Longwave (LW) Spectral Response Characterization

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Total Channel Spectral Response

- Total Channel (0.3-200um) is a broadband measurement channel. Calibration lamps are used for SW and FTS is used for the LW.

- Ground Calibrations for LW used NFBB measurements at various temperatures-205K-312K.

- FM1 is considered in this analysis.
Filtered Radiance

\[ I_T^f = \int_{\lambda=0}^{\infty} S_\lambda I_{\lambda, T_{NFBB}} d\lambda \]

Filtered Radiance

Spectral Response Function

Radiance of Source
Ground Cal- Radiance vs. Counts

Assume flat spectral response

$R^2 = 1$
Ground Cal- Radiance vs. Counts

Assume flat spectral response

R²=1

Provides Gain-No Spectral Information
Ground Cal: Radiance-Counts Ratio

\[ \lambda = \frac{2898}{T} \]

Percent Change

Wavelength(μm)
Production SRF
Radiance vs. Counts- Production SRF

\[ R^2 = 1 \]
Residual Counts
FTS Spectral Characterization

- BIORAD-60A Spectrometer is used as a broadband spectral source.
- Measurements taken by CERES instrument as well as a reference detector.
- Spectrally flat Lithium Tantalaate Pyroelectric Reference Detector (PRD) is used as a reference.
- Spectral estimate is obtained by taking ratio of CERES sensor measurement with PRD measurement.

\[ S_\lambda = \frac{m_{\lambda,CERES}^f}{m_{\lambda,PRD}^f} \]
FTS Wavelength Bands and Sources Used

• **NIR**
  – 2-4um
  – Source: Quartz Tungsten Halogen lamp
  – Beamsplitter: Quartz

• **MIR**
  – 2-20um
  – Source: Ceramic Glow bar
  – Beamsplitter: KBr

• **FIR**
  – 10-50um
  – Source: Ceramic Glow bar
  – Beamsplitter: Mylar

• **VFIR**
  – 20-100um
  – Source: Ceramic Glow bar
  – Beamsplitter: Mylar

• **XFIR**
  – 40-100um
  – Source: Ceramic Glow bar
  – Beamsplitter: Mylar
Tying various spectral bands

• For each spectral band, an estimate of the spectral response function is obtained by taking the ratio of the sensor output to the PRD output.

• The overlap regions are used to tie adjacent spectral regions.

• Since the detector is broadband, the gain is assumed to be constant across all wavelengths.

• Tie the various spectral bands together while retaining the spectral features and keeping the gain constant.
First-cut Spectral Response

![Graph showing spectral response versus wavelength (μm).]
Radiance vs. Counts

$R^2 = 0.998$
Residual

Counts

0 2 4 6 8 10 12

-8 -6 -4 -2 0 2 4 6 8
Radiance-Counts Ratio

![Graph showing the relationship between percent change and wavelength (μm). The graph has a smooth curve that decreases from left to right, reaching a minimum around the middle, and then increases again. The x-axis represents wavelength in micrometers (μm), ranging from 9 to 15. The y-axis represents percent change, ranging from -4 to 4.]
FTS System Setup

Figure 1. FTS Vacuum Spectral Characterization Facility Layout

Figure 2. Opto-Mechanical Layout of the BIO-RAD Model 60A Spectrometer