

Measurement Results

Results of Step 2 of the comparison. All uncertainties should be reported as absolute uncertainties.

Table A-2i Measurement Results

Laboratory: [NIST](#)

Filter Identifier: [A](#)

Date: 12/30/2013

Temperature of Laboratory: 25.19 °C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Spectral Transmittance ^(a)	9.1177E-01	9.1364E-01	9.1682E-01	9.1874E-01	9.1998E-01	9.2079E-01	9.2143E-01	9.2199E-01
Number of Measurements	2	2	2	2	2	2	2	2
Temperature	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19
Type A Uncertainty ^(b)	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 ^(c)	6.25E-05	6.25E-05	6.25E-05	6.25E-05	6.25E-05	6.25E-05	6.25E-05	6.25E-05
Type B Uncertainty ^(d)	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 ^(e)	5.22E-04	5.24E-04	5.27E-04	5.29E-04	5.31E-04	5.32E-04	5.33E-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: 12/30/2013

Temperature of Laboratory: 25.18 °C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Spectral Transmittance ^(a)	4.0954E-01	6.0823E-01	6.2223E-01	6.0986E-01	6.3734E-01	5.7664E-01	5.0142E-01	4.5293E-01
Number of Measurements	2	2	2	2	2	2	2	2
Temperature	25.18	25.18	25.18	25.18	25.18	25.18	25.18	25.18
Type A Uncertainty ^(b)	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 ^(c)	1.46E-04	1.46E-04	1.46E-04	1.46E-04	5.24E-05	5.24E-05	5.24E-05	5.24E-05
Type B Uncertainty ^(d)	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 ^(e)	1.67E-03	9.65E-04	3.09E-04	1.87E-04	1.82E-04	1.81E-04	1.42E-04	1.00E-04
Degrees of Freedom	8.43E+07	5.48E+06	7.69E+05	6.78E+04	8.76E+04	7.33E+04	1.98E+04	3.54E+03

Filter Identifier: C

Date: 12/30/2013

Temperature of Laboratory: 25.20 °C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Spectral Transmittance ^(a)	2.1654E-02	9.4948E-02	9.1705E-02	7.6857E-02	1.6070E-01	1.4980E-01	1.0264E-01	7.6400E-02
Number of Measurements	2	2	2	2	2	2	2	2
Temperature	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20
Type A Uncertainty ^(b)	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 ^(c)	4.39E-05	4.39E-05	2.13E-05	2.13E-05	2.13E-05	2.13E-05	2.13E-05	2.13E-05
Type B Uncertainty ^(d)	6.11E-04	3.49E-04	1.25E-04	8.27E-05	6.67E-05	6.01E-05	5.59E-05	5.81E-06
Total Uncertainty ^(e)	6.13E-04	3.51E-04	1.27E-04	8.49E-05	7.07E-05	6.42E-05	5.94E-05	1.93E-05
Degrees of Freedom	2.20E+06	5.17E+05	3.10E+04	6.79E+03	1.34E+03	1.07E+03	1.32E+03	20.6

Filter Identifier: D

Date: 12/30/2013

Temperature of Laboratory: 25.21 °C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Spectral Transmittance ^(a)	4.0281E-04	5.1617E-03	8.3973E-03	8.3104E-03	2.6411E-02	3.2147E-02	2.2478E-02	1.6623E-02
Number of Measurements	2	2	2	2	2	2	2	2
Temperature	25.21	25.21	25.21	25.21	25.21	25.21	25.21	25.21
Type A Uncertainty ^(b)	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 ^(c)	4.51E-05	1.23E-05	1.23E-05	1.23E-05	1.23E-05	1.23E-05	1.23E-05	1.23E-05
Type B Uncertainty ^(d)	3.75E-05	2.45E-05	6.52E-06	1.41E-05	2.12E-05	5.76E-06	1.50E-05	4.55E-06
Total Uncertainty ^(e)	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	46.0	13.1	37.3	109.2	16.2	46.0	11.9

Filter Identifier: E

Date: 12/30/2013

Temperature of Laboratory: 25.22 °C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Spectral Transmittance ^(a)	1.8480E-05	3.5908E-04	9.8757E-04	1.0574E-03	5.2499E-03	1.0015E-02	8.7339E-03	7.3962E-03
Number of Measurements	2	2	2	2	2	2	2	2
Temperature	25.22	25.22	25.22	25.22	25.22	25.22	25.22	25.22
Type A Uncertainty ^(b)	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 ^(c)	4.66E-06	4.66E-06	4.66E-06	4.66E-06	4.66E-06	4.66E-06	4.66E-06	4.66E-06
Type B Uncertainty ^(d)	2.48E-06	2.03E-06	4.51E-07	2.41E-06	7.56E-06	2.52E-06	3.77E-06	2.37E-06
Total Uncertainty ^(e)	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	10.0	9.1

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

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

^(c)**Type A Uncertainty.** The uncertainties associated with the spectral transmittance values as determined by the reproducibility of the measurement. For Step 2, only two measurements were used to evaluate reproducibility due to hardware issues. It is anticipated that for Step 4 three measurements will be used to evaluate reproducibility.

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

^(e)**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
Nonlinearity	4.16E-05	4.17E-05	4.20E-05	4.22E-05	4.23E-05	4.24E-05	4.25E-05	4.25E-05
Temperature	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
Stray Light	1.17E-05	5.34E-06	3.89E-07	4.13E-08	2.52E-08	6.09E-08	1.82E-07	2.45E-07
Beam Size & Position	5.57E-05	5.60E-05	5.64E-05	5.66E-05	5.68E-05	5.69E-05	5.69E-05	5.70E-05
Inter-reflection ^(a)	4.27E-04	4.29E-04	4.32E-04	4.33E-04	4.35E-04	4.35E-04	4.36E-04	4.36E-04
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
Polarization	0	0	0	0	0	0	0	0
Source Drift & Fluctuation	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
Other ^(b)								
Detector range ratio	0	0	0	0	0	0	0	0
Detector gain ratio	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
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
Nonlinearity	1.68E-05	0.0	3.87E-05	3.72E-05	4.06E-05	3.33E-05	2.51E-05	2.05E-05
Temperature	0.0	0.0	4.23E-06	1.11E-05	5.76E-06	2.73E-06	1.02E-06	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
Stray Light	9.83E-05	1.15E-05	3.23E-06	1.13E-06	2.22E-06	5.26E-07	4.15E-06	8.71E-06
Beam Size & Position	2.93E-05	6.46E-05	6.76E-05	6.50E-05	7.10E-05	5.81E-05	4.39E-05	3.58E-05
Inter-reflection	2.93E-05	6.46E-05	6.76E-05	6.50E-05	7.09E-05	5.81E-05	4.39E-05	3.58E-05
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
Polarization	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
Bandwidth	2.01E-06	4.44E-06	4.65E-06	4.46E-06	4.88E-06	3.99E-06	3.02E-06	2.46E-06
Other ^(b)								
Detector range ratio	0.0	7.40E-05	0.0	0.0	0.0	0.0	0.0	0.0
Detector gain ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector reproducibility	5.87E-05	1.29E-04	1.36E-04	1.30E-04	1.42E-04	1.16E-04	8.80E-05	7.18E-05
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	4.25E+1 1	2.13E+0 9	9.26E+0 8	2.55E+0 6	3.21E+0 7	6.20E+0 8	1.16E+1 0	1.94E+0 7

Filter Identifier: C

Wavelength (nm)	380	400	500	600	700	800	900	1000
Nonlinearity	0.0	0.0	0.0	0.0	2.58E-06	0.0	0.0	0.0
Temperature	0.0	0.0	3.62E-06	8.32E-06	6.81E-06	2.73E-06	7.53E-07	2.06E-06
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
Stray Light	2.76E-06	1.58E-06	2.96E-07	2.15E-07	4.88E-07	5.78E-07	1.26E-07	4.30E-07
Beam Size & Position	7.49E-08	1.44E-06	1.35E-06	9.46E-07	4.13E-06	3.59E-06	1.68E-06	9.32E-07
Inter-reflection	8.92E-08	1.71E-06	1.60E-06	1.13E-06	4.92E-06	4.27E-06	2.01E-06	1.11E-06
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
Polarization	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
Bandwidth	4.31E-08	8.28E-07	7.74E-07	5.45E-07	2.38E-06	2.07E-06	9.69E-07	5.37E-07
Other ^(b)								
Detector range ratio	0.0	1.80E-06	0.0	0.0	0.0	4.49E-06	0.0	0.0
Detector gain ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector reproducibility	1.64E-07	3.15E-06	2.95E-06	2.07E-06	9.05E-06	7.86E-06	3.69E-06	2.04E-06
Total Type B Uncertainty	6.11E-04	3.49E-04	1.25E-04	8.27E-05	6.67E-05	6.01E-05	5.59E-05	5.81E-06
Degrees of Freedom	2.24E+1 2	7.41E+0 7	4.78E+0 7	3.23E+0 5	3.02E+0 5	7.75E+0 6	1.00E+0 9	2.09E+0 3

Filter Identifier: **D**

Wavelength (nm)	380	400	500	600	700	800	900	1000
Nonlinearity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperature	0.0	1.12E-06	6.75E-07	1.71E-06	2.28E-06	1.08E-06	2.79E-07	7.21E-07
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
Stray Light	1.15E-08	5.95E-08	1.26E-08	6.64E-09	1.27E-08	4.62E-08	7.29E-09	6.31E-09
Beam Size & Position	2.33E-10	3.82E-08	1.02E-07	9.99E-08	1.01E-06	1.49E-06	7.28E-07	3.98E-07
Inter-reflection	5.70E-11	9.33E-09	2.49E-08	2.44E-08	2.46E-07	3.64E-07	1.78E-07	9.72E-08
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
Polarization	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
Bandwidth	1.70E-11	2.78E-09	7.42E-09	7.28E-09	7.34E-08	1.09E-07	5.31E-08	2.90E-08
Other ^(b)								
Detector range ratio	3.24E-11	5.30E-09	1.41E-08	1.39E-08	1.40E-07	2.07E-07	1.01E-07	5.52E-08
Detector gain ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector reproducibility	5.67E-11	9.28E-09	2.47E-08	2.43E-08	2.45E-07	3.62E-07	1.77E-07	9.66E-08
Total Type B Uncertainty	3.75E-05	2.45E-05	6.52E-06	1.41E-05	2.12E-05	5.76E-06	1.50E-05	4.55E-06
Degrees of Freedom	1.41E+1 3	7.70E+0 6	2.87E+0 5	1.49E+0 5	2.50E+0 5	2.67E+0 4	2.76E+0 8	5.26E+0 4

Filter Identifier: E

Wavelength (nm)	380	400	500	600	700	800	900	1000
Nonlinearity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperature	0.0	1.19E-07	1.17E-07	3.20E-07	6.74E-07	4.63E-07	1.39E-07	6.25E-07
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
Stray Light	7.23E-11	1.49E-09	5.63E-10	3.12E-10	6.15E-11	5.49E-09	3.16E-09	2.47E-09
Beam Size & Position	1.30E-12	4.88E-10	3.72E-09	4.29E-09	1.05E-07	3.82E-07	2.91E-07	2.08E-07
Inter-reflection	3.47E-13	1.31E-10	9.98E-10	1.15E-09	2.82E-08	1.02E-07	7.79E-08	5.57E-08
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
Polarization	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
Bandwidth	4.42E-14	1.66E-11	1.27E-10	1.46E-10	3.59E-09	1.31E-08	9.92E-09	7.10E-09
Other ^(b)								
Detector range ratio	6.81E-14	2.56E-11	1.96E-10	2.25E-10	5.53E-09	2.01E-08	1.53E-08	1.09E-08
Detector gain ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector reproducibility	1.19E-13	4.48E-11	3.42E-10	3.94E-10	9.67E-09	3.51E-08	2.67E-08	1.91E-08
Total Type B Uncertainty	2.48E-06	2.03E-06	4.51E-07	2.41E-06	7.56E-06	2.52E-06	3.77E-06	2.37E-06
Degrees of Freedom	1.39E+1 3	2.75E+0 6	7.21E+0 3	1.07E+0 5	5.21E+0 5	2.91E+0 4	1.80E+0 7	6.80E+0 3

^(a) **Inter-reflection.** NIST speculates that the contamination seen on this filter following Step 2 may be due to the sample holder used in NIST's transfer instrument. Although measurements for transmittance were completed on the reference instrument prior to filter measurements made using the transfer instrument, the measurements for evaluating the inter-reflection were made on the reference instrument following filter measurements made using the transfer instrument. Therefore, the uncertainty component for inter-reflection for filter A may be re-evaluated during Step 4.

^(b) **Other.** The three rows provided below this one list additional components of uncertainty considered for NIST.

Signature :

Date :