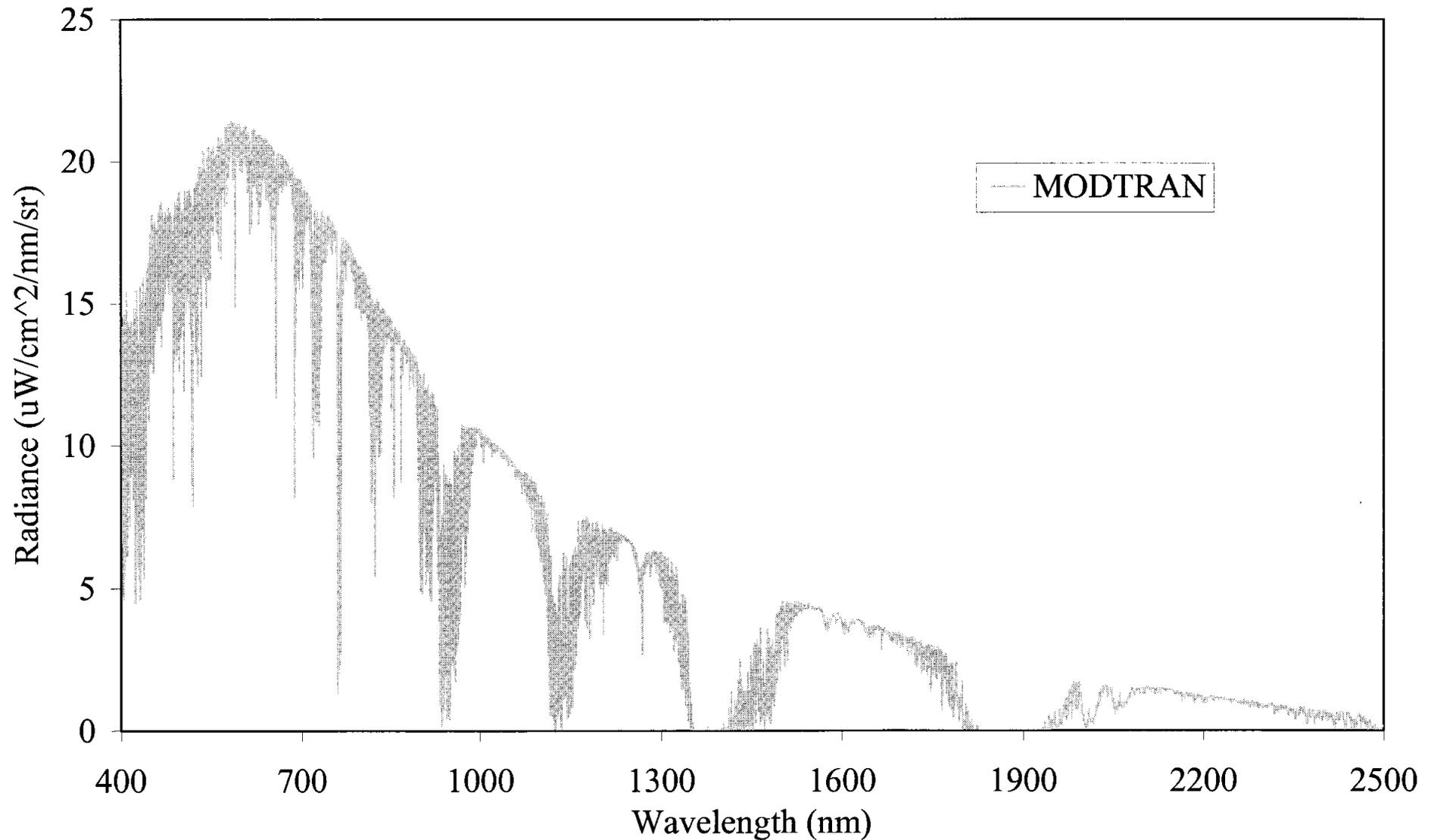
Wavelength

Failure by Frown

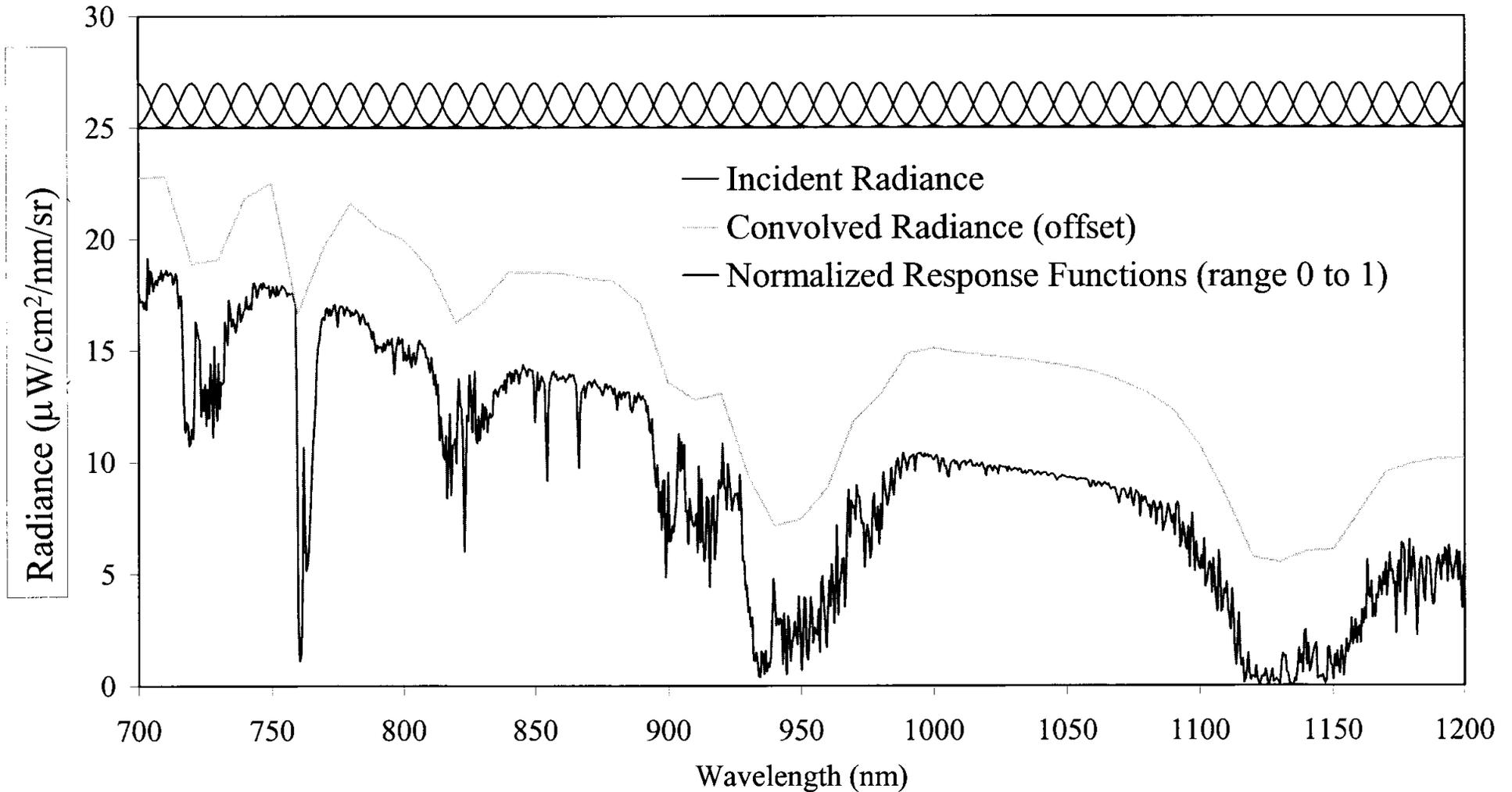
Spectral Radiance is What We Measure.

- The AVIRIS radiometric performance model allows estimation of the signal throughput and noise properties of AVIRIS at the component level.
- With an understanding of these properties areas for component improvement can be determined.
- Also, the signal-to-noise ratio properties may be estimated
- An accurate radiometric performance model is essential for understanding existing instruments and designing new instruments.

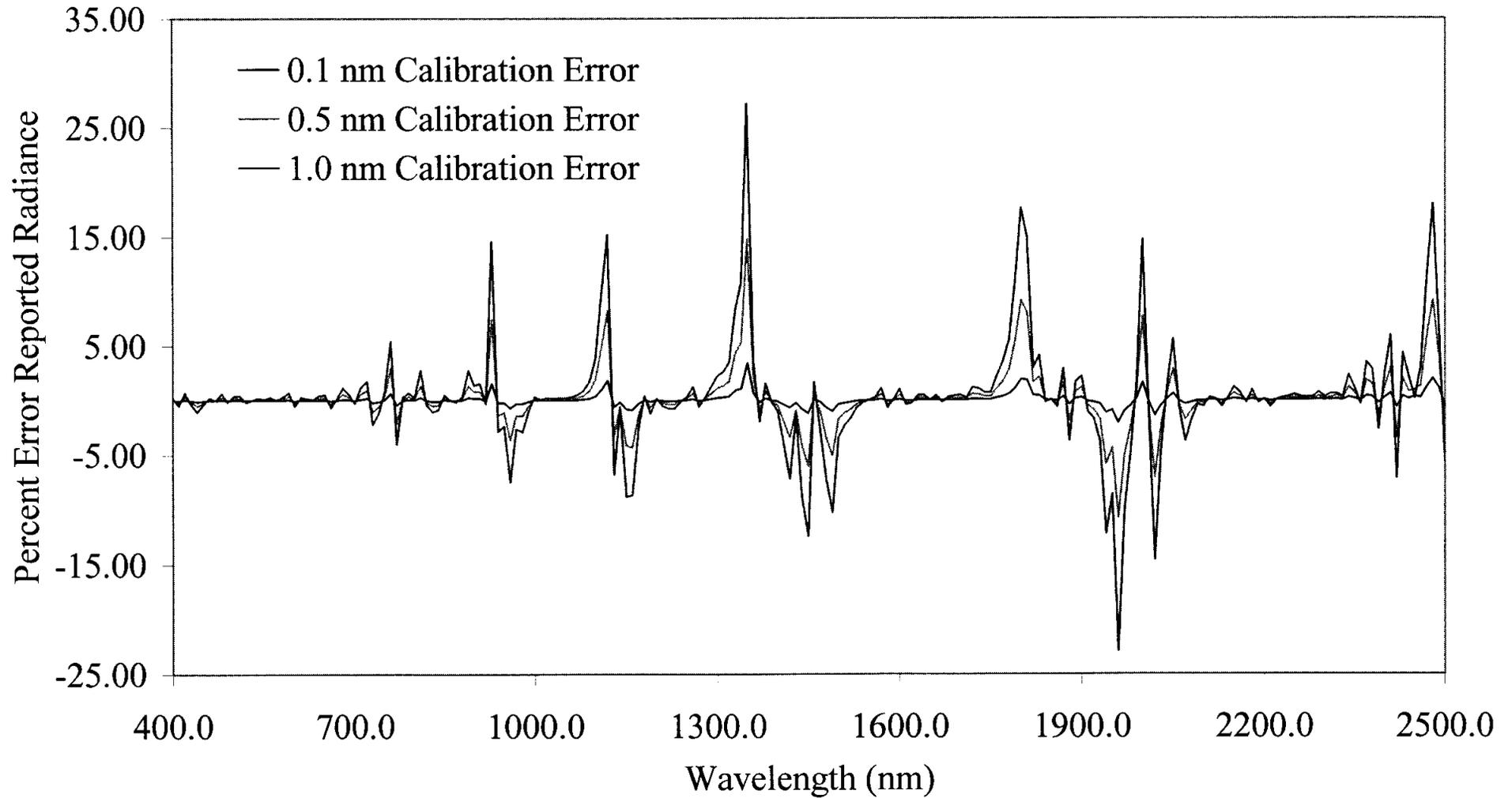
We Measure Spectral Upwelling Radiance



Expanded Spectral Convolution



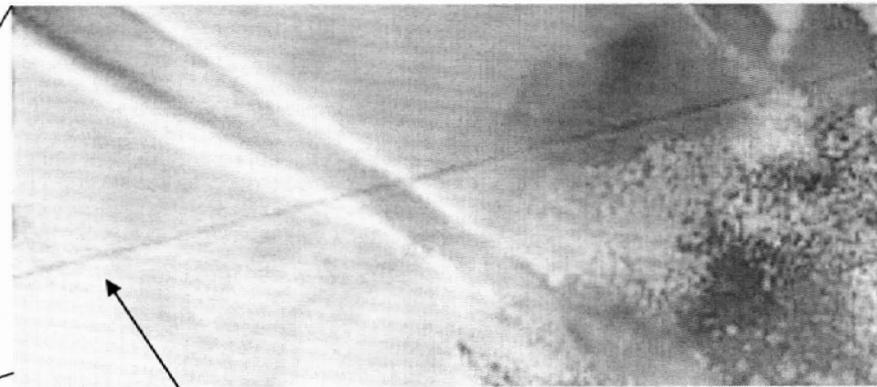
Radiometric Error from Spectral Error



Hyperion Measurements Arizaro 010207

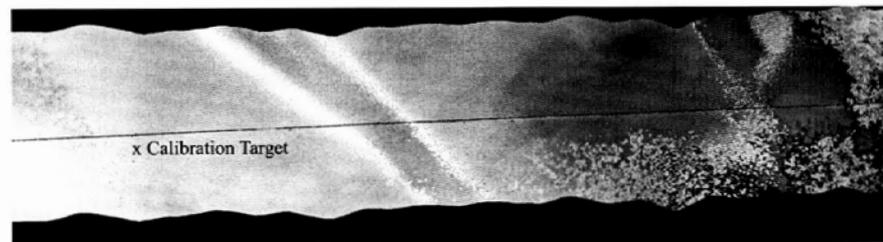


Hyperion Image



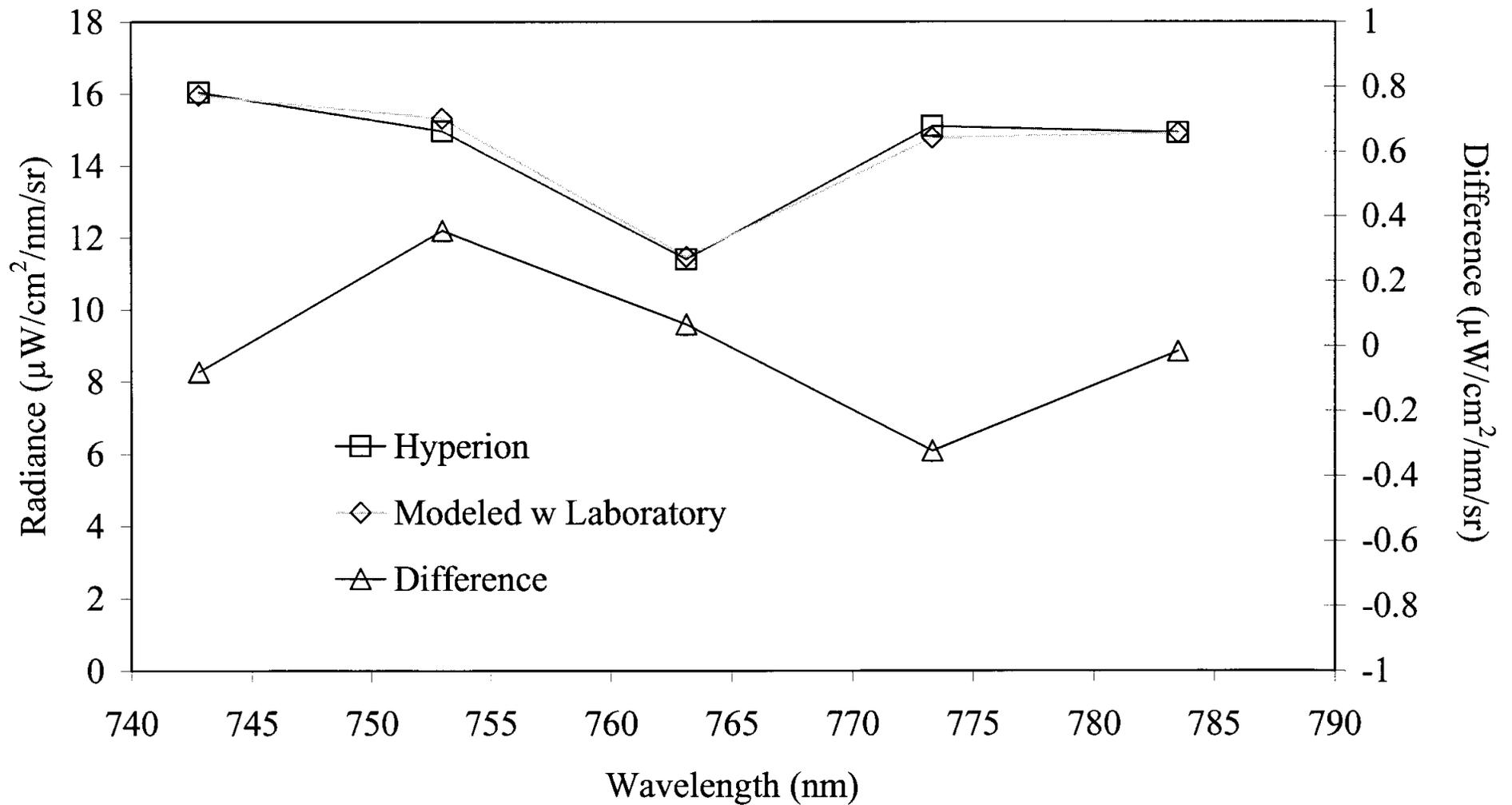
Calibration Target

AVIRIS Measurement



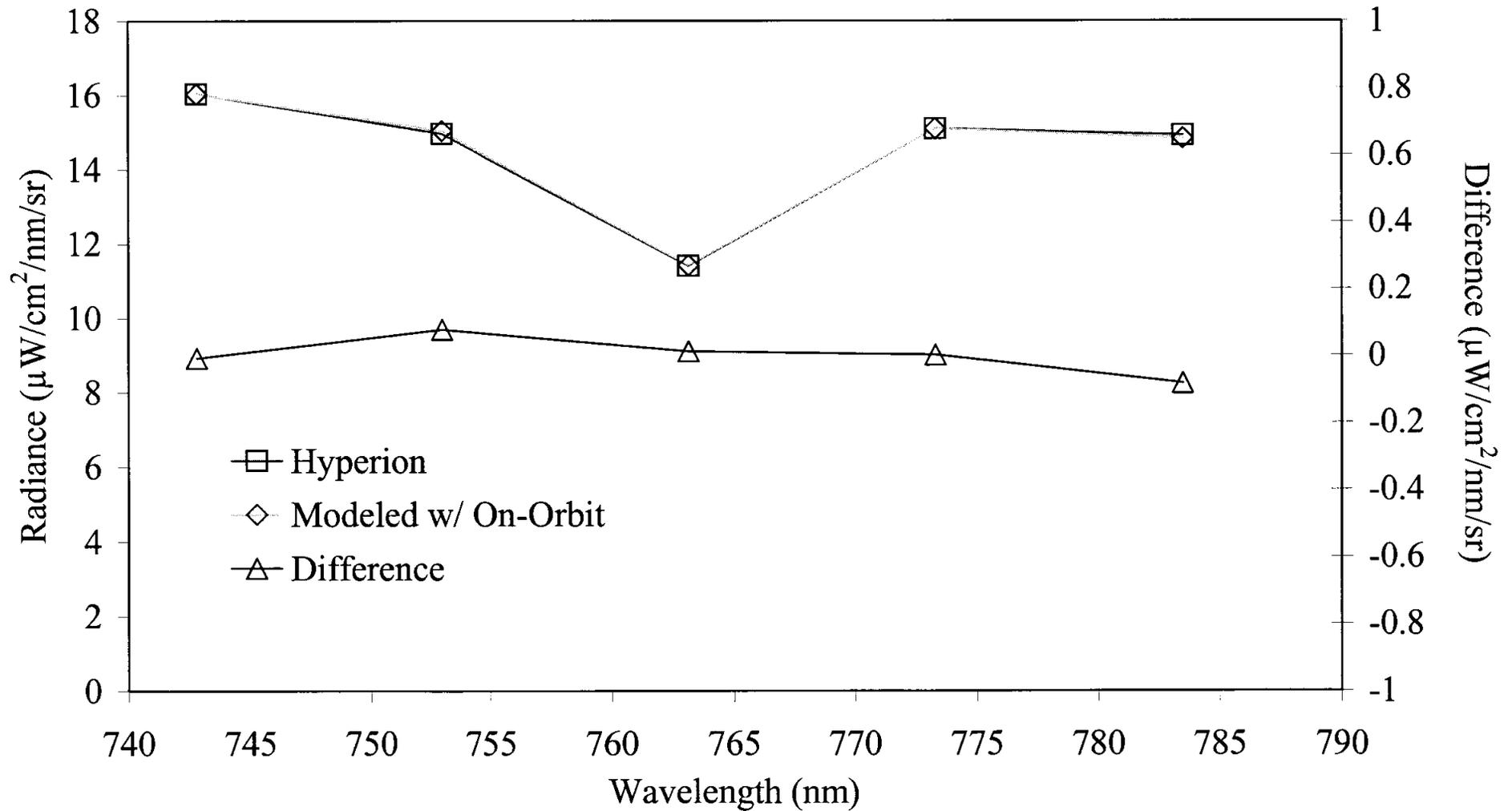
Hyperion Arizaro Calibration Experiment

Fit with nm shift from laboratory calibration

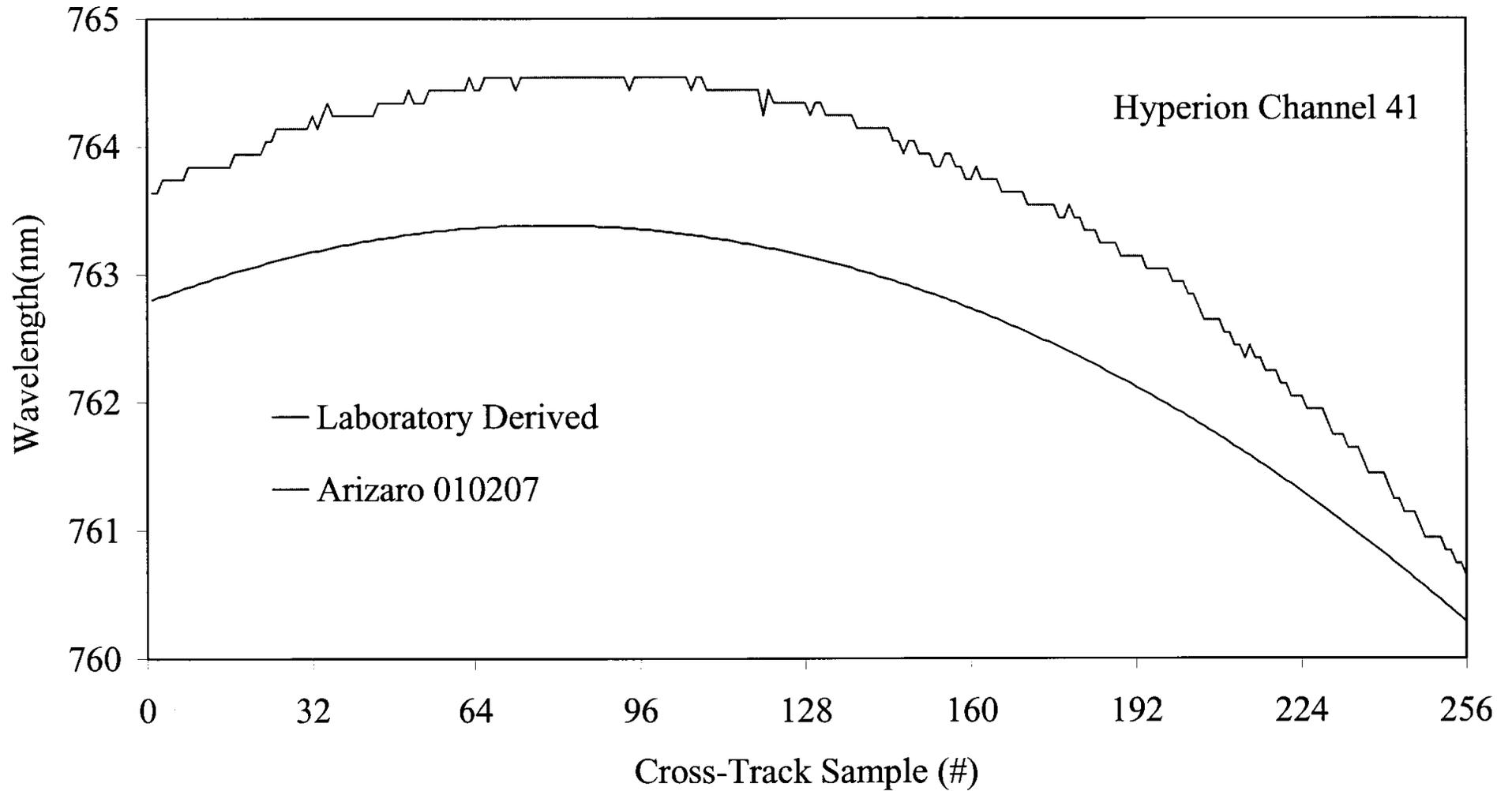


Arizaro Calibration Experiment

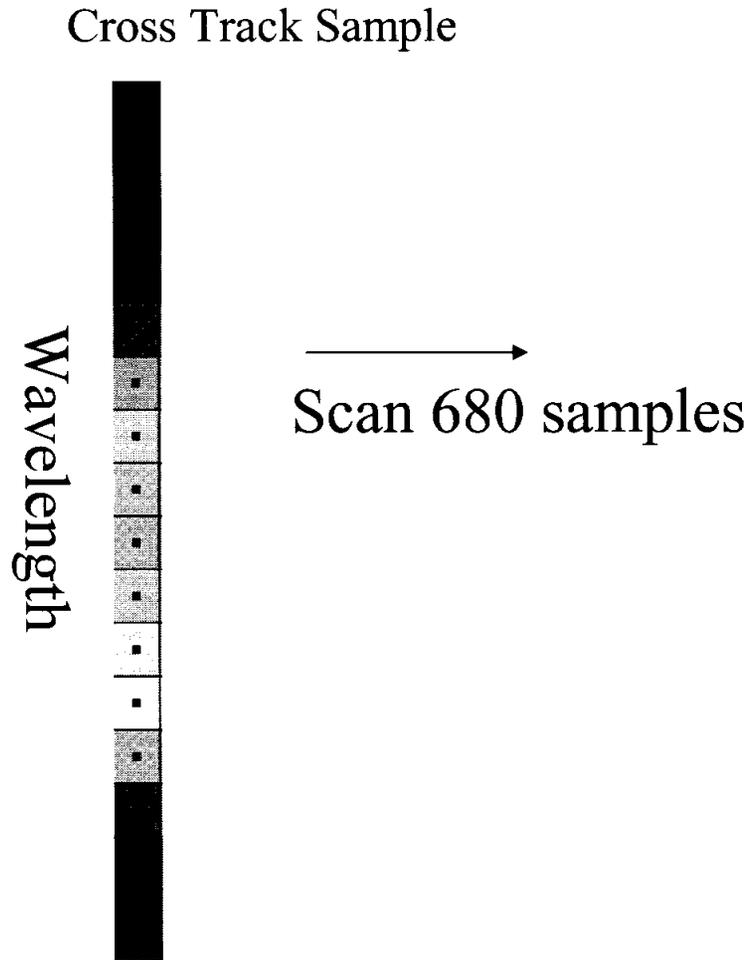
Sample 2 with 0.5 nm shift from laboratory calibration



Spectral Calibration VNIR



The AVIRIS System



Depiction

- Grids are the detectors
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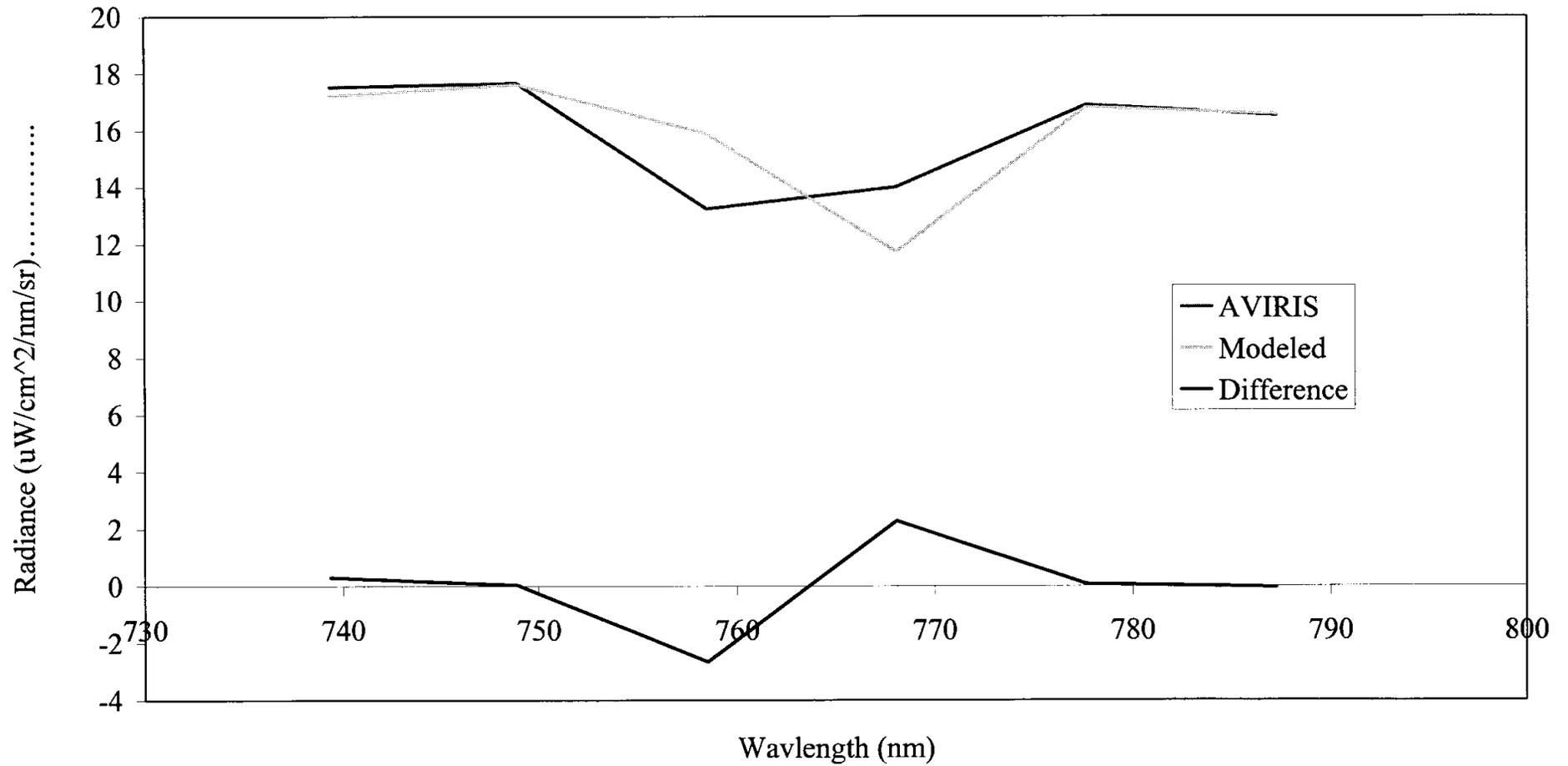
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This is what is desired.

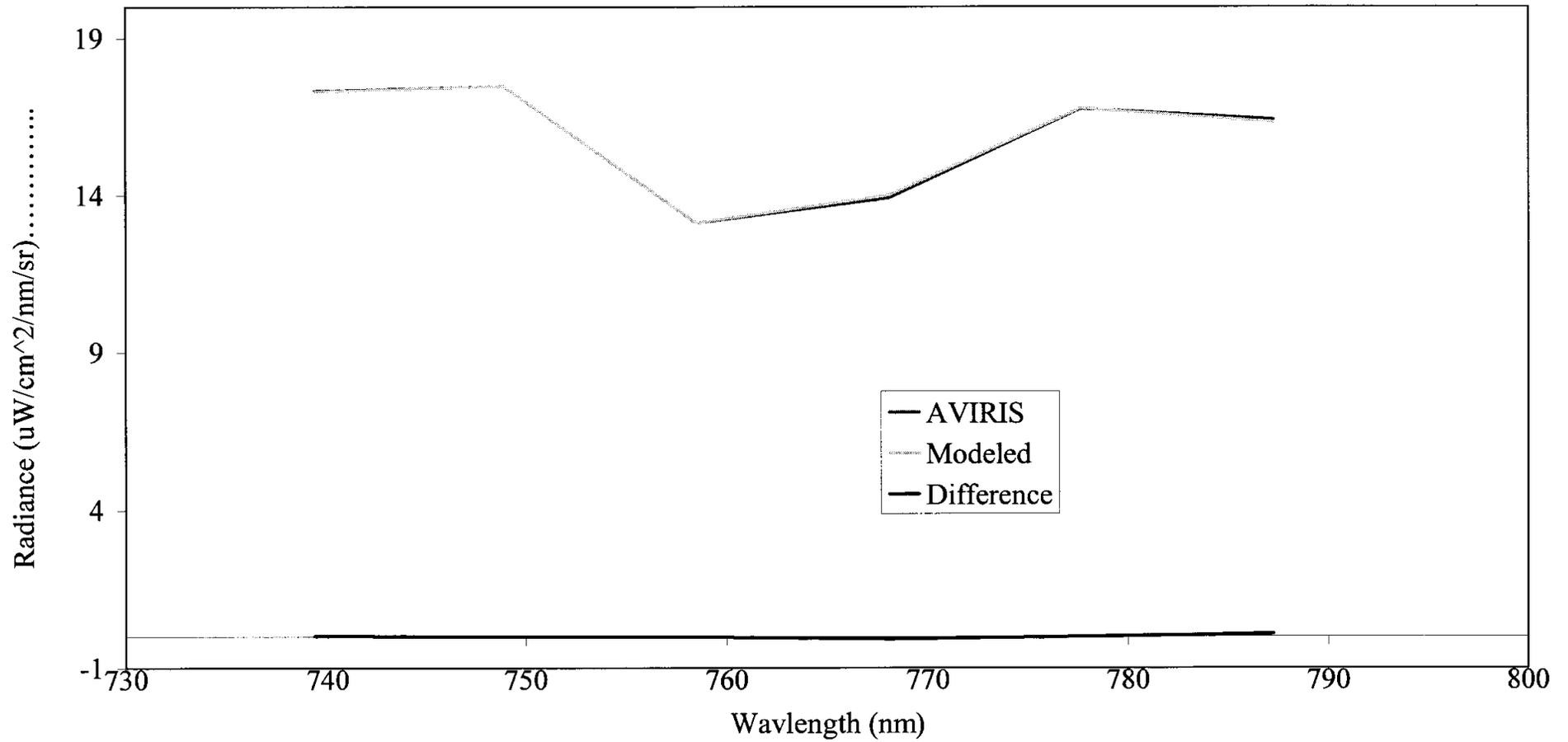
Rogers Dry Lake, California



Spectral Fit Sensitivity

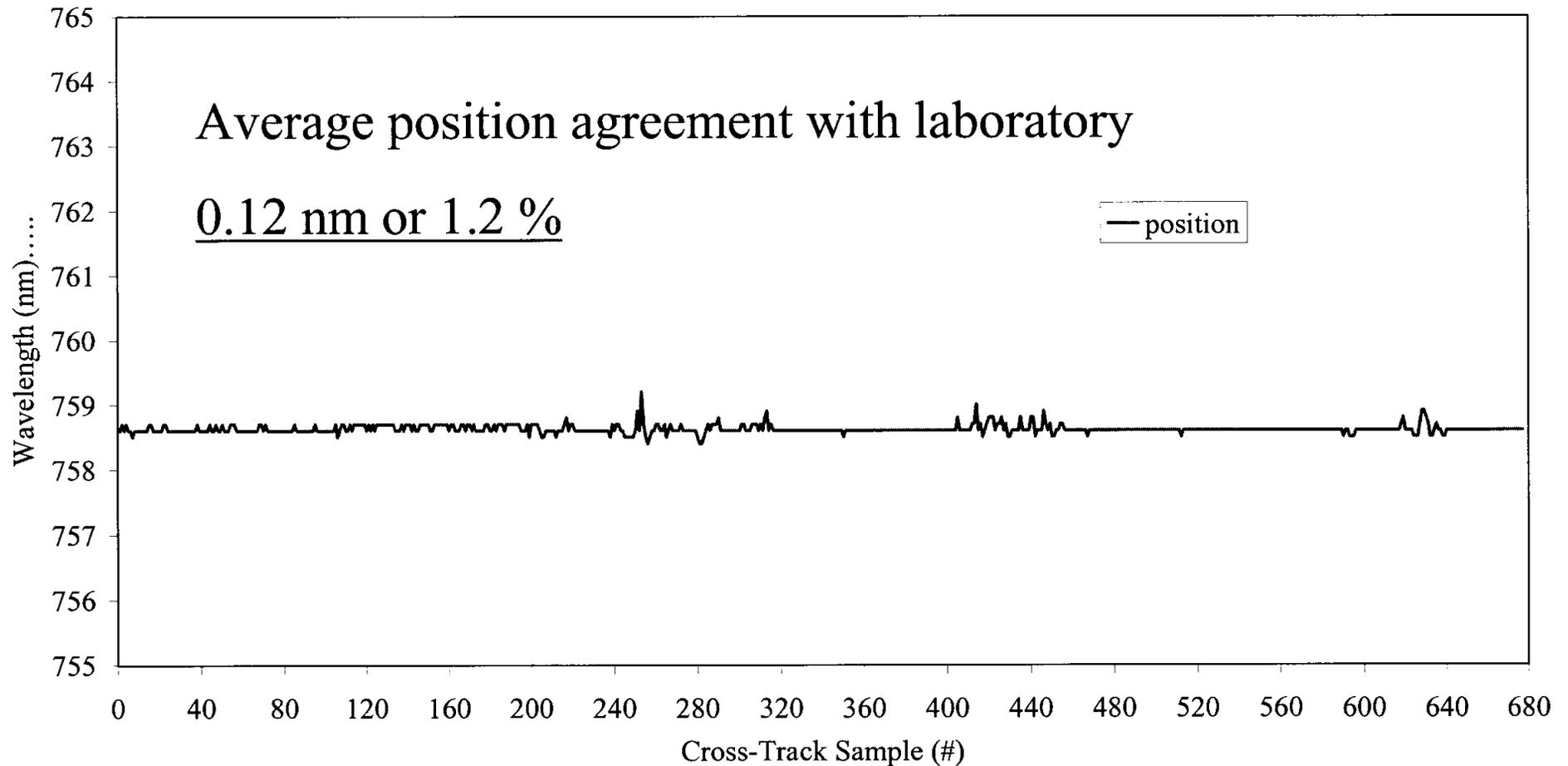


AVIRIS fit F040611 Rogers Dry Lake



AVIRIS Cross-Track Uniformity

<1% non-uniform



As expected based on the design AVIRIS is uniform

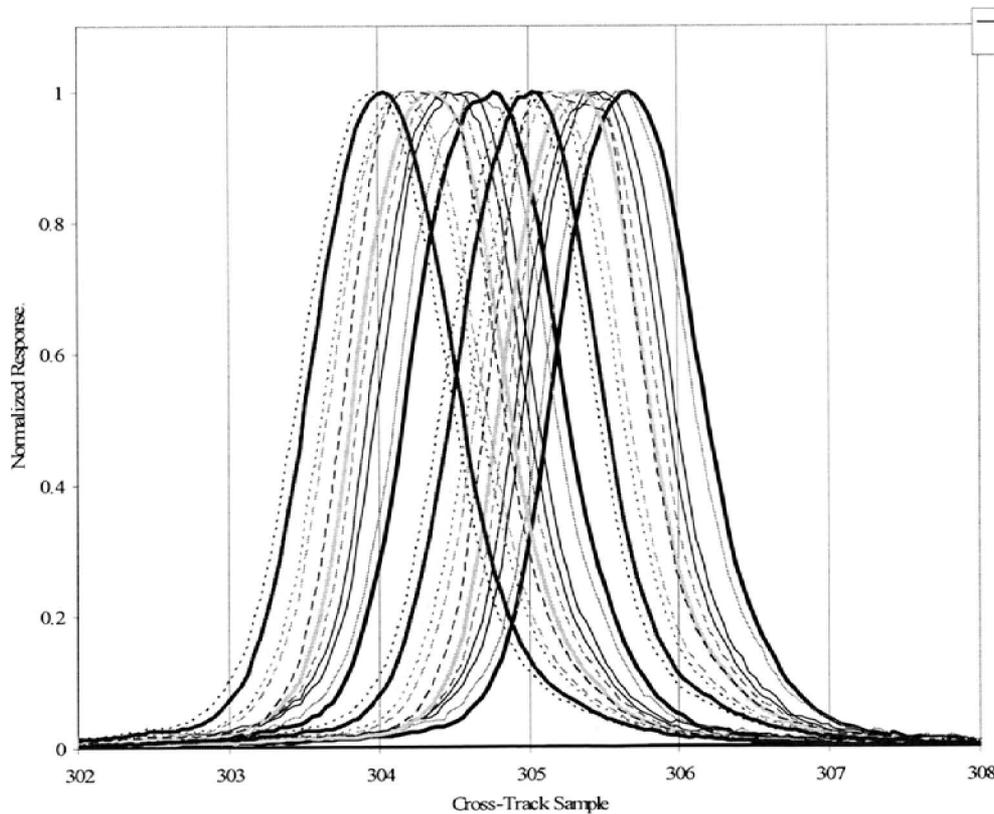
Why Uniformity Matters

- A non-uniform imaging spectrometer is like having a laboratory spectrometer where every spectrum had a different calibration.
- Ignoring it produces large errors in derived products.
- Because we are not over sampling we can not resample the measured radiance to achieve uniformity.
- If a near perfect atmospheric correction can be achieved, then resampling might of the reflectance data would be possible.
- If there are artifacts in the atmospherically corrected data then resampling will smear the artifacts.
- For vegetation and minerals we care about small shifts in wavelength that relate to chemistry and science objectives.

Spectral-IFOV-Shift non-Uniformity

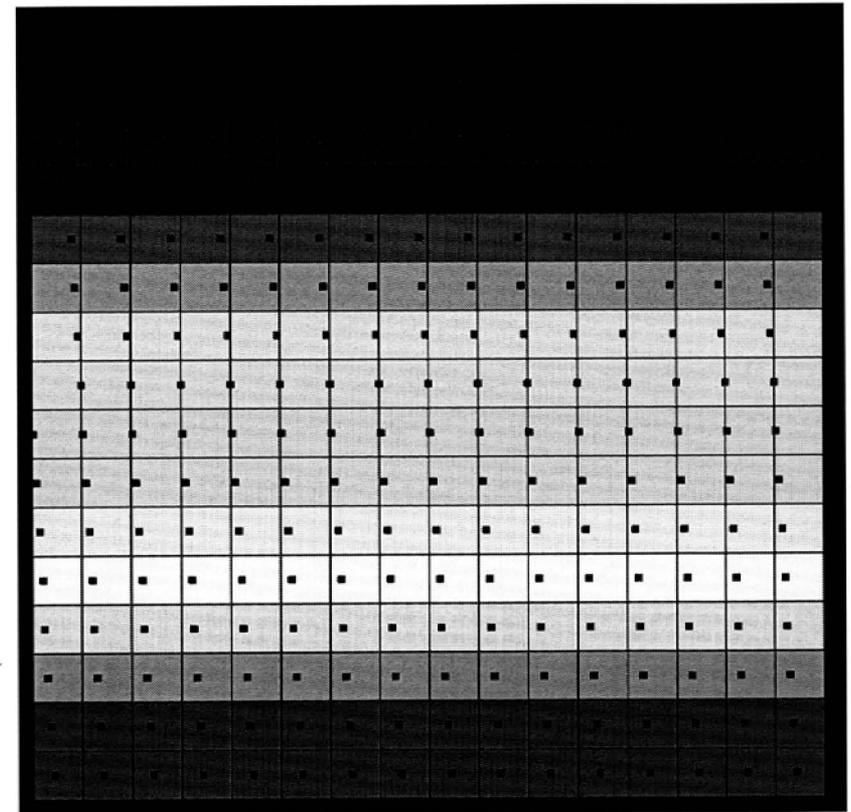
Spectral-IFOV-Shift creates spectra where different wavelengths arrive from different locations on the ground.

Example 80% SIS



Depiction Below

- Grids are the detectors
- Spots are the IFOV centers
- Colors are the wavelengths



Failure by Spectral-IFOV-shift

AVIRIS Spectral-IFOV Uniformity

- AVIRIS uses 4 spectrometers with snapshot detector read.
- Each detector array in readout simultaneously giving excellent spectral-IFOV uniformity within each spectrometer.
- The four spectrometers measure the ground in sequence. This means AVIRIS has moved $3/1000$ forward between the first and last spectrometer. This gives a spectral-IFOV non-uniformity of $\sim 0.3\%$ between spectrometer A and D.

Summary and Conclusions

- Spectral cross-track uniformity allows all spectra to be inter-compared.
- Resampling the radiance data is not possible because of the fine structure present in the upwelling radiance. Resampling after atmospheric correction is only possible with an artifact free atmospheric correction product.
- Spectral-IFOV uniformity assures that all the wavelength are measured from the same sample.
- Resampling to correct spectral-IFOV-shift will distort the spectral content of the IFOVs as a function of wavelength. The spatial resolution is effectively coarsened. Measurements of features at the IFOV and sub-IFOV scale are undermined.
- AVIRIS has excellent spectral-cross-track and spectral-IFOV uniformity. This enables the science of imaging spectroscopy to proceed directly from the measured data.

Thank You

Questions?