

## Measurement Results

Results of Step 4 of the comparison. All uncertainties should be reported as absolute uncertainties.

Table A-2i Measurement Results

Laboratory: [NIST](#)

Filter Identifier: [A](#)

Date: 11/17/2014

Temperature of Laboratory: 25.32 °C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Spectral Transmittance <sup>(a)</sup>	9.1241E-01	9.1418E-01	9.1707E-01	9.1881E-01	9.2003E-01	9.2079E-01	9.2134E-01	9.2202E-01
Number of Measurements	3	3	3	3	3	3	3	3
Temperature	25.32	25.32	25.32	25.32	25.32	25.32	25.32	25.32
Type A Uncertainty <sup>(b)</sup>	2.67E-05	2.08E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05
Type A Uncertainty <sup>(c)</sup>	7.67E-05	7.67E-05	7.67E-05	7.67E-05	7.67E-05	7.67E-05	7.67E-05	7.67E-05
Type B Uncertainty <sup>(d)</sup>	5.22E-04	5.24E-04	5.27E-04	5.29E-04	5.31E-04	5.32E-04	5.32E-04	5.33E-04
Total Uncertainty <sup>(e)</sup>	5.23E-04	5.24E-04	5.27E-04	5.29E-04	5.31E-04	5.32E-04	5.32E-04	5.33E-04
Degrees of Freedom	1.17E+06	3.22E+06	1.95E+07	1.98E+07	2.00E+07	2.02E+07	2.03E+07	2.04E+07

Filter Identifier: [B](#)

Date: 11/17/2014

Temperature of Laboratory: 25.39 °C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Spectral Transmittance <sup>(a)</sup>	4.1353E-01	6.0783E-01	6.2173E-01	6.0960E-01	6.3708E-01	5.7646E-01	5.0128E-01	4.5283E-01
Number of Measurements	3	3	3	3	3	3	3	3
Temperature	25.39	25.39	25.39	25.39	25.39	25.39	25.39	25.39
Type A Uncertainty <sup>(b)</sup>	2.67E-05	2.08E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05
Type A Uncertainty <sup>(c)</sup>	2.25E-04	2.25E-04	2.25E-04	2.25E-04	5.98E-05	5.98E-05	5.98E-05	5.98E-05
Type B Uncertainty <sup>(d)</sup>	1.66E-03	9.64E-04	3.08E-04	1.85E-04	1.81E-04	1.80E-04	1.40E-04	9.70E-05
Total Uncertainty <sup>(e)</sup>	1.67E-03	9.65E-04	3.09E-04	1.87E-04	1.82E-04	1.81E-04	1.42E-04	1.01E-04
Degrees of Freedom	7.31E+07	2.03E+07	5.94E+05	5.17E+04	6.73E+04	5.54E+04	1.46E+04	2.60E+03

Filter Identifier: C

Date: 11/17/2014

Temperature of Laboratory: 25.26 °C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Spectral Transmittance <sup>(a)</sup>	2.2510E-02	9.5054E-02	9.1657E-02	7.6840E-02	1.6061E-01	1.4979E-01	1.0264E-01	7.6415E-02
Number of Measurements	3	3	3	3	3	3	3	3
Temperature	25.26	25.26	25.26	25.26	25.26	25.26	25.26	25.26
Type A Uncertainty <sup>(b)</sup>	2.67E-05	2.08E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05
Type A Uncertainty <sup>(c)</sup>	2.46E-05	2.46E-05	2.66E-05	2.66E-05	2.66E-05	2.66E-05	2.66E-05	2.66E-05
Type B Uncertainty <sup>(d)</sup>	6.11E-04	3.49E-04	1.25E-04	8.26E-05	6.65E-05	6.01E-05	5.59E-05	5.66E-06
Total Uncertainty <sup>(e)</sup>	6.13E-04	3.51E-04	1.27E-04	8.48E-05	7.07E-05	6.43E-05	5.95E-05	1.95E-05
Degrees of Freedom	2.20E+06	5.07E+05	2.91E+04	6.48E+03	1.22E+03	982.6	1.24E+03	20.4

Filter Identifier: D

Date: 11/17/2014

Temperature of Laboratory: 25.25 °C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Spectral Transmittance <sup>(a)</sup>	4.1380E-04	5.1715E-03	8.3937E-03	8.3073E-03	2.6380E-02	3.2139E-02	2.2481E-02	1.6638E-02
Number of Measurements	3	3	3	3	3	3	3	3
Temperature	25.25	25.25	25.25	25.25	25.25	25.25	25.25	25.25
Type A Uncertainty <sup>(b)</sup>	2.67E-05	2.08E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05
Type A Uncertainty <sup>(c)</sup>	1.55E-05	1.45E-05	1.45E-05	1.45E-05	1.45E-05	1.45E-05	1.45E-05	1.45E-05
Type B Uncertainty <sup>(d)</sup>	3.75E-05	2.45E-05	6.51E-06	1.40E-05	2.12E-05	5.71E-06	1.50E-05	4.53E-06
Total Uncertainty <sup>(e)</sup>	4.62E-05	3.24E-05	1.51E-05	1.95E-05	2.59E-05	1.62E-05	2.08E-05	1.48E-05
Degrees of Freedom	70.8	45.9	13.1	37.1	108.6	16.3	46.1	12.0

Filter Identifier: E

Date: 11/17/2014

Temperature of Laboratory: 25.27 °C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Spectral Transmittance <sup>(a)</sup>	3.6300E-05	3.6064E-04	9.8826E-04	1.0573E-03	5.2404E-03	1.0007E-02	8.7327E-03	7.3900E-03
Number of Measurements	3	3	3	3	3	3	3	3
Temperature	25.27	25.27	25.27	25.27	25.27	25.27	25.27	25.27
Type A Uncertainty <sup>(b)</sup>	2.67E-05	2.08E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05	1.33E-05
Type A Uncertainty <sup>(c)</sup>	5.27E-06	5.27E-06	5.27E-06	5.27E-06	5.27E-06	5.27E-06	5.27E-06	5.27E-06
Type B Uncertainty <sup>(d)</sup>	2.48E-06	2.03E-06	4.45E-07	2.40E-06	7.55E-06	2.50E-06	3.77E-06	2.33E-06
Total Uncertainty <sup>(e)</sup>	2.69E-05	2.11E-05	1.33E-05	1.35E-05	1.54E-05	1.39E-05	1.41E-05	1.38E-05
Degrees of Freedom	8.1	8.2	8.0	8.6	14.4	9.5	10.1	9.1

<sup>(a)</sup>**Spectral transmittance.** The value of the spectral transmittance of the central 17 mm diameter of the filter as measured by the participant laboratory.

<sup>(b)</sup>**Type A Uncertainty.** The uncertainties associated with the spectral transmittance values as determined by the repeatability of the measurement.

<sup>(c)</sup>**Type A Uncertainty.** The uncertainties associated with the spectral transmittance values as determined by the reproducibility of the measurement. For Step 4, three measurements were used to evaluate reproducibility.

<sup>(d)</sup>**Type B Uncertainty.** The uncertainties associated with the spectral transmittance values attributed to all Type B sources.

<sup>(e)</sup>**Total Uncertainty.** The total uncertainty of the measurement of spectral transmittance for a coverage factor of  $k=1$ . This value includes only the Type A Uncertainty determined by repeatability of the measurement and the Type B Uncertainty. The Type A Uncertainty determined by reproducibility is not typically reported in NIST calibration reports and is, thus, not included in the total uncertainty.

Table A-2ii Type B Uncertainty Budget

Laboratory: NIST

Filter Identifier: A

Wavelength (nm)	380	400	500	600	700	800	900	1000	Correlation Coefficient <sup>(b)</sup>
Nonlinearity	4.16E-05	4.18E-05	4.20E-05	4.22E-05	4.23E-05	4.24E-05	4.24E-05	4.25E-05	1.0
Temperature	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wavelength	1.38E-05	9.76E-06	1.95E-06	2.32E-06	1.25E-06	8.68E-07	7.36E-07	8.68E-07	0.0
Stray Light	1.17E-05	5.35E-06	3.89E-07	4.13E-08	2.52E-08	6.09E-08	1.81E-07	2.45E-07	1.0
Beam Size & Position	5.58E-05	5.60E-05	5.64E-05	5.66E-05	5.68E-05	5.69E-05	5.69E-05	5.70E-05	1.0
Inter-reflection <sup>(a)</sup>	4.27E-04	4.29E-04	4.32E-04	4.33E-04	4.35E-04	4.35E-04	4.36E-04	4.36E-04	0.5
Obliquity	2.59E-07	2.59E-07	2.59E-07	2.59E-07	2.59E-07	2.59E-07	2.59E-07	2.59E-07	1.0
Polarization	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Source Drift & Fluctuation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bandwidth	3.33E-06	3.34E-06	3.36E-06	3.38E-06	3.39E-06	3.39E-06	3.40E-06	3.40E-06	1.0
Other <sup>(c)</sup>									
Detector range ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Detector gain ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector reproducibility	2.91E-04	2.92E-04	2.94E-04	2.95E-04	2.96E-04	2.97E-04	2.97E-04	2.98E-04	1.0
Total Type B Uncertainty	5.22E-04	5.24E-04	5.27E-04	5.29E-04	5.31E-04	5.32E-04	5.32E-04	5.33E-04	
Degrees of Freedom	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	

Filter Identifier: B

Wavelength (nm)	380	400	500	600	700	800	900	1000	Correlation Coefficient <sup>(b)</sup>
Nonlinearity	1.69E-05	0.0	3.87E-05	3.72E-05	4.06E-05	3.32E-05	2.51E-05	2.05E-05	1.0
Temperature	0.0	0.0	3.19E-06	8.39E-06	4.35E-06	2.06E-06	7.74E-07	0.0	0.0
Wavelength	1.66E-03	9.48E-04	2.56E-04	8.59E-05	9.51E-05	1.04E-04	8.60E-05	3.45E-05	0.0
Stray Light	9.93E-05	1.15E-05	3.23E-06	1.13E-06	2.22E-06	5.26E-07	4.15E-06	8.70E-06	1.0
Beam Size & Position	2.96E-05	6.45E-05	6.76E-05	6.49E-05	7.09E-05	5.81E-05	4.39E-05	3.58E-05	1.0
Inter-reflection	2.96E-05	6.45E-05	6.76E-05	6.49E-05	7.09E-05	5.80E-05	4.39E-05	3.58E-05	1.0
Obliquity	1.11E-06	1.11E-06	1.11E-06	1.11E-06	1.11E-06	1.11E-06	1.11E-06	1.11E-06	1.0
Polarization	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Source Drift & Fluctuation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bandwidth	2.03E-06	4.43E-06	4.64E-06	4.46E-06	4.87E-06	3.99E-06	3.02E-06	2.46E-06	1.0
Other <sup>(c)</sup>									
Detector range ratio	0.0	7.39E-05	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Detector gain ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector reproducibility	5.93E-05	1.29E-04	1.35E-04	1.30E-04	1.42E-04	1.16E-04	8.80E-05	7.18E-05	1.0
Total Type B Uncertainty	1.66E-03	9.64E-04	3.08E-04	1.85E-04	1.81E-04	1.80E-04	1.40E-04	9.70E-05	
Degrees of Freedom	2.01E+12	1.05E+10	4.58E+09	1.25E+07	1.58E+08	3.05E+09	5.70E+10	9.56E+07	

Filter Identifier: C

Wavelength (nm)	380	400	500	600	700	800	900	1000	Correlation Coefficient <sup>(b)</sup>
Nonlinearity	0.0	0.0	0.0	0.0	2.58E-06	0.0	0.0	0.0	1.0
Temperature	0.0	0.0	2.73E-06	6.27E-06	5.14E-06	2.06E-06	5.69E-07	1.56E-06	0.0
Wavelength	6.11E-04	3.49E-04	1.25E-04	8.23E-05	6.53E-05	5.90E-05	5.57E-05	4.69E-06	0.0
Stray Light	2.87E-06	1.58E-06	2.96E-07	2.15E-07	4.88E-07	5.78E-07	1.26E-07	4.30E-07	1.0
Beam Size & Position	7.78E-08	1.44E-06	1.34E-06	9.46E-07	4.13E-06	3.59E-06	1.68E-06	9.33E-07	1.0
Inter-reflection	9.27E-08	1.71E-06	1.60E-06	1.13E-06	4.92E-06	4.27E-06	2.01E-06	1.11E-06	1.0
Obliquity	8.95E-07	8.95E-07	8.95E-07	8.95E-07	8.95E-07	8.95E-07	8.95E-07	8.95E-07	1.0
Polarization	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Source Drift & Fluctuation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bandwidth	4.48E-08	8.29E-07	7.74E-07	5.45E-07	2.38E-06	2.07E-06	9.69E-07	5.37E-07	1.0
Other <sup>(c)</sup>									
Detector range ratio	0.0	1.80E-06	0.0	0.0	0.0	4.49E-06	0.0	0.0	1.0
Detector gain ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector reproducibility	1.70E-07	3.15E-06	2.94E-06	2.07E-06	9.04E-06	7.86E-06	3.69E-06	2.04E-06	1.0
Total Type B Uncertainty	6.11E-04	3.49E-04	1.25E-04	8.26E-05	6.65E-05	6.01E-05	5.59E-05	5.66E-06	
Degrees of Freedom	9.41E+12	3.61E+08	2.37E+08	1.59E+06	1.49E+06	3.82E+07	4.95E+09	9.18E+03	

Filter Identifier: **D**

Wavelength (nm)	380	400	500	600	700	800	900	1000	Correlation Coefficient <sup>(b)</sup>
Nonlinearity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperature	0.0	8.48E-07	5.09E-07	1.29E-06	1.72E-06	8.15E-07	2.10E-07	5.46E-07	0.0
Wavelength	3.75E-05	2.45E-05	6.48E-06	1.39E-05	2.11E-05	5.42E-06	1.50E-05	4.46E-06	0.0
Stray Light	1.18E-08	5.96E-08	1.26E-08	6.64E-09	1.27E-08	4.62E-08	7.29E-09	6.31E-09	1.0
Beam Size & Position	2.39E-10	3.83E-08	1.02E-07	9.99E-08	1.01E-06	1.49E-06	7.28E-07	3.98E-07	1.0
Inter-reflection	5.85E-11	9.35E-09	2.48E-08	2.44E-08	2.46E-07	3.64E-07	1.78E-07	9.73E-08	1.0
Obliquity	3.37E-07	3.37E-07	3.37E-07	3.37E-07	3.37E-07	3.37E-07	3.37E-07	3.37E-07	1.0
Polarization	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Source Drift & Fluctuation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bandwidth	1.75E-11	2.79E-09	7.41E-09	7.28E-09	7.33E-08	1.09E-07	5.31E-08	2.90E-08	1.0
Other <sup>(c)</sup>									
Detector range ratio	3.33E-11	5.31E-09	1.41E-08	1.39E-08	1.40E-07	2.07E-07	1.01E-07	5.53E-08	1.0
Detector gain ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector reproducibility	5.82E-11	9.30E-09	2.47E-08	2.43E-08	2.44E-07	3.62E-07	1.77E-07	9.67E-08	1.0
Total Type B Uncertainty	3.75E-05	2.45E-05	6.51E-06	1.40E-05	2.12E-05	5.71E-06	1.50E-05	4.53E-06	
Degrees of Freedom	6.19E+13	3.69E+07	1.42E+06	7.39E+05	1.23E+06	1.28E+05	1.36E+09	2.52E+05	

Filter Identifier: E

Wavelength (nm)	380	400	500	600	700	800	900	1000	Correlation Coefficient <sup>(b)</sup>
Nonlinearity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperature	0.0	9.12E-08	8.86E-08	2.40E-07	5.07E-07	3.49E-07	1.05E-07	4.73E-07	0.0
Wavelength	2.48E-06	2.02E-06	4.12E-07	2.39E-06	7.53E-06	2.44E-06	3.75E-06	2.27E-06	0.0
Stray Light	1.42E-10	1.49E-09	5.64E-10	3.12E-10	6.14E-11	5.48E-09	3.16E-09	2.47E-09	1.0
Beam Size & Position	2.55E-12	4.90E-10	3.73E-09	4.29E-09	1.05E-07	3.82E-07	2.91E-07	2.08E-07	1.0
Inter-reflection	6.82E-13	1.31E-10	9.98E-10	1.15E-09	2.81E-08	1.02E-07	7.78E-08	5.57E-08	1.0
Obliquity	1.41E-07	1.41E-07	1.41E-07	1.41E-07	1.41E-07	1.41E-07	1.41E-07	1.41E-07	1.0
Polarization	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Source Drift & Fluctuation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bandwidth	8.69E-14	1.67E-11	1.27E-10	1.46E-10	3.59E-09	1.30E-08	9.92E-09	7.09E-09	1.0
Other <sup>(c)</sup>									
Detector range ratio	1.34E-13	2.57E-11	1.96E-10	2.25E-10	5.52E-09	2.01E-08	1.53E-08	1.09E-08	1.0
Detector gain ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector reproducibility	2.34E-13	4.50E-11	3.42E-10	3.94E-10	9.65E-09	3.51E-08	2.67E-08	1.91E-08	1.0
Total Type B Uncertainty	2.48E-06	2.03E-06	4.45E-07	2.40E-06	7.55E-06	2.50E-06	3.77E-06	2.33E-06	
Degrees of Freedom	4.53E+12	1.29E+07	3.37E+04	5.32E+05	2.60E+06	1.40E+05	8.88E+07	3.14E+04	

<sup>(a)</sup> **Inter-reflection.** NIST previously speculated that the contamination seen on this filter following Step 2 may have contributed to the magnitude of the inter-reflection uncertainty component. During Step 4, the inter-reflection uncertainty component was re-evaluated. However, there was no change in the value. Therefore, the component determined during Step 2 is used for Step 4, and the correlation coefficient is 1.

<sup>(b)</sup> **Correlation coefficient** of uncertainty component relative to measurements made during step 2.

<sup>(c)</sup> **Other.** The three rows provided below this one list additional components of uncertainty considered for NIST.

**Signature :**

**Date :**