



Irradiance Calibration Validation Report

Customer: [REDACTED]
Calibration Type: VIS-CR2
Spectrometer Serial Number: [REDACTED]
Validation Range: 350–1100 nm
Date: [REDACTED]

1. Calibration Overview

This certificate documents the verification of the Corrected Irradiance Calibration performed on Spectrometer SN: [REDACTED] using a NIST-traceable VIS calibration lamp. The new calibration file ("Corrected Calibration") is evaluated against the lamp standard and compared to the previous calibration file ("Previous Calibration").

All calculations were performed using strictly numeric irradiance data. Because the lamp standard is on a different wavelength grid, the Corrected and Previous calibration files were linearly interpolated onto the lamp wavelength grid for a direct comparison. The analysis region is 350–1100 nm.

2. Data Processing

Numeric-only parsing

- Each file was read line by line.
- Only lines containing exactly two numeric values (wavelength, irradiance) were kept.
- Any non-numeric metadata lines were automatically discarded.

Spectral range and alignment

- Only lamp wavelengths between 350.0 nm and 1100.0 nm were retained.
- The calibration files were interpolated to the lamp wavelength grid so each row represents the same λ for lamp, corrected, and previous.
- Lamp grid interval is handled dynamically (no fixed step size assumed).

Computed quantities per wavelength λ



General Percent Error Definition

$$\%E(\lambda) = 100 * (I_{\text{test}}(\lambda) - I_{\text{reference}}(\lambda)) / I_{\text{reference}}(\lambda)$$

Where:

- $I_{\text{test}}(\lambda)$ = irradiance from the calibration being evaluated (Corrected Calibration, Previous Calibration, or any calibration file)
- $I_{\text{reference}}(\lambda)$ = irradiance from the calibration lamp standard
- $\%E(\lambda)$ = percent error at wavelength λ
- N = number of wavelength points in the evaluation range

This single equation is used for:

- Corrected vs Lamp
- Previous vs Lamp
- Corrected vs Previous (where $I_{\text{reference}} = I_{\text{prev}}$)

Mean % Error

$$\text{Mean_}\% \text{Error} = (1/N) * \Sigma \%E(\lambda)$$

What it tells you

- Shows overall bias between the calibration and the reference.
- A negative value means the calibration is underestimating irradiance.
- A positive value means the calibration is overestimating irradiance.
- Close to 0% means the calibration has no systematic offset.

Mean Absolute % Error

$$\text{Mean_Absolute_}\% \text{Error} = (1/N) * \Sigma | \%E(\lambda) |$$

What it tells you

- Measures the average magnitude of the error, ignoring sign.
- Represents typical point-by-point deviation across the spectrum.
- Lower values mean tighter wavelength alignment to the lamp.
- This is the most intuitive measure of calibration accuracy.



RMS % Error

$$\text{RMS_}\%_Error = \sqrt{(1/N) * \sum (\%E(\lambda))^2 }$$

What it tells you

- Root-mean-square emphasizes large deviations more strongly.
- Sensitive to sharp peaks or large local calibration errors.
- Good indicator of spectral shape mismatch or tilt.
- If $\text{RMS} \approx \text{Mean Absolute Error}$ → errors are uniformly small
- If $\text{RMS} \gg \text{Mean Absolute Error}$ → some wavelengths have large spikes

Ratios

$$I_{\text{corr}}(\lambda) / I_{\text{lamp}}(\lambda)$$

$$I_{\text{prev}}(\lambda) / I_{\text{lamp}}(\lambda)$$

Absolute Deviations

$$| I_{\text{corr}}(\lambda) - I_{\text{lamp}}(\lambda) |$$

$$| I_{\text{prev}}(\lambda) - I_{\text{lamp}}(\lambda) |$$

Area Mismatch

$$\text{AreaMismatch} = (\sum | I_{\text{cal}}(\lambda) - I_{\text{lamp}}(\lambda) |) / (\sum I_{\text{lamp}}(\lambda)) \quad [\text{computed on lamp grid}]$$



3. Numerical Results (350–1100 nm)

3.1 Corrected Calibration vs Lamp

Mean % Error: -1.45 %

Mean Absolute % Error: 1.86 %

RMS % Error: 9.35 %

The Corrected Calibration reproduces the lamp irradiance very closely, with typical point-by-point deviations of only a few percent.

3.2 Previous Calibration vs Lamp

Mean % Error: -5.84 %

Mean Absolute % Error: 6.74 %

RMS % Error: 11.07 %

3.3 Corrected vs Previous Calibration

Mean % Difference: +4.75 %

Mean Absolute % Difference: 6.47 %

RMS % Difference: 7.98 %

The Corrected Calibration significantly reshapes the spectrum relative to the Previous version to better match the lamp standard.

3.4 Integrated Area Mismatch vs Lamp

Corrected Calibration: ~1.35 % integrated deviation

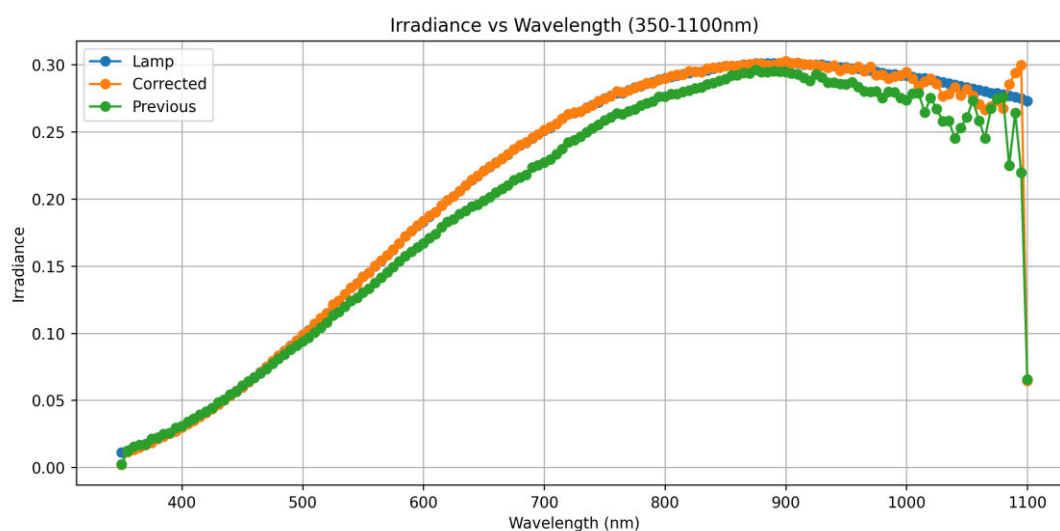
Previous Calibration: ~6.62 % integrated deviation

In terms of total irradiance over the validation band, the Corrected Calibration agrees with the lamp within only a few percent.

4. Spectral Plots

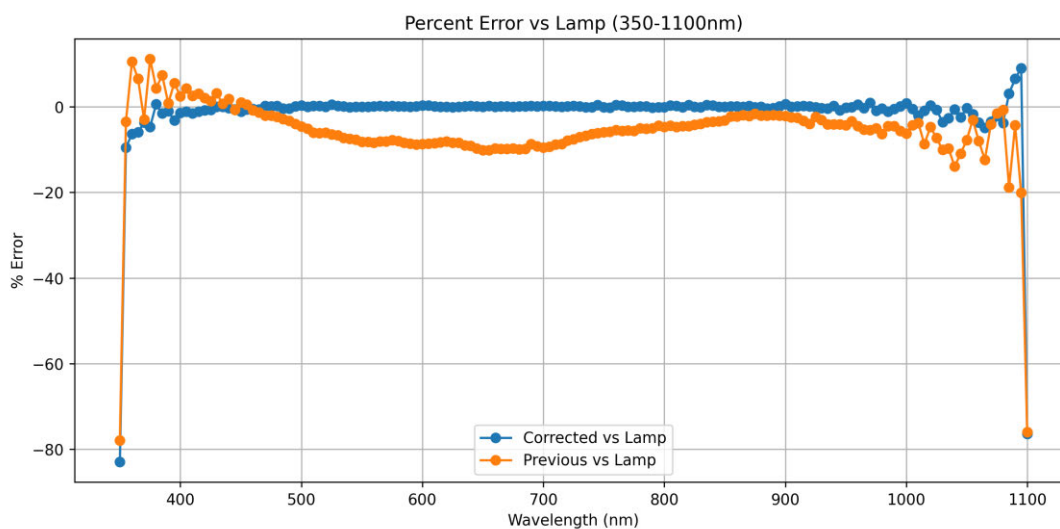
The following plots (350–1100 nm) illustrate the calibration performance:

Irradiance vs Wavelength



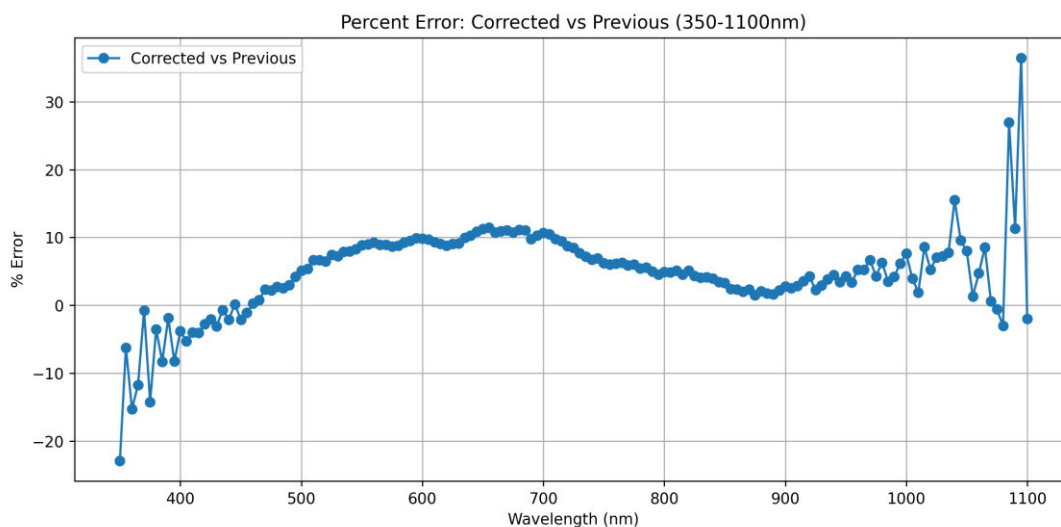
Corrected and lamp curves overlap closely across almost the entire range.

Percent Error vs Lamp



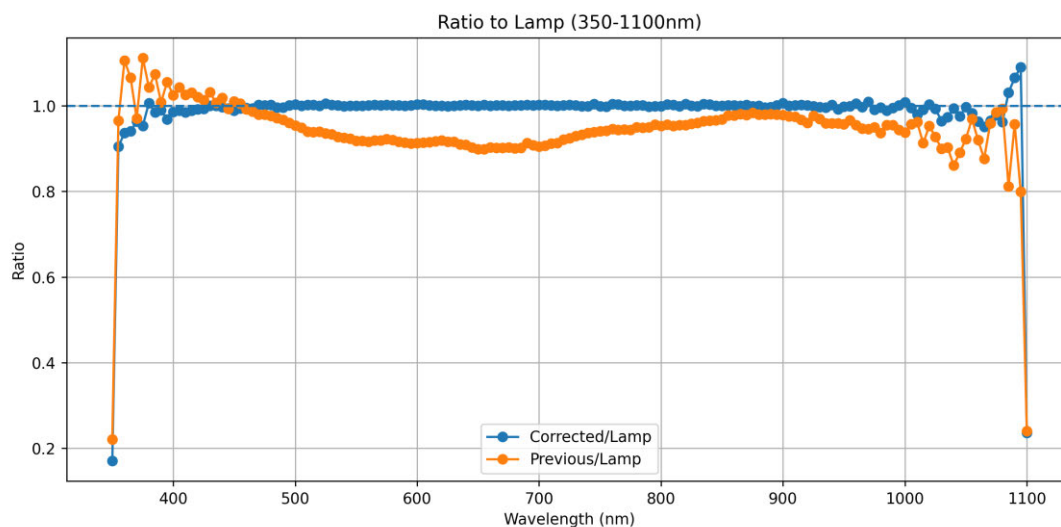
Corrected: error confined to a narrow band around 0%, generally within a small percentage range.

Percent Error: Corrected vs Previous



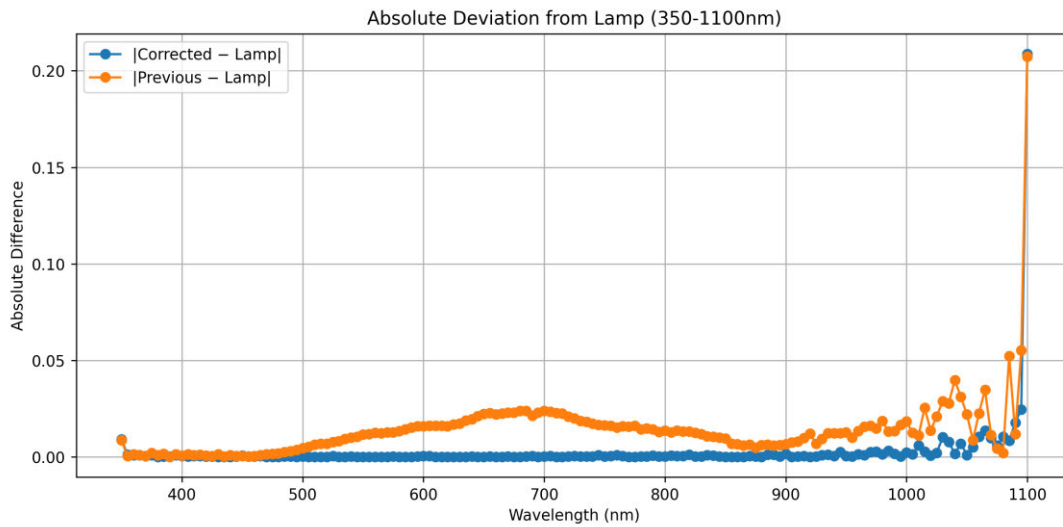
Shows the magnitude and wavelength dependence of the correction applied versus the previous calibration.

Ratio to Lamp (Corrected/Lamp, Previous/Lamp)



Corrected/Lamp ≈ 1.0 across the band indicates correct shape and scale relative to the lamp.

Absolute Deviation from Lamp



|Corrected - Lamp| is small across the band.

5. Calibration Quality & Conclusion

Based on the analysis of the files provided:

The Corrected Calibration shows excellent agreement with the calibration lamp standard in the 350–1100 nm range, with ~1.9% typical error and ~1.3% integrated deviation.

Conclusion:

The Corrected Calibration is validated and passes, accurately reproducing the lamp standard over 350–1100 nm.