Report of the Key Comparison

CCPR-K5

Spectral Diffuse Reflectance

Final Report

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1. Introduction

Under the authority given to the Comité International des Poids et Mesures (CIPM) in the Metre Convention, the committee has drawn up an agreement for *Mutual recognition of national standards and of calibration and measurement certificates issued by national metrology institutes* [BIPM publication, 1999, 41 pages]. The technical basis of this agreement will be the results of a number of key comparisons of national measurement standards, now being carried out by the Bureau International des Poids et Mesures (BIPM) and by the Consultative Committees, complemented by corresponding key comparisons carried out by the Regional Metrology Organisations (RMOs). Six key comparisons were decided upon at the 14th CCPR meeting in June 1997, one of which is spectral diffuse reflectance.

The first invitation letter to participate in the spectral diffuse reflectance comparison was sent on May 1999. NIST is the pilot laboratory for this comparison. The working group consists of NIST (Edward Early), KRISS (Kim Chang Soon), NPL (Julie Taylor), NRC (Joanne Zwinkels), and PTB (Werner Möller). The second invitation letter was sent on March 2002. At that point the technical protocol was still under discussion. The experimental conditions agreed upon were 0º:d or d:0º measurement geometry and the wavelength range of 360 nm to 830 nm. There was debate about the artifacts to be measured. Spectralon[1] will be one of the artifacts, even though PTB has seen changes in reflectance with exposure time, while the other artifact would be either matte opal or matte ceramic tile. The choice would be based primarily upon availability. At the end, the standards chosen for the comparison are Spectralon and matte ceramic tile.

[1] Spectralon is a registered trademark of Labsphere, Inc., and is a sintered plaque of pressed Polytetrafluoroethylene (PTFE) powder. Certain commercial equipment, instruments, or materials (or suppliers, or software, ...) are identified in this paper to foster understanding. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

2. Participants

Acronyms	***Laboratory Name***	***Country***	***Contact Persons***
CSIR-NML	Council for Scientific and Industrial Research, National Metrology Laboratory; as of May 1, 2008 known as National Metrology Institute of South Africa (NMISA)	South Africa	Natasha Nel-Sakharova
HUT	Helsinki University of Technology; as of May 1, 2008 known as Metrology Research Institute, Centre for Metrology and Accreditation (MIKES)	Finland	Farshid Manoocheri, Erkki Ikonen
IFA-CSIC	Instituto de Fisica Aplicada – Consejo Superior de Investigaciones Cientificas ; In 2010, changed to Instituto de Óptica, Agencia Estatal Consejo Superior de Investigaciones Científicas (IO-CSIC)	Spain	Alicia Pons, Joaquin Campos
KRISS	Korea Research Institute of Standards and Science	Republic of Korea	Kim Chang Soon Jisoo Hwang, Dong-Hoon Lee
MSL	Measurement Standards Laboratory	New Zealand	John Clare
NIM	National Institute of Metrology	China	Ma Yu, Lin Yandong
NIST	National Institute of Standards and Technology	USA	Maria Nadal, Kenneth Eckerle, Edward Early
NMIJ, AIST	National Metrology Institute of Japan	Japan	Hiroshi Shitomi, Tatsuya Zama
NPL	National Physical Laboratory	UK	Christopher Chunnilall, Julie Taylor, Nigel Fox
NRC	National Research Council	Canada	Joanne Zwinkels
OMH	Országos Mérésügyi Hivatal; as of January 2007 known as Hungarian Trade licensing Office (MKEH)	Hungary	George Andor
PTB	Physikalisch-Technische Bundesanstalt	Germany	Andreas Höpe Werner Möller
VNIIOFI	All-Russian Research Institute for Optical and Physical Measurements	Russia Federation	Svetlana Morozova

3. Technical Protocol of the Comparison

The spectral diffuse reflectance of each sample was measured using the d:0º (or 0º:d) geometry from 360 nm to 820 nm at 20 nm increments. Note that the directional angle should truly be 0º, not ±10º. At each laboratory, at least one sample of each type (Spectralon and matte white ceramic tile) was measured three (3) times on three (3) separate days, and the other two samples of each type were measured once, if not three times. The samples measured three times should be removed from the instrument between repeated measurements, so that the reproducibility of the measurements can be assessed. The purpose of including three samples of each type is redundancy in case of a problem with one of the samples. Therefore, it was not necessary to measure all six samples three times each, but this was permissible if the institute so desired.

The logistics of the comparison, instructed to each participant, is as follow. The designated person for each participating institute is first contacted prior to shipping the samples to verify that the institute is ready to receive and measure the samples. Upon receipt of the package, if there is an accompanying ATA Carnet document, keep it attached to the package, as it will be needed when the samples are returned to NIST. The samples should first be inspected for damage. The samples will be face-down in their containers, with the serial numbers visible. Always wear gloves when handling the samples to prevent contamination of the front surface. Remove the samples from the package, and inspect the front surfaces for damage, such as dents or scratches. Dirt can be removed by blowing with air or a clean gas. The participants should report receipt of the samples and any damage to the comparison coordinator. If a sample is damaged, a replacement will be sent to the participating institute. Upon completion of the measurements, repackage the samples as they were upon arrival and send the package, along with the ATA Carnet document, if applicable, back to NIST. Each participating institute is responsible for the shipping costs to return the samples to NIST.

Additional samples, supplied by the participating institute, can also be included in the comparison as a supplement to the key comparison. These samples, measured under the same conditions as those of the key comparison detailed below, could serve as artifacts residing at the participating institute at the conclusion of the key comparison. They would be sent to NIST at the same time as the key comparison samples are returned, NIST would measure them along with the key comparison samples, and then they would be returned to the participating institute. Arrangements for these additional samples must be made by contacting the comparison coordinator prior to their arrival at NIST. It was decided later that these additional comparisons are regarded as unofficial bilateral comparisons, separate from the CCPR Key Comparison, thus, these results are not reported in this report.

The samples will be mounted for measurement using the normal practice for each participating institute. The exterior dimensions of the samples are similar so that the two types are easily interchangeable on the sample port of an integrating sphere. Therefore, the frames of the Spectralon samples should normally not be removed. The samples can be modified to accommodate the requirements of an instrument, provided these modifications are done in consultation with NIST. If the samples must be permanently modified (e.g. corners removed or dimensions reduced), consult with NIST and the modifications will be performed at NIST before they are measured and sent to the participating institute. If the frame of the Spectralon sample must be removed, place a black surface at the back of the sample since Spectralon is translucent. Any mounts or frames used with modified samples are to be sent to NIST along with the returned samples so that their effect on the measured reflectance can be evaluated.

The measurement results will be reported to NIST when the samples are returned, and items are enclosed with the samples for this purpose. Two tables on sheets of paper are to be filled out, the measurement results are to be placed on the floppy disk, and all are to be returned with the samples. Additionally, the results should be e-mailed to NIST if at all possible. Note that failure to return all the requested information and results will cause the institute to be excluded from the report on the comparison.

The accompanying Tables 3.1 and 3.2, detailing the measurement parameters and uncertainties, respectively, must be completed. Indicate the parameters and uncertainties that are not applicable to the measurement, and include any additional ones that are relevant. The uncertainties can be broken down by wavelength region, if needed, and should be reported with a coverage factor k = 1. Additional communication between NIST and the participating institute may be required to obtain all the necessary information.

The results for each sample and measurement are to be reported as a separate ASCII tab-delimited file. The file name will be of the form IIII_SSS_N_WW.txt, where

IIII is the institute (e.g. NIST, PTB),
SSS is the sample serial number (e.g. S09, C15),
N is the measurement index (1, 2, or 3), and
WW is the wavelength increment (20 required, others optional, e.g. 25, V).

The file will contain two columns of tab-delimited numbers; first the wavelength and second the diffuse reflectance. The diffuse reflectance must be reported for wavelengths from 360 nm to 820 nm every 20 nm. At a minimum, two samples will each be measured three times and four samples will each be measured once, so there will be a minimum of 10 files of the form IIII_SSS_N_20.txt, where N = 1, 2, or 3. If the institute measures all six samples three times each, there will be 18 files. For those instruments that do not measure with a 20 nm wavelength increment, the results at the measured wavelengths are also to be reported, resulting in additional files. Use the actual wavelength increment in the file name if it is regular (e.g. 25), and use a “V” in the file name if the increment is variable. Also, include in the returned package a description of the technique used to convert the diffuse reflectance measured at the instrument wavelengths to those at every 20 nm.

Table 3.1 Measurement Parameters

Parameter	Value or Description
Geometry (0º:d or d:0º)	
Directional Angle	
Sphere Diameter	
Sphere Coating	
Diameter of Entrance Port	
Diameter of Sample Port	
Diameter of Viewing Port	
Beam Diameter	
Beam f/# (f/∞ for collimated)	
Beam Polarization	
Spectral Bandwidth	
Wavelength Range and Increment	
Calibration Standard Traceability	

Table 3.2 Measurement Uncertainties

Source of Uncertainty	Type (A or B)	Standard Uncertainty	Uncertainty in Diffuse reflectance
Signal Noise			
Instrument Stability			
Wavelength			
Detector Linearity			
Van den Akker Method			
Calibration Standard			
Sharp-Little Method			
Calibration Standard			

(Continued.)

Korte Method			
Port Correction			
Irradiance Uniformity			
Wall Correlation			

4. NIST Measurement Capabilities as the Pilot Laboratory

4.1 Comparison reference standards

A set of three Spectralon samples with serial numbers S01, S02, and S03 and a set of three Ceramic tile samples with serial numbers C01, C02, and C03 were used as the reference standards to maintain the scale for the comparison. These six samples are designated as *Comparison reference standards*. The diffuse reflectance of these samples was initially measured on the NIST Spectral Tri-function Automated Reference Reflectometer (STARR) [1]. STARR is the NIST reference instrument for spectral reflectance measurements of spectrally neutral, non-fluorescent samples at room temperature. These reference standards were used to calibrate the NIST transfer spectrophotometer, Cary5E. All of the comparison artifacts in this comparison were measured using the Cary5E against the comparison reference standards. STARR has the capability of measuring absolute bi-directional reflectance (on samples with widths from 50 mm to 300 mm) as well as diffuse reflectance at wavelengths from 250 nm to 1100 nm, while specular reflectance can be measured at wavelengths from 250 nm to 2500 nm.

4.2 STARR

4.2.1 Description of instrument

STARR was used to initially calibrate the comparison reference standards at the start of the comparison and also to check the stability of the comparison reference standards during the comparison. STARR performs relative measurements of directional-hemispherical reflectance on samples with widths from 50 mm to 300 mm. The primary standard used at NIST is pressed polytetrafluoroethylene (PTFE), whose 0º:d spectral diffuse reflectance was determined using the absolute method of Van den Akker [2]. The reflectance can be measured with either a 6º or 0º angle of illumination, specular component included or excluded, respectively, at wavelengths from 250 nm to 2500 nm.

A spherical mirror focuses radiant flux from a source through an order-sorting filter and a shutter onto the entrance slit of a single-grating monochromator. The beam emerging from the exit slit of the monochromator is incident on an iris to provide a circular illumination beam and is focused by an off-axis parabolic mirror. The beam passes through the entrance port of the integrating sphere and is incident upon one of two positions: sample or wall. The reflected radiant flux undergoes multiple reflections within the sphere, and a portion is viewed by the detector, which produces a signal proportional to the reflected radiant flux. The integrating sphere has a diameter of 30 cm, is lined with a 10 mm thick coating of PTFE, and has a sample port with a diameter of 5 cm. In the sample position the radiant flux is incident upon the item placed at the sample port, while in the wall position the radiant flux is incident upon the wall of the sphere. In each position the shutter on the monochromator is closed for a dark signal measurement. At each wavelength, signals are measured from the sample, shutter, wall, shutter, sample, and shutter positions, in order. Signals from the sample and wall positions are proportional to the reflectance factor of the sample and wall, respectively. Net signals for the sample and wall positions are obtained by subtracting the shutter signals.

The sampling aperture, defined by the illumination beam, had a diameter of 25 mm and was located at the center of the calibration item. The maximum deviation of any ray within the illumination beam from the illumination angle was 0.36º. The angle of illumination was the normal of the surface of the calibration item and reflected radiant flux was collected by the integrating sphere, excluding the specular component. This geometry is designated as 0º:d.

4.2.2 Uncertainty budget for STARR

The designation 0º:d refers to the directional-diffuse geometry of the measurement, where the illumination angle is 0º and viewing is over the entire hemisphere, excluding the specular component of reflection.

The reflectance factor R at each wavelength λ is given by

$$R(\lambda) = \frac{y(\lambda)}{y_w(\lambda)} \cdot \frac{y_{w,s}(\lambda)}{y_s(\lambda)} \cdot R_s(\lambda) \qquad (4.1)$$

where $y(\lambda)$ is the net signal from the reflected radiant flux from the item, $y_w(\lambda)$ is the net signal from the reflected radiant flux from the wall when the item is at the sample port, $y_{w,s}(\lambda)$ is the net signal from the reflected radiant flux from the wall when the standard is at the sample port, $y_s(\lambda)$ is the net signal from the reflected radiant flux from the standard, and R_s is the 0º:d spectral reflectance factor of the PTFE standard. Measuring the 0º:d spectral reflectance factor of the calibration item is a relative measurement and therefore requires comparison to a standard with a calibrated 0º:d spectral reflectance factor. The final 0º:d spectral reflectance factor was obtained by averaging the values from multiple scans.

Samples of the pressed PTFE standard and the transfer standards were cleaned with an air bulb and sequentially mounted and centered at the sample port of the integrating sphere. The PTFE standard and the transfer standards were measured at wavelengths from 360 nm to 820 nm at 20 nm increments. The spectral bandwidth of the illumination beam was 14.5 nm. The source was a Quartz Tungsten Halogen (QTH) and the detector was an ultraviolet-enhanced Si photodiode.

Uncertainties were calculated according to the procedures outlined in Refs. [1] and [3]. Sources of uncertainty due to random effects are source stability and detector noise. The uncertainty contribution caused by these sources was evaluated from the standard deviation of repeat measurements of the standard and item.

Uncertainty components due to systematic effects are the wavelength of the monochromator, linearity of the receiver, item uniformity, and the 0º:d spectral reflectance factor of the PTFE standard. The uncertainty caused by wavelength was evaluated from the derivative of the spectral reflectance factor. The uncertainty contribution caused by linearity includes both the detector and the signal electronics. The uncertainty caused by the standard was evaluated previously [4]. All the uncertainty components were assumed to have normal probability distributions.

The resulting uncertainty contributions to 0º:d spectral reflectance factor due to Type A or B are given in Table 4.1. The expanded uncertainty was obtained from the root-sum-square of the uncertainty contributions multiplied by a coverage factor $k = 2$. The expanded uncertainty in 0º:d spectral reflectance factor is also given in Table 4.1.

Table 4.1 Uncertainty contributions and expanded uncertainty ($k = 2$) of the 0º:d spectral reflectance factor for the reference diffuse reflectance standards, Spectralon samples serial number S01-03 and Ceramic tiles C01-03 measured with the NIST reference instrument STARR.

Component of Uncertainty	Type (A or B)	Standard Uncertainty	Uncertainty in Reflectance Factor
Calibration Standard (based on Van den Akker Method)	B	0.09 %	0.09 % [2]
Signal Noise	A	0.05 %	0.05 %
Instrument Stability	A	0.04 %	0.04 %
Wavelength	B	0.1 nm	
360 nm ≤ λ ≤ 400 nm			< 0.01 % (S#n); 0.1 – 0.05 % (C#n)
420 nm ≤ λ ≤ 820 nm			< 0.01 % (S#n) ; 0.02-0.00 % (C#n)
Detector Linearity	B	< 0.01 %	< 0.01 %
Combined standard uncertainty			0.11 % (spectralon) 0.12 % (ceramic tile)

4.3 Cary 5E

4.3.1 Description of instrument

The Cary5E spectrophotometer is a transfer instrument for spectral transmittance and reflectance measurements of non-fluorescent samples at room temperature. A transfer instrument measures samples relative to standards calibrated on reference instruments.

In reflectance mode, the Cary5E performs absolute measurements of the diffuse spectral transmittance and relative measurements of the 0º:d diffuse spectral reflectance. The sample dimensions can have widths from 25 mm to 100 mm, while the wavelength range is from 250 nm to 2500 nm. The reflectance measurements are always relative to a standard, either pressed polytetrafluoroethylene (PTFE) or a reference standard similar to the sample. The fundamental quantity for diffuse reflectance measurements is the reflectance factor.

One of three sources – a deuterium lamp, a quartz-tungsten-halogen lamp, and a mercury lamp – can be selected. The first two are used for scans of spectrophotometric quantities, with the transition between the two occurring at 350 nm, while the last is used for wavelength calibration. The light beam from the selected source passes through an order-sorting filter before entering the monochromator. The monochromator is a double out-of-plane Littrow type, with dual gratings in each compartment. The gratings are switched from UV/VIS to NIR at the wavelength at which the detector change occurs, generally 800 nm. The UV/VIS grating has 1200 lines/mm and is blazed at 250 nm, while the NIR grating has 300 lines/mm and is blazed at 1192 nm. The intermediate slit of the monochromator reduces the stray-light, while the exit slit determines the spectral bandwidth.

The light exiting the monochromator passes through the chopper compartment. The chopper directs light into the sample and reference beams, as well as blocking the light for a dark signal. The optics in the chopper compartment are arranged so that the sum of the deflection angles in the sample and reference beams are equal, ensuring identical polarizations of the two beams.

The two beams pass through the sample compartment and into the detector compartment. Mirrors direct the two chopped beams onto one of two detectors. The UV/VIS detector is an R928 photomultiplier, while the NIR detector is an electrothermally cooled lead sulfide photodiode operating at 0 ºC.

In the reflectance mode, the front beam is the reference beam and the rear beam is the sample beam. The integrating sphere has a diameter of 110 mm and is coated with polytetrafluoroethylene. The entrance port is 19 mm high by 17 mm wide, and the sample port has a diameter of 16 mm. At the entrance port, the sampling aperture is 22 mm high by 10 mm wide at full beam height and 10 mm high by 10 mm wide at reduced beam height. At the sample port, the sampling aperture is 15 mm high by 4 mm wide at full beam height and 12 mm high by 4 mm wide at reduced beam height.

4.3.2 Uncertainty budget for Cary5E

The following equation for each wavelength is used to calculate the diffuse spectral reflectance factor *R*

$$R = \frac{y - y_d}{y_s - y_d} \cdot R_s \,, \qquad (4.2)$$

where y is the sample signal, y_d is the dark signal, y_s is the standard signal (usually with pressed PTFE at the sample port), and R_s is the reflectance factor of the standard. These signals can be from one measurement, an average of measurements, or bracketing measurements.

Table 4.2 Uncertainty contributions and expanded uncertainty (k = 2) of the 0º:d spectral reflectance factor for the reference diffuse reflectance standards, Spectralon samples serial number S01-03 and Ceramic tiles C01-03 measured with the NIST transfer spectrometer Cary5E.

Source of Uncertainty	**Type (A or B)**	**Standard Uncertainty**	**Uncertainty in Reflectance Factor**
Signal Noise	A	0.08 %	0.08 %
Instrument Stability	A	0.05 %	0.05 %
Wavelength	B	0.1 nm	< 0.01 %
Detector Linearity	B	< 0.01 %	< 0.01 %
Unknown variation* in calibrated reference samples (ceramic samples only)	A	0.44 % at 360 nm to 0.00 % at 820 nm	0.44 % at 360 nm to 0.00 % at 820 nm

* It is considered that this factor might be related to fluorescence of ceramic samples.

4.4 Uncertainties associated with the transfer between NIST (Pilot) and the participants' laboratories

The comparison reference standards were initially calibrated by STARR, and their assigned values were never changed during the course of the comparison, though the standards were occasionally checked by STARR during the comparison. All the comparison measurements at NIST were performed with the Cary5E. Thus, the uncertainties in the transfer of the reflectance factor scale between NIST, pilot laboratory and participants arose only from the stability of the comparison reference standards and from the reproducibility of the NIST measurements by the Cary5E (with respect to the comparison reference standards), in addition to the stability of transfer standard samples and the uncertainty contributions from the participant's measurements. The uncertainties in the measurements by STARR did not contribute to the transfer uncertainty as the pilot laboratory, though they contributed to the NIST uncertainties as a participant. The components of the transfer uncertainties by the Cary 5E are described briefly below.

Since the comparison reference standards were of the same type of Spectralon or ceramic tiles used as transfer standards, most of the systematic uncertainty components are reduced to negligible level. Listed below are the estimated uncertainty components and contributions to NIST measurement as the pilot laboratory. The uncertainty contributions from NIST transfer measurements are discussed below.

4.4.1 Stability of Comparison Reference Standards

To check the stability of the six Comparison Reference Standards, all the six samples were measured at STARR occasionally over the period from 2001 to 2005. Figures 4.1 to 4.4 show the 2002 and 2004 measurements. Though there may be slight trend of shifts, no changes or corrections to the assigned values were made for the standard samples throughout the comparison, due to the relatively large uncertainty of the STARR measurements. Instead, possible drifts of the reference standards are considered as an uncertainty component, and their uncertainty contributions were evaluated based on the 2004 data as listed in Table 4.3.

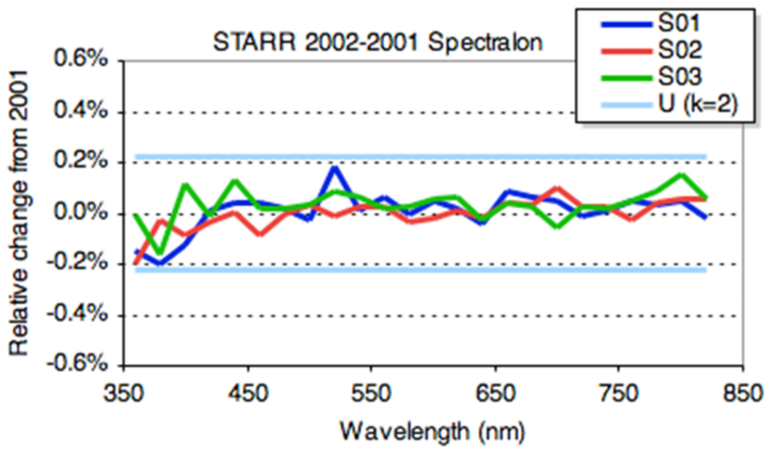


Figure 4.1 Results of the 2002 stability check by STARR for Spectralon samples.

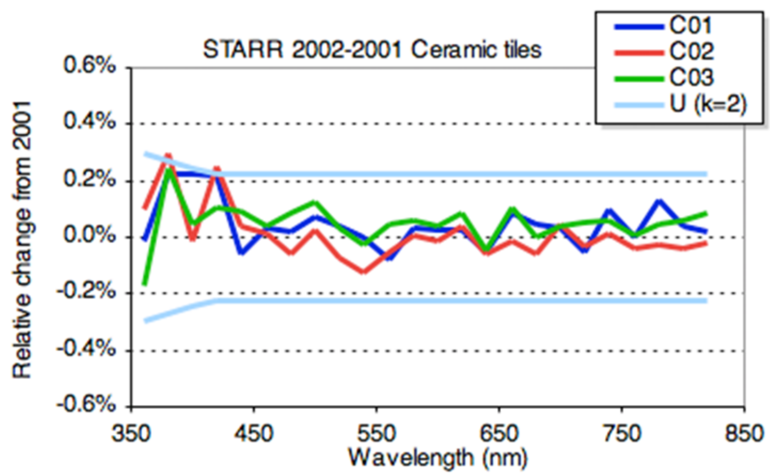


Figure 4.2 Results of the 2002 stability check by STARR for Ceramic tile samples.

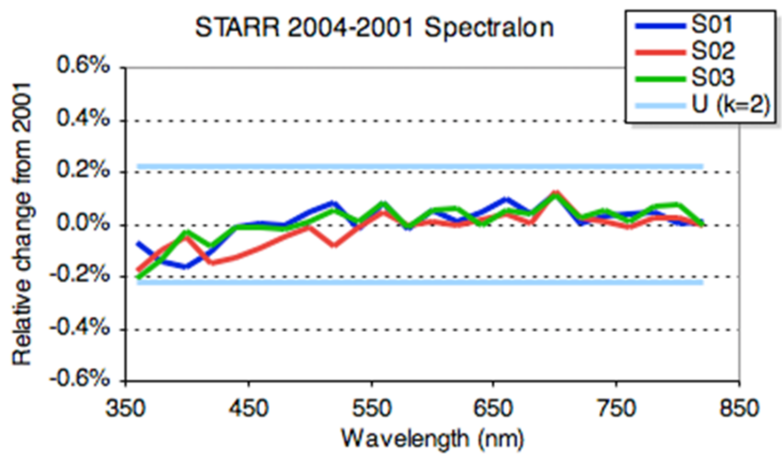


Figure 4.3 Results of the 2004 stability check by STARR for Spectralon samples.

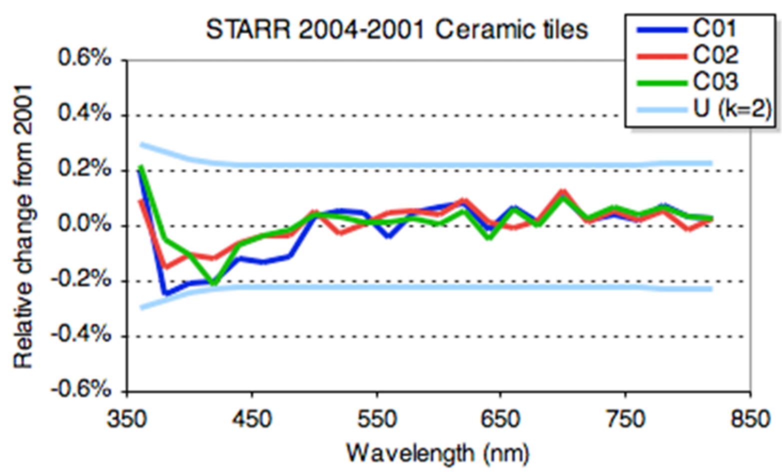


Figure 4.4 Results of the 2004 stability check by STARR for Ceramic tile samples.

Table 4.3 Uncertainty contributions due to possible long-term drift of the comparison reference standards based on the 2004 stability check data.

Wavelength (nm)	***Spectralon***	***Ceramic tile***
360	0.09%	0.11%
380	0.07%	0.09%
400	0.06%	0.08%
420	0.05%	0.06%
440	0.04%	0.05%
460	0.03%	0.04%
480	0.02%	0.03%

(Continued.)

500	0.02%	0.03%
520	0.02%	0.02%
540	0.02%	0.02%
560	0.02%	0.02%
580	0.02%	0.02%
600	0.02%	0.02%
620	0.02%	0.02%
640	0.02%	0.02%
660	0.02%	0.02%
680	0.02%	0.02%
700	0.03%	0.03%
720	0.03%	0.03%
740	0.03%	0.03%
760	0.03%	0.03%
780	0.03%	0.02%
800	0.03%	0.02%
820	0.03%	0.02%

4.4.2 Reproducibility of the NIST measurements by Cary5E

Prior to distributing the transfer standards, test measurements of all the transfer standards were done with the Cary5E in 2001 and 2002 to test the stability of the samples as well as the reproducibility of the NIST measurements over several months. Each sample was measured using the same procedure as in the comparison, i.e., each sample was measured three times against the three Comparison Reference Standards. Examples of the results are shown in Figs. 4.5 and 4.6.

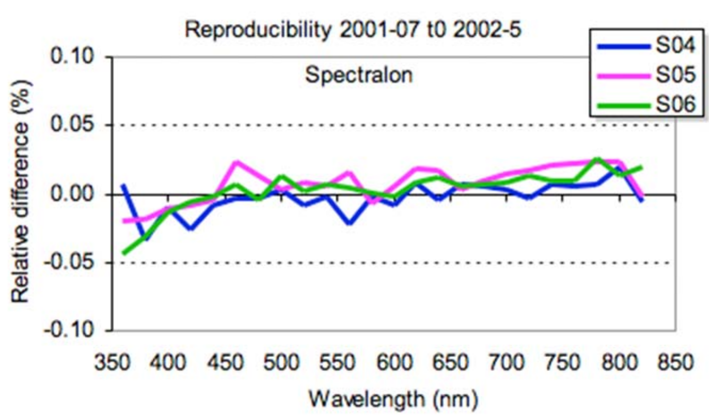


Figure 4.5 Differences between Cary 5E measurements separated by 10 months of Spectralon samples S04 to S06.

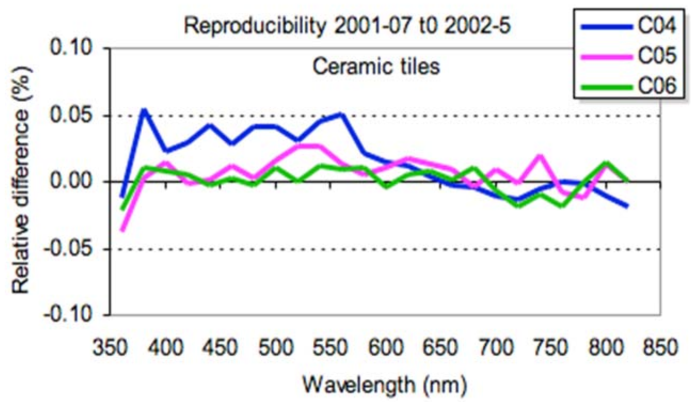


Figure 4.6 Difference between Cary 5E measurements separated by 10 months of Ceramic tile samples C04 to C06.

All other samples were also measured in similar time intervals in 2001 and 2002 before the samples were shipped to the participant's laboratories and similar results were obtained. The standard deviations of the relative differences in two measurements of all 12 transfer standards of each type are listed in Table 4.4. These values are taken as the uncertainty contribution from the reproducibility of NIST measurements with respect to the Comparison Reference Standards.

Table 4.4 Reproducibility of the NIST Cary5E spectrophotometer measurements tested over a period of several months.

Wavelength [nm]	***Spectralon std. dev. (%)***	***Ceramic tiles std. dev. (%)***
360	0.06	0.04
380	0.05	0.03
400	0.04	0.03
420	0.04	0.02
440	0.03	0.02
460	0.03	0.02
480	0.02	0.02
500	0.03	0.02
520	0.03	0.02
540	0.02	0.02
560	0.03	0.02
580	0.02	0.03
600	0.03	0.02
620	0.03	0.03

(Continued.)

640	0.02	0.02
660	0.02	0.02
680	0.02	0.02
700	0.03	0.02
720	0.02	0.02
740	0.02	0.03
760	0.03	0.03
780	0.02	0.02
800	0.02	0.02
820	0.02	0.02

4.4.3 Other uncertainty components

The values in Table 4.4 are the uncertainty contributions from the reproducibility of NIST measurements, thus including uncertainty contributions from signal noise, wavelength scale variation, and other instrument instabilities. While the uncertainty of the wavelength scale (0.1 nm), e.g., would contribute significantly to the NIST absolute measurement uncertainty of ceramic tile samples, only its repeatability (random components) affects the transfer measurement as the Pilot laboratory. The effect of bandwidth in the transfer measurement (substitution of the same type of sample) is negligible even for ceramic tile samples.

4.4.4 Overall NIST transfer uncertainty

The overall transfer uncertainty of NIST measurement as the pilot laboratory is obtained as the uncertainties combined from those in table 4.3 and table 4.4. When the results of three samples are averaged to obtain the participant/NIST ratio, the reproducibility uncertainty may reduce. However, the reproducibility uncertainty of the three samples measured at the same time are strongly correlated, and it is difficult to know the degree of correlation, the reproducibility of the three samples are taken as fully correlated as an approximation when combining the uncertainty from the three samples.

Table 4.5 Overall uncertainties of NIST transfer measurements as the pilot laboratory

Wavelength [nm]	***Spectralon***	***Ceramic tile***
360	0.11%	0.12%
380	0.08%	0.10%
400	0.07%	0.08%
420	0.06%	0.07%
440	0.05%	0.06%
460	0.04%	0.05%
480	0.03%	0.04%
500	0.03%	0.04%

(Continued.)

520	0.03%	0.03%
540	0.03%	0.03%
560	0.03%	0.03%
580	0.03%	0.03%
600	0.03%	0.03%
620	0.03%	0.03%
640	0.03%	0.03%
660	0.03%	0.03%
680	0.03%	0.03%
700	0.04%	0.03%
720	0.04%	0.03%
740	0.04%	0.04%
760	0.04%	0.04%
780	0.04%	0.03%
800	0.04%	0.03%
820	0.04%	0.03%

5. Preliminary Work at NIST

In preparation for the comparison, NIST participated in bi-lateral comparisons with PTB and NRC. These were performed to verify that the NIST scale is comparable to the scales maintained by these two laboratories.

An informal bi-lateral comparison was performed in the summer of 1999, involving measurements at NIST and a visit to PTB for additional measurements. Results for the 0º:d reflectance factor for a Spectralon sample and an opal sample are shown in Figs. 5.1 to 5.4. The differences with PTB were less than 0.1 % for Spectralon sample at most of the wavelengths and are within the combined uncertainty of the measurements.

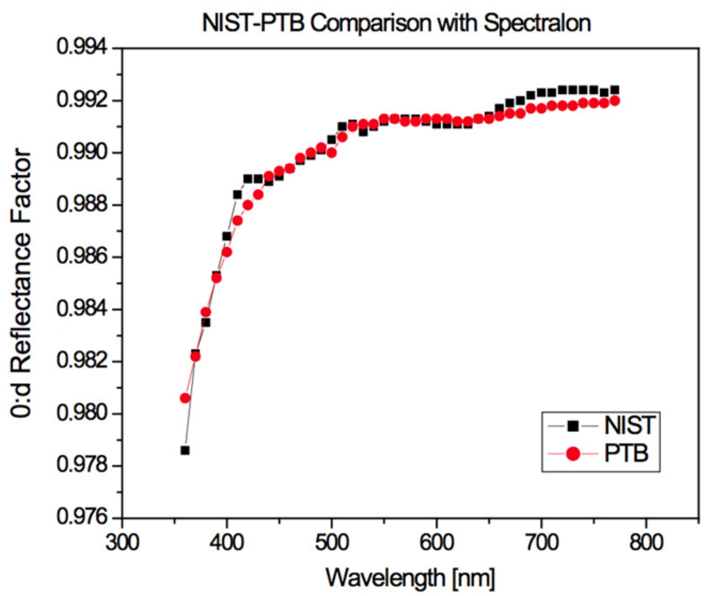


Figure 5.1 0º:d reflectance factor of the Spectralon sample measured in the NIST - PTB comparison.

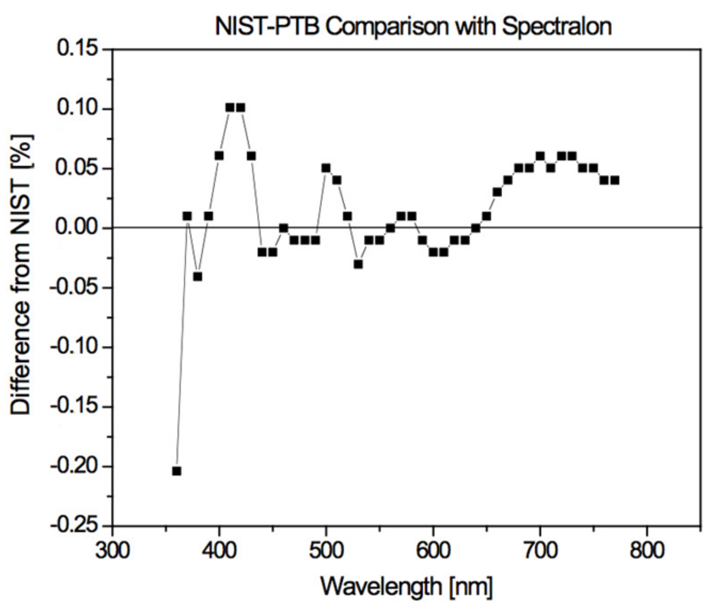


Figure 5.2 Differences in the 0º:d reflectance factor from that obtained by PTB for the Spectralon sample measured in the NIST-PTB comparison.

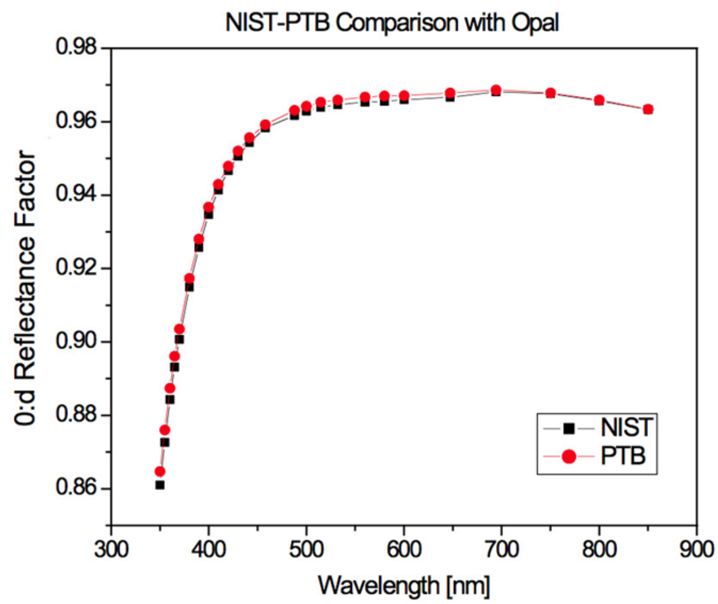


Figure 5.3 0º:d reflectance factor of the opal sample measured in the NIST -PTB comparison.

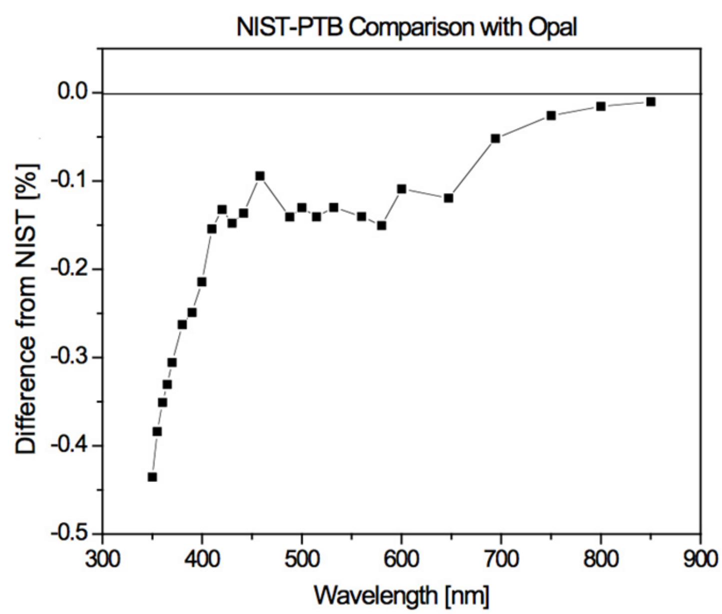


Figure 5.4 Differences in the 0º:d reflectance factor from that obtained by PTB for the opal sample measured in the NIST-PTB comparison.

A second informal bi-lateral comparison was performed in the summer of 2000, involving measurements at NIST and at NRC. Results for the 6º:di reflectance factor for an Spectralon are shown in Figs. 5.5 and 5.6. The differences were about 0.2 % and are within the combined uncertainty of the measurements.

The good agreement found in both bi-lateral comparisons indicated that the NIST scale is in good status.

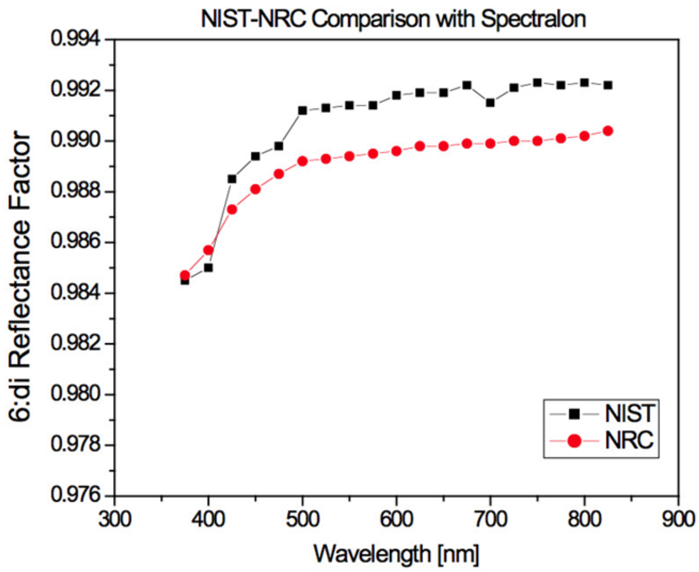


Figure 5.5 6º:di reflectance factor of the Spectralon sample measured in the NIST - NRC comparison.

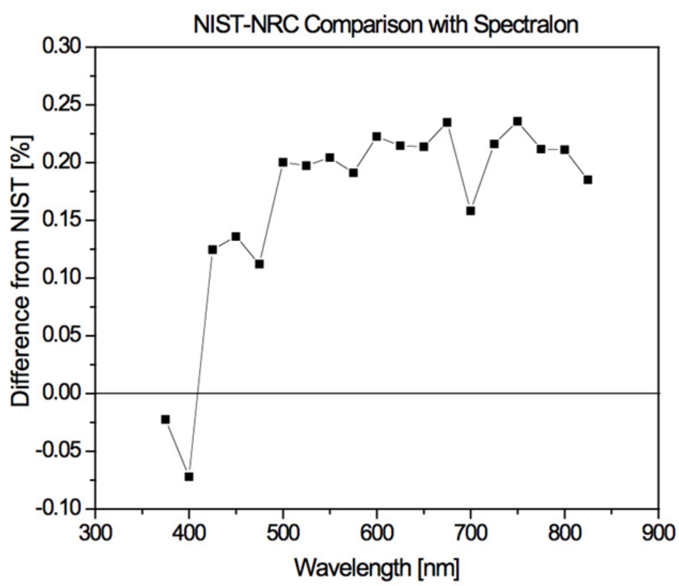
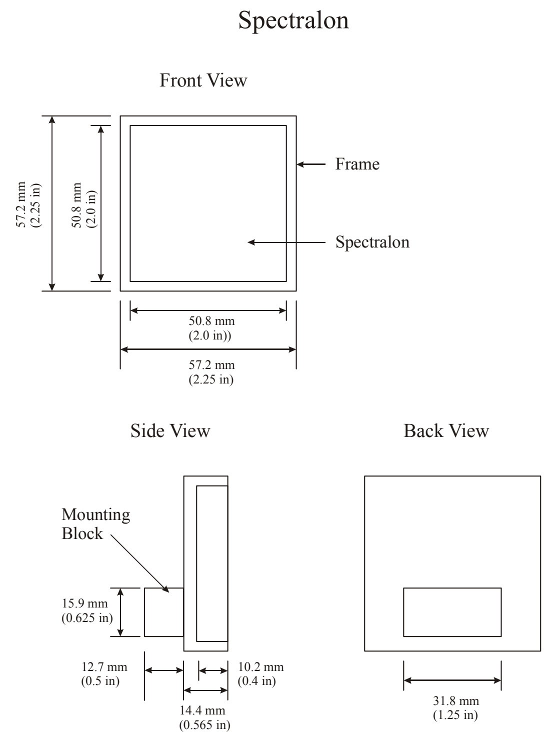


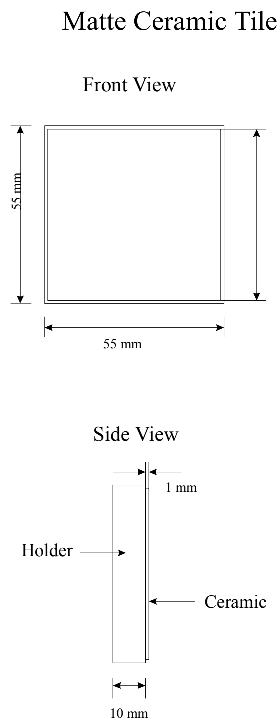
Figure 5.6 Differences in the 6º:di reflectance factor from that obtained by NRC for the Spectralon sample measured in the NIST-NRC comparison.

6. Description of Artifacts

6.1 Specifications of artifacts

Each participating national metrology institute received a package containing six (6) samples to be measured – three (3) of Spectralon and three (3) of matte white ceramic tile. The Spectralon samples are mounted in a black anodized aluminum frame, while the matte ceramic tile samples are encased in a plastic frame. The dimensions of the samples are shown in the accompanying drawings. Each sample has a permanent identifying serial number on the back of the frame.





6.2 Schedule of artifacts measurements

Table 6.1 shows the months when measurement took place at NIST for which samples. S04 through S18 are Spectralon samples. C04 through C18 are ceramic samples. Transfer and measurement at participant laboratories took place between the two measurements labeled (1) and (2).

Table 6.1 Schedule of artifacts measurements

S04, S05, S06 C04, C05, C06	Aug. 2002 PTB(1)	Jan. 2003 PTB(2) OMH(1)	Apr. 2003 OMH(2) VNIIOFI(1)	Sep. 2003 VNIIOFI(2) HUT(1)	Jan. 2004 HUT(2) MSL(1)	Oct. 2004 MSL(2)
S07,S08,S09 C07.C08,C09	Aug. 2002 NPL(1)	Sep. 2004 NPL(2)				
S10,S11,S12 C10,C11,C12	Aug. 2002 NRC(1)	Jan. 2003 NRC(2) CISR(1)	Aug. 2005 CSIR(2)			
S13,S14,S15 C13,C14,C15	Aug. 2002 KRISS(1)	Mar. 2003 KRISS(2) NIM(1)	Jul. 2005 NIM(2)			
S16,S17,S18 C16,C17,C18	Aug. 2002 IFA(1)	Jan. 2003 IFA(2) NMIJ(1)	Aug. 2005 NMIJ(2)			

7. Participants' Measurement Capabilities

7.1 CSIR-NML

Parameter	***Value or Description***
Geometry (0º:d or d:0º)	0º:d
Directional Angle	0 degrees
Sphere Diameter	6 cm
Sphere Coating	Barium Sulphate
Diameter of Entrance Port	1.8 cm
Diameter of Sample Port	1.8 cm
Diameter of Viewing Port	1 cm
Beam Diameter	0.8 cm x 0.5 cm
Beam f/# (f/∞ for collimated)	f/∞
Beam Polarization	Unpolarized
Spectral Bandwidth	2 nm
Wavelength Range and Increment	360 nm to 820 nm by 20 nm
Calibration Standard Traceability	Sharp-Little Method Calibration Standard traceable to PTB

7.2 HUT

Parameter	***Value or Description***
Geometry (0º:d or d:0º)	0º:d
Directional Angle	0 degrees
Aperture diameter	25 mm
Aperture-to-sample distance	485 mm
Beam Diameter	17 mm
Beam f/# (f/∞ for collimated)	f/∞
Beam Polarization	Linear; measured with both s- and p-polarization
Spectral Bandwidth	5.4 nm
Wavelength Range and Increment	360 nm to 820 nm by 20 nm
Calibration standard traceabiity	Absolute gonioreflectrometric method

7.3 IFA-CSIC

Parameter	***Value or Description***
Geometry (0º:d or d:0º)	0º:d
Directional Angle	0 degrees
Sphere Diameter	90 mm
Sphere Coating	Barium Sulphate
Diameter of Entrance Port	23.8 mm x 14.3 mm
Diameter of Sample Port	22.2 mm x 7.9 mm
Diameter of Detector Port	20.6 mm diameter
Beam Diameter (irradiated area)	15.4 mm x 2 mm
Beam f/# (f/∞ for collimated)	Almost collimated
Beam Polarization	Not measured
Spectral Bandwidth	Variable, 7 nm at 780nm, 1.2 nm at 700nm, 0.4 nm at 550 nm, 1.9 nm at 380 nm
Wavelength Range and Increment	360 nm to 820 nm by 20 nm
Calibration Standard Traceability	Reference standard traceable to NPL

7.4 KRISS

Parameter	***Value of Description***
Geometry (0º:d or d:0º)	d:0º
Directional Angle	0
Sphere Diameter	104mm (inner)
Sphere Coating	PTFE
Diameter of Entrance Port	15 mm
Diameter of Sample Port	15 mm
Diameter of Viewing Port	15 mm
Beam Diameter	15 mm
Beam f/#(f/∞ for collimated)	2π diffused
Beam Polarization	Unpolarized
Spectral Bandwidth	2 nm
Wavelength Range and Increment	380 nm to 780 nm by 1 nm
Calibration Standard Traceability	Sharp-Little Method

7.5 MSL

Parameter	***Value or Description***
Geometry (0º:d or d:0º)	6º:di
Directional Angle	6 degrees
Sphere Diameter	235 mm ID
Sphere Coating	10 mm of pressed Halon[2]
Diameter of Entrance Port	18 mm
Diameter of Sample Port	35 mm
Diameter of Viewing Port	16 mm x 18 mm rectangular
Beam Diameter	16 mm x 17 mm rectangular at sample
Beam f/# (f/∞ for collimated)	f/17
Beam Polarization	8% – 22% plane polarization component
Spectral Bandwidth	3.2 nm
Wavelength Range and Increment	360 nm to 820 nm by 20 nm
Calibration Standard Traceability	NIST, Test No. 844/265215-01

7.6 NIM

Parameters	***Value or Description***
Geometry (0º:d or d:0º)	d:0º
Directional Angle	0 degree
Sphere Diameter	29.4 cm
Sphere Coating	Barium sulfate
Diameter of Entrance Port	3.9 cm
Diameter of Sample Port	3.9 cm
Diameter of Viewing Port	1.2 cm
Beam Diameter	3 cm
Beam *f/# (f/∞* for collimated)	*f/68*
Beam Polarization	Unpolarized
Spectral Bandwidth	10 nm
Wavelength Range and Increment	360 to 820 by 20 nm
Calibration Standard Traceability	Sharp-Little Method

[2] Halon is a registered trademark of Allied Chemical and is a form of PTFE.

7.7 NIST

Parameter	***Value or Description***
Geometry (0º:d or d:0º)	0º:d
Directional Angle	0 degrees
Sphere Diameter	30 cm
Sphere Coating	PTFE
Diameter of Entrance Port	3.8 cm
Diameter of Sample Port	5 cm
Diameter of Viewing Port	NA
Beam Diameter	25 mm
Beam f/# (f/∞ for collimated)	f/80
Beam Polarization	Unpolarized
Spectral Bandwidth	15 nm
Wavelength Range and Increment	360 nm to 820 nm by 20 nm increments
Calibration Standard Traceability	Van den Akker Method

7.8 NMIJ

Parameter	***Value of Description***
Geometry (0º:d or d:0º)	0º:d
Directional Angle	0 degrees
Sphere Diameter	500 mm
Sphere Coating	Barium Sulfate (Spray Coating)
Diameter of Entrance Port	60 mm
Diameter of Sample Port	30 mm
Diameter of Viewing Port	60 mm
Beam Diameter	12 mm
Beam f/#	f/125
Beam Polarization	Unpolarized
Spectral Bandwidth	3.0 nm
Wavelength Range and Increment	360 nm to 820 nm with 20 nm increment
Calibration Standard Traceability	Modified Sharp-Little Method (Developed at NMIJ)
Calibration Procedure	1. Absolute calibration of spectral diffuse reflectance based on the Modified Sharp-Little method 2. Calibration of working standards (Spectralon tiles) using the NMIJ Reference spectrophotometer [Standard: Absolute reflectance scale obtained by the Modified Sharp-Little method] 3. Calibration of DUTs using the NMIJ Reference spectrophotometer [Standard: Working standards]

7.9 NPL

Parameter	***Value or Description***
Geometry (0º:d or d:0º)	d:0º
Directional Angle	0 degrees
Sphere Diameter	150 mm
Sphere Coating	Spectralon
Sample beam Entrance Port	23 mm (baffled to detectors)
Reference beam entrance port	23 mm
Sample port diameter	35 mm (baffled to detectors)
Reference port diameter	35 mm (baffled to detectors)
8º:d specular port diameter	35 mm (baffled to detectors)
Diameter of detector port 1 (NIR)	19 mm
Diameter of detector port 2 (UV/Vis)	Elliptical; major axis 35 mm; minor axis 15 mm
Beam size at sample	18 mm high x 3.5 mm wide
Beam f/# (f/∞ for collimated)	f/12 vertical, f/19 horizontal
Beam Polarization	Unknown
Calibration Standard Traceability	Reference standards calibrated on National Reference Reflectometer

7.10 NRC

Parameter	***Value or Description***
Geometry (0º:d or d:0º)	d:0º
Directional Angle	Diffuse illumination, 0° viewing
Sphere Diameter	200 mm
Sphere Coating	Barium sulphate paint
Diameter of Entrance Port	25 mm
Diameter of Sample Port	28 mm
Diameter of Viewing Port	NA
Beam Diameter (viewed)	11 mm
Beam f/# (f/∞ for collimated)	f/∞
Beam Polarization	unpolarized
Spectral Bandwidth	~10 nm
Wavelength Range and Increment	350 to 850 nm, variable increment
Calibration Standard Traceability	Modified Sharp-Little Method*

7.11 OMH

Parameter	***Value or Description***
Geometry (0º:d or d:0º)	8º/di
Directional Angle	8 degrees
Sphere Diameter	20 cm
Sphere Coating	Barium Sulphate
Diameter of Entrance Port	30 mm
Diameter of Sample Port	40 mm
Diameter of Detector Port	30 mm
Beam Diameter (irradiated area)	25 mm
Beam f/# (f/∞ for collimated)	f/15
Beam Polarization	Unpolarized
Spectral Bandwidth	4 nm
Wavelength Range and Increment	360 nm to 780 nm by 20 nm
Calibration Standard Traceability	Modified Taylor-Budde Method and Modified Erb Method

7.12 PTB

Parameter	***Value or Description***
Geometry (0º:d or d:0º)	d:0º
Directional Angle	0 degrees
Sphere Diameter	50 cm
Sphere Coating	Barium Sulphate
Diameter of Entrance Port	NA
Diameter of Sample Port	NA
Diameter of Viewing Port 2x	4.6 cm
Spot size measured on sample	2.1 cm diameter
Beam f/# (f/∞ for collimated)	f/27
Beam Polarization	Unpolarized
Spectral Bandwidth	<2 nm, depends on Interference filter
Wavelength Range and Increment	360 nm to 820 nm, variable
Calibration Standard Traceability	Korte-Schmidt Method

7.13 VNIIOFI

Parameter	***Value or Description***
Geometry (0º:d or d:0º)	d:0º
Directional Angle	0 degrees
Sphere Diameter	500 mm
Sphere Coating	$BaS0_4$
Diameter Entrance Port	40 mm
Diameter Viewing Port	40 mm
Beam Diameter	25 mm
Beam f/#	f/l0
Beam Polarization	Unpolarized
Spectral Bandwidth	8 nm
Wavelength Range and Increment	360 nm to 820 nm, 20 nm
Calibration Standard Traceability	The modified Erb method

8. Participants' Stated Uncertainties

8.1 CSIR-NML

Source of Uncertainty	*Type (A or B)*	*Standard Uncertainty (Absolute)*	*Uncertainty in Reflectance Factor (Absolute)*
Signal Noise	A	360 nm $\leq\lambda<$400 nm: 2 x 10^{-3} 400 nm $\leq\lambda<$450 nm: 1 x 10^{-3} 450 nm $\leq\lambda<$800 nm: 8 x 10^{-4} 800 nm $\leq\lambda\leq$820 nm: 2 x 10^{-3}	360 nm $\leq\lambda<$400 nm: 2 x 10^{-3} 400 nm $\leq\lambda<$450 nm: 1 x 10^{-3} 450 nm $\leq\lambda<$800 nm: 8 x 10^{-4} 800 nm $\leq\lambda\leq$820 nm: 2 x 10^{-3}
Instrument Stability	A	360 nm $\leq\lambda<$400 nm: 1 x 10^{-3} 400 nm $\leq\lambda<$450 nm: 4 x 10^{-4} 450 nm $\leq\lambda<$800 nm: 3 x 10^{-4} 800 nm $\leq\lambda\leq$820 nm: 5 x 10^{-4}	360 nm $\leq\lambda<$400 nm: 1 x 10^{-3} 400 nm $\leq\lambda<$450 nm: 4 x 10^{-4} 450 nm $\leq\lambda<$800 nm: 3 x 10^{-4} 800 nm $\leq\lambda\leq$820 nm: 5 x 10^{-4}
Wavelength	B	360 nm $\leq\lambda\leq$820 nm: 0.4 nm	360 nm $\leq\lambda\leq$820 nm: < 1x10^{-4} ($\lambda\leq$460 nm: 8 x 10^{-4} for Ceram samples)
Detector Linearity	B	360 nm $\leq\lambda\leq$820 nm: 5 x 10^{-4}	360 nm $\leq\lambda\leq$820 nm: 5 x 10^{-4}
Van den Akker Method			
Calibration Standard		N/A	
Sharp-Little Method			
Calibration Standard	B	360 nm $\leq\lambda<$450 nm: 2.3x10^{-3} 450 nm $\leq\lambda<$800 nm: 1.8x10^{-3} 800 nm $\leq\lambda\leq$820 nm: 2.0x10^{-3}	360nm $\leq\lambda<$450nm: 2.3 x 10^{-3} 450nm $\leq\lambda<$800nm: 1.8 x 10^{-3} 800nm $\leq\lambda\leq$820nm: 2.0 x 10^{-3}
Korte Method			
Port Correction		N/A	
Irradiance Uniformity		N/A	
Wall Correlation		N/A	

8.2 HUT

Source of Uncertainty	***Type (A or B)***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise 360 nm to 400 nm 400 nm to 440 nm 440 nm to 820 nm	A	0.08% 0.05% 0.03%	0.08% 0.05% 0.03%
Instrument stability	A	0.02%	0.02%
Aperture-to-sample distance	B	0.15 mm	0.06%
Aperture diameter	B	2.0 μm	0.02%
Wavelength	B	0.1 nm	Spectralon <0.01% MWCT: 0.10%
Stray light isochromatic heterochromatic	B B	0.14% <0.01%	0.14% <0.01 %
Detector linearity	B	0.04%	0.04%
Spatial uniformity	B	0.10%	0.10%
Illumination and viewing angles	B	0.1°	<0.01%
Polarization	B	0.05%	0.05%
Combined uncertainty			0.21 %

8.3 IFA-CSIC

Source of Uncertainty	***Type (A or B)***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	0.04%	0.05%
Instrument stability	A	0.1%	0.11%
Wavelength	B	0.23 nm	<0.01%
Detector Linearity	B	0.09%	0.09%
Calibration Standard	B	380-460 nm: 0.28% 465-780 nm:0.18%	0.28% 0.18 %

8.4 KRISS

Source of Uncertainty	***Type (A or B)***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	0.01 – 0.22 %	0.01 – 0.22 %
Instrument Stability	B	0.03 – 0.31 %	0.03 – 0.31 %
Wavelength	B	0.2 nm	NA
Detector Linearity	B	0.02%	0.02 %
Sharp-Little Method			
Calibration Standard			
Recess	B	0.5 mm	0.09 – 0.36 %
Opening	B	ΔR = 1 mm Δr = 0.5 mm	0.17 %

8.5 MSL

Uncertainty Component	***Type (A or B)***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	0.005 %	0.00007
Instrument Stability	A	0.022 %	0.0003
Wavelength	B	0.1 nm	< 0.0005 †
Detector Linearity	B	< 0.05 %	< 0.00005
Sample spatial uniformity	B	0.1 %	0.001
Calibration Standards (set of 3) ‡	B	0.17 %	0.0017
Van den Akker Method	NA		
Calibration Standard			
Sharp-Little Method	NA		
Calibration Standard			
Korte Method	NA		
Port Correction			
Irradiance Uniformity			
Wall Correlation			

† Less than 0.00005 except for C04, C05, C06 over 360 nm — 420 nm.
‡ Uncertainties in these standards are partially correlated.

8.6 NIM

Uncertainty Component	***Type (A or B)***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	0.29%	0.29%
Instrument Stability	A	0.02%	0.02%
Wavelength	B	0.4 nm	0.01%
Detector Linearity•	B	0.06%: 380 nm - 800 nm	0.06%: 380 nm - 800 nm
		0.29%: 360 nm, 820 nm	0.29%: 360 nm, 820 nm
Van den Akker Method			
Calibration Standard		NA	
Sharp-Little Method			
Calibration Standard	B	0.6%: 380 nm – 820 nm	0.6%: 380 nm – 820 nm
		0.7%: 360 nm	0.7%: 360 nm
Korte Method			
Port Correction		NA	
Irradiance Uniformity		NA	
Wall Correlation		NA	

- The detector linearity is not evaluated separately; it is in fact the linearity of the whole system.

8.7 NIST

Source of Uncertainty	***Type (A or B)***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Calibration of reference standard samples by NIST reference instrument "STARR"			
Van den Akker Method			
Calibration Standard	B	0.09 %	0.09 %
Signal Noise	A	0.05 %	0.05 %
Instrument Stability	A	0.04 %	0.04 %
Wavelength	B	0.1 nm	
360 nm ≤ λ ≤ 400 nm			< 0.01 % (S#n); 0.1 – 0.05 % (C#n)
420 nm ≤ λ ≤ 820 nm			< 0.01 % (S#n); 0.02-0.00 % (C#n)
Detector Linearity	B	< 0.01 %	< 0.01 %

Measurement of comparison samples by a spectrophotometer			
Signal Noise	A	0.08 %	0.08 %
Instrument Stability	A	0.05 %	0.05 %
Wavelength	B	0.1 nm	< 0.01 %
Detector Linearity	B	< 0.01 %	< 0.01 %

(Continued.)

Unknown variation* in calibrated reference samples (ceramic samples only)	A	0.44 % at 360 nm to 0.00 % at 820 nm	0.44 % at 360 nm to 0.00 % at 820 nm

* It is considered that this factor might be related to fluorescence of ceramic samples.

8.8 NMIJ

Table 1 Uncertainties for S16, S17, and S18 samples

Source of Uncertainty	***Type***	***Wavelength Range***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	360 nm to 440 nm (440 nm is not included)	0.07%	0.07%
		440 nm to 760 nm (760 nm is not included)	0.04%	0.04%
		760 nm to 830 nm	0.08%	0.08%
Instrument Stability	A	360 nm to 440 nm (440 nm is not included)	0.06%	0.06%
		440 nm to 760 nm (760 nm is not included)	0.04%	0.04%
		760 nm to 830 nm	0.04%	0.04%
Wavelength	B	360 nm to 440 nm (440 nm is not included)	0.06%	0.06%
		440 nm to 760 nm (760 nm is not included)	0.02%	0.02%
		760 nm to 830 nm	0.02%	0.02%
Detector Linearity				N/A
Van den Akker Method Calibration Standard				N/A
Sharp-Little Method Calibration Standard				N/A
Korte Method				
Port Correction				N/A
Irradiance Uniformity				N/A
Wall Correction				N/A
Working Standards at NMIJ *	B			
		360 nm to 440 nm (440 nm is not included)	0.20%	0.20%

(Continued.)

		440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.13% 0.18%	0.13% 0.18%
Relative combined standard uncertainty (k = 1) in the calibration of DUTs		360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm		0.23% 0.15% 0.21%

* For the uncertainty budget of the Working standards, please refer to Table 3 as additional information.

Table 2 Uncertainties for the C16, C17, and C18 samples

Source of Uncertainty	***Type***	***Wavelength Range***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.07% 0.04% 0.08%	0.07% 0.04% 0.08%
Instrument Stability	A	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.06% 0.04% 0.04%	0.06% 0.04% 0.04%
Wavelength	B	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.06% 0.02% 0.02%	0.06% 0.02% 0.02%
Detector Linearity			N/A	N/A
Van den Akker Method Calibration Standard			N/A	N/A
Sharp-Little Method Calibration Standard			N/A	N/A
Korte Method Port Correction Irradiance			N/A	N/A

(Continued.)

Uniformity Wall Correction				
Working Standards at NMIJ *	B	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.20% 0.13% 0.18%	0.20% 0.13% 0.18%
Photoluminescence	B	360 nm to 400 nm ** 400 nm to 830 nm (400 nm is not included)	0.03 % to 0.15 % N/A	0.03 % to 0.15 % N/A
Relative combined standard uncertainty (k = 1) in the calibration of DUTs		360 nm to 400 nm ** 400 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm		0.23 % to 0.28 % 0.23% 0.15% 0.21%

***** For the uncertainty budget of the Working standards, please refer to Table 4 as additional information

** Wavelength dependent

Table 3 Additional information on uncertainties (NMIJ working standards)

Source of Uncertainty	***Type***	***Wavelength Range***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.07% 0.04% 0.08%	0.07% 0.04% 0.08%
Instrument Stability	A	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.06% 0.04% 0.04%	0.06% 0.04% 0.04%
(Continued.) Wavelength	B	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.06% 0.02% 0.02%	0.06% 0.02% 0.02%
Detector Linearity Van den Akker Method Calibration Standard			N/A N/A	N/A N/A

(Continued)

Sharp-Little Method Calibration Standard Korte Method Port Correction Irradiance Uniformity Wall Correction Modified Sharp-Little Method Calibration Standard *	B	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	N/A N/A N/A N/A 0.17% 0.12% 0.16%	N/A N/A N/A NA 0.17% 0.12% 0.16%
Relative combined standard uncertainty (k = 1) of the working standards (Continued.)		360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm		0.20% 0.13% 0.18%

* For the uncertainty budget of the Modified Sharp Little method, please refer to Table 4 as additional information.

Table 4 Additional information on uncertainties (Modified Sharp-Little method)

Source of Uncertainty	***Type***	***Wavelength Range***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.06% 0.03% 0.05%	0.06% 0.03% 0.05%
Instrument Stability	A	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.04% 0.04% 0.04%	0.04% 0.04% 0.04%
Integrating sphere error	B	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.15% 0.10% 0.14%	0.15% 0.10% 0.14%
Ageing of the integrating sphere wall	B	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.02% 0.02% 0.02%	0.02% 0.02% 0.02%
Wavelength	B	360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm	0.04% 0.04% 0.04%	0.04% 0.04% 0.04%
Relative combined standard uncertainty (k = 1) in the modified Sharp-Little method		360 nm to 440 nm (440 nm is not included) 440 nm to 760 nm (760 nm is not included) 760 nm to 830 nm		0.17% 0.12% 0.16%

8.9 NPL

Source of Uncertainty	***Value*** ±	***Probability Distribution***	***Divisor***	u_i ±%
Absolute Components				
Repeatability		Normal	1	
Stray light (sample measurement) from compartment	0.010 %	Rect	1.732	0.006
Combine uncertainty				0.006
Relative Components				
Angle independent components				
Obscuring incident light from detector for reference measurement	0.025 %	Rect	1.732	0.014
Stray light (sample measurement) from sample onto compartment	0.010 %	Rect	1.732	0.006
Stray light (sample measurement) from sample compartment back onto sample	0.005 %	Rect	1.732	0.003
Stray light (reference measurement) form compartment	0.010 %	Rect	1.732	0.006
Irradiance non-uniformity (filter & polarizer dependent)	0.005 %	Rect	1.732	0.003
Detector non-linearity	0.005 %	Rect	1.732	0.003
Detector spatial response non-uniformity	0.015 %	Rect	1.732	0.009
Detector polarization bias	0.020 %	Rect	1.732	0.012
DVM linearity	0.010 %	Rect	1.732	0.006
Amplifier (range changing)	0.025 %	Rect	1.732	0.015
Geometrical factor calculation	0.005 %	Rect	1.732	0.003
Solid angle determination (5.1e-7 sr)	0.050 %	Normal	1	0.050
Combined uncertainty		Normal		0.057
Angle and sample dependent components				
Setting sample angle to 0 degrees	0.05 deg	Rect	1.732	
Setting detector angle reference position	0.05 deg	Rect	1.732	
Detector angle (positional uncertainty)	0.02 deg	Rect	1.732	
Setting sample aperture on axis of rotation	0.35 mm	Rect	1.732	
Setting sample plane on aperture plane		Rect	1.732	
Offset of irradiating patch transverse to optical axis	0.2 mm	Rect	1.732	
Sample dependent components				
Leakage outside pass band (heterochromatic stray light)		Rect	1.732	
Wavelength	0.6 nm	Rect	1.732	

Note) The uncertainty components listed above are for the National Reference Reflectometer listed at the bottom of Table 7.9.

8.10 NRC

Table 2a NRC Uncertainties in Spectral Diffuse Reflectance (k=1) for the Spectral Range 400 nm to 850 nm

Uncertainty Component		***Type (A or B)***	***Standard Uncertainty (k=1)***	***Relative Uncertainty in Reflectance Factor***
Signal to Noise		A	0.02 %	0.02 %
Instrument Stability	Short-term	A	0.02 %	0.02 %
Instrument Stability	Long-term	A	0.05 %	0.05 %
Wavelength		B	0.15 nm	<0.01 % (S#n); <0.03% (C#n))
Detector Linearity		B	<0.01 %	<0.01 %
Modified Sharp-Little Method				
R > 0.85		B	0.05 %	0.05 %
0.75 < R <=0.85		B	0.10 – 0.05 %	0.10 - 0.05%
0.60 < R <=0.75		B	0.15 – 0.10 %	0.15 – 0.10 %

Table 2b NRC Uncertainties in Spectral Diffuse Reflectance (*k*=1) for the Spectral Range 350 nm to 390 nm.

Uncertainty Component		***Type (A or B)***	***Standard Uncertainty (k=1)***	***Relative Uncertainty in Reflectance Factor***
Signal to Noise		A	0.08 %	0.08 %
Instrument Stability	Short-term	A	0.04 %	0.04 %
Instrument Stability	Long-term	A	0.05%	0.05 %
Wavelength		B	0.15 nm	<0.01 % (S#n); 0.10% (C#n)
Detector Linearity		B	<0.01 %	<0.01 %
Modified Sharp-Little Method				
R > 0.85		B	0.05 %	0.05 %
0.75 < R <= 0.85		B	0.10 – 0.05 %	0.10 – 0.05 %
0.60 < R <= 0.75		B	0.15 – 0.10 %	0.15 – 0.10 %

8.11 OMH

Source of Uncertainty	***Type (A or B)***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	0.05% - 0.25%	0.05% - 0.25%
Instrument stability			
Wavelength	B	0.3 nm	<0.01%
Detector Linearity	B	<0.1%	<0.1%
Erb Method	B	0.31% - 0.60%	0.31 % - 0.60 %
		Depending on wavelength	

8.12 PTB

Source of Uncertainty	***Type (A or B)***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	0.02%	0.02%
Instrument stability	A	0.02%	0.02%
Wavelength	B	0.1 nm	*
Detector Linearity	B	<0.01%	<0.01%
Spline Interpolation	B	0.04 %	0.04%
Korte Method			
Port Correction	B	0.002%	0.002%
Irradiance Uniformity and wall correction	A	0.05%	0.05%

* depends on sample used and current wavelength to be measured: uncertainty is the largest for ceramic tile at 360 nm and nearly zero for wavelengths from the visible to the near IR U(λ): 0.09 %> U(λ) >=0

8.13 VNIIOFI

Source of Uncertainty	***Type (A or B)***	***Standard Uncertainty***	***Uncertainty in Reflectance Factor***
Signal Noise	A	0.03% - 0.3%	0.03% - 0.3%
Instrument stability	A	0.05%	0.05%
Wavelength	B	0.2 nm	0.01%
Detector Linearity	B	0.05%	0.05%
Erb Method	B	0.2% - 0.35%	0.2 % - 0.35 %

9. Participants' Raw Data

This section provides the reported raw data from all the participants. As prescribed by the technical protocol, the participants were asked to measure one of each of the sample type three times and the other two samples only once. Some of the participant's laboratories measured all three samples three times and only one of the sample standard deviation from the three measurements was used for the data analysis.

Table 9.1.a CSIR- NML raw data reported on Spectralon sample, S10.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.980	0.982	0.980	0.9807	0.0012
380	0.979	0.986	0.985	0.9833	0.0038
400	0.985	0.990	0.987	0.9873	0.0025
420	0.987	0.991	0.988	0.9887	0.0021
440	0.986	0.988	0.990	0.9880	0.0020
460	0.988	0.990	0.990	0.9893	0.0012
480	0.985	0.990	0.989	0.9880	0.0026
500	0.987	0.989	0.989	0.9883	0.0012
520	0.989	0.989	0.991	0.9897	0.0012
540	0.988	0.990	0.991	0.9897	0.0015
560	0.987	0.988	0.989	0.9880	0.0010
580	0.987	0.989	0.989	0.9883	0.0012
600	0.987	0.988	0.990	0.9883	0.0015
620	0.989	0.988	0.990	0.9890	0.0010
640	0.987	0.988	0.989	0.9880	0.0010
660	0.985	0.989	0.989	0.9877	0.0023
680	0.985	0.987	0.988	0.9867	0.0015
700	0.988	0.988	0.989	0.9883	0.0006
720	0.986	0.986	0.987	0.9863	0.0006
740	0.986	0.987	0.989	0.9873	0.0015
760	0.983	0.987	0.988	0.9860	0.0026
780	0.982	0.986	0.987	0.9850	0.0026
800	0.985	0.986	0.985	0.9853	0.0006
820	0.984	0.988	0.986	0.9860	0.0020

Table 9.1.b CSIR- NML raw data reported on Spectralon sample, S11.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.979	0.976	0.974	0.9763	0.0025
380	0.985	0.982	0.980	0.9823	0.0025
400	0.987	0.984	0.982	0.9843	0.0025
420	0.986	0.985	0.984	0.9850	0.0010
440	0.986	0.982	0.985	0.9843	0.0021
460	0.987	0.982	0.985	0.9847	0.0025
480	0.987	0.983	0.984	0.9847	0.0021

(Continued.)

500	0.988	0.983	0.984	0.9850	0.0026
520	0.990	0.984	0.986	0.9867	0.0031
540	0.989	0.984	0.986	0.9863	0.0025
560	0.988	0.982	0.984	0.9847	0.0031
580	0.988	0.983	0.985	0.9853	0.0025
600	0.988	0.982	0.985	0.9850	0.0030
620	0.990	0.983	0.986	0.9863	0.0035
640	0.988	0.982	0.985	0.9850	0.0030
660	0.987	0.983	0.985	0.9850	0.0020
680	0.986	0.981	0.984	0.9837	0.0025
700	0.987	0.983	0.985	0.9850	0.0020
720	0.987	0.980	0.983	0.9833	0.0035
740	0.987	0.982	0.985	0.9847	0.0025
760	0.985	0.981	0.983	0.9830	0.0020
780	0.984	0.980	0.983	0.9823	0.0021
800	0.986	0.979	0.981	0.9820	0.0036
820	0.986	0.981	0.982	0.9830	0.0026

Table 9.1.c CSIR- NML raw data reported on Spectralon sample, S12.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.980	0.978	0.977	0.9783	0.0015
380	0.983	0.983	0.984	0.9833	0.0006
400	0.986	0.985	0.986	0.9857	0.0006
420	0.988	0.986	0.986	0.9867	0.0012
440	0.986	0.982	0.987	0.9850	0.0026
460	0.987	0.983	0.988	0.9860	0.0026
480	0.986	0.984	0.987	0.9857	0.0015
500	0.986	0.983	0.987	0.9853	0.0021
520	0.988	0.984	0.989	0.9870	0.0026
540	0.986	0.985	0.988	0.9863	0.0015
560	0.985	0.982	0.987	0.9847	0.0025
580	0.986	0.983	0.987	0.9853	0.0021
600	0.986	0.982	0.987	0.9850	0.0026
620	0.987	0.983	0.988	0.9860	0.0026
640	0.986	0.981	0.987	0.9847	0.0032
660	0.984	0.984	0.987	0.9850	0.0017
680	0.984	0.981	0.986	0.9837	0.0025
700	0.985	0.981	0.987	0.9843	0.0031
720	0.983	0.979	0.986	0.9827	0.0035
740	0.984	0.981	0.987	0.9840	0.0030
760	0.982	0.981	0.984	0.9823	0.0015
780	0.981	0.979	0.984	0.9813	0.0025
800	0.983	0.978	0.985	0.9820	0.0036
820	0.981	0.982	0.983	0.9820	0.0010

Table 9.1.d CSIR- NML raw data reported on Ceramic sample, C10.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.642	0.644	0.647	0.6443	0.0025
380	0.758	0.755	0.760	0.7577	0.0025
400	0.833	0.833	0.836	0.8340	0.0017
420	0.866	0.866	0.868	0.8667	0.0012
440	0.876	0.876	0.876	0.8760	0.0000
460	0.887	0.887	0.887	0.8870	0.0000
480	0.892	0.892	0.894	0.8927	0.0012
500	0.898	0.897	0.897	0.8973	0.0006
520	0.901	0.901	0.901	0.9010	0.0000
540	0.902	0.901	0.902	0.9017	0.0006
560	0.902	0.901	0.900	0.9010	0.0010
580	0.898	0.899	0.899	0.8987	0.0006
600	0.902	0.901	0.901	0.9013	0.0006
620	0.903	0.902	0.902	0.9023	0.0006
640	0.902	0.901	0.902	0.9017	0.0006
660	0.904	0.902	0.904	0.9033	0.0012
680	0.905	0.904	0.906	0.9050	0.0010
700	0.907	0.907	0.908	0.9073	0.0006
720	0.908	0.906	0.907	0.9070	0.0010
740	0.908	0.907	0.908	0.9077	0.0006
760	0.906	0.906	0.909	0.9070	0.0017
780	0.907	0.906	0.907	0.9067	0.0006
800	0.906	0.906	0.906	0.9060	0.0000
820	0.906	0.906	0.907	0.9063	0.0006

Table 9.1.e CSIR- NML raw data reported on Ceramic sample, C11.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.606	0.609	0.610	0.6083	0.0021
380	0.730	0.728	0.733	0.7303	0.0025
400	0.816	0.817	0.819	0.8173	0.0015
420	0.854	0.855	0.857	0.8553	0.0015
440	0.867	0.866	0.867	0.8667	0.0006
460	0.877	0.877	0.878	0.8773	0.0006
480	0.884	0.884	0.885	0.8843	0.0006
500	0.890	0.890	0.890	0.8900	0.0000
520	0.894	0.895	0.894	0.8943	0.0006
540	0.897	0.896	0.897	0.8967	0.0006
560	0.897	0.896	0.896	0.8963	0.0006
580	0.894	0.894	0.894	0.8940	0.0000

(Continued.)

600	0.897	0.897	0.896	0.8967	0.0006
620	0.899	0.899	0.898	0.8987	0.0006
640	0.899	0.898	0.897	0.8980	0.0010
660	0.900	0.899	0.900	0.8997	0.0006
680	0.902	0.900	0.901	0.9010	0.0010
700	0.901	0.903	0.903	0.9023	0.0012
720	0.904	0.903	0.903	0.9033	0.0006
740	0.904	0.904	0.903	0.9037	0.0006
760	0.901	0.901	0.903	0.9017	0.0012
780	0.904	0.901	0.904	0.9030	0.0017
800	0.903	0.902	0.901	0.9020	0.0010
820	0.903	0.901	0.904	0.9027	0.0015

Table 9.1.f CSIR- NML raw data reported on Ceramic sample, C12.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.607	0.613	0.615	0.6117	0.0042
380	0.732	0.732	0.734	0.7327	0.0012
400	0.818	0.818	0.822	0.8193	0.0023
420	0.857	0.856	0.859	0.8573	0.0015
440	0.868	0.868	0.868	0.8680	0.0000
460	0.879	0.880	0.880	0.8797	0.0006
480	0.884	0.885	0.887	0.8853	0.0015
500	0.890	0.891	0.891	0.8907	0.0006
520	0.894	0.895	0.895	0.8947	0.0006
540	0.896	0.896	0.897	0.8963	0.0006
560	0.897	0.896	0.896	0.8963	0.0006
580	0.892	0.894	0.895	0.8937	0.0015
600	0.896	0.896	0.897	0.8963	0.0006
620	0.898	0.898	0.897	0.8977	0.0006
640	0.897	0.897	0.897	0.8970	0.0000
660	0.898	0.898	0.899	0.8983	0.0006
680	0.899	0.899	0.900	0.8993	0.0006
700	0.900	0.901	0.902	0.9010	0.0010
720	0.901	0.901	0.901	0.9010	0.0000
740	0.903	0.901	0.902	0.9020	0.0010
760	0.900	0.900	0.902	0.9007	0.0012
780	0.901	0.899	0.901	0.9003	0.0012
800	0.900	0.900	0.900	0.9000	0.0000
820	0.900	0.899	0.901	0.9000	0.0010

Table 9.2.a HUT raw data reported on Spectralon sample, S04.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9824	0.9823	0.9824	0.98237	0.00006
380	0.9848	0.9847	0.9852	0.98490	0.00026
400	0.9879	0.9881	0.9882	0.98807	0.00015
420	0.9898	0.9901	0.9898	0.98990	0.00017
440	0.9906	0.9894	0.9907	0.99023	0.00072
460	0.9911	0.9909	0.9916	0.99120	0.00036
480	0.9922	0.9925	0.9920	0.99223	0.00025
500	0.9921	0.9927	0.9924	0.99240	0.00030
520	0.9924	0.9924	0.9930	0.99260	0.00035
540	0.9924	0.9926	0.9929	0.99263	0.00025
560	0.9927	0.9926	0.9929	0.99273	0.00015
580	0.9930	0.9929	0.9932	0.99303	0.00015
600	0.9929	0.9929	0.9933	0.99303	0.00023
620	0.9928	0.9928	0.9932	0.99293	0.00023
640	0.9927	0.9926	0.9932	0.99283	0.00032
660	0.9927	0.9925	0.9933	0.99283	0.00042
680	0.9933	0.9932	0.9936	0.99337	0.00021
700	0.9933	0.9935	0.9937	0.99350	0.00020
720	0.9932	0.9933	0.9938	0.99343	0.00032
740	0.9934	0.9938	0.9940	0.99373	0.00031
760	0.9938	0.9941	0.9942	0.99403	0.00021
780	0.9939	0.9939	0.9943	0.99403	0.00023
800	0.9938	0.9941	0.9945	0.99413	0.00035
820	0.9943	0.9942	0.9947	0.99440	0.00026

Table 9.2.b HUT raw data reported on Spectralon sample, S05.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9802	0.9793	0.9786	0.97937	0.00080
380	0.9830	0.9828	0.9827	0.98283	0.00015
400	0.9855	0.9858	0.9855	0.98560	0.00017
420	0.9868	0.9874	0.9874	0.98720	0.00035
440	0.9881	0.9884	0.9883	0.98827	0.00015
460	0.9890	0.9892	0.9891	0.98910	0.00010
480	0.9900	0.9901	0.9899	0.99000	0.00010
500	0.9897	0.9907	0.9904	0.99027	0.00051
520	0.9905	0.9909	0.9907	0.99070	0.00020
540	0.9907	0.9910	0.9907	0.99080	0.00017
560	0.9906	0.9913	0.9911	0.99100	0.00036
580	0.9912	0.9916	0.9914	0.99140	0.00020

(Continued.)

600	0.9913	0.9918	0.9916	0.99157	0.00025
620	0.9913	0.9919	0.9916	0.99160	0.00030
640	0.9917	0.9921	0.9916	0.99180	0.00026
660	0.9916	0.9921	0.9918	0.99183	0.00025
680	0.9922	0.9924	0.9921	0.99223	0.00015
700	0.9922	0.9925	0.9923	0.99233	0.00015
720	0.9922	0.9927	0.9924	0.99243	0.00025
740	0.9925	0.9929	0.9925	0.99263	0.00023
760	0.9927	0.9932	0.9929	0.99293	0.00025
780	0.9929	0.9934	0.9930	0.99310	0.00026
800	0.9935	0.9935	0.9933	0.99343	0.00012
820	0.9936	0.9938	0.9935	0.99363	0.00015

Table 9.2.c HUT raw data reported on Spectralon sample, S06.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9818	0.9821		0.98195	0.00021
380	0.9850	0.9853		0.98515	0.00021
400	0.9879	0.9879		0.98790	0.00000
420	0.9893	0.9893		0.98930	0.00000
440	0.9902	0.9903		0.99025	0.00007
460	0.9909	0.9911		0.99100	0.00014
480	0.9916	0.9917		0.99165	0.00007
500	0.9920	0.9921		0.99205	0.00007
520	0.9921	0.9924		0.99225	0.00021
540	0.9922	0.9925		0.99235	0.00021
560	0.9923	0.9927		0.99250	0.00028
580	0.9926	0.9929		0.99275	0.00021
600	0.9927	0.9929		0.99280	0.00014
620	0.9928	0.9931		0.99295	0.00021
640	0.9927	0.9931		0.99290	0.00028
660	0.9929	0.9932		0.99305	0.00021
680	0.9931	0.9933		0.99320	0.00014
700	0.9932	0.9934		0.99330	0.00014
720	0.9933	0.9935		0.99340	0.00014
740	0.9934	0.9937		0.99355	0.00021
760	0.9938	0.9940		0.99390	0.00014
780	0.9939	0.9941		0.99400	0.00014
800	0.9941	0.9942		0.99415	0.00007
820	0.9945	0.9945		0.99450	0.00000

Table 9.2.d HUT raw data reported on Ceramic sample, C04.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6121	0.6097	0.6089	0.61023	0.00167
380	0.7321	0.7301	0.7294	0.73053	0.00140
400	0.8152	0.8144	0.8141	0.81457	0.00057
420	0.8523	0.8517	0.8517	0.85190	0.00035
440	0.8662	0.8656	0.8656	0.86580	0.00035
460	0.8769	0.8763	0.8762	0.87647	0.00038
480	0.8845	0.8840	0.8851	0.88453	0.00055
500	0.8899	0.8894	0.8898	0.88970	0.00026
520	0.8929	0.8924	0.8927	0.89267	0.00025
540	0.8952	0.8947	0.8949	0.89493	0.00025
560	0.8959	0.8955	0.8955	0.89563	0.00023
580	0.8949	0.8944	0.8946	0.89463	0.00025
600	0.8976	0.8970	0.8972	0.89727	0.00031
620	0.8984	0.8979	0.8978	0.89803	0.00032
640	0.8992	0.8987	0.8988	0.89890	0.00026
660	0.9009	0.9004	0.9003	0.90053	0.00032
680	0.9035	0.9030	0.9030	0.90317	0.00029
700	0.9049	0.9044	0.9045	0.90460	0.00026
720	0.9060	0.9056	0.9057	0.90577	0.00021
740	0.9063	0.9059	0.9057	0.90597	0.00031
760	0.9069	0.9064	0.9065	0.90660	0.00026
780	0.9071	0.9067	0.9069	0.90690	0.00020
800	0.9060	0.9057	0.9058	0.90583	0.00015
820	0.9061	0.9063	0.9063	0.90623	0.00012

Table 9.2.e HUT raw data reported on Ceramic sample, C05.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6106	0.6102		0.61040	0.00028
380	0.7306	0.7300		0.73030	0.00042
400	0.8141	0.8145		0.81430	0.00028
420	0.8513	0.8514		0.85135	0.00007
440	0.8650	0.8653		0.86515	0.00021
460	0.8757	0.8759		0.87580	0.00014
480	0.8833	0.8835		0.88340	0.00014
500	0.8888	0.8889		0.88885	0.00007
520	0.8917	0.8917		0.89170	0.00000
540	0.8939	0.8941		0.89400	0.00014
560	0.8946	0.8947		0.89465	0.00007
580	0.8934	0.8934		0.89340	0.00000

(Continued.)

600	0.8960	0.8960		0.89600	0.00000
620	0.8967	0.8967		0.89670	0.00000
640	0.8976	0.8976		0.89760	0.00000
660	0.8993	0.8993		0.89930	0.00000
680	0.9018	0.9017		0.90175	0.00007
700	0.9031	0.9030		0.90305	0.00007
720	0.9042	0.9041		0.90415	0.00007
740	0.9044	0.9044		0.90440	0.00000
760	0.9049	0.9049		0.90490	0.00000
780	0.9052	0.9052		0.90520	0.00000
800	0.9043	0.9043		0.90430	0.00000
820	0.9048	0.9048		0.90480	0.00000

Table 9.2.f HUT raw data reported on Ceramic sample, C06.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6063	0.6105	0.6115	0.60943	0.00276
380	0.7278	0.7306	0.7299	0.72943	0.00146
400	0.8114	0.8135	0.8126	0.81250	0.00105
420	0.8487	0.8502	0.8498	0.84957	0.00078
440	0.8626	0.8640	0.8634	0.86333	0.00070
460	0.8733	0.8746	0.8741	0.87400	0.00066
480	0.8811	0.8825	0.8819	0.88183	0.00070
500	0.8864	0.8882	0.8872	0.88727	0.00090
520	0.8894	0.8909	0.8902	0.89017	0.00075
540	0.8916	0.8929	0.8923	0.89227	0.00065
560	0.8923	0.8937	0.8931	0.89303	0.00070
580	0.8911	0.8924	0.8919	0.89180	0.00066
600	0.8937	0.8950	0.8945	0.89440	0.00066
620	0.8944	0.8957	0.8952	0.89510	0.00066
640	0.8953	0.8966	0.8961	0.89600	0.00066
660	0.8970	0.8984	0.8979	0.89777	0.00071
680	0.8997	0.9011	0.9005	0.90043	0.00070
700	0.9011	0.9024	0.9020	0.90183	0.00067
720	0.9023	0.9036	0.9032	0.90303	0.00067
740	0.9025	0.9038	0.9033	0.90320	0.00066
760	0.9030	0.9045	0.9040	0.90383	0.00076
780	0.9035	0.9048	0.9043	0.90420	0.00066
800	0.9025	0.9039	0.9034	0.90327	0.00071
820	0.9042	0.9045	0.9041	0.90427	0.00021

Table 9.3.a IFA-CSIC raw data reported on Spectralon sample, S16.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360					
380	0.9612	0.9635	0.9585	0.9611	0.0025
400	0.9661	0.9687	0.9612	0.9653	0.0038
420	0.9683	0.9741	0.9698	0.9707	0.0030
440	0.9701	0.9748	0.9755	0.9735	0.0029
460	0.9758	0.9800	0.9767	0.9775	0.0022
480	0.9809	0.9819	0.9825	0.9818	0.0008
500	0.9809	0.9802	0.9786	0.9799	0.0012
520	0.9818	0.9802	0.9823	0.9814	0.0011
540	0.9825	0.9816	0.9825	0.9822	0.0005
560	0.9840	0.9868	0.9836	0.9848	0.0017
580	0.9843	0.9857	0.9840	0.9847	0.0009
600	0.9841	0.9848	0.9840	0.9843	0.0004
620	0.9871	0.9848	0.9834	0.9851	0.0019
640	0.9856	0.9843	0.9851	0.9850	0.0007
660	0.9885	0.9831	0.9855	0.9857	0.0027
680	0.9863	0.9865	0.9868	0.9865	0.0003
700	0.9873	0.9837	0.9858	0.9856	0.0018
720	0.9907	0.9867	0.9855	0.9876	0.0027
740	0.9880	0.9879	0.9885	0.9881	0.0003
760	0.9846	0.9885	0.9875	0.9869	0.0020
780	0.9865	0.9894	0.9849	0.9869	0.0023
800					
820					

Table 9.3.b IFA-CSIC raw data reported on Spectralon sample, S17.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360					
380	0.9669	0.9698	0.9628	0.9665	0.0035
400	0.9695	0.9759	0.9616	0.9690	0.0072
420	0.9724	0.9774	0.9731	0.9743	0.0027
440	0.9784	0.9809	0.9796	0.9796	0.0013
460	0.9773	0.9797	0.9807	0.9792	0.0017
480	0.9854	0.9812	0.9830	0.9832	0.0021
500	0.9841	0.9790	0.9805	0.9812	0.0026
520	0.9850	0.9827	0.9816	0.9831	0.0017
540	0.9848	0.9809	0.9840	0.9832	0.0021
560	0.9869	0.9882	0.9836	0.9862	0.0024
580	0.9875	0.9825	0.9845	0.9848	0.0025

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600	0.9887	0.9814	0.9830	0.9844	0.0038
620	0.9876	0.9842	0.9844	0.9854	0.0019
640	0.9873	0.9834	0.9848	0.9852	0.0020
660	0.9892	0.9857	0.9849	0.9866	0.0023
680	0.9894	0.9856	0.9855	0.9868	0.0022
700	0.9888	0.9863	0.9865	0.9872	0.0014
720	0.9907	0.9884	0.9857	0.9883	0.0025
740	0.9888	0.9873	0.9870	0.9877	0.0010
760	0.9863	0.9852	0.9863	0.9859	0.0006
780	0.9868	0.9873	0.9840	0.9860	0.0018
800					
820					

Table 9.3.c IFA-CSIC raw data reported on Spectralon sample, S18.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360					
380	0.9691	0.9732	0.9688	0.9704	0.0025
400	0.9695	0.9784	0.9707	0.9729	0.0048
420	0.9747	0.9786	0.9814	0.9782	0.0034
440	0.9741	0.9804	0.9848	0.9798	0.0054
460	0.9762	0.9846	0.9846	0.9818	0.0048
480	0.9879	0.9855	0.9852	0.9862	0.0015
500	0.9811	0.9826	0.9848	0.9828	0.0019
520	0.9834	0.9866	0.9851	0.9850	0.0016
540	0.9864	0.9856	0.9874	0.9865	0.0009
560	0.9842	0.9928	0.9868	0.9879	0.0044
580	0.9857	0.9868	0.9873	0.9866	0.0008
600	0.9864	0.9875	0.9883	0.9874	0.0010
620	0.9869	0.9862	0.9859	0.9863	0.0005
640	0.9884	0.9887	0.9874	0.9882	0.0007
660	0.9891	0.9873	0.9882	0.9882	0.0009
680	0.9851	0.9892	0.9895	0.9879	0.0025
700	0.9883	0.9888	0.9888	0.9886	0.0003
720	0.9858	0.9898	0.9877	0.9878	0.0020
740	0.9894	0.9890	0.9900	0.9895	0.0005
760	0.9867	0.9893	0.9877	0.9879	0.0013
780	0.9875	0.9907	0.9861	0.9881	0.0024
800					
820					

Table 9.3.d IFA-CSIC raw data reported on Ceramic sample, C16.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360					
380	0.7126	0.7153	0.7163	0.7147	0.0019
400	0.8004	0.7986	0.8000	0.7997	0.0009
420	0.8374	0.8428	0.8372	0.8391	0.0032
440	0.8507	0.8684	0.8539	0.8577	0.0094
460	0.8629	0.8721	0.8641	0.8664	0.0050
480	0.8758	0.8806	0.8770	0.8778	0.0025
500	0.8806	0.8858	0.8799	0.8821	0.0032
520	0.8893	0.8872	0.8831	0.8865	0.0032
540	0.8904	0.8922	0.8847	0.8891	0.0039
560	0.8920	0.8933	0.8862	0.8905	0.0038
580	0.8872	0.8909	0.8880	0.8887	0.0019
600	0.8938	0.8935	0.8904	0.8926	0.0019
620	0.8922	0.8952	0.8916	0.8930	0.0019
640	0.8947	0.9052	0.8915	0.8971	0.0072
660	0.8970	0.8970	0.8941	0.8960	0.0017
680	0.8986	0.9000	0.8950	0.8979	0.0026
700	0.8980	0.9017	0.8983	0.8993	0.0021
720	0.9007	0.9013	0.8981	0.9000	0.0017
740	0.9007	0.9027	0.8991	0.9008	0.0018
760	0.9008	0.9019	0.8999	0.9009	0.0010
780	0.9013	0.9052	0.9000	0.9022	0.0027
800					
820					

Table 9.3.e IFA-CSIC raw data reported on Ceramic sample, C17.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360					
380	0.7129	0.7196	0.7148	0.7158	0.0035
400	0.8003	0.8046	0.7994	0.8014	0.0028
420	0.8375	0.8492	0.8399	0.8422	0.0062
440	0.8510	0.8579	0.8554	0.8548	0.0035
460	0.8659	0.8713	0.8653	0.8675	0.0033
480	0.8769	0.8824	0.8753	0.8782	0.0037
500	0.8806	0.8842	0.8803	0.8817	0.0022
520	0.8870	0.8888	0.8830	0.8863	0.0030
540	0.8875	0.8898	0.8859	0.8877	0.0020
560	0.8894	0.8964	0.8893	0.8917	0.0041
580	0.8886	0.8920	0.8871	0.8892	0.0025

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600	0.8924	0.8927	0.8917	0.8923	0.0005
620	0.8918	0.8946	0.8934	0.8933	0.0014
640	0.8948	0.8969	0.8945	0.8954	0.0013
660	0.8952	0.8985	0.8947	0.8961	0.0021
680	0.8972	0.9014	0.8974	0.8987	0.0024
700	0.8983	0.9028	0.8992	0.9001	0.0024
720	0.9024	0.9048	0.8998	0.9023	0.0025
740	0.9024	0.9044	0.9001	0.9023	0.0022
760	0.9003	0.9050	0.9007	0.9020	0.0026
780	0.9002	0.9073	0.9030	0.9035	0.0036
800					
820					

Table 9.3.f IFA-CSIC raw data reported on Ceramic sample, C18.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360					
380	0.7182	0.7178	0.7119	0.7160	0.0035
400	0.8025	0.8046	0.7989	0.8020	0.0029
420	0.8462	0.8456	0.8449	0.8456	0.0007
440	0.8587	0.8560	0.8613	0.8587	0.0027
460	0.8707	0.8682	0.8662	0.8684	0.0023
480	0.8852	0.8794	0.8751	0.8799	0.0051
500	0.8873	0.8818	0.8798	0.8830	0.0039
520	0.8914	0.8854	0.8868	0.8879	0.0031
540	0.8919	0.8879	0.8897	0.8898	0.0020
560	0.8928	0.8919	0.8919	0.8922	0.0005
580	0.8924	0.8900	0.8884	0.8903	0.0020
600	0.8969	0.8910	0.8926	0.8935	0.0031
620	0.8949	0.8917	0.8952	0.8939	0.0019
640	0.8972	0.8942	0.8926	0.8947	0.0023
660	0.8993	0.8939	0.8939	0.8957	0.0031
680	0.9023	0.9006	0.8989	0.9006	0.0017
700	0.9020	0.8999	0.8993	0.9004	0.0014
720	0.9077	0.9046	0.8993	0.9039	0.0042
740	0.9053	0.9042	0.9009	0.9035	0.0023
760	0.9045	0.9050	0.9039	0.9045	0.0006
780	0.9066	0.9078	0.9022	0.9055	0.0029
800					
820					

Table 9.4.a KRISS raw data reported on Spectralon sample, S13.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360				
380	0.9810			0.9810
400	0.9840			0.9840
420	0.9854			0.9854
440	0.9867			0.9867
460	0.9875			0.9875
480	0.9881			0.9881
500	0.9885			0.9885
520	0.9889			0.9889
540	0.9894			0.9894
560	0.9897			0.9897
580	0.9896			0.9896
600	0.9897			0.9897
620	0.9896			0.9896
640	0.9896			0.9896
660	0.9897			0.9897
680	0.9894			0.9894
700	0.9895			0.9895
720	0.9891			0.9891
740	0.9889			0.9889
760	0.9887			0.9887
780	0.9885			0.9885
800				
820				

Table 9.4.b KRISS raw data reported on Spectralon sample, S14.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360				
380	0.9825			0.9825
400	0.9854			0.9854
420	0.9873			0.9873
440	0.9886			0.9886
460	0.9890			0.9890
480	0.9893			0.9893
500	0.9899			0.9899
520	0.9903			0.9903
540	0.9908			0.9908
560	0.9909			0.9909
580	0.9908			0.9908

(Continued.)

600	0.9909			0.9909
620	0.9909			0.9909
640	0.9908			0.9908
660	0.9908			0.9908
680	0.9905			0.9905
700	0.9907			0.9907
720	0.9901			0.9901
740	0.9899			0.9899
760	0.9897			0.9897
780	0.9896			0.9896
800				
820				

Table 9.4.c KRISS raw data reported on Spectralon sample, S15.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360					
380	0.9816	0.9801	0.9799	0.9805	0.0009
400	0.9844	0.9833	0.9838	0.9838	0.0006
420	0.9862	0.9855	0.9858	0.9858	0.0004
440	0.9873	0.9869	0.9870	0.9871	0.0002
460	0.9880	0.9874	0.9873	0.9876	0.0004
480	0.9885	0.9881	0.9878	0.9881	0.0004
500	0.9890	0.9884	0.9883	0.9886	0.0004
520	0.9893	0.9890	0.9889	0.9891	0.0002
540	0.9897	0.9893	0.9895	0.9895	0.0002
560	0.9898	0.9895	0.9899	0.9897	0.0002
580	0.9897	0.9894	0.9897	0.9896	0.0002
600	0.9896	0.9897	0.9899	0.9897	0.0002
620	0.9895	0.9894	0.9900	0.9896	0.0003
640	0.9896	0.9895	0.9898	0.9896	0.0002
660	0.9894	0.9893	0.9896	0.9894	0.0002
680	0.9892	0.9892	0.9897	0.9894	0.0003
700	0.9894	0.9893	0.9897	0.9895	0.0002
720	0.9889	0.9889	0.9892	0.9890	0.0002
740	0.9886	0.9885	0.9889	0.9887	0.0002
760	0.9885	0.9884	0.9888	0.9886	0.0002
780	0.9880	0.9882	0.9888	0.9883	0.0004
800					
820					

Table 9.4.d KRISS raw data reported on Ceramic sample, C13.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360					
380	0.7224	0.7223	0.7215	0.7221	0.0005
400	0.8101	0.8098	0.8094	0.8098	0.0004
420	0.8486	0.8489	0.8480	0.8485	0.0005
440	0.8636	0.8628	0.8632	0.8632	0.0004
460	0.8746	0.8739	0.8743	0.8743	0.0004
480	0.8819	0.8824	0.8818	0.8820	0.0003
500	0.8878	0.8872	0.8880	0.8877	0.0004
520	0.8922	0.8914	0.8913	0.8916	0.0005
540	0.8941	0.8942	0.8942	0.8942	0.0001
560	0.8946	0.8952	0.8950	0.8949	0.0003
580	0.8942	0.8938	0.8931	0.8937	0.0006
600	0.8963	0.8966	0.8966	0.8965	0.0002
620	0.8978	0.8970	0.8971	0.8973	0.0004
640	0.8977	0.8983	0.8979	0.8980	0.0003
660	0.8999	0.8994	0.8992	0.8995	0.0004
680	0.9022	0.9024	0.9015	0.9020	0.0005
700	0.9037	0.9035	0.9034	0.9035	0.0002
720	0.9046	0.9047	0.9045	0.9046	0.0001
740	0.9039	0.9038	0.9037	0.9038	0.0001
760	0.9049	0.9038	0.9034	0.9040	0.0008
780	0.9041	0.9040	0.9042	0.9041	0.0001
800					
820					

Table 9.4.e KRISS raw data reported on Ceramic sample, C14.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360				
380	0.7244			0.7244
400	0.8117			0.8117
420	0.8499			0.8499
440	0.8645			0.8645
460	0.8761			0.8761
480	0.8829			0.8829
500	0.8890			0.8890
520	0.8929			0.8929
540	0.8952			0.8952
560	0.8953			0.8953
580	0.8948			0.8948

(Continued.)

600	0.8973			0.8973
620	0.8980			0.8980
640	0.8980			0.8980
660	0.9007			0.9007
680	0.9032			0.9032
700	0.9044			0.9044
720	0.9046			0.9046
740	0.9050			0.9050
760	0.9060			0.9060
780	0.9048			0.9048
800				
820				

Table 9.4.f KRISS raw data reported on Ceramic sample, C15.

Wavelength [nm]	**Run #1**	**Run #2**	**Run #3**	**Average**
360				
380	0.7233			0.7233
400	0.8108			0.8108
420	0.8493			0.8493
440	0.8637			0.8637
460	0.8750			0.8750
480	0.8821			0.8821
500	0.8881			0.8881
520	0.8923			0.8923
540	0.8945			0.8945
560	0.8950			0.8950
580	0.8943			0.8943
600	0.8970			0.8970
620	0.8979			0.8979
640	0.8979			0.8979
660	0.9004			0.9004
680	0.9029			0.9029
700	0.9045			0.9045
720	0.9046			0.9046
740	0.9050			0.9050
760	0.9057			0.9057
780	0.9059			0.9059
800				
820				

Table 9.5.a MSL raw data reported on Spectralon sample, S04.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9810	0.9808	0.9809	0.9809	0.0001
380	0.9838	0.9838	0.9840	0.9839	0.0001
400	0.9868	0.9870	0.9870	0.9869	0.0001
420	0.9887	0.9890	0.9888	0.9888	0.0002
440	0.9896	0.9892	0.9892	0.9893	0.0002
460	0.9900	0.9898	0.9903	0.9900	0.0003
480	0.9906	0.9906	0.9908	0.9907	0.0001
500	0.9916	0.9910	0.9912	0.9913	0.0003
520	0.9912	0.9910	0.9914	0.9912	0.0002
540	0.9912	0.9914	0.9913	0.9913	0.0001
560	0.9912	0.9915	0.9913	0.9913	0.0002
580	0.9913	0.9916	0.9912	0.9914	0.0002
600	0.9912	0.9914	0.9915	0.9914	0.0002
620	0.9913	0.9916	0.9917	0.9915	0.0002
640	0.9920	0.9919	0.9917	0.9919	0.0002
660	0.9918	0.9920	0.9915	0.9918	0.0003
680	0.9917	0.9918	0.9918	0.9918	0.0001
700	0.9920	0.9916	0.9916	0.9917	0.0002
720	0.9917	0.9920	0.9917	0.9918	0.0002
740	0.9917	0.9918	0.9918	0.9918	0.0001
760	0.9914	0.9915	0.9918	0.9916	0.0002
780	0.9915	0.9917	0.9917	0.9916	0.0001
800	0.9917	0.9914	0.9913	0.9915	0.0002
820	0.9918	0.9918	0.9918	0.9918	0.0000

Table 9.5.b MSL raw data reported on Spectralon sample, S05.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9779	0.9779	0.9781	0.9780	0.0001
380	0.9815	0.9810	0.9810	0.9812	0.0003
400	0.9845	0.9844	0.9846	0.9845	0.0001
420	0.9866	0.9864	0.9863	0.9864	0.0002
440	0.9874	0.9874	0.9872	0.9873	0.0001
460	0.9880	0.9877	0.9880	0.9879	0.0002
480	0.9885	0.9888	0.9886	0.9886	0.0002
500	0.9893	0.9892	0.9895	0.9893	0.0002
520	0.9894	0.9896	0.9898	0.9896	0.0002
540	0.9898	0.9900	0.9899	0.9899	0.0001
560	0.9902	0.9898	0.9899	0.9900	0.0002
580	0.9905	0.9901	0.9901	0.9902	0.0002

(Continued.)

600	0.9902	0.9903	0.9905	0.9903	0.0002
620	0.9911	0.9904	0.9904	0.9906	0.0004
640	0.9907	0.9907	0.9906	0.9907	0.0001
660	0.9910	0.9908	0.9907	0.9908	0.0002
680	0.9907	0.9908	0.9907	0.9907	0.0001
700	0.9907	0.9905	0.9904	0.9905	0.0002
720	0.9907	0.9910	0.9906	0.9908	0.0002
740	0.9905	0.9909	0.9908	0.9907	0.0002
760	0.9906	0.9908	0.9910	0.9908	0.0002
780	0.9910	0.9909	0.9910	0.9910	0.0001
800	0.9909	0.9909	0.9909	0.9909	0.0000
820	0.9914	0.9910	0.9911	0.9912	0.0002

Table 9.5.c MSL raw data reported on Spectralon sample, S06.

Wavelength [nm]	**Run #1**	**Run #2**	**Run #3**	**Average**	**Standard Deviation**
360	0.9810	0.9811	0.9809	0.9810	0.0001
380	0.9835	0.9832	0.9833	0.9833	0.0002
400	0.9863	0.9865	0.9863	0.9864	0.0001
420	0.9880	0.9878	0.9882	0.9880	0.0002
440	0.9886	0.9885	0.9886	0.9886	0.0001
460	0.9895	0.9892	0.9895	0.9894	0.0002
480	0.9902	0.9902	0.9896	0.9900	0.0003
500	0.9905	0.9904	0.9906	0.9905	0.0001
520	0.9904	0.9908	0.9907	0.9906	0.0002
540	0.9906	0.9909	0.9909	0.9908	0.0002
560	0.9907	0.9911	0.9907	0.9908	0.0002
580	0.9915	0.9908	0.9909	0.9911	0.0004
600	0.9915	0.9911	0.9911	0.9912	0.0002
620	0.9912	0.9914	0.9914	0.9913	0.0001
640	0.9922	0.9916	0.9915	0.9918	0.0004
660	0.9916	0.9916	0.9914	0.9915	0.0001
680	0.9916	0.9911	0.9915	0.9914	0.0003
700	0.9916	0.9915	0.9915	0.9915	0.0001
720	0.9920	0.9917	0.9914	0.9917	0.0003
740	0.9916	0.9916	0.9916	0.9916	0.0000
760	0.9914	0.9922	0.9918	0.9918	0.0004
780	0.9916	0.9919	0.9914	0.9916	0.0003
800	0.9916	0.9918	0.9916	0.9917	0.0001
820	0.9919	0.9913	0.9914	0.9915	0.0003

Table 9.5.d MSL raw data reported on Ceramic sample, C04.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6110	0.6100	0.6107	0.6106	0.0005
380	0.7298	0.7291	0.7294	0.7294	0.0004
400	0.8147	0.8144	0.8145	0.8145	0.0002
420	0.8519	0.8522	0.8521	0.8521	0.0002
440	0.8659	0.8654	0.8656	0.8656	0.0003
460	0.8759	0.8759	0.8763	0.8760	0.0002
480	0.8836	0.8839	0.8836	0.8837	0.0002
500	0.8892	0.8894	0.8890	0.8892	0.0002
520	0.8921	0.8921	0.8921	0.8921	0.0000
540	0.8946	0.8943	0.8943	0.8944	0.0002
560	0.8951	0.8953	0.8949	0.8951	0.0002
580	0.8938	0.8937	0.8937	0.8937	0.0001
600	0.8966	0.8966	0.8962	0.8965	0.0002
620	0.8972	0.8975	0.8973	0.8973	0.0002
640	0.8983	0.8984	0.8982	0.8983	0.0001
660	0.9002	0.8999	0.8996	0.8999	0.0003
680	0.9025	0.9021	0.9023	0.9023	0.0002
700	0.9035	0.9039	0.9031	0.9035	0.0004
720	0.9050	0.9052	0.9047	0.9050	0.0003
740	0.9056	0.9050	0.9048	0.9051	0.0004
760	0.9058	0.9057	0.9058	0.9058	0.0001
780	0.9056	0.9056	0.9057	0.9056	0.0001
800	0.9043	0.9048	0.9048	0.9046	0.0003
820	0.9048	0.9047	0.9047	0.9047	0.0001

Table 9.5.e MSL raw data reported on Ceramic sample, C05.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6106	0.6103	0.6106	0.6105	0.0002
380	0.7293	0.7291	0.7293	0.7292	0.0001
400	0.8141	0.8136	0.8138	0.8138	0.0003
420	0.8514	0.8511	0.8514	0.8513	0.0002
440	0.8650	0.8644	0.8650	0.8648	0.0003
460	0.8750	0.8751	0.8753	0.8751	0.0002
480	0.8828	0.8827	0.8829	0.8828	0.0001
500	0.8880	0.8881	0.8883	0.8881	0.0002
520	0.8913	0.8912	0.8914	0.8913	0.0001
540	0.8933	0.8933	0.8935	0.8934	0.0001
560	0.8935	0.8939	0.8938	0.8937	0.0002
580	0.8928	0.8922	0.8926	0.8925	0.0003

(Continued.)

600	0.8958	0.8950	0.8951	0.8953	0.0004
620	0.8962	0.8959	0.8960	0.8960	0.0002
640	0.8970	0.8965	0.8968	0.8968	0.0003
660	0.8987	0.8982	0.8985	0.8985	0.0003
680	0.9008	0.9006	0.9010	0.9008	0.0002
700	0.9019	0.9019	0.9022	0.9020	0.0002
720	0.9032	0.9030	0.9032	0.9031	0.0001
740	0.9034	0.9031	0.9035	0.9033	0.0002
760	0.9038	0.9037	0.9040	0.9038	0.0002
780	0.9045	0.9038	0.9040	0.9041	0.0004
800	0.9026	0.9027	0.9027	0.9027	0.0001
820	0.9030	0.9029	0.9032	0.9030	0.0002

Table 9.5.f MSL raw data reported on Ceramic sample, C06.

Wavelength [nm]	**Run #1**	**Run #2**	**Run #3**	**Average**	**Standard Deviation**
360	0.6102	0.6089	0.6097	0.6096	0.0007
380	0.7280	0.7269	0.7278	0.7276	0.0006
400	0.8122	0.8115	0.8122	0.8120	0.0004
420	0.8497	0.8488	0.8495	0.8493	0.0005
440	0.8630	0.8624	0.8630	0.8628	0.0003
460	0.8739	0.8725	0.8734	0.8733	0.0007
480	0.8812	0.8803	0.8809	0.8808	0.0005
500	0.8868	0.8862	0.8867	0.8866	0.0003
520	0.8892	0.8885	0.8896	0.8891	0.0006
540	0.8914	0.8909	0.8919	0.8914	0.0005
560	0.8924	0.8918	0.8921	0.8921	0.0003
580	0.8910	0.8902	0.8908	0.8907	0.0004
600	0.8937	0.8931	0.8937	0.8935	0.0003
620	0.8944	0.8941	0.8945	0.8943	0.0002
640	0.8957	0.8946	0.8954	0.8952	0.0006
660	0.8971	0.8961	0.8973	0.8968	0.0006
680	0.9000	0.8989	0.8995	0.8995	0.0006
700	0.9012	0.9000	0.9005	0.9006	0.0006
720	0.9021	0.9012	0.9023	0.9019	0.0006
740	0.9022	0.9014	0.9022	0.9019	0.0005
760	0.9025	0.9019	0.9025	0.9023	0.0003
780	0.9029	0.9021	0.9028	0.9026	0.0004
800	0.9016	0.9012	0.9018	0.9015	0.0003
820	0.9020	0.9011	0.9021	0.9017	0.0006

Table 9.6.a NIM raw data reported on Spectralon sample, S13.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.9726			0.9726
380	0.9754			0.9754
400	0.9776			0.9776
420	0.9810			0.9810
440	0.9839			0.9839
460	0.9850			0.9850
480	0.9858			0.9858
500	0.9861			0.9861
520	0.9862			0.9862
540	0.9863			0.9863
560	0.9863			0.9863
580	0.9863			0.9863
600	0.9862			0.9862
620	0.9861			0.9861
640	0.9859			0.9859
660	0.9857			0.9857
680	0.9856			0.9856
700	0.9856			0.9856
720	0.9857			0.9857
740	0.9859			0.9859
760	0.9862			0.9862
780	0.9866			0.9866
800	0.9868			0.9868
820	0.9868			0.9868

Table 9.6.b NIM raw data reported on Spectralon sample, S14.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9738	0.9742	0.9750	0.9743	0.0006
380	0.9767	0.9771	0.9779	0.9772	0.0006
400	0.9800	0.9800	0.9803	0.9801	0.0002
420	0.9835	0.9825	0.9826	0.9829	0.0006
440	0.9858	0.9847	0.9845	0.9850	0.0007
460	0.9869	0.9863	0.9859	0.9864	0.0005
480	0.9875	0.9872	0.9868	0.9872	0.0004
500	0.9876	0.9875	0.9872	0.9874	0.0002
520	0.9876	0.9877	0.9874	0.9876	0.0002
540	0.9876	0.9876	0.9874	0.9875	0.0001
560	0.9876	0.9875	0.9873	0.9875	0.0002
580	0.9876	0.9873	0.9872	0.9874	0.0002

(Continued.)

600	0.9875	0.9869	0.9871	0.9872	0.0003
620	0.9874	0.9867	0.9869	0.9870	0.0004
640	0.9871	0.9866	0.9866	0.9868	0.0003
660	0.9869	0.9864	0.9863	0.9865	0.0003
680	0.9866	0.9862	0.9860	0.9863	0.0003
700	0.9865	0.9860	0.9857	0.9861	0.0004
720	0.9865	0.9860	0.9857	0.9861	0.0004
740	0.9867	0.9861	0.9859	0.9862	0.0004
760	0.9869	0.9864	0.9863	0.9865	0.0003
780	0.9872	0.9867	0.9867	0.9869	0.0003
800	0.9874	0.9869	0.9870	0.9871	0.0003
820	0.9875	0.9871	0.9877	0.9874	0.0003

Table 9.6.c NIM raw data reported on Spectralon sample, S15.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.9716			0.9716
380	0.9745			0.9745
400	0.9776			0.9776
420	0.9812			0.9812
440	0.9840			0.9840
460	0.9852			0.9852
480	0.9858			0.9858
500	0.9860			0.9860
520	0.9860			0.9860
540	0.9860			0.9860
560	0.9861			0.9861
580	0.9863			0.9863
600	0.9863			0.9863
620	0.9862			0.9862
640	0.9861			0.9861
660	0.9858			0.9858
680	0.9856			0.9856
700	0.9855			0.9855
720	0.9855			0.9855
740	0.9857			0.9857
760	0.9860			0.9860
780	0.9863			0.9863
800	0.9864			0.9864
820	0.9863			0.9863

Table 9.6.d NIM raw data reported on Ceramic sample, C13.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.5985			0.5985
380	0.7130			0.7130
400	0.7994			0.7994
420	0.8380			0.8380
440	0.8528			0.8528
460	0.8651			0.8651
480	0.8732			0.8732
500	0.8784			0.8784
520	0.8812			0.8812
540	0.8833			0.8833
560	0.8837			0.8837
580	0.8840			0.8840
600	0.8847			0.8847
620	0.8857			0.8857
640	0.8866			0.8866
660	0.8882			0.8882
680	0.8908			0.8908
700	0.8924			0.8924
720	0.8935			0.8935
740	0.8938			0.8938
760	0.8946			0.8946
780	0.8955			0.8955
800	0.8954			0.8954
820	0.8958			0.8958

Table 9.6.e NIM raw data reported on Ceramic sample, C14.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6027	0.6041	0.6045	0.6038	0.0009
380	0.7161	0.7179	0.7169	0.7170	0.0009
400	0.8014	0.8007	0.8005	0.8009	0.0005
420	0.8398	0.8400	0.8400	0.8399	0.0001
440	0.8552	0.8571	0.8564	0.8562	0.0010
460	0.8667	0.8669	0.8677	0.8671	0.0005
480	0.8747	0.8746	0.8756	0.8750	0.0006
500	0.8798	0.8804	0.8809	0.8804	0.0006
520	0.8827	0.8841	0.8841	0.8836	0.0008
540	0.8850	0.8856	0.8859	0.8855	0.0005
560	0.8855	0.8859	0.8862	0.8859	0.0004
580	0.8857	0.8858	0.8864	0.8860	0.0004

(Continued.)

600	0.8864	0.8861	0.8866	0.8864	0.0003
620	0.8872	0.8869	0.8876	0.8872	0.0004
640	0.8881	0.8885	0.8885	0.8884	0.0002
660	0.8901	0.8904	0.8905	0.8903	0.0002
680	0.8921	0.8924	0.8924	0.8923	0.0002
700	0.8936	0.8942	0.8944	0.8941	0.0004
720	0.8949	0.8955	0.8954	0.8953	0.0003
740	0.8958	0.8959	0.8962	0.8960	0.0002
760	0.8962	0.8961	0.8962	0.8962	0.0001
780	0.8963	0.8961	0.8958	0.8961	0.0003
800	0.8961	0.8960	0.8959	0.8960	0.0001
820	0.8959	0.8963	0.8959	0.8960	0.0002

Table 9.6.f NIM raw data reported on Ceramic sample, C15.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.6014			0.6014
380	0.7158			0.7158
400	0.8008			0.8008
420	0.8396			0.8396
440	0.8548			0.8548
460	0.8663			0.8663
480	0.8743			0.8743
500	0.8798			0.8798
520	0.8830			0.8830
540	0.8848			0.8848
560	0.8851			0.8851
580	0.8856			0.8856
600	0.8863			0.8863
620	0.8874			0.8874
640	0.8881			0.8881
660	0.8902			0.8902
680	0.8921			0.8921
700	0.8936			0.8936
720	0.8948			0.8948
740	0.8957			0.8957
760	0.8963			0.8963
780	0.8965			0.8965
800	0.8965			0.8965
820	0.8966			0.8966

Table 9.7.a NMIJ raw data reported on Spectralon sample, S16.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9712	0.9703	0.9714	0.9710	0.0006
380	0.9745	0.9748	0.9741	0.9745	0.0004
400	0.9776	0.9781	0.9782	0.9780	0.0003
420	0.9798	0.9802	0.9802	0.9801	0.0002
440	0.9819	0.9820	0.9821	0.9820	0.0001
460	0.9833	0.9837	0.9839	0.9836	0.0003
480	0.9845	0.9845	0.9844	0.9845	0.0001
500	0.9854	0.9855	0.9852	0.9854	0.0002
520	0.9862	0.9864	0.9865	0.9864	0.0002
540	0.9867	0.9871	0.9870	0.9869	0.0002
560	0.9876	0.9875	0.9877	0.9876	0.0001
580	0.9878	0.9878	0.9880	0.9879	0.0001
600	0.9878	0.9878	0.9882	0.9879	0.0002
620	0.9884	0.9882	0.9887	0.9884	0.0003
640	0.9888	0.9886	0.9887	0.9887	0.0001
660	0.9888	0.9890	0.9892	0.9890	0.0002
680	0.9893	0.9893	0.9894	0.9893	0.0001
700	0.9895	0.9894	0.9896	0.9895	0.0001
720	0.9897	0.9901	0.9899	0.9899	0.0002
740	0.9894	0.9902	0.9897	0.9898	0.0004
760	0.9893	0.9900	0.9900	0.9898	0.0004
780	0.9892	0.9901	0.9900	0.9898	0.0005
800	0.9893	0.9896	0.9903	0.9897	0.0005
820	0.9892	0.9900	0.9903	0.9898	0.0006

Table 9.7.b NMIJ raw data reported on Spectralon sample, S17.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9767	0.9764	0.9768	0.9766	0.0002
380	0.9795	0.9802	0.9793	0.9797	0.0005
400	0.9822	0.9830	0.9826	0.9826	0.0004
420	0.9838	0.9843	0.9843	0.9841	0.0003
440	0.9851	0.9855	0.9855	0.9854	0.0002
460	0.9865	0.9864	0.9865	0.9865	0.0001
480	0.9872	0.9871	0.9871	0.9871	0.0001
500	0.9875	0.9876	0.9876	0.9876	0.0001
520	0.9882	0.9882	0.9884	0.9883	0.0001
540	0.9888	0.9890	0.9887	0.9888	0.0002
560	0.9888	0.9892	0.9892	0.9891	0.0002
580	0.9895	0.9891	0.9893	0.9893	0.0002

(Continued.)

600	0.9898	0.9890	0.9892	0.9893	0.0004
620	0.9901	0.9895	0.9898	0.9898	0.0003
640	0.9903	0.9897	0.9898	0.9899	0.0003
660	0.9904	0.9900	0.9900	0.9901	0.0002
680	0.9904	0.9902	0.9902	0.9903	0.0001
700	0.9906	0.9905	0.9902	0.9904	0.0002
720	0.9907	0.9910	0.9906	0.9908	0.0002
740	0.9906	0.9908	0.9909	0.9908	0.0002
760	0.9910	0.9909	0.9903	0.9907	0.0004
780	0.9908	0.9909	0.9902	0.9906	0.0004
800	0.9904	0.9905	0.9902	0.9904	0.0002
820	0.9903	0.9907	0.9901	0.9904	0.0003

Table 9.7.c NMIJ raw data reported on Spectralon sample, S18.

Wavelength [nm]	**Run #1**	**Run #2**	**Run #3**	**Average**	**Standard Deviation**
360	0.9807	0.9807	0.9801	0.9805	0.0003
380	0.9830	0.9835	0.9828	0.9831	0.0004
400	0.9852	0.9856	0.9855	0.9854	0.0002
420	0.9864	0.9870	0.9869	0.9868	0.0003
440	0.9877	0.9877	0.9878	0.9877	0.0001
460	0.9887	0.9886	0.9886	0.9886	0.0001
480	0.9892	0.9890	0.9888	0.9890	0.0002
500	0.9895	0.9895	0.9895	0.9895	0.0000
520	0.9902	0.9901	0.9900	0.9901	0.0001
540	0.9903	0.9903	0.9901	0.9902	0.0001
560	0.9903	0.9908	0.9906	0.9906	0.0003
580	0.9906	0.9905	0.9906	0.9906	0.0001
600	0.9909	0.9906	0.9906	0.9907	0.0002
620	0.9913	0.9909	0.9909	0.9910	0.0002
640	0.9914	0.9908	0.9908	0.9910	0.0003
660	0.9912	0.9907	0.9911	0.9910	0.0003
680	0.9911	0.9910	0.9911	0.9911	0.0001
700	0.9913	0.9914	0.9911	0.9913	0.0002
720	0.9914	0.9914	0.9913	0.9914	0.0001
740	0.9912	0.9916	0.9914	0.9914	0.0002
760	0.9909	0.9915	0.9913	0.9912	0.0003
780	0.9905	0.9911	0.9912	0.9909	0.0004
800	0.9901	0.9910	0.9909	0.9907	0.0005
820	0.9902	0.9908	0.9912	0.9907	0.0005

Table 9.7.d NMIJ raw data reported on Ceramic sample, C16.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6027	0.6030	0.6026	0.6028	0.0002
380	0.7236	0.7236	0.7230	0.7234	0.0003
400	0.8132	0.8135	0.8136	0.8134	0.0002
420	0.8491	0.8489	0.8489	0.8490	0.0001
440	0.8626	0.8626	0.8626	0.8626	0.0000
460	0.8736	0.8735	0.8734	0.8735	0.0001
480	0.8813	0.8813	0.8809	0.8812	0.0002
500	0.8869	0.8864	0.8866	0.8866	0.0003
520	0.8901	0.8903	0.8902	0.8902	0.0001
540	0.8925	0.8928	0.8925	0.8926	0.0002
560	0.8935	0.8934	0.8932	0.8934	0.0002
580	0.8915	0.8916	0.8918	0.8916	0.0002
600	0.8944	0.8939	0.8936	0.8940	0.0004
620	0.8952	0.8950	0.8952	0.8951	0.0001
640	0.8963	0.8956	0.8956	0.8958	0.0004
660	0.8975	0.8975	0.8976	0.8975	0.0001
680	0.9000	0.8997	0.8999	0.8999	0.0002
700	0.9009	0.9009	0.9007	0.9008	0.0001
720	0.9019	0.9021	0.9018	0.9019	0.0002
740	0.9020	0.9022	0.9019	0.9020	0.0002
760	0.9024	0.9021	0.9017	0.9021	0.0004
780	0.9022	0.9029	0.9025	0.9025	0.0004
800	0.9019	0.9014	0.9013	0.9015	0.0003
820	0.9022	0.9012	0.9011	0.9015	0.0006

Table 9.7.e NMIJ raw data reported on Ceramic sample, C17.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6027	0.6032	0.6026	0.6028	0.0003
380	0.7229	0.7235	0.7225	0.7230	0.0005
400	0.8130	0.8138	0.8137	0.8135	0.0004
420	0.8496	0.8495	0.8492	0.8494	0.0002
440	0.8629	0.8633	0.8631	0.8631	0.0002
460	0.8738	0.8742	0.8743	0.8741	0.0003
480	0.8817	0.8821	0.8819	0.8819	0.0002
500	0.8869	0.8874	0.8870	0.8871	0.0003
520	0.8908	0.8910	0.8905	0.8908	0.0003
540	0.8932	0.8933	0.8931	0.8932	0.0001
560	0.8939	0.8939	0.8940	0.8939	0.0001
580	0.8932	0.8925	0.8926	0.8928	0.0004

(Continued.)

600	0.8946	0.8948	0.8950	0.8948	0.0002
620	0.8959	0.8961	0.8960	0.8960	0.0001
640	0.8972	0.8968	0.8968	0.8969	0.0002
660	0.8987	0.8988	0.8985	0.8987	0.0002
680	0.9012	0.9012	0.9010	0.9011	0.0001
700	0.9024	0.9026	0.9023	0.9024	0.0002
720	0.9036	0.9039	0.9038	0.9038	0.0002
740	0.9040	0.9040	0.9038	0.9039	0.0001
760	0.9041	0.9042	0.9046	0.9043	0.0003
780	0.9045	0.9041	0.9043	0.9043	0.0002
800	0.9042	0.9029	0.9033	0.9035	0.0007
820	0.9032	0.9028	0.9037	0.9032	0.0005

Table 9.7.f NMIJ raw data reported on Ceramic sample, C18.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6040	0.6046	0.6042	0.6043	0.0003
380	0.7242	0.7245	0.7237	0.7241	0.0004
400	0.8146	0.8147	0.8149	0.8147	0.0002
420	0.8500	0.8501	0.8505	0.8502	0.0003
440	0.8636	0.8641	0.8638	0.8638	0.0003
460	0.8744	0.8746	0.8749	0.8746	0.0003
480	0.8819	0.8820	0.8820	0.8820	0.0001
500	0.8870	0.8873	0.8873	0.8872	0.0002
520	0.8907	0.8908	0.8909	0.8908	0.0001
540	0.8929	0.8932	0.8933	0.8931	0.0002
560	0.8937	0.8940	0.8940	0.8939	0.0002
580	0.8926	0.8927	0.8926	0.8926	0.0001
600	0.8951	0.8949	0.8952	0.8951	0.0002
620	0.8964	0.8967	0.8965	0.8965	0.0002
640	0.8977	0.8971	0.8976	0.8975	0.0003
660	0.8989	0.8992	0.8992	0.8991	0.0002
680	0.9016	0.9016	0.9018	0.9017	0.0001
700	0.9028	0.9027	0.9026	0.9027	0.0001
720	0.9041	0.9042	0.9043	0.9042	0.0001
740	0.9043	0.9044	0.9044	0.9044	0.0001
760	0.9044	0.9046	0.9045	0.9045	0.0001
780	0.9045	0.9047	0.9048	0.9047	0.0002
800	0.9040	0.9033	0.9030	0.9034	0.0005
820	0.9039	0.9032	0.9031	0.9034	0.0004

Table 9.8.a NPL raw data reported on Spectralon sample, S07.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9851	0.9861	0.9856	0.9856	0.0005
380	0.9891	0.9891	0.9892	0.9891	0.0001
400	0.9934	0.9941	0.9938	0.9938	0.0004
420	0.9947	0.9953	0.9956	0.9952	0.0005
440	0.9950	0.9955	0.9964	0.9956	0.0007
460	0.9952	0.9960	0.9965	0.9959	0.0007
480	0.9958	0.9963	0.9969	0.9963	0.0006
500	0.9959	0.9963	0.9968	0.9963	0.0005
520	0.9959	0.9962	0.9967	0.9963	0.0004
540	0.9960	0.9964	0.9966	0.9963	0.0003
560	0.9956	0.9960	0.9966	0.9961	0.0005
580	0.9960	0.9964	0.9965	0.9963	0.0003
600	0.9961	0.9964	0.9966	0.9964	0.0003
620	0.9964	0.9964	0.9960	0.9963	0.0002
640	0.9962	0.9960	0.9960	0.9961	0.0001
660	0.9965	0.9955	0.9960	0.9960	0.0005
680	0.9963	0.9961	0.9959	0.9961	0.0002
700	0.9966	0.9959	0.9962	0.9962	0.0004
720	0.9962	0.9959	0.9952	0.9958	0.0005
740	0.9964	0.9964	0.9959	0.9962	0.0003
760	0.9954	0.9958	0.9961	0.9958	0.0004
780	0.9967	0.9960	0.9960	0.9962	0.0004
800	0.9967	0.9965	0.9970	0.9967	0.0003
820	0.9965	0.9964	0.9975	0.9968	0.0006

Table 9.8.b NPL raw data reported on Spectralon sample, S08.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9821	0.9829	0.9821	0.9824	0.0005
380	0.9861	0.9867	0.9866	0.9865	0.0003
400	0.9915	0.9917	0.9916	0.9916	0.0001
420	0.9940	0.9941	0.9934	0.9938	0.0004
440	0.9952	0.9954	0.9945	0.9950	0.0005
460	0.9953	0.9955	0.9954	0.9954	0.0001
480	0.9954	0.9955	0.9954	0.9954	0.0001
500	0.9957	0.9958	0.9954	0.9956	0.0002
520	0.9957	0.9958	0.9955	0.9957	0.0002
540	0.9959	0.9958	0.9954	0.9957	0.0003
560	0.9961	0.9960	0.9955	0.9959	0.0003
580	0.9961	0.9963	0.9959	0.9961	0.0002

(Continued.)

600	0.9962	0.9962	0.9956	0.9960	0.0003
620	0.9960	0.9958	0.9961	0.9960	0.0002
640	0.9954	0.9961	0.9958	0.9958	0.0004
660	0.9954	0.9962	0.9957	0.9958	0.0004
680	0.9958	0.9958	0.9947	0.9954	0.0006
700	0.9956	0.9957	0.9954	0.9956	0.0002
720	0.9948	0.9955	0.9959	0.9954	0.0006
740	0.9954	0.9962	0.9958	0.9958	0.0004
760	0.9950	0.9962	0.9955	0.9956	0.0006
780	0.9958	0.9959	0.9955	0.9957	0.0002
800	0.9963	0.9967	0.9961	0.9964	0.0003
820	0.9955	0.9966	0.9966	0.9962	0.0006

Table 9.8.c NPL raw data reported on Spectralon sample, S09.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9806	0.9819	0.9809	0.9811	0.0007
380	0.9855	0.9858	0.9851	0.9855	0.0004
400	0.9906	0.9904	0.9904	0.9905	0.0001
420	0.9930	0.9927	0.9923	0.9927	0.0004
440	0.9942	0.9939	0.9935	0.9939	0.0004
460	0.9943	0.9944	0.9944	0.9944	0.0001
480	0.9946	0.9947	0.9950	0.9948	0.0002
500	0.9951	0.9950	0.9950	0.9950	0.0001
520	0.9948	0.9951	0.9947	0.9949	0.0002
540	0.9953	0.9950	0.9952	0.9952	0.0002
560	0.9955	0.9956	0.9955	0.9955	0.0001
580	0.9952	0.9954	0.9955	0.9954	0.0002
600	0.9958	0.9955	0.9954	0.9956	0.0002
620	0.9960	0.9956	0.9959	0.9958	0.0002
640	0.9953	0.9956	0.9952	0.9954	0.0002
660	0.9953	0.9959	0.9950	0.9954	0.0005
680	0.9956	0.9956	0.9951	0.9954	0.0003
700	0.9957	0.9953	0.9954	0.9955	0.0002
720	0.9949	0.9954	0.9958	0.9954	0.0005
740	0.9952	0.9958	0.9954	0.9955	0.0003
760	0.9955	0.9958	0.9954	0.9956	0.0002
780	0.9958	0.9957	0.9952	0.9956	0.0003
800	0.9956	0.9963	0.9961	0.9960	0.0004
820	0.9955	0.9969	0.9962	0.9962	0.0007

Table 9.8.d NPL raw data reported on Ceramic sample, C07.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6052	0.6056	0.6061	0.6056	0.0005
380	0.7335	0.7341	0.7335	0.7337	0.0003
400	0.8162	0.8170	0.8167	0.8166	0.0004
420	0.8535	0.8543	0.8542	0.8540	0.0004
440	0.8698	0.8697	0.8697	0.8697	0.0001
460	0.8787	0.8789	0.8788	0.8788	0.0001
480	0.8864	0.8865	0.8863	0.8864	0.0001
500	0.8923	0.8923	0.8924	0.8923	0.0001
520	0.8966	0.8968	0.8962	0.8965	0.0003
540	0.8985	0.8987	0.8984	0.8985	0.0002
560	0.8992	0.8990	0.8985	0.8989	0.0004
580	0.8981	0.8980	0.8978	0.8980	0.0002
600	0.8989	0.8990	0.8991	0.8990	0.0001
620	0.9004	0.9002	0.9003	0.9003	0.0001
640	0.9020	0.9015	0.9019	0.9018	0.0003
660	0.9041	0.9043	0.9041	0.9042	0.0001
680	0.9058	0.9051	0.9052	0.9054	0.0004
700	0.9067	0.9063	0.9065	0.9065	0.0002
720	0.9073	0.9069	0.9076	0.9073	0.0004
740	0.9074	0.9076	0.9071	0.9074	0.0003
760	0.9078	0.9081	0.9075	0.9078	0.0003
780	0.9074	0.9081	0.9075	0.9077	0.0004
800	0.9079	0.9076	0.9083	0.9079	0.0004
820	0.9078	0.9071	0.9062	0.9070	0.0008

Table 9.8.e NPL raw data reported on Ceramic sample, C08.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6083	0.6086	0.6088	0.6086	0.0003
380	0.7364	0.7370	0.7361	0.7365	0.0005
400	0.8181	0.8182	0.8179	0.8181	0.0002
420	0.8541	0.8547	0.8545	0.8544	0.0003
440	0.8692	0.8693	0.8694	0.8693	0.0001
460	0.8780	0.8783	0.8782	0.8782	0.0002
480	0.8852	0.8852	0.8850	0.8851	0.0001
500	0.8914	0.8914	0.8912	0.8913	0.0001
520	0.8954	0.8956	0.8953	0.8954	0.0002
540	0.8972	0.8973	0.8975	0.8973	0.0002
560	0.8977	0.8975	0.8975	0.8976	0.0001
580	0.8969	0.8969	0.8967	0.8968	0.0001

(Continued.)

600	0.8976	0.8977	0.8975	0.8976	0.0001
620	0.8987	0.8988	0.8989	0.8988	0.0001
640	0.9002	0.9003	0.9005	0.9003	0.0002
660	0.9026	0.9027	0.9025	0.9026	0.0001
680	0.9041	0.9037	0.9039	0.9039	0.0002
700	0.9050	0.9050	0.9051	0.9050	0.0001
720	0.9056	0.9057	0.9056	0.9056	0.0001
740	0.9065	0.9060	0.9052	0.9059	0.0007
760	0.9057	0.9061	0.9054	0.9057	0.0004
780	0.9073	0.9064	0.9058	0.9065	0.0008
800	0.9057	0.9063	0.9057	0.9059	0.0003
820	0.9056	0.9053	0.9048	0.9052	0.0004

Table 9.8.f NPL raw data reported on Ceramic sample, C09.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6087	0.6089	0.6094	0.6090	0.0004
380	0.7370	0.7372	0.7369	0.7370	0.0002
400	0.8189	0.8198	0.8197	0.8195	0.0005
420	0.8557	0.8562	0.8564	0.8561	0.0004
440	0.8707	0.8709	0.8711	0.8709	0.0002
460	0.8796	0.8797	0.8798	0.8797	0.0001
480	0.8869	0.8866	0.8868	0.8868	0.0002
500	0.8931	0.8928	0.8929	0.8929	0.0002
520	0.8970	0.8971	0.8969	0.8970	0.0001
540	0.8988	0.8988	0.8990	0.8989	0.0001
560	0.8988	0.8989	0.8987	0.8988	0.0001
580	0.8979	0.8980	0.8980	0.8980	0.0001
600	0.8988	0.8988	0.8986	0.8987	0.0001
620	0.9002	0.9002	0.9001	0.9002	0.0001
640	0.9014	0.9015	0.9017	0.9015	0.0002
660	0.9037	0.9034	0.9036	0.9036	0.0002
680	0.9054	0.9051	0.9052	0.9052	0.0002
700	0.9062	0.9061	0.9067	0.9063	0.0003
720	0.9072	0.9072	0.9072	0.9072	0.0000
740	0.9076	0.9075	0.9071	0.9074	0.0003
760	0.9073	0.9075	0.9069	0.9072	0.0003
780	0.9084	0.9076	0.9071	0.9077	0.0007
800	0.9075	0.9082	0.9076	0.9078	0.0004
820	0.9075	0.9065	0.9065	0.9068	0.0006

Table 9.9.a NRC raw data reported on Spectralon sample, S10.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9788	0.9783	0.9790	0.9787	0.0004
380	0.9806	0.9804	0.9809	0.9806	0.0003
400	0.9823	0.9826	0.9827	0.9825	0.0002
420	0.9841	0.9845	0.9845	0.9844	0.0002
440	0.9855	0.9857	0.9857	0.9856	0.0001
460	0.9867	0.9866	0.9868	0.9867	0.0001
480	0.9874	0.9871	0.9875	0.9873	0.0002
500	0.9877	0.9876	0.9880	0.9878	0.0002
520	0.9878	0.9879	0.9882	0.9880	0.0002
540	0.9879	0.9881	0.9884	0.9881	0.0003
560	0.9880	0.9883	0.9885	0.9883	0.0003
580	0.9881	0.9884	0.9886	0.9884	0.0003
600	0.9881	0.9885	0.9888	0.9885	0.0004
620	0.9882	0.9886	0.9889	0.9886	0.0004
640	0.9884	0.9887	0.9890	0.9887	0.0003
660	0.9885	0.9887	0.9891	0.9888	0.0003
680	0.9886	0.9888	0.9892	0.9889	0.0003
700	0.9887	0.9888	0.9893	0.9889	0.0003
720	0.9888	0.9889	0.9894	0.9890	0.0003
740	0.9889	0.9890	0.9894	0.9891	0.0003
760	0.9891	0.9890	0.9895	0.9892	0.0003
780	0.9892	0.9891	0.9896	0.9893	0.0003
800	0.9893	0.9891	0.9897	0.9894	0.0003
820	0.9894	0.9892	0.9897	0.9894	0.0003

Table 9.9.b NRC raw data reported on Spectralon sample, S11.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.9770			0.9770
380	0.9788			0.9788
400	0.9806			0.9806
420	0.9823			0.9823
440	0.9837			0.9837
460	0.9848			0.9848
480	0.9855			0.9855
500	0.9860			0.9860
520	0.9864			0.9864
540	0.9867			0.9867
560	0.9869			0.9869
580	0.9871			0.9871

(Continued.)

600	0.9872			0.9872
620	0.9874			0.9874
640	0.9876			0.9876
660	0.9877			0.9877
680	0.9878			0.9878
700	0.9879			0.9879
720	0.9880			0.9880
740	0.9881			0.9881
760	0.9882			0.9882
780	0.9883			0.9883
800	0.9883			0.9883
820	0.9884			0.9884

Table 9.9.c NRC raw data reported on Spectralon sample, S12.

Wavelength [nm]	**Run #1**	**Run #2**	**Run #3**	**Average**
360	0.9814			0.9814
380	0.9826			0.9826
400	0.9840			0.9840
420	0.9854			0.9854
440	0.9866			0.9866
460	0.9875			0.9875
480	0.9880			0.9880
500	0.9883			0.9883
520	0.9886			0.9886
540	0.9887			0.9887
560	0.9888			0.9888
580	0.9889			0.9889
600	0.9889			0.9889
620	0.9889			0.9889
640	0.9889			0.9889
660	0.9890			0.9890
680	0.9890			0.9890
700	0.9891			0.9891
720	0.9891			0.9891
740	0.9892			0.9892
760	0.9892			0.9892
780	0.9893			0.9893
800	0.9894			0.9894
820	0.9894			0.9894

Table 9.9.d NRC raw data reported on Ceramic sample, C10.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.6565			0.6565
380	0.7595			0.7595
400	0.8273			0.8273
420	0.8619			0.8619
440	0.8749			0.8749
460	0.8829			0.8829
480	0.8898			0.8898
500	0.8943			0.8943
520	0.8970			0.8970
540	0.8981			0.8981
560	0.8981			0.8981
580	0.8979			0.8979
600	0.8984			0.8984
620	0.8991			0.8991
640	0.9001			0.9001
660	0.9013			0.9013
680	0.9024			0.9024
700	0.9032			0.9032
720	0.9039			0.9039
740	0.9045			0.9045
760	0.9049			0.9049
780	0.9052			0.9052
800	0.9054			0.9054
820	0.9055			0.9055

Table 9.9.e NRC raw data reported on Ceramic sample, C11.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.6211			0.6211
380	0.7330			0.7330
400	0.8089			0.8089
420	0.8497			0.8497
440	0.8651			0.8651
460	0.8739			0.8739
480	0.8814			0.8814
500	0.8865			0.8865
520	0.8898			0.8898
540	0.8916			0.8916
560	0.8923			0.8923
580	0.8927			0.8927

(Continued.)

600	0.8937			0.8937
620	0.8946			0.8946
640	0.8957			0.8957
660	0.8971			0.8971
680	0.8982			0.8982
700	0.8992			0.8992
720	0.9000			0.9000
740	0.9007			0.9007
760	0.9012			0.9012
780	0.9016			0.9016
800	0.9018			0.9018
820	0.9019			0.9019

Table 9.9.f NRC raw data reported on Ceramic sample, C12.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6231	0.6231	0.6240	0.6234	0.0005
380	0.7362	0.7363	0.7367	0.7364	0.0003
400	0.8122	0.8126	0.8127	0.8125	0.0003
420	0.8524	0.8528	0.8527	0.8526	0.0002
440	0.8672	0.8674	0.8671	0.8672	0.0002
460	0.8759	0.8754	0.8756	0.8756	0.0003
480	0.8834	0.8828	0.8833	0.8832	0.0003
500	0.8885	0.8880	0.8886	0.8884	0.0003
520	0.8916	0.8913	0.8918	0.8916	0.0003
540	0.8930	0.8929	0.8933	0.8931	0.0002
560	0.8934	0.8932	0.8936	0.8934	0.0002
580	0.8935	0.8933	0.8935	0.8934	0.0001
600	0.8943	0.8940	0.8941	0.8941	0.0002
620	0.8950	0.8946	0.8948	0.8948	0.0002
640	0.8959	0.8955	0.8958	0.8957	0.0002
660	0.8969	0.8966	0.8971	0.8969	0.0003
680	0.8978	0.8976	0.8981	0.8978	0.0003
700	0.8986	0.8984	0.8989	0.8986	0.0003
720	0.8992	0.8990	0.8996	0.8993	0.0003
740	0.8997	0.8995	0.9001	0.8998	0.0003
760	0.9000	0.8999	0.9005	0.9001	0.0003
780	0.9003	0.9001	0.9007	0.9004	0.0003
800	0.9005	0.9002	0.9008	0.9005	0.0003
820	0.9005	0.9002	0.9007	0.9005	0.0003

Table 9.10.a OMH raw data reported on Spectralon sample, S04.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.9777			0.9777
380	0.9820			0.9820
400	0.9843			0.9843
420	0.9866			0.9866
440	0.9881			0.9881
460	0.9896			0.9896
480	0.9899			0.9899
500	0.9902			0.9902
520	0.9911			0.9911
540	0.9912			0.9912
560	0.9908			0.9908
580	0.9912			0.9912
600	0.9915			0.9915
620	0.9917			0.9917
640	0.9913			0.9913
660	0.9914			0.9914
680	0.9909			0.9909
700	0.9913			0.9913
720	0.9905			0.9905
740	0.9902			0.9902
760	0.9909			0.9909
780	0.9914			0.9914
800				
820				

Table 9.10.b OMH raw data reported on Spectralon sample, S05.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.9778	0.9787	0.9772	0.9779	0.0008
380	0.9813	0.9816	0.9809	0.9813	0.0004
400	0.9837	0.9841	0.9836	0.9838	0.0003
420	0.9862	0.9862	0.9858	0.9861	0.0002
440	0.9868	0.9871	0.9866	0.9868	0.0003
460	0.9874	0.9880	0.9876	0.9877	0.0003
480	0.9878	0.9886	0.9878	0.9881	0.0005
500	0.9897	0.9893	0.9886	0.9892	0.0006
520	0.9899	0.9900	0.9890	0.9896	0.0006
540	0.9899	0.9895	0.9888	0.9894	0.0006
560	0.9898	0.9901	0.9896	0.9898	0.0003
580	0.9906	0.9903	0.9896	0.9902	0.0005

(Continued.)

600	0.9913	0.9903	0.9899	0.9905	0.0007
620	0.9910	0.9907	0.9904	0.9907	0.0003
640	0.9899	0.9905	0.9896	0.9900	0.0005
660	0.9909	0.9909	0.9901	0.9906	0.0005
680	0.9910	0.9909	0.9906	0.9908	0.0002
700	0.9907	0.9908	0.9904	0.9906	0.0002
720	0.9912	0.9905	0.9904	0.9907	0.0004
740	0.9910	0.9902	0.9897	0.9903	0.0007
760	0.9898	0.9899	0.9896	0.9898	0.0002
780	0.9915	0.9915	0.9907	0.9912	0.0005
800					
820					

Table 9.10.c OMH raw data reported on Spectralon sample, S06.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.9780			0.9780
380	0.9815			0.9815
400	0.9838			0.9838
420	0.9860			0.9860
440	0.9879			0.9879
460	0.9885			0.9885
480	0.9893			0.9893
500	0.9892			0.9892
520	0.9905			0.9905
540	0.9908			0.9908
560	0.9907			0.9907
580	0.9909			0.9909
600	0.9911			0.9911
620	0.9914			0.9914
640	0.9912			0.9912
660	0.9915			0.9915
680	0.9911			0.9911
700	0.9909			0.9909
720	0.9907			0.9907
740	0.9908			0.9908
760	0.9908			0.9908
780	0.9913			0.9913
800				
820				

Table 9.10.d OMH raw data reported on Ceramic sample, C04.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.6114			0.6114
380	0.7304			0.7304
400	0.8139			0.8139
420	0.8510			0.8510
440	0.8650			0.8650
460	0.8762			0.8762
480	0.8840			0.8840
500	0.8892			0.8892
520	0.8932			0.8932
540	0.8953			0.8953
560	0.8956			0.8956
580	0.8944			0.8944
600	0.8969			0.8969
620	0.8982			0.8982
640	0.8983			0.8983
660	0.9003			0.9003
680	0.9024			0.9024
700	0.9039			0.9039
720	0.9047			0.9047
740	0.9042			0.9042
760	0.9052			0.9052
780	0.9062			0.9062
800				
820				

Table 9.10.e OMH raw data reported on Ceramic sample, C05.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.6125	0.6134	0.6113	0.6124	0.0011
380	0.7299	0.7291	0.7312	0.7301	0.0011
400	0.8118	0.8136	0.8134	0.8129	0.0010
420	0.8492	0.8499	0.8499	0.8497	0.0004
440	0.8639	0.8642	0.8642	0.8641	0.0002
460	0.8752	0.8753	0.8753	0.8753	0.0001
480	0.8819	0.8822	0.8832	0.8824	0.0007
500	0.8883	0.8870	0.8883	0.8879	0.0008
520	0.8925	0.8918	0.8923	0.8922	0.0004
540	0.8938	0.8937	0.8943	0.8939	0.0003
560	0.8938	0.8940	0.8941	0.8940	0.0002
580	0.8926	0.8924	0.8926	0.8925	0.0001

(Continued.)

600	0.8962	0.8950	0.8955	0.8956	0.0006
620	0.8966	0.8969	0.8962	0.8966	0.0004
640	0.8968	0.8969	0.8965	0.8967	0.0002
660	0.8996	0.8987	0.8987	0.8990	0.0005
680	0.9012	0.9004	0.9005	0.9007	0.0004
700	0.9030	0.9016	0.9021	0.9022	0.0007
720	0.9033	0.9031	0.9029	0.9031	0.0002
740	0.9024	0.9014	0.9024	0.9021	0.0006
760	0.9036	0.9032	0.9030	0.9033	0.0003
780	0.9040	0.9050	0.9045	0.9045	0.0005
800					
820					

Table 9.10.f OMH raw data reported on Ceramic sample, C06.

Wavelength [nm]	Run #1	Run #2	Run #3	Average
360	0.6114			0.6114
380	0.7287			0.7287
400	0.8116			0.8116
420	0.8484			0.8484
440	0.8623			0.8623
460	0.8732			0.8732
480	0.8813			0.8813
500	0.8865			0.8865
520	0.8905			0.8905
540	0.8927			0.8927
560	0.8927			0.8927
580	0.8911			0.8911
600	0.8940			0.8940
620	0.8949			0.8949
640	0.8953			0.8953
660	0.8972			0.8972
680	0.8991			0.8991
700	0.9009			0.9009
720	0.9017			0.9017
740	0.9008			0.9008
760	0.9022			0.9022
780	0.9031			0.9031
800				
820				

Table 9.11.a PTB raw data reported on Spectralon sample, S04.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.979	0.979	0.979	0.979	0.000
380	0.982	0.982	0.982	0.982	0.000
400	0.985	0.985	0.985	0.985	0.000
420	0.987	0.987	0.987	0.987	0.000
440	0.988	0.988	0.988	0.988	0.000
460	0.989	0.989	0.989	0.989	0.000
480	0.989	0.989	0.989	0.989	0.000
500	0.990	0.990	0.990	0.990	0.000
520	0.990	0.990	0.990	0.990	0.000
540	0.990	0.990	0.990	0.990	0.000
560	0.991	0.991	0.991	0.991	0.000
580	0.991	0.991	0.991	0.991	0.000
600	0.991	0.991	0.991	0.991	0.000
620	0.991	0.991	0.991	0.991	0.000
640	0.991	0.991	0.991	0.991	0.000
660	0.991	0.991	0.991	0.991	0.000
680	0.991	0.991	0.991	0.991	0.000
700	0.991	0.991	0.991	0.991	0.000
720	0.991	0.991	0.991	0.991	0.000
740	0.991	0.991	0.991	0.991	0.000
760	0.991	0.991	0.992	0.991	0.001
780	0.991	0.991	0.991	0.991	0.000
800	0.991	0.991	0.991	0.991	0.000
820	0.991	0.991	0.991	0.991	0.000

Table 9.12.b PTB raw data reported on Spectralon sample, S05.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.977	0.977	0.977	0.977	0.000
380	0.980	0.980	0.980	0.980	0.000
400	0.983	0.983	0.983	0.983	0.000
420	0.985	0.985	0.985	0.985	0.000
440	0.987	0.987	0.987	0.987	0.000
460	0.987	0.987	0.987	0.987	0.000
480	0.988	0.988	0.988	0.988	0.000
500	0.989	0.988	0.989	0.989	0.001
520	0.989	0.989	0.989	0.989	0.000
540	0.989	0.989	0.989	0.989	0.000
560	0.990	0.990	0.990	0.990	0.000
580	0.990	0.990	0.990	0.990	0.000

(Continued.)

600	0.990	0.990	0.990	0.990	0.000
620	0.990	0.990	0.990	0.990	0.000
640	0.990	0.990	0.990	0.990	0.000
660	0.990	0.990	0.991	0.990	0.001
680	0.990	0.990	0.991	0.990	0.001
700	0.991	0.991	0.991	0.991	0.000
720	0.991	0.991	0.991	0.991	0.000
740	0.991	0.991	0.991	0.991	0.000
760	0.991	0.991	0.991	0.991	0.000
780	0.991	0.991	0.991	0.991	0.000
800	0.991	0.991	0.991	0.991	0.000
820	0.991	0.991	0.991	0.991	0.000

Table 9.12.c PTB raw data reported on Spectralon sample, S06.

Wavelength [nm]	**Run #1**	**Run #2**	**Run #3**	**Average**	**Standard Deviation**
360	0.979	0.979	0.979	0.979	0.000
380	0.982	0.982	0.982	0.982	0.000
400	0.984	0.984	0.985	0.984	0.001
420	0.986	0.986	0.986	0.986	0.000
440	0.987	0.987	0.987	0.987	0.000
460	0.988	0.988	0.988	0.988	0.000
480	0.988	0.989	0.989	0.989	0.001
500	0.989	0.989	0.989	0.989	0.000
520	0.989	0.989	0.990	0.989	0.001
540	0.990	0.990	0.990	0.990	0.000
560	0.990	0.990	0.990	0.990	0.000
580	0.990	0.990	0.990	0.990	0.000
600	0.990	0.990	0.991	0.990	0.001
620	0.991	0.991	0.991	0.991	0.000
640	0.991	0.991	0.991	0.991	0.000
660	0.991	0.991	0.991	0.991	0.000
680	0.991	0.991	0.991	0.991	0.000
700	0.991	0.991	0.991	0.991	0.000
720	0.991	0.991	0.991	0.991	0.000
740	0.991	0.991	0.991	0.991	0.000
760	0.991	0.991	0.991	0.991	0.000
780	0.991	0.991	0.991	0.991	0.000
800	0.991	0.991	0.991	0.991	0.000
820	0.991	0.991	0.991	0.991	0.000

Table 9.12.d PTB raw data reported on Ceramic sample, C04.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.602	0.602	0.602	0.602	0.000
380	0.723	0.723	0.723	0.723	0.000
400	0.808	0.808	0.808	0.808	0.000
420	0.847	0.847	0.847	0.847	0.000
440	0.861	0.861	0.861	0.861	0.000
460	0.872	0.872	0.872	0.872	0.000
480	0.880	0.880	0.880	0.880	0.000
500	0.887	0.887	0.887	0.887	0.000
520	0.890	0.890	0.890	0.890	0.000
540	0.892	0.892	0.892	0.892	0.000
560	0.893	0.893	0.893	0.893	0.000
580	0.892	0.892	0.892	0.892	0.000
600	0.894	0.894	0.894	0.894	0.000
620	0.895	0.895	0.895	0.895	0.000
640	0.896	0.896	0.896	0.896	0.000
660	0.898	0.898	0.898	0.898	0.000
680	0.900	0.900	0.900	0.900	0.000
700	0.902	0.902	0.902	0.902	0.000
720	0.902	0.903	0.902	0.902	0.001
740	0.903	0.903	0.903	0.903	0.000
760	0.903	0.903	0.903	0.903	0.000
780	0.903	0.903	0.903	0.903	0.000
800	0.903	0.903	0.903	0.903	0.000
820	0.903	0.903	0.903	0.903	0.000

Table 9.12.e PTB raw data reported on Ceramic sample, C05.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.602	0.602	0.603	0.602	0.001
380	0.723	0.723	0.723	0.723	0.000
400	0.807	0.808	0.808	0.808	0.001
420	0.847	0.847	0.847	0.847	0.000
440	0.860	0.860	0.860	0.860	0.000
460	0.872	0.871	0.871	0.871	0.001
480	0.879	0.879	0.879	0.879	0.000
500	0.886	0.886	0.886	0.886	0.000
520	0.889	0.889	0.889	0.889	0.000
540	0.891	0.891	0.891	0.891	0.000
560	0.892	0.892	0.892	0.892	0.000
580	0.890	0.891	0.890	0.890	0.001

(Continued.)

600	0.893	0.893	0.893	0.893	0.000
620	0.894	0.894	0.894	0.894	0.000
640	0.895	0.895	0.895	0.895	0.000
660	0.896	0.896	0.896	0.896	0.000
680	0.898	0.898	0.899	0.898	0.001
700	0.900	0.900	0.900	0.900	0.000
720	0.901	0.901	0.901	0.901	0.000
740	0.901	0.901	0.901	0.901	0.000
760	0.901	0.901	0.901	0.901	0.000
780	0.901	0.901	0.901	0.901	0.000
800	0.901	0.901	0.901	0.901	0.000
820	0.901	0.901	0.901	0.901	0.000

Table 9.12.f PTB raw data reported on Ceramic sample, C06.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.601	0.601	0.601	0.601	0.000
380	0.722	0.722	0.722	0.722	0.000
400	0.806	0.806	0.806	0.806	0.000
420	0.845	0.845	0.845	0.845	0.000
440	0.858	0.859	0.859	0.859	0.001
460	0.870	0.870	0.870	0.870	0.000
480	0.877	0.878	0.878	0.878	0.001
500	0.884	0.884	0.884	0.884	0.000
520	0.888	0.888	0.888	0.888	0.000
540	0.890	0.890	0.890	0.890	0.000
560	0.890	0.890	0.890	0.890	0.000
580	0.889	0.889	0.889	0.889	0.000
600	0.891	0.891	0.891	0.891	0.000
620	0.892	0.892	0.892	0.892	0.000
640	0.893	0.893	0.893	0.893	0.000
660	0.895	0.895	0.895	0.895	0.000
680	0.897	0.897	0.897	0.897	0.000
700	0.899	0.899	0.899	0.899	0.000
720	0.899	0.899	0.899	0.899	0.000
740	0.900	0.900	0.900	0.900	0.000
760	0.900	0.900	0.900	0.900	0.000
780	0.900	0.900	0.900	0.900	0.000
800	0.900	0.900	0.900	0.900	0.000
820	0.900	0.900	0.900	0.900	0.000

Table 9.13.a VNIIOFI raw data reported on Spectralon sample, S04.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.97953	0.97960	0.97940	0.97951	0.00010
380	0.98138	0.98139	0.98131	0.98136	0.00004
400	0.98247	0.98247	0.98239	0.98244	0.00005
420	0.98315	0.98312	0.98309	0.98312	0.00003
440	0.98303	0.98305	0.98291	0.98300	0.00008
460	0.98349	0.98349	0.98343	0.98347	0.00003
480	0.98380	0.98380	0.98372	0.98377	0.00005
500	0.98494	0.98488	0.98491	0.98491	0.00003
520	0.98538	0.98540	0.98530	0.98536	0.00005
540	0.98567	0.98577	0.98551	0.98565	0.00013
560	0.98591	0.98581	0.98596	0.98589	0.00008
580	0.98615	0.98605	0.98615	0.98612	0.00006
600	0.98643	0.98641	0.98640	0.98641	0.00002
620	0.98633	0.98623	0.98638	0.98631	0.00008
640	0.98582	0.98580	0.98580	0.98581	0.00001
660	0.98595	0.98586	0.98596	0.98592	0.00006
680	0.98600	0.98602	0.98591	0.98598	0.00006
700	0.98548	0.98546	0.98546	0.98547	0.00001
720	0.98590	0.98595	0.98577	0.98587	0.00009
740	0.98628	0.98631	0.98620	0.98626	0.00006
760	0.98650	0.98647	0.98646	0.98648	0.00002
780	0.98700	0.98697	0.98698	0.98698	0.00002
800	0.98745	0.98746	0.98736	0.98742	0.00006
820	0.98620	0.98616	0.98616	0.98617	0.00002

Table 9.13.b VNIIOFI raw data reported on Spectralon sample, S05.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.97551	0.97528	0.97508	0.97529	0.00022
380	0.97760	0.97767	0.97744	0.97757	0.00012
400	0.97908	0.97912	0.97859	0.97893	0.00030
420	0.98012	0.98014	0.97966	0.97997	0.00027
440	0.98034	0.98022	0.97971	0.98009	0.00033
460	0.98086	0.98080	0.98037	0.98068	0.00027
480	0.98116	0.98134	0.98088	0.98113	0.00023
500	0.98273	0.98256	0.98222	0.98250	0.00026
520	0.98322	0.98308	0.98282	0.98304	0.00020
540	0.98367	0.98352	0.98318	0.98346	0.00025
560	0.98408	0.98393	0.98371	0.98391	0.00019
580	0.98430	0.98432	0.98411	0.98424	0.00012

(Continued.)

600	0.98494	0.98498	0.98451	0.98481	0.00026
620	0.98489	0.98502	0.98457	0.98483	0.00023
640	0.98447	0.98474	0.98421	0.98447	0.00027
660	0.98473	0.98480	0.98422	0.98458	0.00032
680	0.98472	0.98496	0.98432	0.98467	0.00032
700	0.98437	0.98463	0.98402	0.98434	0.00031
720	0.98477	0.98504	0.98433	0.98471	0.00036
740	0.98552	0.98555	0.98499	0.98535	0.00032
760	0.98569	0.98563	0.98517	0.98550	0.00028
780	0.98619	0.98614	0.98554	0.98596	0.00036
800	0.98670	0.98662	0.98599	0.98644	0.00039
820	0.98518	0.98547	0.98502	0.98522	0.00023

Table 9.13.c VNIIOFI raw data reported on Spectralon sample, S06.

Wavelength [nm]	**Run #1**	**Run #2**	**Run #3**	**Average**	**Standard Deviation**
360	0.97797	0.97811	0.97801	0.97803	0.00007
380	0.98006	0.98035	0.98017	0.98019	0.00015
400	0.98116	0.98128	0.98126	0.98123	0.00006
420	0.98183	0.98200	0.98186	0.98190	0.00009
440	0.98198	0.98201	0.98195	0.98198	0.00003
460	0.98258	0.98245	0.98248	0.98250	0.00007
480	0.98295	0.98306	0.98295	0.98299	0.00006
500	0.98430	0.98420	0.98420	0.98423	0.00006
520	0.98487	0.98480	0.98480	0.98482	0.00004
540	0.98502	0.98517	0.98507	0.98509	0.00008
560	0.98544	0.98543	0.98540	0.98542	0.00002
580	0.98550	0.98567	0.98555	0.98557	0.00009
600	0.98599	0.98603	0.98598	0.98600	0.00003
620	0.98594	0.98600	0.98593	0.98596	0.00004
640	0.98552	0.98550	0.98550	0.98551	0.00001
660	0.98556	0.98571	0.98560	0.98562	0.00008
680	0.98563	0.98580	0.98570	0.98571	0.00009
700	0.98528	0.98546	0.98534	0.98536	0.00009
720	0.98583	0.98588	0.98583	0.98585	0.00003
740	0.98628	0.98646	0.98535	0.98603	0.00060
760	0.98645	0.98654	0.98645	0.98648	0.00005
780	0.98718	0.98705	0.98710	0.98711	0.00007
800	0.98777	0.98754	0.98762	0.98764	0.00012
820	0.98632	0.98639	0.98630	0.98634	0.00005

Table 9.13.d VNIIOFI raw data reported on Ceramic sample, C04.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.59939	0.59950	0.59873	0.59921	0.00042
380	0.72070	0.72105	0.72030	0.72068	0.00038
400	0.80532	0.80593	0.80546	0.80557	0.00032
420	0.84206	0.84305	0.84278	0.84263	0.00051
440	0.85535	0.85640	0.85604	0.85593	0.00053
460	0.86593	0.86727	0.86700	0.86673	0.00071
480	0.87365	0.87513	0.87468	0.87449	0.00076
500	0.88012	0.88136	0.88111	0.88086	0.00066
520	0.88331	0.88473	0.88441	0.88415	0.00074
540	0.88588	0.88728	0.88689	0.88668	0.00072
560	0.88691	0.88823	0.88803	0.88772	0.00071
580	0.88569	0.88699	0.88680	0.88649	0.00070
600	0.88884	0.89015	0.88993	0.88964	0.00070
620	0.88962	0.89093	0.89080	0.89045	0.00072
640	0.89004	0.89136	0.89130	0.89090	0.00075
660	0.89173	0.89314	0.89281	0.89256	0.00074
680	0.89430	0.89585	0.89554	0.89523	0.00082
700	0.89820	0.89690	0.89655	0.89722	0.00087
720	0.89721	0.89850	0.89805	0.89792	0.00065
740	0.89701	0.89873	0.89836	0.89803	0.00091
760	0.89790	0.89955	0.89913	0.89886	0.00086
780	0.89905	0.90057	0.89984	0.89982	0.00076
800	0.89810	0.89963	0.89914	0.89896	0.00078
820	0.89740	0.89899	0.89827	0.89822	0.00080

Table 9.13.e VNIIOFI raw data reported on Ceramic sample, C05.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.59872	0.59973	0.59921	0.59922	0.00051
380	0.72006	0.72131	0.72092	0.72076	0.00064
400	0.80536	0.80623	0.80605	0.80588	0.00046
420	0.84244	0.84320	0.84292	0.84285	0.00038
440	0.85572	0.85640	0.85619	0.85610	0.00035
460	0.86668	0.86719	0.86722	0.86703	0.00030
480	0.87453	0.87513	0.87506	0.87491	0.00033
500	0.88103	0.88128	0.88134	0.88122	0.00016
520	0.88407	0.88465	0.88456	0.88443	0.00031
540	0.88648	0.88705	0.88682	0.88678	0.00029
560	0.88744	0.88800	0.88788	0.88777	0.00029
580	0.88596	0.88654	0.88649	0.88633	0.00032

(Continued.)

600	0.88916	0.88962	0.88948	0.88942	0.00024
620	0.88993	0.89033	0.89027	0.89018	0.00022
640	0.89023	0.89083	0.89062	0.89056	0.00030
660	0.89189	0.89246	0.89235	0.89223	0.00030
680	0.89459	0.89509	0.89486	0.89485	0.00025
700	0.89540	0.89599	0.89587	0.89575	0.00031
720	0.89697	0.89751	0.89729	0.89726	0.00027
740	0.89722	0.89774	0.89745	0.89747	0.00026
760	0.89807	0.89841	0.89829	0.89826	0.00017
780	0.89881	0.89935	0.89901	0.89906	0.00027
800	0.89837	0.89826	0.89822	0.89828	0.00008
820	0.89731	0.89769	0.89736	0.89745	0.00021

Table 9.13.f VNIIOFI raw data reported on Ceramic sample, C06.

Wavelength [nm]	Run #1	Run #2	Run #3	Average	Standard Deviation
360	0.59791	0.59851	0.59805	0.59816	0.00031
380	0.71878	0.71957	0.71904	0.71913	0.00040
400	0.80364	0.80407	0.80375	0.80382	0.00022
420	0.84065	0.84104	0.84061	0.84077	0.00024
440	0.85393	0.85417	0.85388	0.85399	0.00016
460	0.86482	0.86495	0.86483	0.86487	0.00007
480	0.87259	0.87289	0.87252	0.87267	0.00020
500	0.87908	0.87904	0.87887	0.87900	0.00011
520	0.88227	0.88233	0.88209	0.88223	0.00012
540	0.88468	0.88487	0.88457	0.88471	0.00015
560	0.88564	0.88574	0.88555	0.88564	0.00010
580	0.88415	0.88428	0.88423	0.88422	0.00007
600	0.88735	0.88744	0.88722	0.88734	0.00011
620	0.88812	0.88807	0.88801	0.88807	0.00006
640	0.88849	0.88864	0.88851	0.88855	0.00008
660	0.89023	0.89042	0.89031	0.89032	0.00010
680	0.89300	0.89312	0.89297	0.89303	0.00008
700	0.89389	0.89402	0.89405	0.89399	0.00009
720	0.89553	0.89562	0.89547	0.89554	0.00008
740	0.89570	0.89577	0.89577	0.89575	0.00004
760	0.89663	0.89644	0.89654	0.89654	0.00010
780	0.89744	0.89745	0.89741	0.89743	0.00002
800	0.89684	0.89681	0.89640	0.89668	0.00025
820	0.89579	0.89594	0.89599	0.89591	0.00010

10. Participant's Reported Measurement Uncertainties

Table 10.1 CSIR-NML Reported Final Uncertainties for Spectralon Sample, S10 and Ceramic Sample C10

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S10**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C10**
360	0.0032	0.0033
380	0.0032	0.0033
400	0.0026	0.0033
420	0.0026	0.0033
440	0.0026	0.0033
460	0.0021	0.0033
480	0.0021	0.0021
500	0.0021	0.0021
520	0.0021	0.0021
540	0.0021	0.0021
560	0.0021	0.0021
580	0.0021	0.0021
600	0.0021	0.0021
620	0.0021	0.0021
640	0.0021	0.0021
660	0.0021	0.0021
680	0.0021	0.0021
700	0.0021	0.0021
720	0.0021	0.0021
740	0.0021	0.0021
760	0.0021	0.0021
780	0.0021	0.0021
800	0.0029	0.0029
820	0.0029	0.0029

Table10.2 HUT Reported Final Uncertainties for Spectralon Sample, S04 and Ceramic Sample C04

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S04**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C04**
360	0.0021	0.0013
380	0.0021	0.0015
400	0.0021	0.0017
420	0.0021	0.0018
440	0.0021	0.0018
460	0.0021	0.0018
480	0.0021	0.0019
500	0.0021	0.0019
520	0.0021	0.0019
540	0.0021	0.0019
560	0.0021	0.0019
580	0.0021	0.0019
600	0.0021	0.0019
620	0.0021	0.0019
640	0.0021	0.0019
660	0.0021	0.0019
680	0.0021	0.0019
700	0.0021	0.0019
720	0.0021	0.0019
740	0.0021	0.0019
760	0.0021	0.0019
780	0.0021	0.0019
800	0.0021	0.0019
820	0.0021	0.0019

Table 10.3 IFA-CSIC Reported Final Uncertainties for Spectralon Sample, S16 and Ceramic Sample C16

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S16**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C16**
360		
380	0.0031	0.0023
400	0.0031	0.0025
420	0.0031	0.0027
440	0.0031	0.0027
460	0.0031	0.0027
480	0.0023	0.0021
500	0.0023	0.0021
520	0.0023	0.0021
540	0.0023	0.0021
560	0.0023	0.0021
580	0.0023	0.0021
600	0.0023	0.0021
620	0.0023	0.0021
640	0.0023	0.0021
660	0.0023	0.0021
680	0.0023	0.0021
700	0.0023	0.0021
720	0.0023	0.0021
740	0.0023	0.0021
760	0.0023	0.0021
780	0.0023	0.0021
800		
820		

Table 10.4 KRISS Reported Final Uncertainties for Spectralon Sample, S13 and Ceramic Sample C13

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S13**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C13**
360		
380	0.0051	0.0038
400	0.0031	0.0026
420	0.0024	0.0021
440	0.0022	0.0020
460	0.0022	0.0021
480	0.0021	0.0020
500	0.0020	0.0020
520	0.0020	0.0018
540	0.0019	0.0018
560	0.0019	0.0018
580	0.0019	0.0019
600	0.0020	0.0019
620	0.0019	0.0019
640	0.0019	0.0019
660	0.0019	0.0018
680	0.0019	0.0020
700	0.0019	0.0019
720	0.0019	0.0018
740	0.0019	0.0018
760	0.0019	0.0021
780	0.0019	0.0020
800		
820		

Table 10.5 MSL Reported Final Uncertainties for Spectralon Sample, S04 and Ceramic Sample C04

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S04**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C04**
360	0.0020	0.0020
380	0.0020	0.0020
400	0.0020	0.0020
420	0.0020	0.0020
440	0.0020	0.0020
460	0.0020	0.0020
480	0.0020	0.0020
500	0.0020	0.0020
520	0.0020	0.0020
540	0.0020	0.0020
560	0.0020	0.0020
580	0.0020	0.0020
600	0.0020	0.0020
620	0.0020	0.0020
640	0.0020	0.0020
660	0.0020	0.0020
680	0.0020	0.0020
700	0.0020	0.0020
720	0.0020	0.0020
740	0.0020	0.0020
760	0.0020	0.0020
780	0.0020	0.0020
800	0.0020	0.0020
820	0.0020	0.0020

Table 10.6 NIM Reported Final Uncertainties for Spectralon Sample, S13 and Ceramic Sample C13

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S13**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C13**
360	0.0103	0.0063
380	0.0078	0.0057
400	0.0073	0.0060
420	0.0071	0.0060
440	0.0072	0.0062
460	0.0072	0.0063
480	0.0072	0.0064
500	0.0072	0.0064
520	0.0072	0.0064
540	0.0072	0.0064
560	0.0072	0.0065
580	0.0072	0.0065
600	0.0072	0.0065
620	0.0072	0.0065
640	0.0072	0.0065
660	0.0072	0.0065
680	0.0072	0.0065
700	0.0072	0.0065
720	0.0072	0.0065
740	0.0072	0.0065
760	0.0072	0.0065
780	0.0072	0.0065
800	0.0072	0.0065
820	0.0077	0.0070

Table 10.7 NIST Reported Final Uncertainties for Spectralon Sample and Ceramic Sample

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for Spectralon**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for Ceramic**
360	0.0014	0.0030
380	0.0014	0.0019
400	0.0014	0.0016
420	0.0014	0.0016
440	0.0014	0.0015
460	0.0014	0.0014
480	0.0014	0.0014
500	0.0014	0.0014
520	0.0014	0.0013
540	0.0014	0.0013
560	0.0014	0.0014
580	0.0014	0.0014
600	0.0014	0.0013
620	0.0014	0.0013
640	0.0014	0.0013
660	0.0014	0.0013
680	0.0014	0.0013
700	0.0014	0.0014
720	0.0014	0.0013
740	0.0014	0.0014
760	0.0014	0.0013
780	0.0014	0.0014
800	0.0014	0.0013
820	0.0014	0.0013

Table 10.8 NMIJ Reported Final Uncertainties for Spectralon Sample, S16 and Ceramic Sample C16

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S16**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C16**
360	0.0022	0.0017
380	0.0022	0.0018
400	0.0022	0.0019
420	0.0023	0.0020
440	0.0015	0.0013
460	0.0015	0.0013
480	0.0015	0.0013
500	0.0015	0.0013
520	0.0015	0.0013
540	0.0015	0.0013
560	0.0015	0.0013
580	0.0015	0.0013
600	0.0015	0.0013
620	0.0015	0.0013
640	0.0015	0.0013
660	0.0015	0.0013
680	0.0015	0.0014
700	0.0015	0.0014
720	0.0015	0.0014
740	0.0015	0.0014
760	0.0021	0.0019
780	0.0021	0.0019
800	0.0021	0.0019
820	0.0021	0.0019

Table 10.9 NPL Reported Final Uncertainties for Spectralon Sample, S07 and Ceramic Sample C07

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S07**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C07**
360	0.0026	0.0034
380	0.0019	0.0025
400	0.0013	0.0017
420	0.0012	0.0014
440	0.0013	0.0015
460	0.0013	0.0012
480	0.0012	0.0011
500	0.0012	0.0011
520	0.0011	0.0011
540	0.0011	0.0011
560	0.0011	0.0012
580	0.0011	0.0012
600	0.0011	0.0011
620	0.0012	0.0012
640	0.0012	0.0012
660	0.0012	0.0012
680	0.0011	0.0011
700	0.0011	0.0011
720	0.0011	0.0011
740	0.0011	0.0011
760	0.0011	0.0011
780	0.0011	0.0011
800	0.0011	0.0011
820	0.0012	0.0014

Table 10.10 NRC Reported Final Uncertainties for Spectralon Sample, S10 and Ceramic Sample C10

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S10**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C10**
360	0.0012	0.0019
380	0.0012	0.0015
400	0.0009	0.0013
420	0.0009	0.0011
440	0.0009	0.0015
460	0.0009	0.0008
480	0.0009	0.0012
500	0.0009	0.0008
520	0.0009	0.0009
540	0.0009	0.0009
560	0.0008	0.0008
580	0.0008	0.0012
600	0.0008	0.0009
620	0.0008	0.0009
640	0.0008	0.0009
660	0.0008	0.0008
680	0.0008	0.0009
700	0.0008	0.0009
720	0.0008	0.0009
740	0.0008	0.0009
760	0.0008	0.0008
780	0.0008	0.0009
800	0.0008	0.0009
820	0.0008	0.0009

Table 10.11 OMH Reported Final Uncertainties for Spectralon Sample, S04 and Ceramic Sample C04

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S04**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C04**
360	0.0059	0.0037
380	0.0043	0.0032
400	0.0039	0.0033
420	0.0038	0.0033
440	0.0038	0.0033
460	0.0037	0.0033
480	0.0034	0.0031
500	0.0033	0.0030
520	0.0032	0.0029
540	0.0032	0.0029
560	0.0032	0.0029
580	0.0031	0.0028
600	0.0031	0.0028
620	0.0031	0.0028
640	0.0031	0.0028
660	0.0030	0.0027
680	0.0030	0.0028
700	0.0030	0.0028
720	0.0031	0.0028
740	0.0031	0.0028
760	0.0031	0.0029
780	0.0032	0.0029
800		
820		

Table 10.12 PTB Reported Final Uncertainties for Spectralon Sample, S04 and Ceramic Sample C04

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S04**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C04**
360	0.0007	0.0007
380	0.0007	0.0008
400	0.0007	0.0009
420	0.0007	0.0010
440	0.0007	0.0006
460	0.0007	0.0006
480	0.0007	0.0006
500	0.0007	0.0006
520	0.0007	0.0006
540	0.0007	0.0006
560	0.0007	0.0006
580	0.0007	0.0006
600	0.0007	0.0006
620	0.0007	0.0006
640	0.0007	0.0006
660	0.0007	0.0006
680	0.0007	0.0006
700	0.0007	0.0006
720	0.0007	0.0006
740	0.0007	0.0006
760	0.0007	0.0006
780	0.0007	0.0006
800	0.0007	0.0006
820	0.0007	0.0006

Table 10.13 VNIIOFI Reported Final Uncertainties for Spectralon Sample, S04 and Ceramic Sample C04

Wavelength [nm]	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for S04**	**Absolute (Reflectance Factor Units) Standard Uncertainty (*k*=1) for C04**
360	0.0046	0.0040
380	0.0037	0.0030
400	0.0028	0.0025
420	0.0025	0.0023
440	0.0022	0.0021
460	0.0021	0.0020
480	0.0021	0.0020
500	0.0021	0.0020
520	0.0021	0.0020
540	0.0021	0.0020
560	0.0021	0.0020
580	0.0021	0.0020
600	0.0021	0.0020
620	0.0021	0.0020
640	0.0021	0.0020
660	0.0021	0.0020
680	0.0021	0.0020
700	0.0021	0.0020
720	0.0021	0.0020
740	0.0021	0.0020
760	0.0021	0.0020
780	0.0021	0.0020
800	0.0021	0.0020
820	0.0021	0.0020

11. Pilot Raw Data

Table 11.1 Raw data of Pilot (NIST) measurements of CSIR-NML samples: S10, S11, S12

Wavelength [nm]	S10 Reflectance factor (Before)	S10 Reflectance factor (After)	S11 Reflectance factor (Before)	S11 Reflectance factor (After)	S12 Reflectance factor (Before)	S12 Reflectance factor (After)
360	0.9796	0.9774	0.9770	0.9769	0.9821	0.9811
380	0.9826	0.9814	0.9799	0.9800	0.9845	0.9832
400	0.9829	0.9824	0.9804	0.9808	0.9846	0.9845
420	0.9871	0.9864	0.9847	0.9854	0.9883	0.9883
440	0.9878	0.9870	0.9854	0.9855	0.9888	0.9889
460	0.9887	0.9872	0.9860	0.9861	0.9892	0.9889
480	0.9895	0.9886	0.9870	0.9870	0.9898	0.9902
500	0.9898	0.9894	0.9873	0.9873	0.9901	0.9902
520	0.9900	0.9895	0.9875	0.9882	0.9902	0.9902
540	0.9904	0.9894	0.9879	0.9880	0.9905	0.9908
560	0.9902	0.9893	0.9877	0.9881	0.9902	0.9908
580	0.9910	0.9901	0.9886	0.9890	0.9909	0.9917
600	0.9906	0.9898	0.9882	0.9882	0.9904	0.9906
620	0.9910	0.9902	0.9884	0.9888	0.9907	0.9911
640	0.9911	0.9905	0.9887	0.9892	0.9909	0.9910
660	0.9908	0.9905	0.9884	0.9884	0.9904	0.9905
680	0.9912	0.9906	0.9887	0.9889	0.9908	0.9910
700	0.9905	0.9896	0.9881	0.9886	0.9901	0.9904
720	0.9914	0.9901	0.9892	0.9893	0.9909	0.9911
740	0.9913	0.9909	0.9890	0.9895	0.9908	0.9910
760	0.9917	0.9908	0.9895	0.9895	0.9911	0.9919
780	0.9914	0.9916	0.9892	0.9892	0.9908	0.9910
800	0.9915	0.9905	0.9896	0.9891	0.9911	0.9920
820	0.9919	0.9916	0.9898	0.9895	0.9913	0.9918

Table 11.2 Raw data of Pilot (NIST) measurements of CSIR-NML samples: C10, C11, C12

Wavelength [nm]	C10 Reflectance factor (Before)	C10 Reflectance factor (After)	C11 Reflectance factor (Before)	C11 Reflectance factor (After)	C12 Reflectance factor (Before)	C12 Reflectance factor (After)
360	0.6629	0.6597	0.6243	0.6219	0.6271	0.6243
380	0.7641	0.7611	0.7354	0.7337	0.7381	0.7352
400	0.8361	0.8326	0.8177	0.8154	0.8202	0.8168
420	0.8654	0.8623	0.8534	0.8511	0.8556	0.8526
440	0.8759	0.8735	0.8659	0.8644	0.8678	0.8658
460	0.8849	0.8829	0.8756	0.8747	0.8773	0.8752
480	0.8919	0.8900	0.8834	0.8821	0.8849	0.8832
500	0.8961	0.8937	0.8882	0.8866	0.8896	0.8877
520	0.8986	0.8963	0.8915	0.8904	0.8927	0.8907
540	0.9003	0.8986	0.8940	0.8929	0.8948	0.8937
560	0.9002	0.8984	0.8946	0.8937	0.8953	0.8939
580	0.8982	0.8972	0.8933	0.8925	0.8936	0.8928
600	0.8999	0.8985	0.8956	0.8949	0.8956	0.8942
620	0.9002	0.8991	0.8962	0.8950	0.8960	0.8949
640	0.9015	0.9004	0.8974	0.8964	0.8970	0.8962
660	0.9030	0.9023	0.8991	0.8982	0.8983	0.8978
680	0.9061	0.9053	0.9018	0.9007	0.9007	0.9000
700	0.9062	0.9051	0.9020	0.9009	0.9006	0.8999
720	0.9082	0.9075	0.9041	0.9033	0.9026	0.9019
740	0.9080	0.9073	0.9041	0.9034	0.9023	0.9015
760	0.9084	0.9079	0.9047	0.9046	0.9029	0.9022
780	0.9082	0.9081	0.9046	0.9044	0.9027	0.9023
800	0.9076	0.9069	0.9041	0.9031	0.9023	0.9001
820	0.9078	0.9067	0.9043	0.9031	0.9025	0.9012

Table 11.3 Raw data of Pilot (NIST) measurements of HUT samples: S04, S05, S06

Wavelength [nm]	S04 Reflectance factor (Before)	S04 Reflectance factor (After)	S05 Reflectance factor (Before)	S05 Reflectance factor (After)	S06 Reflectance factor (Before)	S06 Reflectance factor (After)
360	0.9792	0.9790	0.9755	0.9751	0.9795	0.9807
380	0.9821	0.9830	0.9789	0.9790	0.9828	0.9841
400	0.9826	0.9833	0.9796	0.9799	0.9833	0.9844
420	0.9869	0.9875	0.9839	0.9842	0.9874	0.9885
440	0.9872	0.9879	0.9845	0.9848	0.9879	0.9888
460	0.9878	0.9884	0.9851	0.9854	0.9885	0.9895
480	0.9885	0.9891	0.9862	0.9864	0.9895	0.9903
500	0.9887	0.9893	0.9866	0.9866	0.9897	0.9905
520	0.9890	0.9893	0.9867	0.9869	0.9898	0.9907
540	0.9892	0.9898	0.9872	0.9875	0.9901	0.9911
560	0.9889	0.9892	0.9869	0.9871	0.9899	0.9906
580	0.9898	0.9902	0.9879	0.9881	0.9907	0.9916
600	0.9892	0.9896	0.9874	0.9878	0.9902	0.9911
620	0.9893	0.9899	0.9877	0.9880	0.9905	0.9913
640	0.9894	0.9900	0.9879	0.9882	0.9906	0.9915
660	0.9893	0.9897	0.9877	0.9879	0.9905	0.9911
680	0.9892	0.9898	0.9879	0.9880	0.9907	0.9913
700	0.9884	0.9891	0.9871	0.9874	0.9900	0.9905
720	0.9895	0.9901	0.9882	0.9886	0.9909	0.9915
740	0.9896	0.9901	0.9886	0.9886	0.9911	0.9914
760	0.9898	0.9904	0.9886	0.9889	0.9912	0.9916
780	0.9894	0.9899	0.9886	0.9887	0.9910	0.9914
800	0.9900	0.9903	0.9889	0.9890	0.9914	0.9915
820	0.9900	0.9906	0.9889	0.9893	0.9915	0.9918

Table 11.4 Raw data of Pilot (NIST) measurements of HUT samples: C04, C05, C06

Wavelength [nm]	C04 Reflectance factor (Before)	C04 Reflectance factor (After)	C05 Reflectance factor (Before)	C05 Reflectance factor (After)	C06 Reflectance factor (Before)	C06 Reflectance factor (After)
360	0.6249	0.6253	0.6250	0.6251	0.6241	0.6241
380	0.7353	0.7360	0.7357	0.7358	0.7339	0.7342
400	0.8174	0.8180	0.8174	0.8175	0.8154	0.8157
420	0.8533	0.8538	0.8530	0.8532	0.8508	0.8513
440	0.8661	0.8666	0.8658	0.8657	0.8637	0.8638
460	0.8760	0.8763	0.8757	0.8754	0.8735	0.8737
480	0.8841	0.8842	0.8835	0.8833	0.8813	0.8816
500	0.8887	0.8890	0.8881	0.8879	0.8861	0.8863
520	0.8920	0.8923	0.8914	0.8913	0.8893	0.8896
540	0.8945	0.8946	0.8937	0.8935	0.8916	0.8919
560	0.8952	0.8956	0.8943	0.8944	0.8923	0.8928
580	0.8939	0.8942	0.8930	0.8929	0.8909	0.8912
600	0.8963	0.8966	0.8952	0.8952	0.8932	0.8936
620	0.8969	0.8972	0.8957	0.8955	0.8939	0.8942
640	0.8984	0.8986	0.8971	0.8970	0.8953	0.8956
660	0.8997	0.8999	0.8984	0.8982	0.8966	0.8968
680	0.9023	0.9026	0.9012	0.9011	0.8993	0.8997
700	0.9025	0.9028	0.9013	0.9012	0.8996	0.8999
720	0.9049	0.9051	0.9037	0.9034	0.9020	0.9022
740	0.9049	0.9049	0.9035	0.9033	0.9018	0.9019
760	0.9053	0.9057	0.9041	0.9039	0.9025	0.9027
780	0.9053	0.9055	0.9040	0.9037	0.9025	0.9026
800	0.9046	0.9048	0.9035	0.9031	0.9018	0.9019
820	0.9047	0.9050	0.9032	0.9032	0.9019	0.9020

Table 11.5 Raw data of Pilot (NIST) measurements of IFA-CSIC samples: S16, S17, S18

Wavelength [nm]	**S16 Reflectance factor (Before)**	**S16 Reflectance factor (After)**	**S17 Reflectance factor (Before)**	**S17 Reflectance factor (After)**	**S18 Reflectance factor (Before)**	**S18 Reflectance factor (After)**
360						
380	0.9753	0.9763	0.9819	0.9789	0.9841	0.9827
400	0.9770	0.9781	0.9829	0.9804	0.9843	0.9833
420	0.9822	0.9831	0.9874	0.9853	0.9885	0.9877
440	0.9836	0.9844	0.9884	0.9863	0.9890	0.9882
460	0.9851	0.9856	0.9894	0.9873	0.9895	0.9887
480	0.9863	0.9868	0.9903	0.9883	0.9903	0.9893
500	0.9872	0.9876	0.9907	0.9890	0.9905	0.9896
520	0.9877	0.9882	0.9908	0.9893	0.9904	0.9897
540	0.9886	0.9888	0.9915	0.9898	0.9910	0.9901
560	0.9883	0.9886	0.9911	0.9896	0.9904	0.9896
580	0.9895	0.9900	0.9920	0.9907	0.9910	0.9905
600	0.9892	0.9896	0.9916	0.9905	0.9905	0.9900
620	0.9897	0.9899	0.9919	0.9908	0.9909	0.9901
640	0.9901	0.9903	0.9921	0.9910	0.9911	0.9903
660	0.9900	0.9902	0.9919	0.9908	0.9907	0.9900
680	0.9905	0.9905	0.9922	0.9911	0.9909	0.9902
700	0.9898	0.9900	0.9914	0.9906	0.9902	0.9896
720	0.9908	0.9909	0.9923	0.9915	0.9911	0.9906
740	0.9908	0.9910	0.9923	0.9917	0.9912	0.9906
760	0.9911	0.9912	0.9926	0.9919	0.9914	0.9910
780	0.9909	0.9911	0.9923	0.9916	0.9910	0.9908
800						
820						

Table 11.6 Raw data of Pilot (NIST) measurements of IFA-CSIC samples: C16, C17, C18

Wavelength [nm]	**C16 Reflectance factor (Before)**	**C16 Reflectance factor (After)**	**C17 Reflectance factor (Before)**	**C17 Reflectance factor (After)**	**C18 Reflectance factor (Before)**	**C18 Reflectance factor (After)**
360						
380	0.7348	0.7349	0.7352	0.7356	0.7363	0.7357
400	0.8172	0.8172	0.8177	0.8181	0.8187	0.8181
420	0.8529	0.8529	0.8538	0.8540	0.8544	0.8537
440	0.8655	0.8656	0.8665	0.8667	0.8667	0.8662
460	0.8753	0.8752	0.8762	0.8765	0.8765	0.8758
480	0.8833	0.8833	0.8844	0.8846	0.8844	0.8837
500	0.8880	0.8882	0.8891	0.8894	0.8889	0.8883
520	0.8913	0.8915	0.8925	0.8927	0.8921	0.8916
540	0.8937	0.8938	0.8949	0.8950	0.8946	0.8939
560	0.8942	0.8945	0.8955	0.8956	0.8954	0.8948
580	0.8927	0.8929	0.8941	0.8942	0.8940	0.8934
600	0.8948	0.8950	0.8962	0.8965	0.8961	0.8957
620	0.8952	0.8954	0.8969	0.8970	0.8969	0.8964
640	0.8965	0.8966	0.8982	0.8983	0.8982	0.8978
660	0.8977	0.8978	0.8995	0.8995	0.8994	0.8991
680	0.9000	0.9003	0.9019	0.9022	0.9021	0.9019
700	0.9000	0.9003	0.9022	0.9023	0.9023	0.9020
720	0.9019	0.9022	0.9043	0.9045	0.9045	0.9042
740	0.9016	0.9019	0.9043	0.9043	0.9045	0.9041
760	0.9023	0.9024	0.9050	0.9048	0.9051	0.9047
780	0.9019	0.9023	0.9046	0.9047	0.9048	0.9047
800						
820						

Table 11.7 Raw data of Pilot (NIST) measurements of KRISS samples: S13, S14, S15

Wavelength [nm]	S13 Reflectance factor (Before)	S13 Reflectance factor (After)	S14 Reflectance factor (Before)	S14 Reflectance factor (After)	S15 Reflectance factor (Before)	S15 Reflectance factor (After)
360						
380	0.9849	0.9849	0.9813	0.9854	0.9841	0.9846
400	0.9850	0.9850	0.9814	0.9853	0.9843	0.9849
420	0.9891	0.9888	0.9853	0.9891	0.9885	0.9887
440	0.9896	0.9893	0.9857	0.9896	0.9891	0.9892
460	0.9902	0.9899	0.9861	0.9901	0.9896	0.9898
480	0.9907	0.9905	0.9865	0.9906	0.9900	0.9903
500	0.9910	0.9907	0.9867	0.9907	0.9904	0.9904
520	0.9911	0.9908	0.9866	0.9909	0.9905	0.9905
540	0.9915	0.9912	0.9869	0.9912	0.9908	0.9910
560	0.9910	0.9908	0.9863	0.9907	0.9903	0.9905
580	0.9919	0.9916	0.9872	0.9916	0.9911	0.9912
600	0.9913	0.9911	0.9867	0.9910	0.9905	0.9908
620	0.9916	0.9914	0.9868	0.9914	0.9908	0.9909
640	0.9917	0.9915	0.9870	0.9913	0.9910	0.9910
660	0.9913	0.9911	0.9866	0.9910	0.9906	0.9907
680	0.9916	0.9915	0.9869	0.9913	0.9909	0.9910
700	0.9908	0.9907	0.9861	0.9904	0.9901	0.9901
720	0.9917	0.9916	0.9871	0.9913	0.9911	0.9910
740	0.9914	0.9914	0.9872	0.9912	0.9909	0.9908
760	0.9918	0.9918	0.9878	0.9916	0.9912	0.9913
780	0.9915	0.9914	0.9876	0.9913	0.9908	0.9909
800						
820						

Table 11.8 Raw data of Pilot (NIST) measurements of KRISS samples: C13, C14, C15

Wavelength [nm]	C13 Reflectance factor (Before)	C13 Reflectance factor (After)	C14 Reflectance factor (Before)	C14 Reflectance factor (After)	C15 Reflectance factor (Before)	C15 Reflectance factor (After)
360						
380	0.7357	0.7358	0.7376	0.7372	0.7369	0.7369
400	0.8183	0.8183	0.8196	0.8191	0.8192	0.8191
420	0.8544	0.8543	0.8554	0.8548	0.8551	0.8548
440	0.8670	0.8669	0.8678	0.8673	0.8676	0.8674
460	0.8769	0.8765	0.8776	0.8768	0.8774	0.8769
480	0.8848	0.8846	0.8854	0.8847	0.8852	0.8848
500	0.8894	0.8893	0.8900	0.8894	0.8897	0.8894
520	0.8928	0.8927	0.8933	0.8926	0.8931	0.8929
540	0.8953	0.8951	0.8958	0.8950	0.8958	0.8954
560	0.8960	0.8957	0.8963	0.8955	0.8964	0.8961
580	0.8947	0.8945	0.8950	0.8940	0.8951	0.8946
600	0.8969	0.8966	0.8972	0.8962	0.8974	0.8968
620	0.8976	0.8973	0.8978	0.8968	0.8981	0.8975
640	0.8989	0.8986	0.8991	0.8982	0.8994	0.8990
660	0.9003	0.9000	0.9005	0.8997	0.9008	0.9004
680	0.9029	0.9026	0.9032	0.9023	0.9034	0.9029
700	0.9031	0.9028	0.9034	0.9027	0.9037	0.9033
720	0.9053	0.9048	0.9057	0.9049	0.9058	0.9055
740	0.9053	0.9048	0.9057	0.9050	0.9058	0.9056
760	0.9059	0.9055	0.9063	0.9056	0.9065	0.9060
780	0.9057	0.9054	0.9063	0.9056	0.9064	0.9060
800						
820						

Table 11.9 Raw data of Pilot (NIST) measurements of MSL samples: S04, S05, S06

Wavelength [nm]	S04 Reflectance factor (Before)	S04 Reflectance factor (After)	S05 Reflectance factor (Before)	S05 Reflectance factor (After)	S06 Reflectance factor (Before)	S06 Reflectance factor (After)
360	0.9790	0.9799	0.9751	0.9758	0.9807	0.9801
380	0.9830	0.9832	0.9790	0.9794	0.9841	0.9835
400	0.9833	0.9834	0.9799	0.9801	0.9844	0.9836
420	0.9875	0.9873	0.9842	0.9843	0.9885	0.9877
440	0.9879	0.9879	0.9848	0.9850	0.9888	0.9884
460	0.9884	0.9882	0.9854	0.9857	0.9895	0.9888
480	0.9891	0.9891	0.9864	0.9867	0.9903	0.9898
500	0.9893	0.9893	0.9866	0.9869	0.9905	0.9899
520	0.9893	0.9893	0.9869	0.9871	0.9907	0.9901
540	0.9898	0.9895	0.9875	0.9874	0.9911	0.9903
560	0.9892	0.9892	0.9871	0.9871	0.9906	0.9900
580	0.9902	0.9899	0.9881	0.9880	0.9916	0.9909
600	0.9896	0.9893	0.9878	0.9877	0.9911	0.9905
620	0.9899	0.9896	0.9880	0.9879	0.9913	0.9904
640	0.9900	0.9898	0.9882	0.9884	0.9915	0.9906
660	0.9897	0.9894	0.9879	0.9879	0.9911	0.9905
680	0.9898	0.9898	0.9880	0.9883	0.9913	0.9906
700	0.9891	0.9888	0.9874	0.9874	0.9905	0.9899
720	0.9901	0.9899	0.9886	0.9884	0.9915	0.9908
740	0.9901	0.9896	0.9886	0.9884	0.9914	0.9908
760	0.9904	0.9901	0.9889	0.9889	0.9916	0.9910
780	0.9899	0.9901	0.9887	0.9887	0.9914	0.9906
800	0.9903	0.9905	0.9890	0.9895	0.9915	0.9914
820	0.9906	0.9907	0.9893	0.9899	0.9918	0.9916

Table 11.10 Raw data of Pilot (NIST) measurements of MSL samples: C04, C05, C06

Wavelength [nm]	**C04 Reflectance factor (Before)**	**C04 Reflectance factor (After)**	**C05 Reflectance factor (Before)**	**C05 Reflectance factor (After)**	**C06 Reflectance factor (Before)**	**C06 Reflectance factor (After)**
360	0.6253	0.6248	0.6251	0.6248	0.6241	0.6234
380	0.7360	0.7356	0.7358	0.7355	0.7342	0.7335
400	0.8180	0.8175	0.8175	0.8172	0.8157	0.8147
420	0.8538	0.8532	0.8532	0.8530	0.8513	0.8503
440	0.8666	0.8658	0.8657	0.8651	0.8638	0.8632
460	0.8763	0.8759	0.8754	0.8754	0.8737	0.8730
480	0.8842	0.8836	0.8833	0.8830	0.8816	0.8808
500	0.8890	0.8885	0.8879	0.8879	0.8863	0.8852
520	0.8923	0.8918	0.8913	0.8912	0.8896	0.8888
540	0.8946	0.8944	0.8935	0.8937	0.8919	0.8915
560	0.8956	0.8951	0.8944	0.8943	0.8928	0.8919
580	0.8942	0.8939	0.8929	0.8929	0.8912	0.8907
600	0.8966	0.8960	0.8952	0.8950	0.8936	0.8926
620	0.8972	0.8968	0.8955	0.8956	0.8942	0.8936
640	0.8986	0.8982	0.8970	0.8970	0.8956	0.8946
660	0.8999	0.8993	0.8982	0.8985	0.8968	0.8961
680	0.9026	0.9021	0.9011	0.9008	0.8997	0.8987
700	0.9028	0.9023	0.9012	0.9012	0.8999	0.8992
720	0.9051	0.9046	0.9034	0.9031	0.9022	0.9017
740	0.9049	0.9047	0.9033	0.9032	0.9019	0.9015
760	0.9057	0.9055	0.9039	0.9039	0.9027	0.9025
780	0.9055	0.9053	0.9037	0.9036	0.9026	0.9021
800	0.9048	0.9042	0.9031	0.9031	0.9019	0.9015
820	0.9050	0.9043	0.9032	0.9034	0.9020	0.9019

Table 11.11 Raw data of Pilot (NIST) measurements of NIM samples: S13, S14, S15

Wavelength [nm]	S13 Reflectance factor (Before)	S13 Reflectance factor (After)	S14 Reflectance factor (Before)	S14 Reflectance factor (After)	S15 Reflectance factor (Before)	S15 Reflectance factor (After)
360	0.9823	0.9772	0.9829	0.9777	0.9816	0.9772
380	0.9849	0.9810	0.9854	0.9810	0.9846	0.9821
400	0.9850	0.9816	0.9853	0.9814	0.9849	0.9822
420	0.9888	0.9866	0.9891	0.9862	0.9887	0.9869
440	0.9893	0.9875	0.9896	0.9863	0.9892	0.9873
460	0.9899	0.9882	0.9901	0.9873	0.9898	0.9880
480	0.9905	0.9888	0.9906	0.9882	0.9903	0.9893
500	0.9907	0.9891	0.9907	0.9881	0.9904	0.9893
520	0.9908	0.9895	0.9909	0.9885	0.9905	0.9894
540	0.9912	0.9902	0.9912	0.9891	0.9910	0.9901
560	0.9908	0.9901	0.9907	0.9886	0.9905	0.9892
580	0.9916	0.9909	0.9916	0.9892	0.9912	0.9909
600	0.9911	0.9906	0.9910	0.9888	0.9908	0.9900
620	0.9914	0.9914	0.9914	0.9895	0.9909	0.9910
640	0.9915	0.9910	0.9913	0.9894	0.9910	0.9906
660	0.9911	0.9906	0.9910	0.9894	0.9907	0.9903
680	0.9915	0.9912	0.9913	0.9893	0.9910	0.9906
700	0.9907	0.9903	0.9904	0.9890	0.9901	0.9899
720	0.9916	0.9913	0.9913	0.9898	0.9910	0.9906
740	0.9914	0.9909	0.9912	0.9898	0.9908	0.9908
760	0.9918	0.9917	0.9916	0.9901	0.9913	0.9911
780	0.9914	0.9913	0.9913	0.9893	0.9909	0.9907
800	0.9915	0.9907	0.9915	0.9894	0.9912	0.9900
820	0.9917	0.9902	0.9919	0.9900	0.9915	0.9912

Table 11.12 Raw data of Pilot (NIST) measurements of NIM samples: C13, C14, C15

Wavelength [nm]	C13 Reflectance factor (Before)	C13 Reflectance factor (After)	C14 Reflectance factor (Before)	C14 Reflectance factor (After)	C15 Reflectance factor (Before)	C15 Reflectance factor (After)
360	0.6249	0.6217	0.6271	0.6238	0.6261	0.6234
380	0.7358	0.7320	0.7372	0.7345	0.7369	0.7346
400	0.8183	0.8156	0.8191	0.8175	0.8191	0.8168
420	0.8543	0.8528	0.8548	0.8537	0.8548	0.8534
440	0.8669	0.8657	0.8673	0.8665	0.8674	0.8659
460	0.8765	0.8751	0.8768	0.8760	0.8769	0.8755
480	0.8846	0.8831	0.8847	0.8841	0.8848	0.8832
500	0.8893	0.8880	0.8894	0.8886	0.8894	0.8880
520	0.8927	0.8916	0.8926	0.8922	0.8929	0.8913
540	0.8951	0.8940	0.8950	0.8948	0.8954	0.8941
560	0.8957	0.8948	0.8955	0.8955	0.8961	0.8950
580	0.8945	0.8934	0.8940	0.8938	0.8946	0.8934
600	0.8966	0.8965	0.8962	0.8965	0.8968	0.8962
620	0.8973	0.8965	0.8968	0.8966	0.8975	0.8964
640	0.8986	0.8976	0.8982	0.8980	0.8990	0.8980
660	0.9000	0.8991	0.8997	0.8994	0.9004	0.8993
680	0.9026	0.9015	0.9023	0.9021	0.9029	0.9017
700	0.9028	0.9021	0.9027	0.9021	0.9033	0.9022
720	0.9048	0.9042	0.9049	0.9051	0.9055	0.9047
740	0.9048	0.9044	0.9050	0.9045	0.9056	0.9042
760	0.9055	0.9051	0.9056	0.9054	0.9060	0.9053
780	0.9054	0.9044	0.9056	0.9045	0.9060	0.9055
800	0.9047	0.9043	0.9048	0.9048	0.9052	0.9050
820	0.9047	0.9048	0.9048	0.9052	0.9055	0.9048

Table 11.13 Raw data of Pilot (NIST) measurements of NMIJ samples: S16, S17, S18

Wavelength [nm]	S16 Reflectance factor (Before)	S16 Reflectance factor (After)	S17 Reflectance factor (Before)	S17 Reflectance factor (After)	S18 Reflectance factor (Before)	S18 Reflectance factor (After)
360	0.9720	0.9706	0.9743	0.9777	0.9797	0.9812
380	0.9763	0.9758	0.9789	0.9825	0.9827	0.9851
400	0.9781	0.9765	0.9804	0.9823	0.9833	0.9849
420	0.9831	0.9814	0.9853	0.9872	0.9877	0.9894
440	0.9844	0.9834	0.9863	0.9886	0.9882	0.9897
460	0.9856	0.9852	0.9873	0.9892	0.9887	0.9899
480	0.9868	0.9867	0.9883	0.9899	0.9893	0.9906
500	0.9876	0.9878	0.9890	0.9905	0.9896	0.9910
520	0.9882	0.9886	0.9893	0.9910	0.9897	0.9914
540	0.9888	0.9890	0.9898	0.9916	0.9901	0.9917
560	0.9886	0.9893	0.9896	0.9912	0.9896	0.9912
580	0.9900	0.9908	0.9907	0.9920	0.9905	0.9918
600	0.9896	0.9898	0.9905	0.9919	0.9900	0.9915
620	0.9899	0.9900	0.9908	0.9922	0.9901	0.9915
640	0.9903	0.9909	0.9910	0.9925	0.9903	0.9922
660	0.9902	0.9906	0.9908	0.9919	0.9900	0.9916
680	0.9905	0.9911	0.9911	0.9922	0.9902	0.9919
700	0.9900	0.9908	0.9906	0.9916	0.9896	0.9909
720	0.9909	0.9918	0.9915	0.9926	0.9906	0.9919
740	0.9910	0.9916	0.9917	0.9926	0.9906	0.9916
760	0.9912	0.9919	0.9919	0.9924	0.9910	0.9926
780	0.9911	0.9909	0.9916	0.9926	0.9908	0.9918
800	0.9912	0.9919	0.9920	0.9925	0.9910	0.9923
820	0.9914	0.9921	0.9922	0.9935	0.9912	0.9929

Table 11.14 Raw data of Pilot (NIST) measurements of NMIJ samples: C16, C17, C18

Wavelength [nm]	C16 Reflectance factor (Before)	C16 Reflectance factor (After)	C17 Reflectance factor (Before)	C17 Reflectance factor (After)	C18 Reflectance factor (Before)	C18 Reflectance factor (After)
360	0.6242	0.6238	0.6245	0.6243	0.6248	0.6243
380	0.7349	0.7340	0.7356	0.7349	0.7357	0.7351
400	0.8172	0.8167	0.8181	0.8175	0.8181	0.8178
420	0.8529	0.8529	0.8540	0.8539	0.8537	0.8538
440	0.8656	0.8657	0.8667	0.8667	0.8662	0.8666
460	0.8752	0.8752	0.8765	0.8764	0.8758	0.8760
480	0.8833	0.8834	0.8846	0.8847	0.8837	0.8844
500	0.8882	0.8886	0.8894	0.8895	0.8883	0.8886
520	0.8915	0.8914	0.8927	0.8929	0.8916	0.8919
540	0.8938	0.8936	0.8950	0.8952	0.8939	0.8943
560	0.8945	0.8942	0.8956	0.8954	0.8948	0.8954
580	0.8929	0.8929	0.8942	0.8941	0.8934	0.8935
600	0.8950	0.8947	0.8965	0.8966	0.8957	0.8957
620	0.8954	0.8952	0.8970	0.8970	0.8964	0.8966
640	0.8966	0.8966	0.8983	0.8979	0.8978	0.8977
660	0.8978	0.8977	0.8995	0.8993	0.8991	0.8992
680	0.9003	0.9002	0.9022	0.9021	0.9019	0.9019
700	0.9003	0.9003	0.9023	0.9025	0.9020	0.9019
720	0.9022	0.9025	0.9045	0.9043	0.9042	0.9045
740	0.9019	0.9020	0.9043	0.9045	0.9041	0.9043
760	0.9024	0.9022	0.9048	0.9050	0.9047	0.9046
780	0.9023	0.9016	0.9047	0.9049	0.9047	0.9043
800	0.9017	0.9013	0.9040	0.9040	0.9039	0.9047
820	0.9018	0.9023	0.9042	0.9042	0.9041	0.9047

Table 11.15 Raw data of Pilot (NIST) measurements of NPL samples: S07, S08, S09

Wavelength [nm]	S07 Reflectance factor (Before)	S07 Reflectance factor (After)	S08 Reflectance factor (Before)	S08 Reflectance factor (After)	S09 Reflectance factor (Before)	S09 Reflectance factor (After)
360	0.9834	0.9829	0.9789	0.9776	0.9755	0.9783
380	0.9857	0.9855	0.9819	0.9810	0.9793	0.9818
400	0.9856	0.9854	0.9824	0.9816	0.9807	0.9823
420	0.9893	0.9890	0.9866	0.9858	0.9856	0.9864
440	0.9894	0.9894	0.9869	0.9864	0.9864	0.9872
460	0.9899	0.9899	0.9875	0.9870	0.9873	0.9877
480	0.9905	0.9905	0.9882	0.9877	0.9882	0.9883
500	0.9907	0.9908	0.9884	0.9879	0.9887	0.9887
520	0.9907	0.9908	0.9884	0.9880	0.9889	0.9886
540	0.9912	0.9912	0.9887	0.9884	0.9895	0.9891
560	0.9906	0.9905	0.9881	0.9878	0.9891	0.9887
580	0.9915	0.9915	0.9891	0.9888	0.9904	0.9898
600	0.9912	0.9909	0.9886	0.9881	0.9901	0.9895
620	0.9916	0.9912	0.9888	0.9884	0.9904	0.9898
640	0.9916	0.9913	0.9889	0.9887	0.9905	0.9901
660	0.9913	0.9911	0.9885	0.9883	0.9903	0.9900
680	0.9915	0.9913	0.9887	0.9885	0.9905	0.9905
700	0.9908	0.9904	0.9879	0.9879	0.9899	0.9900
720	0.9916	0.9913	0.9889	0.9887	0.9909	0.9909
740	0.9916	0.9914	0.9890	0.9887	0.9908	0.9907
760	0.9919	0.9916	0.9895	0.9892	0.9913	0.9910
780	0.9915	0.9913	0.9891	0.9888	0.9908	0.9908
800	0.9915	0.9913	0.9893	0.9894	0.9909	0.9908
820	0.9918	0.9917	0.9896	0.9897	0.9915	0.9912

Table 11.16 Raw data of Pilot (NIST) measurements of NPL samples: C07, C08, C09

Wavelength [nm]	C07 Reflectance factor (Before)	C07 Reflectance factor (After)	C08 Reflectance factor (Before)	C08 Reflectance factor (After)	C09 Reflectance factor (Before)	C09 Reflectance factor (After)
360	0.6226	0.6232	0.6264	0.6264	0.6266	0.6261
380	0.7339	0.7343	0.7373	0.7371	0.7376	0.7370
400	0.8171	0.8170	0.8194	0.8188	0.8198	0.8191
420	0.8535	0.8534	0.8548	0.8541	0.8556	0.8546
440	0.8663	0.8663	0.8671	0.8664	0.8679	0.8670
460	0.8760	0.8760	0.8765	0.8757	0.8772	0.8766
480	0.8839	0.8839	0.8843	0.8834	0.8850	0.8843
500	0.8886	0.8886	0.8888	0.8881	0.8896	0.8889
520	0.8921	0.8920	0.8921	0.8914	0.8929	0.8923
540	0.8946	0.8946	0.8945	0.8939	0.8954	0.8947
560	0.8955	0.8954	0.8954	0.8946	0.8961	0.8953
580	0.8940	0.8941	0.8940	0.8933	0.8946	0.8939
600	0.8963	0.8963	0.8963	0.8955	0.8968	0.8960
620	0.8971	0.8972	0.8969	0.8964	0.8974	0.8969
640	0.8985	0.8986	0.8984	0.8976	0.8988	0.8982
660	0.8998	0.8999	0.8997	0.8989	0.9002	0.8995
680	0.9027	0.9025	0.9024	0.9015	0.9029	0.9021
700	0.9029	0.9027	0.9024	0.9016	0.9030	0.9023
720	0.9052	0.9050	0.9046	0.9040	0.9054	0.9046
740	0.9051	0.9048	0.9045	0.9037	0.9052	0.9046
760	0.9058	0.9056	0.9050	0.9043	0.9058	0.9052
780	0.9058	0.9054	0.9048	0.9041	0.9058	0.9050
800	0.9049	0.9050	0.9042	0.9036	0.9051	0.9046
820	0.9050	0.9051	0.9043	0.9036	0.9051	0.9047

Table 11.17 Raw data of Pilot (NIST) measurements of NRC samples: S10, S11, S12

Wavelength [nm]	S10 Reflectance factor (Before)	S10 Reflectance factor (After)	S11 Reflectance factor (Before)	S11 Reflectance factor (After)	S12 Reflectance factor (Before)	S12 Reflectance factor (After)
360	0.9777	0.9796	0.9774	0.9770	0.9827	0.9821
380	0.9806	0.9826	0.9801	0.9799	0.9847	0.9845
400	0.9813	0.9829	0.9808	0.9804	0.9847	0.9846
420	0.9857	0.9871	0.9849	0.9847	0.9886	0.9883
440	0.9865	0.9878	0.9856	0.9854	0.9890	0.9888
460	0.9874	0.9887	0.9864	0.9860	0.9896	0.9892
480	0.9880	0.9895	0.9871	0.9870	0.9901	0.9898
500	0.9886	0.9898	0.9875	0.9873	0.9904	0.9901
520	0.9888	0.9900	0.9877	0.9875	0.9905	0.9902
540	0.9893	0.9904	0.9881	0.9879	0.9908	0.9905
560	0.9888	0.9902	0.9878	0.9877	0.9903	0.9902
580	0.9898	0.9910	0.9886	0.9886	0.9912	0.9909
600	0.9894	0.9906	0.9883	0.9882	0.9909	0.9904
620	0.9898	0.9910	0.9885	0.9884	0.9910	0.9907
640	0.9899	0.9911	0.9888	0.9887	0.9912	0.9909
660	0.9896	0.9908	0.9885	0.9884	0.9908	0.9904
680	0.9900	0.9912	0.9888	0.9887	0.9912	0.9908
700	0.9894	0.9905	0.9883	0.9881	0.9903	0.9901
720	0.9903	0.9914	0.9893	0.9892	0.9911	0.9909
740	0.9903	0.9913	0.9893	0.9890	0.9910	0.9908
760	0.9905	0.9917	0.9898	0.9895	0.9912	0.9911
780	0.9904	0.9914	0.9894	0.9892	0.9909	0.9908
800	0.9905	0.9915	0.9898	0.9896	0.9912	0.9911
820	0.9909	0.9919	0.9899	0.9898	0.9914	0.9913

Table 11.18 Raw data of Pilot (NIST) measurements of NRC samples: C10, C11, C12

Wavelength [nm]	C10 Reflectance factor (Before)	C10 Reflectance factor (After)	C11 Reflectance factor (Before)	C11 Reflectance factor (After)	C12 Reflectance factor (Before)	C12 Reflectance factor (After)
360	0.6628	0.6629	0.6245	0.6243	0.6270	0.6271
380	0.7639	0.7641	0.7355	0.7354	0.7380	0.7381
400	0.8360	0.8361	0.8179	0.8177	0.8201	0.8202
420	0.8654	0.8654	0.8536	0.8534	0.8556	0.8556
440	0.8761	0.8759	0.8663	0.8659	0.8679	0.8678
460	0.8849	0.8849	0.8759	0.8756	0.8773	0.8773
480	0.8921	0.8919	0.8837	0.8834	0.8849	0.8849
500	0.8961	0.8961	0.8884	0.8882	0.8895	0.8896
520	0.8984	0.8986	0.8917	0.8915	0.8926	0.8927
540	0.9001	0.9003	0.8940	0.8940	0.8948	0.8948
560	0.9003	0.9002	0.8948	0.8946	0.8954	0.8953
580	0.8982	0.8982	0.8933	0.8933	0.8934	0.8936
600	0.9000	0.8999	0.8957	0.8956	0.8954	0.8956
620	0.9002	0.9002	0.8963	0.8962	0.8959	0.8960
640	0.9015	0.9015	0.8977	0.8974	0.8970	0.8970
660	0.9031	0.9030	0.8990	0.8991	0.8981	0.8983
680	0.9061	0.9061	0.9017	0.9018	0.9005	0.9007
700	0.9063	0.9062	0.9020	0.9020	0.9006	0.9006
720	0.9083	0.9082	0.9042	0.9041	0.9024	0.9026
740	0.9080	0.9080	0.9041	0.9041	0.9021	0.9023
760	0.9084	0.9084	0.9047	0.9047	0.9026	0.9029
780	0.9082	0.9082	0.9047	0.9046	0.9026	0.9027
800	0.9075	0.9076	0.9040	0.9041	0.9019	0.9023
820	0.9076	0.9078	0.9040	0.9043	0.9022	0.9025

Table 11.19 Raw data of Pilot (NIST) measurements of OMH samples: S04, S05, S06

Wavelength [nm]	S04 Reflectance factor (Before)	S04 Reflectance factor (After)	S05 Reflectance factor (Before)	S05 Reflectance factor (After)	S06 Reflectance factor (Before)	S06 Reflectance factor (After)
360	0.9805	0.9807	0.9766	0.9766	0.9812	0.9810
380	0.9831	0.9835	0.9796	0.9796	0.9838	0.9839
400	0.9834	0.9836	0.9802	0.9802	0.9840	0.9841
420	0.9873	0.9875	0.9844	0.9845	0.9878	0.9879
440	0.9877	0.9881	0.9852	0.9852	0.9883	0.9885
460	0.9883	0.9885	0.9858	0.9858	0.9890	0.9891
480	0.9888	0.9890	0.9866	0.9864	0.9897	0.9898
500	0.9891	0.9894	0.9871	0.9870	0.9902	0.9902
520	0.9891	0.9894	0.9872	0.9871	0.9902	0.9903
540	0.9894	0.9896	0.9877	0.9875	0.9904	0.9906
560	0.9889	0.9891	0.9873	0.9871	0.9901	0.9902
580	0.9897	0.9900	0.9883	0.9882	0.9909	0.9912
600	0.9892	0.9895	0.9879	0.9878	0.9905	0.9907
620	0.9894	0.9898	0.9881	0.9880	0.9907	0.9909
640	0.9897	0.9899	0.9885	0.9881	0.9909	0.9910
660	0.9893	0.9893	0.9881	0.9878	0.9906	0.9907
680	0.9894	0.9898	0.9884	0.9882	0.9909	0.9910
700	0.9887	0.9891	0.9877	0.9875	0.9901	0.9903
720	0.9896	0.9898	0.9886	0.9886	0.9909	0.9911
740	0.9895	0.9899	0.9888	0.9885	0.9909	0.9910
760	0.9900	0.9904	0.9894	0.9890	0.9913	0.9915
780	0.9896	0.9900	0.9889	0.9888	0.9907	0.9912
800						
820						

Table 11.20 Raw data of Pilot (NIST) measurements of OMH samples: C04, C05, C06

Wavelength [nm]	**C04 Reflectance factor (Before)**	**C04 Reflectance factor (After)**	**C05 Reflectance factor (Before)**	**C05 Reflectance factor (After)**	**C06 Reflectance factor (Before)**	**C06 Reflectance factor (After)**
360	0.6254	0.6262	0.6249	0.6262	0.6243	0.6251
380	0.7359	0.7373	0.7352	0.7371	0.7340	0.7351
400	0.8180	0.8192	0.8169	0.8189	0.8153	0.8163
420	0.8537	0.8548	0.8524	0.8542	0.8507	0.8517
440	0.8667	0.8675	0.8651	0.8667	0.8635	0.8641
460	0.8765	0.8771	0.8750	0.8763	0.8734	0.8739
480	0.8845	0.8849	0.8831	0.8840	0.8815	0.8817
500	0.8894	0.8896	0.8878	0.8886	0.8863	0.8863
520	0.8928	0.8928	0.8911	0.8919	0.8898	0.8896
540	0.8952	0.8953	0.8934	0.8942	0.8920	0.8920
560	0.8960	0.8961	0.8942	0.8949	0.8928	0.8926
580	0.8948	0.8947	0.8929	0.8935	0.8914	0.8912
600	0.8971	0.8969	0.8950	0.8957	0.8936	0.8934
620	0.8978	0.8978	0.8956	0.8963	0.8942	0.8941
640	0.8992	0.8990	0.8970	0.8975	0.8956	0.8955
660	0.9004	0.9003	0.8983	0.8988	0.8970	0.8968
680	0.9031	0.9031	0.9009	0.9015	0.8997	0.8995
700	0.9034	0.9033	0.9011	0.9016	0.8999	0.8998
720	0.9057	0.9055	0.9033	0.9036	0.9022	0.9020
740	0.9056	0.9054	0.9031	0.9036	0.9021	0.9020
760	0.9063	0.9062	0.9038	0.9042	0.9027	0.9027
780	0.9062	0.9061	0.9037	0.9041	0.9026	0.9026
800						
820						

Table 11.21 Raw data of Pilot (NIST) measurements of PTB samples: S04, S05, S06

Wavelength [nm]	S04 Reflectance factor (Before)	S04 Reflectance factor (After)	S05 Reflectance factor (Before)	S05 Reflectance factor (After)	S06 Reflectance factor (Before)	S06 Reflectance factor (After)
360	0.9821	0.9805	0.9768	0.9766	0.9813	0.9812
380	0.9849	0.9831	0.9800	0.9796	0.9843	0.9838
400	0.9851	0.9834	0.9804	0.9802	0.9845	0.9840
420	0.9891	0.9873	0.9846	0.9844	0.9885	0.9878
440	0.9894	0.9877	0.9851	0.9852	0.9891	0.9883
460	0.9901	0.9883	0.9860	0.9858	0.9898	0.9890
480	0.9906	0.9888	0.9866	0.9866	0.9905	0.9897
500	0.9908	0.9891	0.9868	0.9871	0.9908	0.9902
520	0.9909	0.9891	0.9870	0.9872	0.9909	0.9902
540	0.9912	0.9894	0.9875	0.9877	0.9914	0.9904
560	0.9906	0.9889	0.9871	0.9873	0.9909	0.9901
580	0.9917	0.9897	0.9880	0.9883	0.9921	0.9909
600	0.9911	0.9892	0.9876	0.9879	0.9915	0.9905
620	0.9912	0.9894	0.9879	0.9881	0.9918	0.9907
640	0.9914	0.9897	0.9881	0.9885	0.9920	0.9909
660	0.9910	0.9893	0.9877	0.9881	0.9916	0.9906
680	0.9912	0.9894	0.9882	0.9884	0.9920	0.9909
700	0.9904	0.9887	0.9875	0.9877	0.9913	0.9901
720	0.9913	0.9896	0.9886	0.9886	0.9920	0.9909
740	0.9913	0.9895	0.9887	0.9888	0.9920	0.9909
760	0.9917	0.9900	0.9891	0.9894	0.9923	0.9913
780	0.9913	0.9896	0.9889	0.9889	0.9919	0.9907
800	0.9913	0.9899	0.9890	0.9893	0.9921	0.9912
820	0.9920	0.9903	0.9895	0.9896	0.9925	0.9914

Table 11.22 Raw data of Pilot (NIST) measurements of PTB samples: C04, C05, C06

Wavelength [nm]	C04 Reflectance factor (Before)	C04 Reflectance factor (After)	C05 Reflectance factor (Before)	C05 Reflectance factor (After)	C06 Reflectance factor (Before)	C06 Reflectance factor (After)
360	0.6257	0.6254	0.6259	0.6249	0.6247	0.6243
380	0.7370	0.7359	0.7370	0.7352	0.7350	0.7340
400	0.8197	0.8180	0.8191	0.8169	0.8167	0.8153
420	0.8553	0.8537	0.8546	0.8524	0.8523	0.8507
440	0.8677	0.8667	0.8669	0.8651	0.8646	0.8635
460	0.8771	0.8765	0.8763	0.8750	0.8739	0.8734
480	0.8849	0.8845	0.8841	0.8831	0.8818	0.8815
500	0.8897	0.8894	0.8888	0.8878	0.8867	0.8863
520	0.8930	0.8928	0.8921	0.8911	0.8900	0.8898
540	0.8955	0.8952	0.8944	0.8934	0.8923	0.8920
560	0.8962	0.8960	0.8950	0.8942	0.8930	0.8928
580	0.8947	0.8948	0.8937	0.8929	0.8916	0.8914
600	0.8971	0.8971	0.8958	0.8950	0.8939	0.8936
620	0.8977	0.8978	0.8963	0.8956	0.8944	0.8942
640	0.8993	0.8992	0.8977	0.8970	0.8959	0.8956
660	0.9005	0.9004	0.8990	0.8983	0.8972	0.8970
680	0.9031	0.9031	0.9017	0.9009	0.8999	0.8997
700	0.9035	0.9034	0.9019	0.9011	0.9002	0.8999
720	0.9058	0.9057	0.9040	0.9033	0.9024	0.9022
740	0.9057	0.9056	0.9038	0.9031	0.9023	0.9021
760	0.9062	0.9063	0.9043	0.9038	0.9028	0.9027
780	0.9062	0.9062	0.9044	0.9037	0.9028	0.9026
800	0.9055	0.9054	0.9035	0.9031	0.9022	0.9020
820	0.9056	0.9056	0.9038	0.9031	0.9025	0.9023

Table 11.23 Raw data of Pilot (NIST) measurements of VNIIOFI samples: S04, S05, S06

Wavelength [nm]	S04 Reflectance factor (Before)	S04 Reflectance factor (After)	S05 Reflectance factor (Before)	S05 Reflectance factor (After)	S06 Reflectance factor (Before)	S06 Reflectance factor (After)
360	0.9807	0.9792	0.9766	0.9755	0.9810	0.9795
380	0.9835	0.9821	0.9796	0.9789	0.9839	0.9828
400	0.9836	0.9826	0.9802	0.9796	0.9841	0.9833
420	0.9875	0.9869	0.9845	0.9839	0.9879	0.9874
440	0.9881	0.9872	0.9852	0.9845	0.9885	0.9879
460	0.9885	0.9878	0.9858	0.9851	0.9891	0.9885
480	0.9890	0.9885	0.9864	0.9862	0.9898	0.9895
500	0.9894	0.9887	0.9870	0.9866	0.9902	0.9897
520	0.9894	0.9890	0.9871	0.9867	0.9903	0.9898
540	0.9896	0.9892	0.9875	0.9872	0.9906	0.9901
560	0.9891	0.9889	0.9871	0.9869	0.9902	0.9899
580	0.9900	0.9898	0.9882	0.9879	0.9912	0.9907
600	0.9895	0.9892	0.9878	0.9874	0.9907	0.9902
620	0.9898	0.9893	0.9880	0.9877	0.9909	0.9905
640	0.9899	0.9894	0.9881	0.9879	0.9910	0.9906
660	0.9893	0.9893	0.9878	0.9877	0.9907	0.9905
680	0.9898	0.9892	0.9882	0.9879	0.9910	0.9907
700	0.9891	0.9884	0.9875	0.9871	0.9903	0.9900
720	0.9898	0.9895	0.9886	0.9882	0.9911	0.9909
740	0.9899	0.9896	0.9885	0.9886	0.9910	0.9911
760	0.9904	0.9898	0.9890	0.9886	0.9915	0.9912
780	0.9900	0.9894	0.9888	0.9886	0.9912	0.9910
800	0.9899	0.9900	0.9890	0.9889	0.9914	0.9914
820	0.9905	0.9900	0.9892	0.9889	0.9916	0.9915

Table 11.24 Raw data of Pilot (NIST) measurements of VNIIOFI samples: C04, C05, C06

Wavelength [nm]	C04 Reflectance factor (Before)	C04 Reflectance factor (After)	C05 Reflectance factor (Before)	C05 Reflectance factor (After)	C06 Reflectance factor (Before)	C06 Reflectance factor (After)
360	0.6262	0.6249	0.6262	0.6250	0.6251	0.6241
380	0.7373	0.7353	0.7371	0.7357	0.7351	0.7339
400	0.8192	0.8174	0.8189	0.8174	0.8163	0.8154
420	0.8548	0.8533	0.8542	0.8530	0.8517	0.8508
440	0.8675	0.8661	0.8667	0.8658	0.8641	0.8637
460	0.8771	0.8760	0.8763	0.8757	0.8739	0.8735
480	0.8849	0.8841	0.8840	0.8835	0.8817	0.8813
500	0.8896	0.8887	0.8886	0.8881	0.8863	0.8861
520	0.8928	0.8920	0.8919	0.8914	0.8896	0.8893
540	0.8953	0.8945	0.8942	0.8937	0.8920	0.8916
560	0.8961	0.8952	0.8949	0.8943	0.8926	0.8923
580	0.8947	0.8939	0.8935	0.8930	0.8912	0.8909
600	0.8969	0.8963	0.8957	0.8952	0.8934	0.8932
620	0.8978	0.8969	0.8963	0.8957	0.8941	0.8939
640	0.8990	0.8984	0.8975	0.8971	0.8955	0.8953
660	0.9003	0.8997	0.8988	0.8984	0.8968	0.8966
680	0.9031	0.9023	0.9015	0.9012	0.8995	0.8993
700	0.9033	0.9025	0.9016	0.9013	0.8998	0.8996
720	0.9055	0.9049	0.9036	0.9037	0.9020	0.9020
740	0.9054	0.9049	0.9036	0.9035	0.9020	0.9018
760	0.9062	0.9053	0.9042	0.9041	0.9027	0.9025
780	0.9061	0.9053	0.9041	0.9040	0.9026	0.9025
800	0.9051	0.9046	0.9033	0.9035	0.9018	0.9018
820	0.9055	0.9047	0.9034	0.9032	0.9020	0.9019

12. Pre-Draft A Process

12.1 Review of uncertainty

This review was performed following the CCPR Guidelines. After all the results were submitted, the reported uncertainties of all participants together with their uncertainty budget information (information presented in sections 7, 8, and 10) were distributed to all participants, and reviewed by all participants in the period from Oct. 20, 2006 to Dec. 22, 2006. Participants were given an opportunity to ask questions or comment on other participants' uncertainty budget. When asked, the participants were requested to respond. All communications were distributed to all participants. Participants, whether they received comments or not, were allowed to submit revised uncertainties for their results during this process, but changes only in the direction to increase the uncertainty values were accepted.

There were several comments and questions from NMIJ, NPL, and NRC distributed to all participants. NMIJ notified an error made by the pilot laboratory (old version of their file). Questions from NPL to NIST and MIKES were responded. A few editorial corrections were received from MSL and MIKES and confirmations were received from CSIR-NML, NIM, and OMH.

During the review process, NMIJ and VNIIOFI revised their uncertainty values. These changes are listed in Appendix C. All changes were in the direction to increase the uncertainty values.

One of the concerns during this review process comments was fluorescence from ceramic tile samples. NMIJ indicated possible significant effect in the comparison results. NRC offered to measure the samples used in K5 with the NRC spectrofluorimeter. NIST sent two samples, C04 and C10 to NRC which they kindly measured for reflected, total, and bispectral luminescent radiance factors in February 2007 (NRC Test Report, 2007-02-13). This report indicated that the effect of fluorescence of both samples were negligible for the results in K5. Their measurement was done in 45°:0, and the Pilot lab calculated the magnification effect in an integrating sphere that the factor would be no more than 2 and no change in the conclusion. We appreciated NRC for their special testing of the sample.

12.2 Review of Relative Data

The purpose of this review process is to identify any problems with the stability of transfer standards, and agree on any removal of parts of measured data from transfer standards, and also possibly discuss detailed methods for calculation of DoE, before participants see the absolute results of the comparison. First, the stability data of the transfer standards are analyzed and reviewed. Second, the internal consistency of results of different samples within each participant is analyzed and reviewed.

12.2.1 Sample stability data

The data presented in this section were distributed to all participants during the Pre-Draft A process. The participants were given the chance to review the stability of the samples during the comparison and to discuss removal of data of any unstable sample. No requests were made by the participants to remove any parts of the submitted results.

Each sample was measured in the scheme: NIST – Participant – NIST, so there were two NIST measurements, before and after shipping the samples and the participant measurement. The plots in the figures below show the relative differences between NIST(after shipping) and NIST(before shipping) measurements for each sample. The pale blue lines indicate the NIST transfer uncertainty as described in section 4.4.4. These samples were the reference standards measured on STARR at NIST and used to validate the transfer spectrophotometer, Cary 5E.

In most cases, the changes were around the NIST transfer uncertainty, but in some cases, the changes are larger than the transfer uncertainty at some parts of the wavelength region. The changes, however, are mostly well within the reported uncertainties (k=2) of each NMI. In some cases, part of the changes might be attributed to some unexpected additional uncertainties from the NIST measurements which are not discussed in section 4.4.

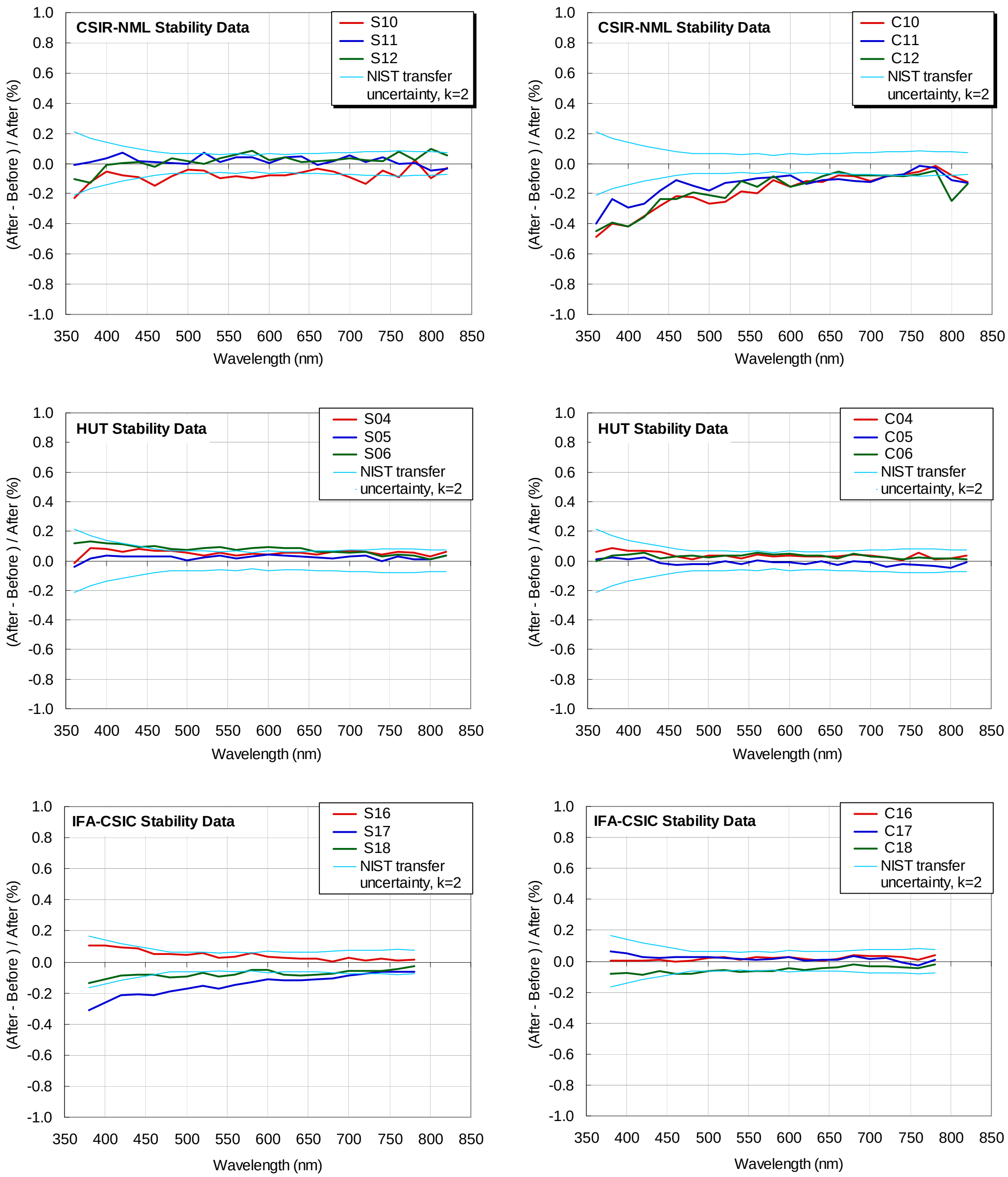


Fig. 12.1-1 % Relative difference between NIST (after shipping) and NIST (before shipping) for each sample sent to every participant.

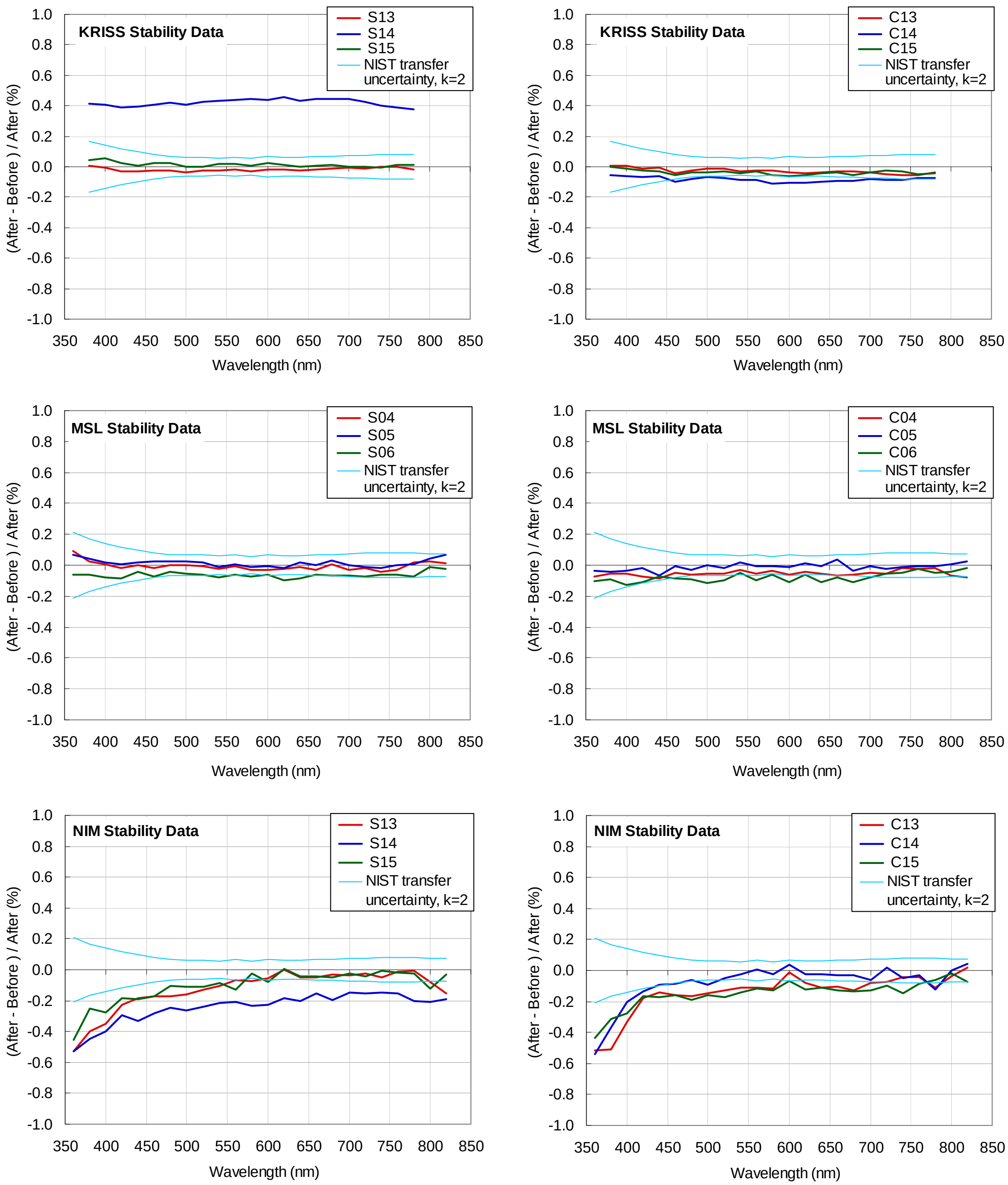


Fig. 12.1-2 % Relative difference between NIST (after shipping) and NIST (before shipping) for each sample sent to every participant.

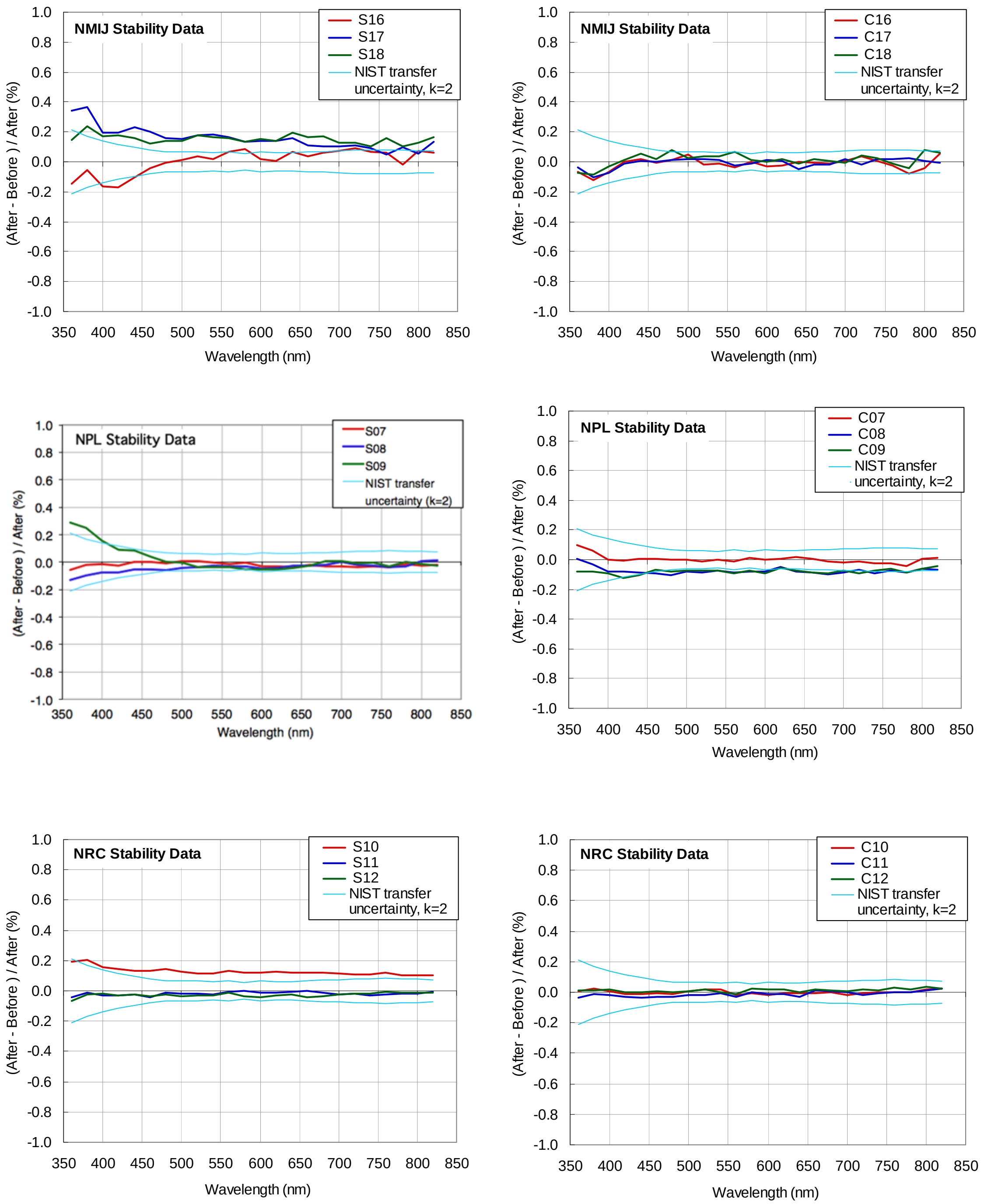


Fig. 12.1-3 % Relative difference between NIST (after shipping) and NIST (before shipping) for each sample sent to every participant.

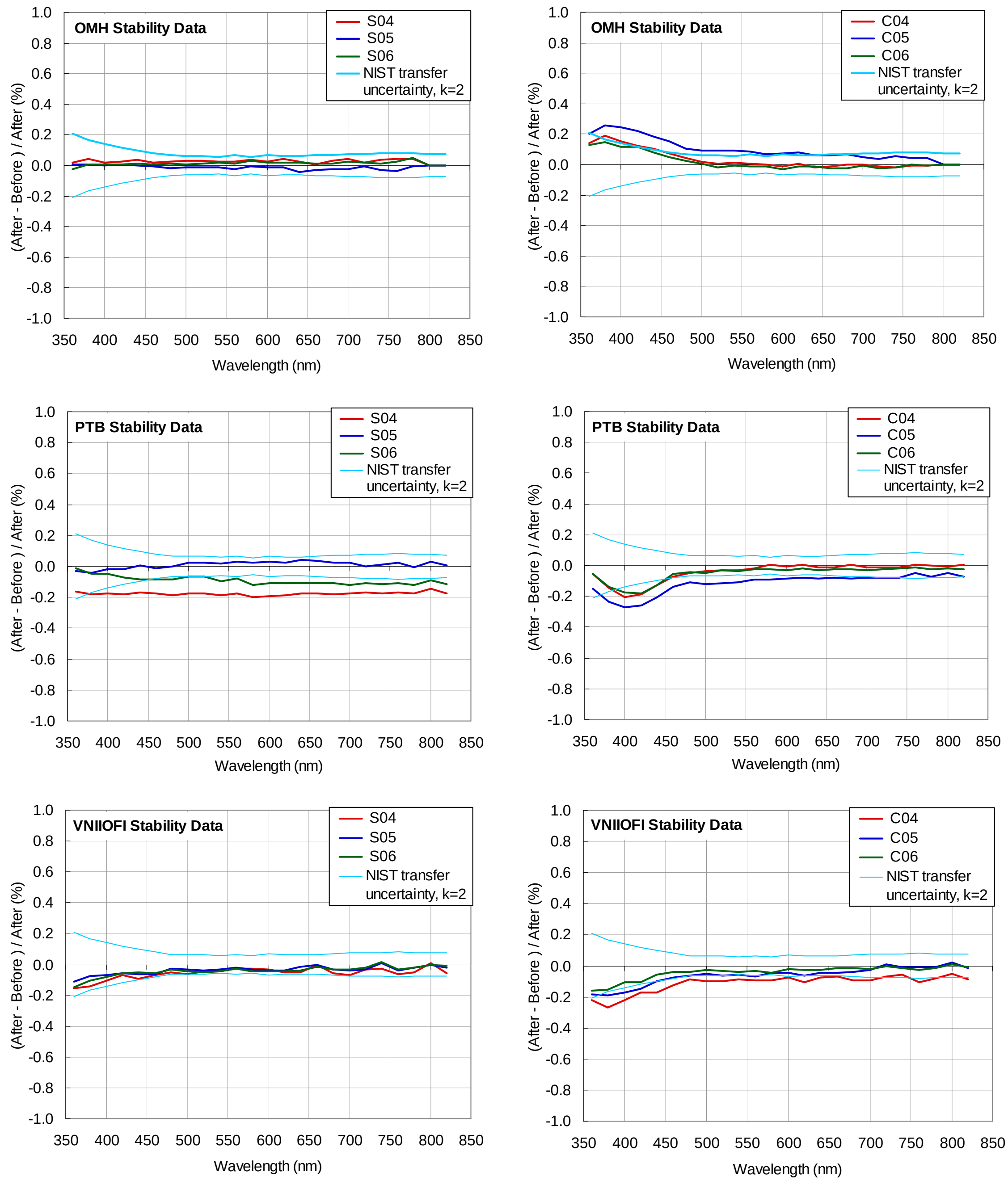


Fig. 12.1-4 % Relative difference between NIST (after shipping) and NIST (before shipping) for each sample sent to every participant.

12.2.2 Self-consistency of each type of sample within each participant

Relative difference from NIST measurement (Before and After) for each sample, $\Delta_{i,j,r} = R_{i,j} / R^{\mathrm{P}}_{i,j,r} - 1$, are first calculated for each sample, where *i* is Laboratory number, *j* is sample number (*j*=1,2,3 for Spectralon, *j*=4,5,6 for Ceramic tiles), and *r* (=1 or 2) for round (Before and After in NIST measurement). The mean of each sample type (3 samples, 6 values) is obtained as

$$\overline{\Delta}_i(\text{Spectralon}) = \frac{1}{6}\sum_{j=1}^{3}\sum_{r=1}^{2} \Delta_{i,j,r} \quad \text{for Spectralon samples, and} \qquad (12.1)$$

$$\overline{\Delta}_i(\text{Ceramic}) = \frac{1}{6}\sum_{j=4}^{6}\sum_{r=1}^{2} \Delta_{i,j,r} \quad \text{for Ceramic tile samples.} \qquad (12.2)$$

Relative difference of each sample is offset by their mean value:

$$\Delta^*_{i,j,r} = \Delta_{i,j,r} - \overline{\Delta}_i(\text{Spectralon}) \quad ; j=1,2,3 \qquad (12.3)$$

$$\Delta^*_{i,j,r} = \Delta_{i,j,r} - \overline{\Delta}_i(\text{Ceramic tiles}) \quad ; j=4,5,6 \qquad (12.4)$$

The calculation above is done for each wavelength. The plots in this section show these relative differences for all samples. The average of all six points at each wavelength is zero. The variation of six curves shows the self-consistency among the three samples of each type within a laboratory, however, they are affected by the changes of each sample and possible inconsistency within the pilot laboratory. These data do not reveal any information on the laboratory's absolute results relative to NIST results. These results also do not indicate any information on consistency between the two types of sample.

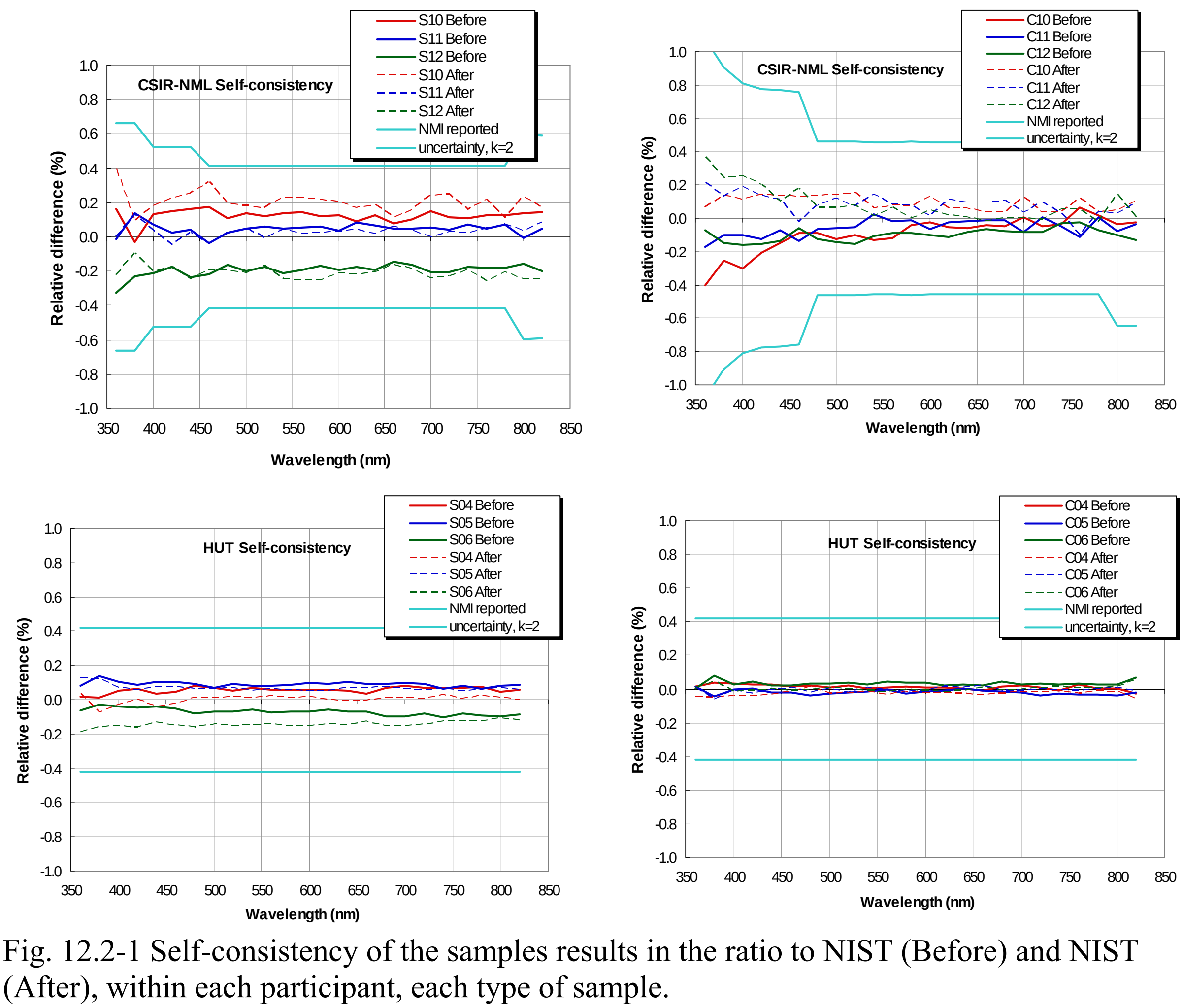


Fig. 12.2-1 Self-consistency of the samples results in the ratio to NIST (Before) and NIST (After), within each participant, each type of sample.

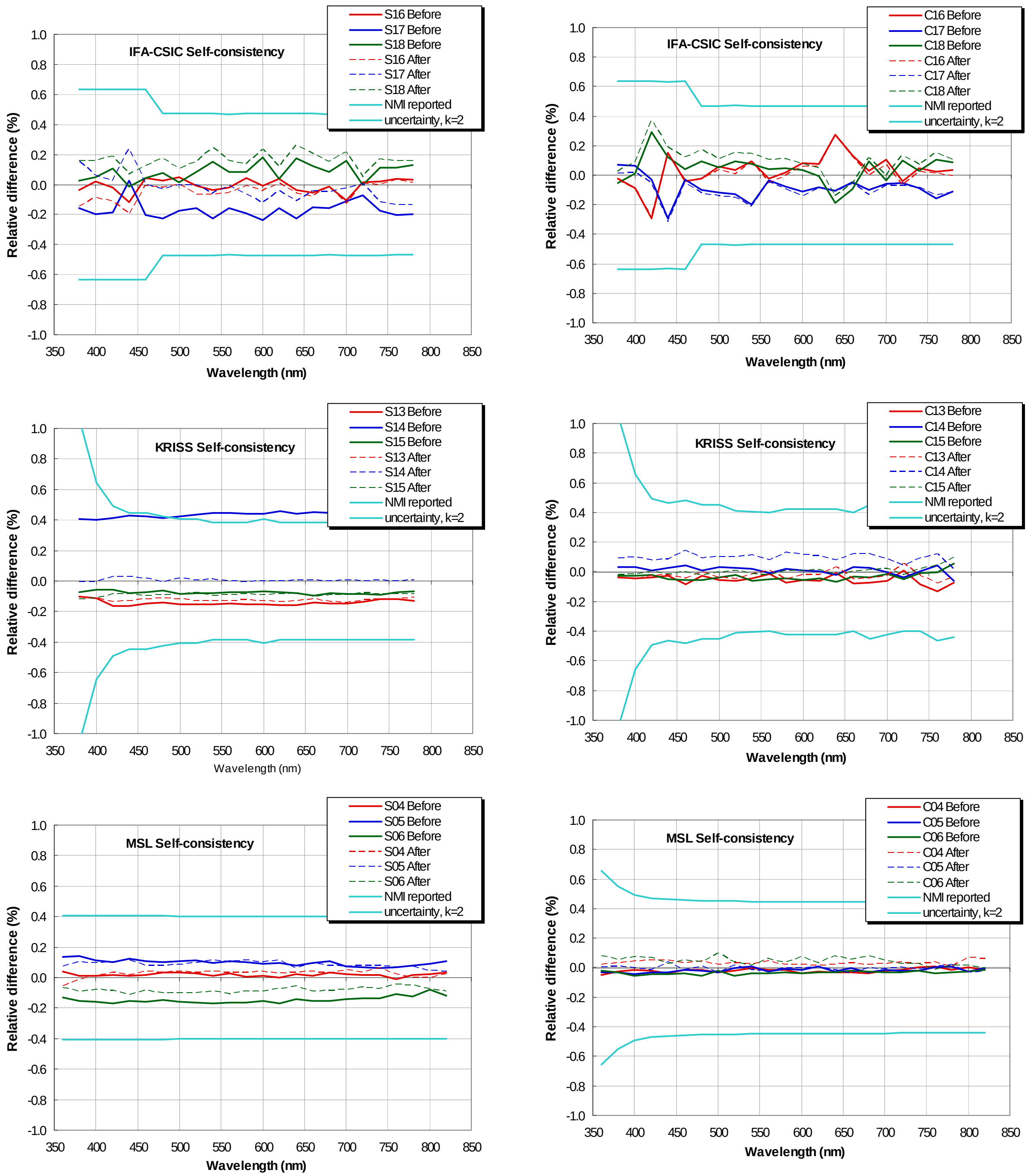


Fig. 12.2-2 Self-consistency of the samples results in the ratio to NIST (Before) and NIST (After), within each participant, each type of sample.

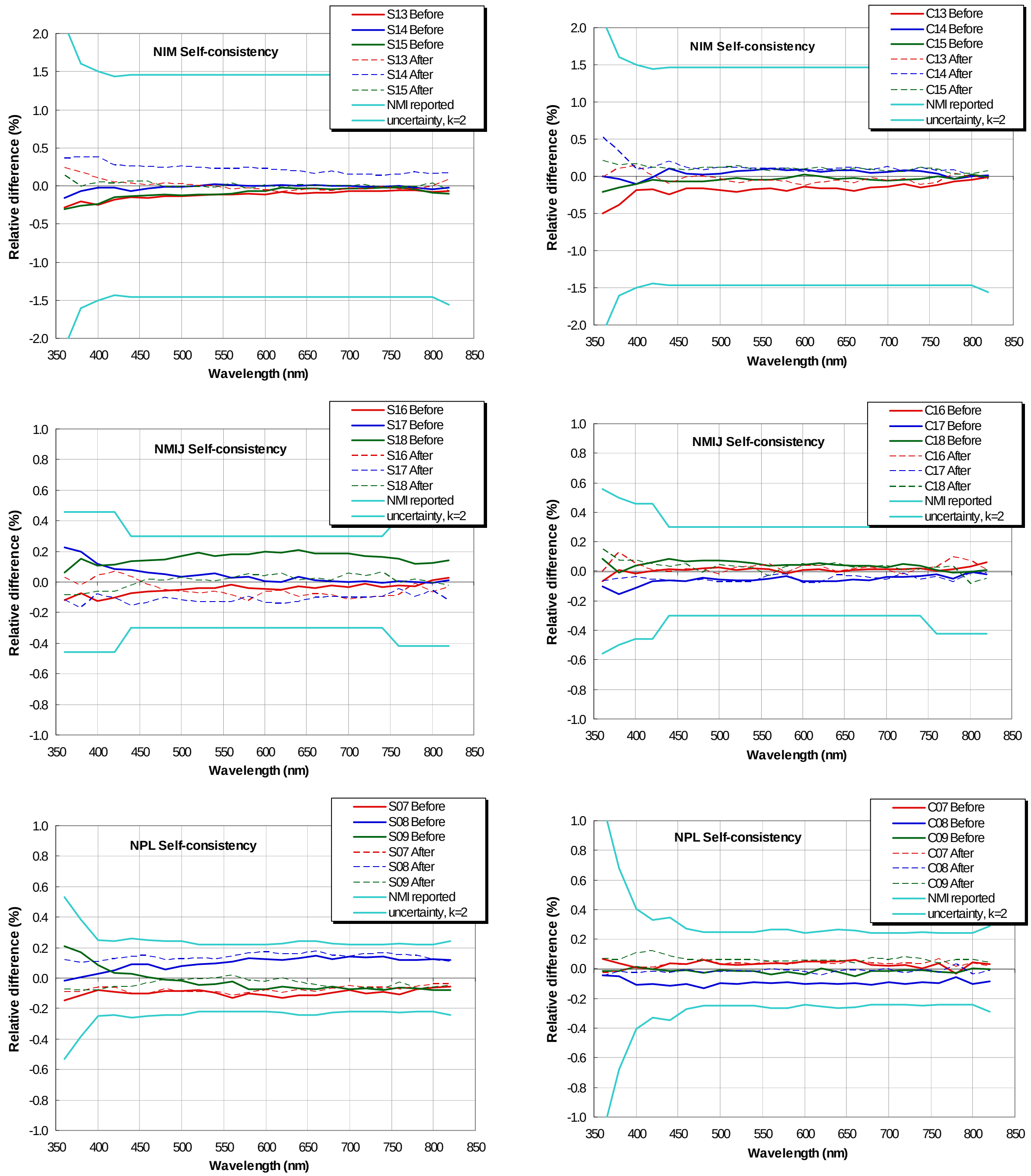


Fig. 12.2-3 Self-consistency of the samples results in the ratio to NIST (Before) and NIST (After), within each participant, each type of sample.

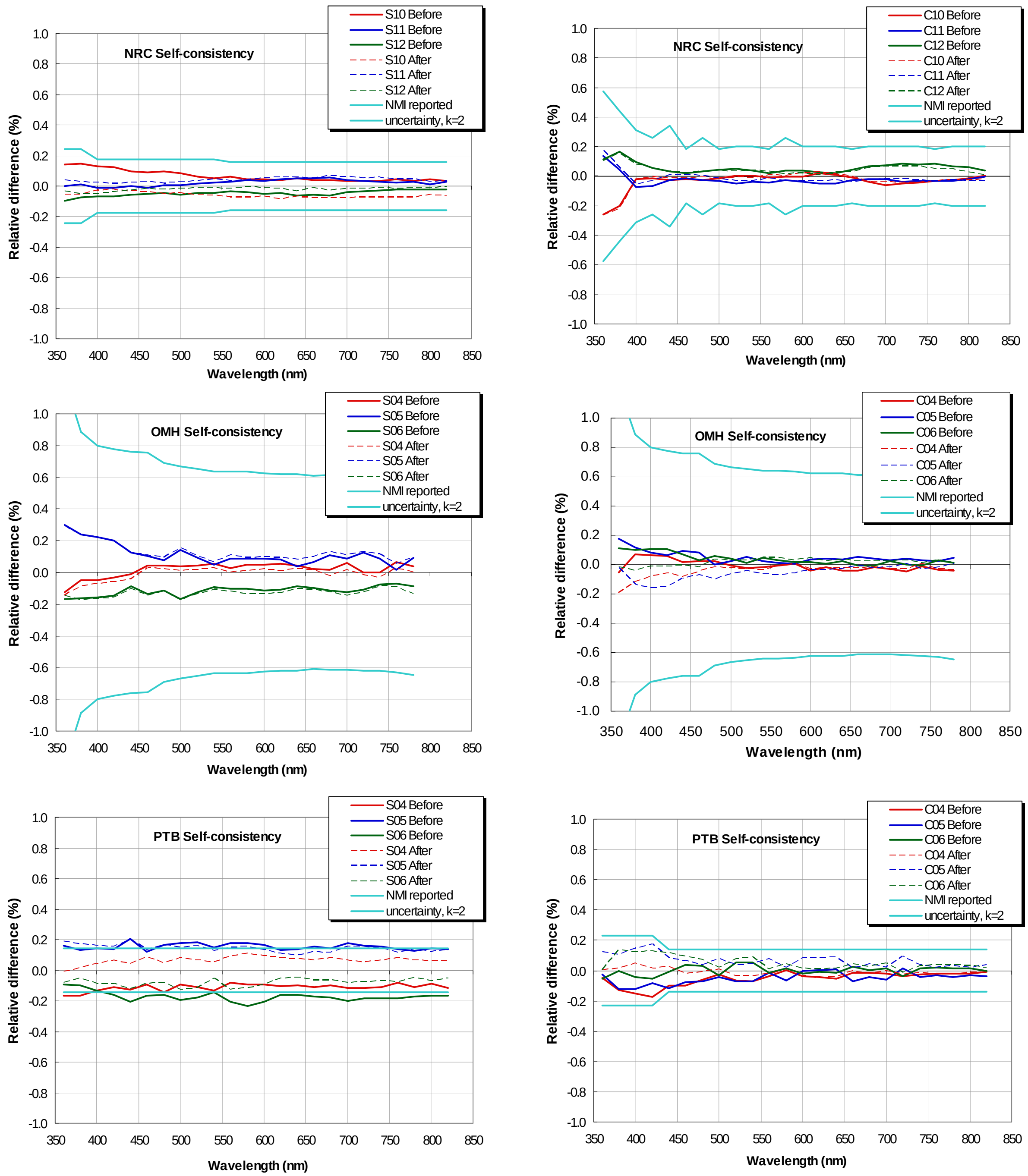
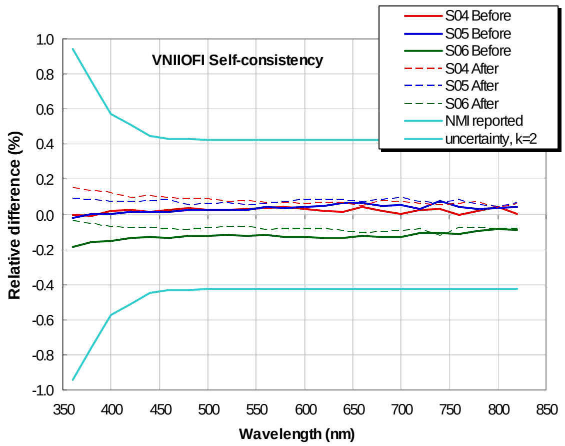


Fig. 12.2-4 Self-consistency of the samples results in the ratio to NIST (Before) and NIST (After), within each participant, each type of sample.



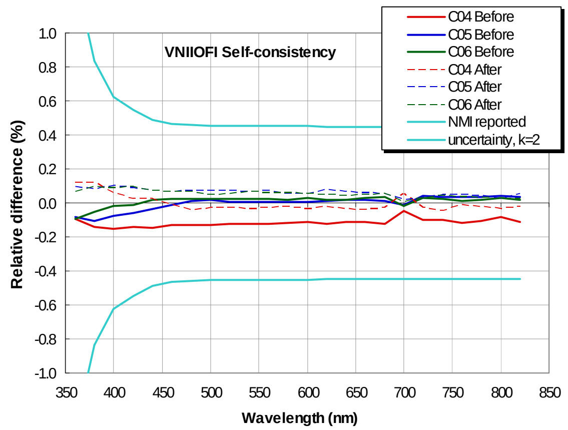


Fig. 12.2-5 Self-consistency of the all samples results in the ratio to NIST (Before) and NIST (After), within each participant, each type of sample.

12.2.3 Self-consistency of all six samples within each participant

The self-consistency of all six samples including both types within each participant was evaluated, but using slightly different way. In Pre-Draft A stage, the Key comparison Reference Values (KCRV) were calculated separately for each type of sample. In these tentative results, some systematic shifts were noticed in the NIST measurement results for ceramic tile samples at shorter wavelengths from 360 nm to 460 nm. For this reason, the self-consistency analysis presented above was not applied to all six samples but separately for each type of sample. The final consistency in results between the Spectralon and Ceramic sample was analyzed in a slightly different manner.

The self-consistency for all samples (including both sample types) was calculated based on the tentative KCRV value. The relative difference values $\Delta_{i,j,r}$ were converted to a relative difference from the KCRV, so

$$\Delta_{i,j,r}^{\mathrm{KCRV}} = (R_{i,j} / R_{i,j,r}^{\mathrm{P}} - 1) - \Delta_{\mathrm{KCRV}} \,. \qquad (12.5)$$

Note that $\mathit{\Delta}_{\mathrm{KCRV}}$ is a value relative to NIST measured values, so with this normalization, any systematic differences in the NIST results between the two types of samples are removed (though NIST results are still affecting KCRV). Then, average of all samples are obtained as

$$\overline{\Delta}_i = \frac{1}{12}\sum_{j=1}^{6}\sum_{r=1}^{2} \Delta_{i,j,r}^{\mathrm{KCRV}} \quad . \qquad (12.6)$$

The relative difference of each sample is offset by

$$\Delta_{i,j}^{*} = \frac{1}{2}\sum_{r=1}^{2}\Delta_{i,j,r} - \overline{\Delta}_i \qquad ; j=1 \text{ to } 6 \text{ (Before and After are averaged for each sample).}$$

(12.7)

The plots show of these normalized $\Delta^*_{i,j}$ for the six samples. So, the average of all six points at each wavelength is zero. The variation of six curves shows self-consistency among all six samples within each Lab, so any inconsistency between the two types of samples. These data do not provide any information on the Lab's results with respect to KCRV. The Lab's reported uncertainty (k=2) (relative % of measured reflectance) is also shown together so that the magnitude of inconsistency can be compared with your reported uncertainty.

In most cases, the inconsistency is found to be well within the stated uncertainties, but you may see some inconsistency between two sample types, and it tends to be larger at short wavelengths. In one or two cases, the variations are larger than NMI's stated uncertainties at some wavelengths. But, these data should not be used for correction of results. These data are presented for our coming discussion on further data analysis.

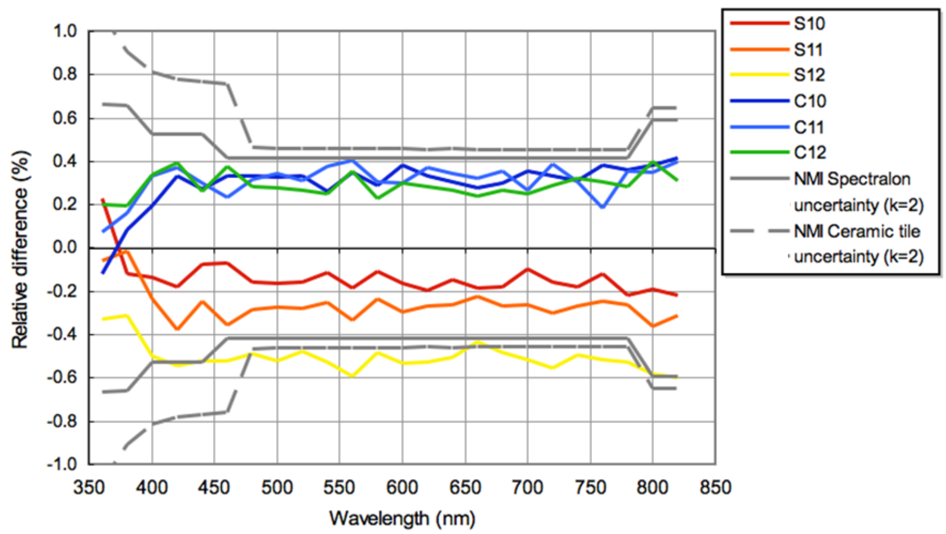


Fig. 12.3-1 CSIR-NML self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

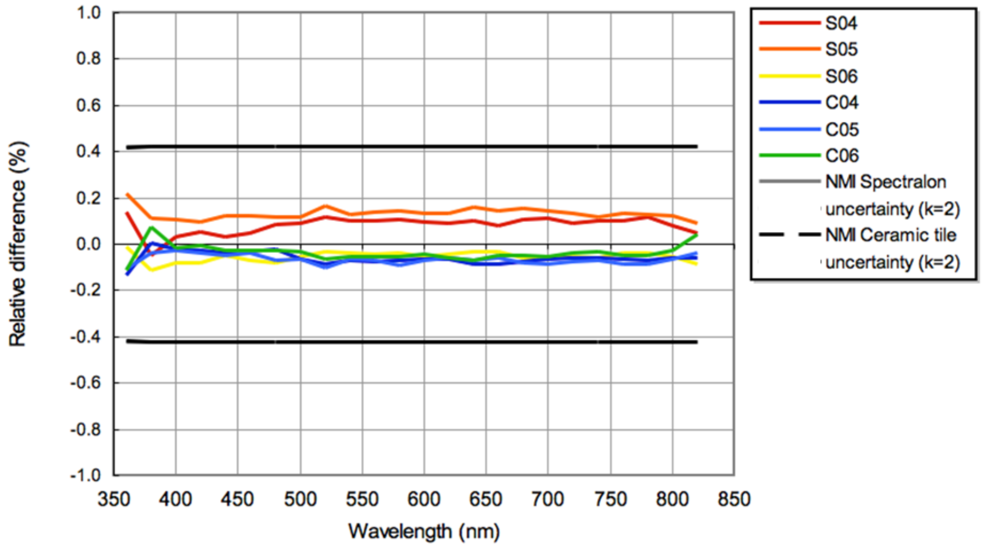


Fig. 12.3-2 HUT self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

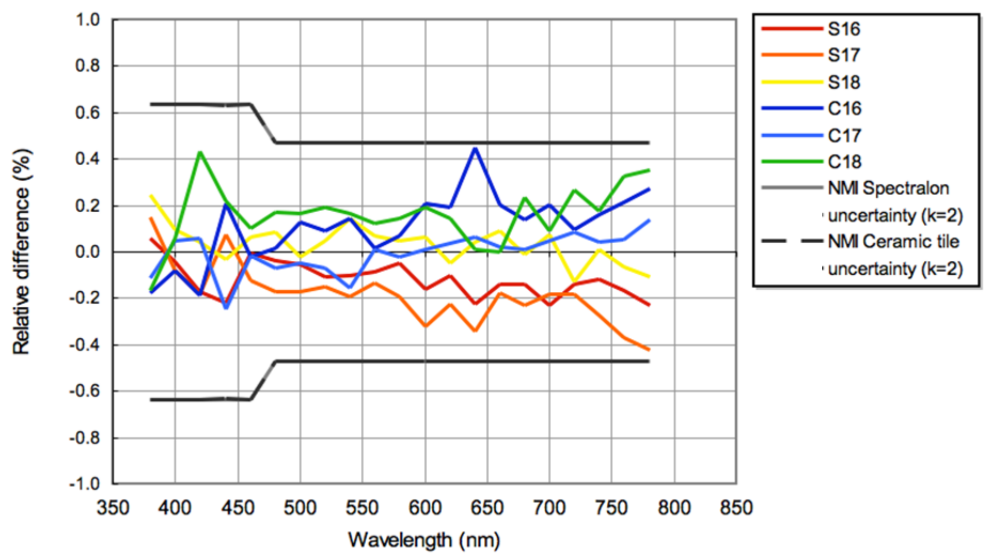


Fig. 12.3-3 IFA self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

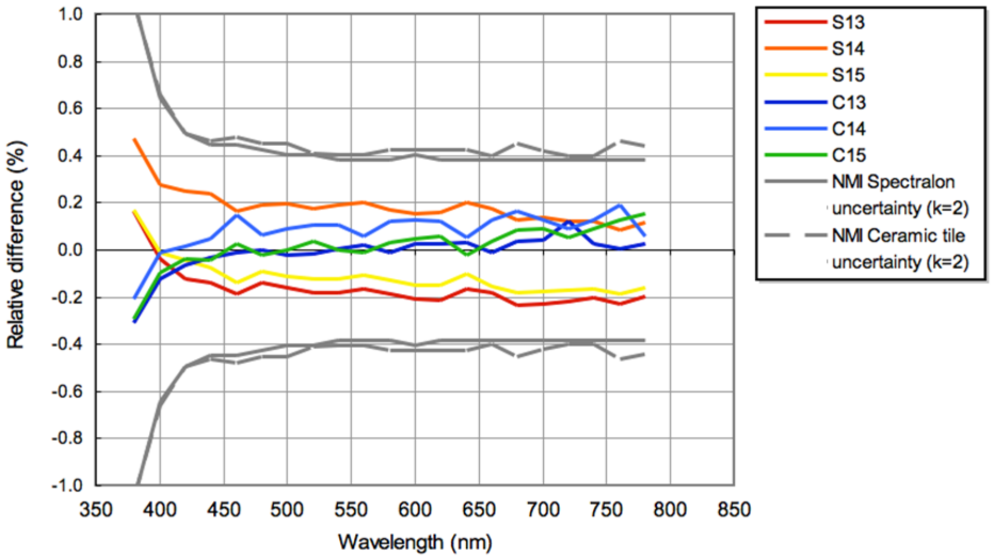


Fig. 12.3-4 KRISS self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

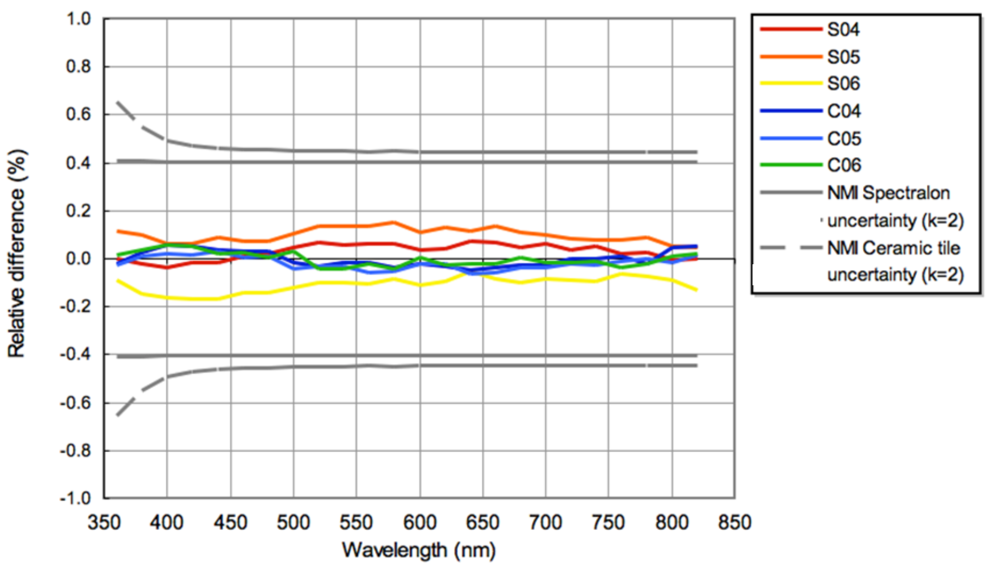


Fig. 12.3-5 MSL self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

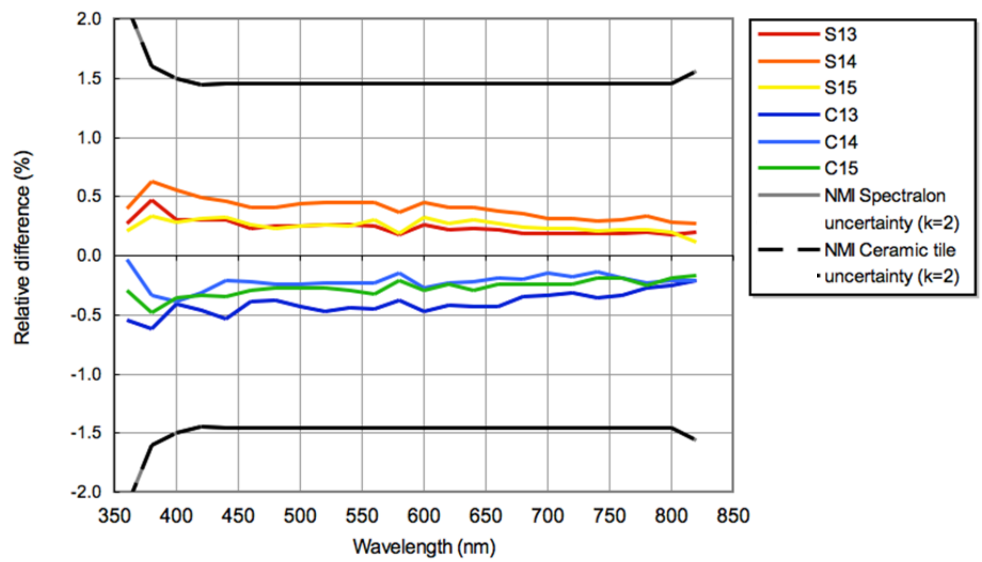


Fig. 12.3-6 NIM self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

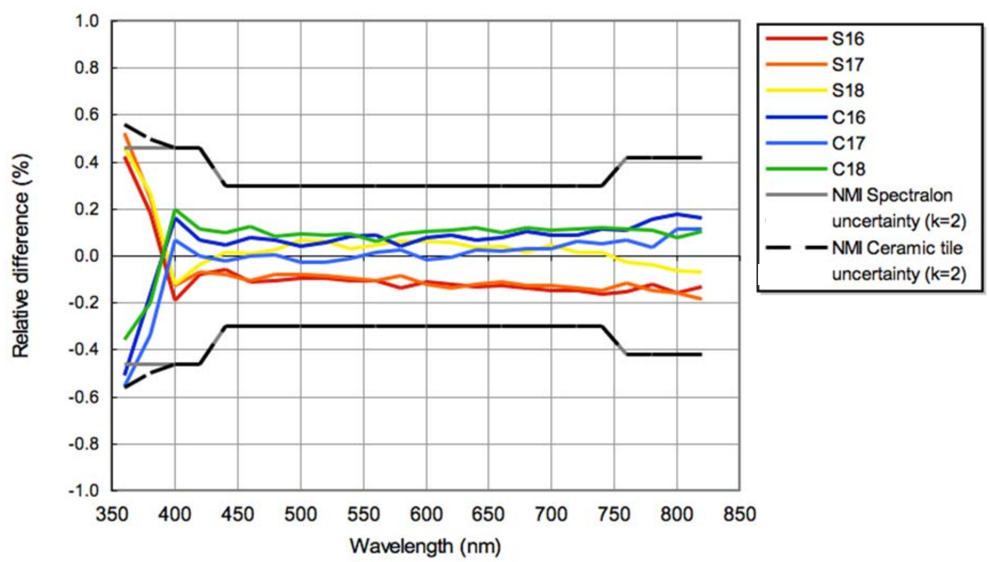


Fig. 12.3-7 NMIJ self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

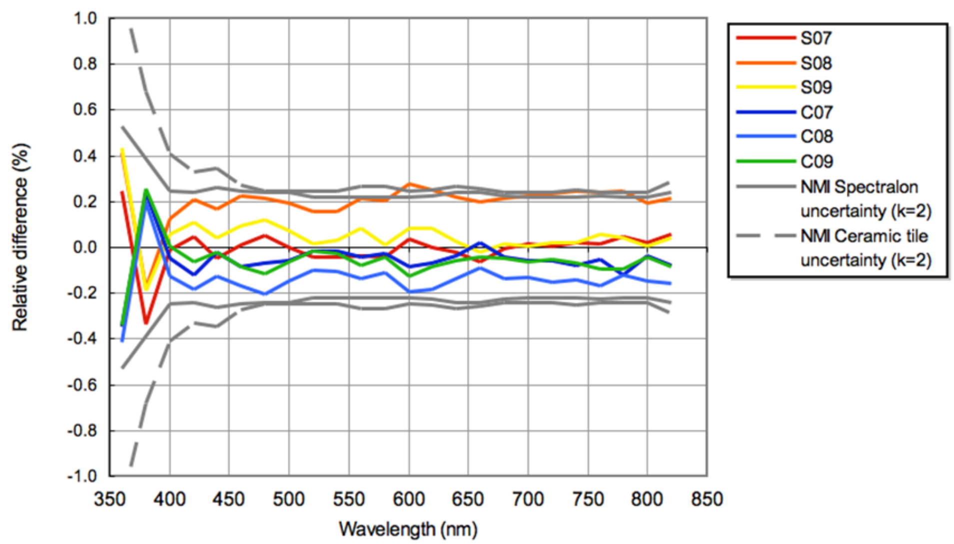


Fig. 12.3-8 NPL self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

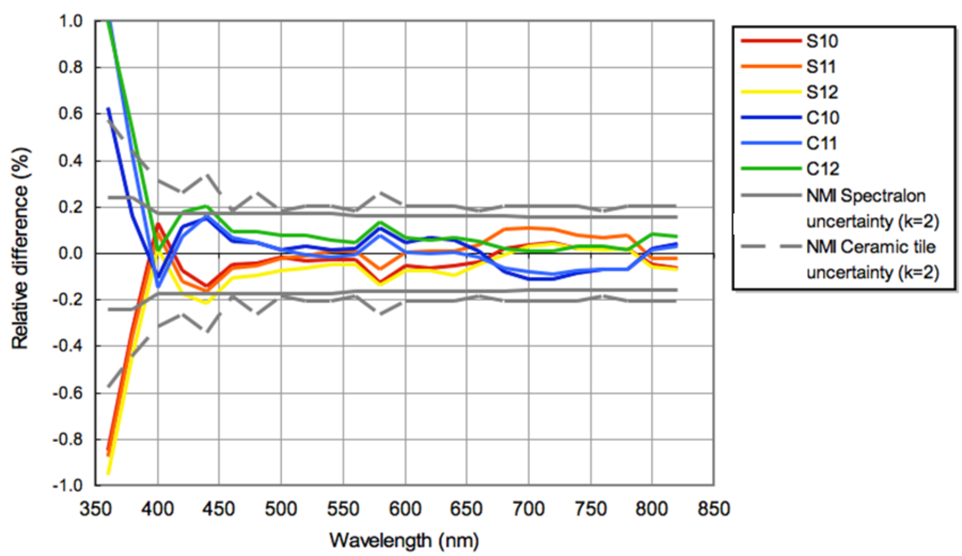


Fig. 12.3-9 NRC self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

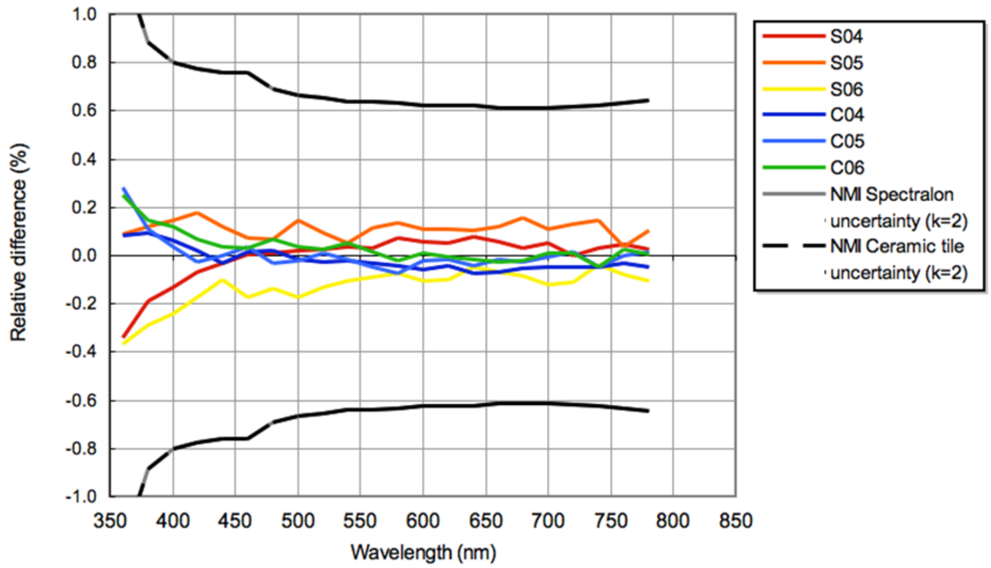


Fig. 12.3-10 OMH self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

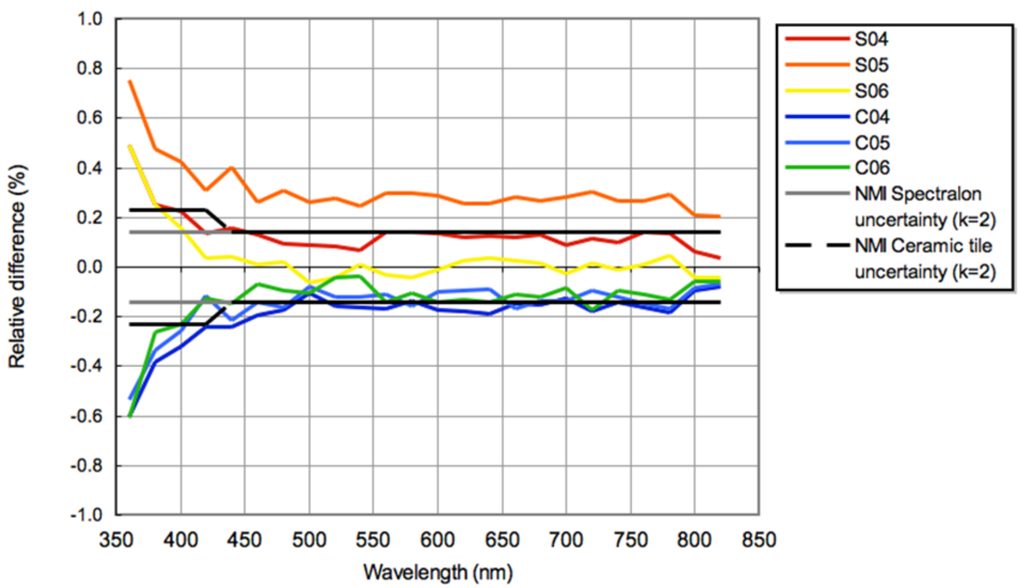


Fig. 12.3-11 PTB self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

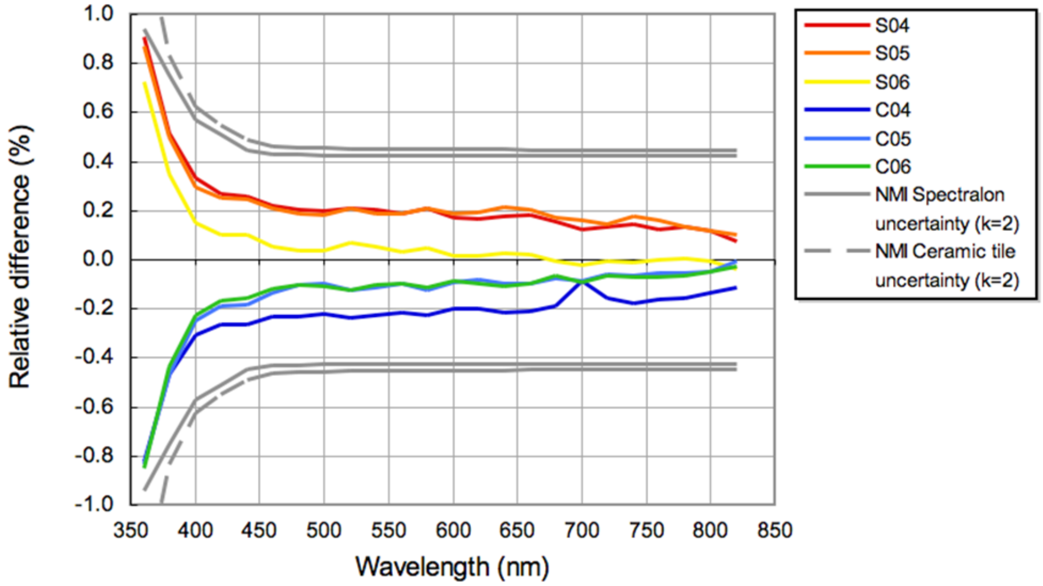


Fig. 12.3-12 VNIIOFI self-consistency of all samples (6 samples: Spectralon and ceramic tiles)

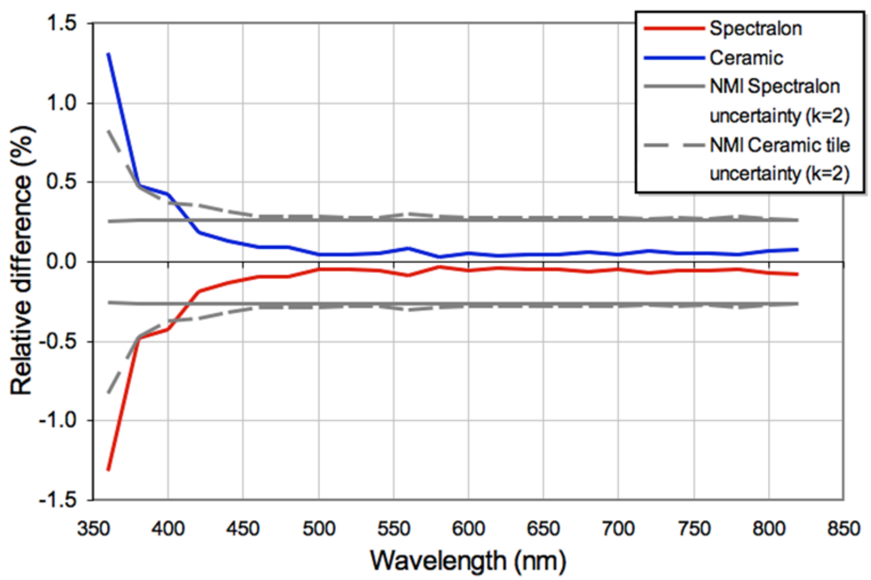


Fig. 12.3-13 NIST self-consistency of all samples (Spectralon and ceramic tiles).

12.2.4 Discussion on Relative Data and decisions

As the second part of Pre-Draft A process, the relative data of all participants were reviewed. The relative data, which shows consistency of results among samples within each participant (reported in sections 12.2.1, 12.2.2, 12.2.3), was sent to each participant individually on June 14, 2007. Some of the results showed notable changes of sample (before – after) and/or inconsistency between the two types of sample at shorter wavelengths, but each participant, having seen only their lab's data, expressed difficulty in understanding the data. One of the participants suggested reviewing the relative rata of all participants. After email discussions, all participants agreed to have the relative data of all participants to be distributed to all participants and this was done on Aug. 22, 2007.

At the same time, the pilot laboratory proposed to use only Spectralon data for the calculation of Degree of Equivalence (DoE) tables of this comparison because several laboratories had significant inconsistency between the results of Spectralon samples and ceramic tile samples. Also, the changes before and after transportation seemed larger for ceramic tile samples, especially at short wavelength region, and finally, in most of other KCs, only one type of most common type of sample was used. There was also an option to produce DoE tables for each type of sample, but Pilot lab did not recommend this option.

NRC reported that in January 2002 when it was decided to revise the technical protocol for this comparison to substitute matte ceramic tiles for matte opal glasses as the second type of exchange artifact, NRC pointed out that these materials (white ceramic tiles) are not spectrally neutral below about 450 nm, and thus it is only meaningful to compare diffuse reflectance measurements of this sample over the range 450 nm to 830 nm. NPL also supported that such treatment of ceramic tile data was anticipated already at that time. It would also be consistent if the K5 comparison is to support the CMC table where diffuse reflectance for spectrally-neutral reflecting material is listed.

After long email discussions between all participants, it was finally agreed to produce one set of DoE tables from the combined results of both types of sample but excluding the data from 360 nm to 440 nm of Ceramic tile samples. However, it was also agreed to report the results of Spectralon and Ceramic tiles separately for information only (without producing DoE tables for these).

During this Relative Data review process, no participants requested removal of any part of the submitted results.

13. Determination of a KCRV and Degree of Equivalence

This data analysis followed the Guidelines for CCPR Comparison Report Preparation (Rev.2, September 18, 2009). Note that all relative differences and uncertainties plotted in the figures as relative % (NOT in absolute reflectance) and expanded uncertainty with k=2. In the plots below, S indicates Spectralon samples and C indicates ceramic samples. Following the Guidelines, the KCRVs were calculated using the CCPR standard method –weighted mean with cut-off as detailed below.

For the calculation of KCRV, as agreed by the participants in Pre-Draft A process, the results from both Spectralon and Ceramic tile samples were combined, except that only Spectralon results were used for the spectral region from 360 nm to 440 nm. Thus, the results of three samples (Spectralon) were combined for the 360 nm to 440 nm region, and the results of six samples (both types) were combined for the rest of the region.

The following notations are used:

N	Number of participant NMIs, not counting the Pilot laboratory (N=12)
$R_{i,j}$	Spectral diffuse reflectance of sample *j* (*j* =1 to 3 for Spectralon, j=4 to 6 for ceramic tile samples) of NMI *i*, measured by the NMI. *The value is the average of three scans (or just one scan).*
$u_{\text{rel}}(R_{i,j})$	Total relative uncertainty of $R_{i,j}$ reported by the NMI.
$R^{\text{P}}_{i,j,r}$	Spectral reflectance factor of sample *j* of NMI *i*, at round *r* (*r* =1 before and *r* =2 after travel) measured by the Pilot laboratory.
$u_{\text{rel}}(R^{\text{P}}_{i,j,r})$	Total relative uncertainty of $R^{\text{P}}_{i,j,r}$.
$u_{\text{rel}}(R^{\text{PR}}_{i,j})$	Reproducibility of the Pilot laboratory measurements of sample *j* of NMI *i*, including the stability of the comparison scale during the period of the comparison and repeatability of the transfer sample.

1. For each NMI *i* and for each sample *j*, the NIST measurements of two rounds are averaged:

$$\overline{R}^{P}_{i,j} = \frac{1}{2}\sum_{r=1}^{2} R^{P}_{i,j,r} \qquad (13.1)$$

and its uncertainty is given by

$$u_{\text{rel}}(\overline{R}^{P}_{i,j}) = \frac{1}{2}\sum_{r=1}^{2} u_{\text{rel}}(R^{P}_{i,j,r}). \qquad (13.2)$$

This is an approximation, assuming that the results from the two rounds of the same sample measured by the pilot laboratory are nearly fully correlated. This is normally the case when the uncertainty of the transfer measurements (random components) is much smaller than the uncertainty of the scale.

2. For each NMI *i* and for each sample *j*, the relative difference $\Delta_{i,j}$ between the NMI measurement and the pilot laboratory measurement (as an average of two rounds) is given by,

$$\Delta_{i,j} = \frac{R_{i,j}}{\overline{R}^{\text{P}}_{i,j}} - 1 \qquad (13.3)$$

and its uncertainty is given by

$$u(\Delta_{i,j}) = \sqrt{u_{\text{rel}}{}^{2}(R_{i,j}) + u_{\text{rel}}{}^{2}(R^{\text{PR}}_{i,j}) + u_{\text{stab}}{}^{2}(\overline{R}^{P}_{i,j})}\,. \qquad (13.4)$$

where $u_{\text{stab}}(\overline{R}^{\text{P}}_{i,j})$ is an additional uncertainty contribution arising possibly from the changes of the sample that occurred between before and after shipping. $u_{\text{stab}}(\overline{R}^{\text{P}}_{i,j})$ is calculated from the difference in the two measurements by the pilot laboratory, taken as a rectangular distribution:

$$u_{\mathrm{stab}}(\overline{R}^{\mathrm{P}}_{i,j}) = \left(R^{\mathrm{P}}_{i,j,2} - R^{\mathrm{P}}_{i,j,1}\right) / \overline{R}^{\mathrm{P}}_{i,j} \cdot \frac{1}{2\sqrt{3}} \quad (13.5)$$

3. For each NMI i, the relative differences Δ_i(average of the three or six samples) is obtained by

$$\Delta_i = \frac{1}{3}\sum_{j=1}^{3}\Delta_{i,j} \quad \text{or} \quad \Delta_i = \frac{1}{6}\sum_{j=1}^{6}\Delta_{i,j} \quad (13.6)$$

and its uncertainty is given by

$$u(\Delta_i) = \frac{1}{3}\sum_{j=1}^{3}u(\Delta_{i,j}) \quad \text{or} \quad u(\Delta_i) = \frac{1}{6}\sum_{j=1}^{6}u(\Delta_{i,j}) \quad (13.7)$$

Note: This uncertainty calculation is an approximation, assuming that the results from the three or six samples measured by the same NMI are nearly fully correlated.

For the pilot laboratory measurements (i = 0 is used hereinafter),

$$\Delta_0 = 0 \quad \text{and} \quad u(\Delta_0) = u_{\mathrm{rel}}(\overline{R}^{\mathrm{P}}) \quad (13.8)$$

where $u_{\mathrm{rel}}(\overline{R}^{\mathrm{P}})$ is the total uncertainty of the NIST measurements as a participant, and is listed in Table 10.7.

4. The relative uncertainty of NIM i measurements, averaged for all samples, is determined by

$$u_{\mathrm{rel}}(\overline{R}_i) = \frac{1}{3}\sum_{l=1}^{3}u_{\mathrm{rel}}(\overline{R}_{i,j}) \quad \text{or} \quad u_{\mathrm{rel}}(\overline{R}_i) = \frac{1}{6}\sum_{l=1}^{6}u_{\mathrm{rel}}(\overline{R}_{i,j}) \quad (13.9)$$

For convenience in the calculation hereinafter,

$$u_{\mathrm{rel}}(\overline{R}_0) = u_{\mathrm{rel}}(\overline{R}^{\mathrm{P}}) \quad (13.10)$$

5. The KCRV is calculated using weighted mean with cut-off. The cut-off value $u_{\mathrm{cut-off}}$ is calculated by

$$u_{\mathrm{cut-off}} = \mathrm{average}\{u_{\mathrm{rel}}(\overline{R}_i)\} \quad \text{for} \quad u_{\mathrm{rel}}(\overline{R}_i) \le \mathrm{median}\{u_{\mathrm{rel}}(\overline{R}_i)\} \; ; i = 0 \text{ to } N \quad (13.11)$$

The reported uncertainty $u_{\mathrm{rel}}(\overline{R}_i)$ of each NMI i is adjusted by the cut-off,

$$\begin{aligned} u_{\mathrm{rel,adj}}(\overline{R}_i) &= u_{\mathrm{rel}}(\overline{R}_i) \quad \text{for} \quad u_{\mathrm{rel}}(\overline{R}_i) \ge u_{\mathrm{cut-off}} \\ u_{\mathrm{rel,adj}}(\overline{R}_i) &= u_{\mathrm{cut-off}} \quad \text{for} \quad u_{\mathrm{rel}}(\overline{R}_i) < u_{\mathrm{cut-off}} \end{aligned} \quad i = 0 \text{ to N} \quad (13.12)$$

The transfer uncertainty component in $u(\Delta_i)$ is separated by

$$u_{\mathrm{T}}(\Delta_i) = \sqrt{u^2(\Delta_i) - u^2_{\mathrm{rel}}(\overline{R}_i)} \quad (13.13)$$

The uncertainty of Δ_i after cut-off is given by

$$u_{\text{adj}}(\Delta_i) = \sqrt{u_{\text{rel,adj}}^2(\overline{R}_i) + u_{\text{T}}^2(\Delta_i)} \tag{13.14}$$

The weights w_i for NMI i is determined by

$$w_i = u_{\text{adj}}^{-2}(\Delta_i) / \sum_{i=0}^{N} u_{\text{adj}}^{-2}(\Delta_i) \tag{13.15}$$

The KCRV, Δ_{KCRV}, is determined by

$$\Delta_{\text{KCRV}} = \sum_{i=0}^{N} w_i \, \Delta_i \tag{13.16}$$

The uncertainty of the KCRV (weighted mean with cut-off) is given by

$$u(\Delta_{\text{KCRV}}) = \sqrt{\sum_{i=0}^{N} \frac{u^2(\Delta_i)}{u_{\text{adj}}^{4}(\Delta_i)}} \Bigg/ \sum_{i=0}^{N} u_{\text{adj}}^{-2}(\Delta_i) \tag{13.17}$$

The unilateral DoE of NMI i is given by

$$D_i = \Delta_i - \Delta_{\text{KCRV}} \tag{13.18}$$

$$U_i = k\sqrt{u^2(\Delta_i) + u^2(\Delta_{\text{KCRV}}) - 2\left(\frac{u^2(\Delta_i)}{u_{\text{adj}}^{2}(\Delta_i)} \Bigg/ \sum_{j=0}^{N} u_{\text{adj}}^{-2}(\Delta_j)\right)} \quad ; \; k=2 \tag{13.19}$$

The intermediate results Δ_i of the KCRV calculations are listed in Table 13.1.

Table 13.1 Δ_i (%) in the KCRV calculations for all participant laboratories.

Wave-length [nm]	CSIR-NML	HUT	IFA-CSIC	KRISS	MSL	NIM	NMIJ	NIST	NPL	NRC	OMH	PTB	VNII OFI	Δ_{KCRV} (%)	$u(\Delta_{\text{KCRV}})$ (%)
360	-0.06	0.31			0.15	-0.71	0.01	0.00	0.37	-0.04	-0.16	-0.14	-0.12	**0.04**	**0.07**
380	0.11	0.27	-1.42	-0.29	0.08	-0.76	-0.12	0.00	0.46	-0.14	-0.07	-0.13	-0.21	**-0.04**	**0.06**
400	0.33	0.51	-1.22	0.01	0.35	-0.51	0.11	0.00	0.91	-0.01	0.14	0.12	-0.14	**0.18**	**0.06**
420	0.01	0.24	-1.14	-0.21	0.12	-0.61	-0.21	0.00	0.69	-0.26	-0.04	-0.10	-0.48	**-0.02**	**0.05**
440	-0.15	0.27	-0.92	-0.13	0.13	-0.39	-0.18	0.00	0.73	-0.19	0.05	-0.01	-0.53	**0.01**	**0.05**
460	0.11	0.17	-0.89	-0.17	0.07	-0.74	-0.17	0.00	0.50	-0.18	0.01	-0.25	-0.79	**-0.08**	**0.05**
480	-0.05	0.17	-0.54	-0.21	0.04	-0.73	-0.22	0.00	0.45	-0.20	0.00	-0.26	-0.81	**-0.10**	**0.05**
500	-0.01	0.20	-0.75	-0.12	0.11	-0.68	-0.19	0.00	0.52	-0.17	0.03	-0.13	-0.66	**-0.06**	**0.05**
520	0.11	0.19	-0.60	-0.07	0.08	-0.71	-0.15	0.00	0.56	-0.16	0.11	-0.13	-0.64	**-0.03**	**0.05**
540	0.04	0.16	-0.61	-0.07	0.06	-0.76	-0.15	0.00	0.51	-0.20	0.08	-0.15	-0.64	**-0.05**	**0.05**
560	-0.08	0.19	-0.36	-0.04	0.07	-0.76	-0.11	0.00	0.51	-0.18	0.06	-0.10	-0.59	**-0.03**	**0.05**
580	-0.15	0.17	-0.50	-0.06	0.04	-0.70	-0.15	0.00	0.49	-0.11	0.03	-0.14	-0.62	**-0.05**	**0.05**
600	-0.09	0.22	-0.41	0.00	0.10	-0.79	-0.12	0.00	0.44	-0.16	0.10	-0.11	-0.52	**-0.03**	**0.05**
620	0.00	0.21	-0.41	-0.01	0.11	-0.79	-0.07	0.00	0.46	-0.15	0.12	-0.09	-0.53	**-0.01**	**0.05**
640	-0.18	0.18	-0.34	-0.08	0.08	-0.82	-0.11	0.00	0.44	-0.17	0.03	-0.12	-0.61	**-0.05**	**0.05**
660	-0.16	0.21	-0.35	-0.02	0.11	-0.79	-0.06	0.00	0.50	-0.16	0.11	-0.08	-0.57	**-0.01**	**0.05**
680	-0.32	0.22	-0.32	-0.05	0.08	-0.83	-0.08	0.00	0.41	-0.26	0.03	-0.13	-0.58	**-0.06**	**0.05**
700	-0.12	0.32	-0.24	0.06	0.17	-0.73	0.02	0.00	0.51	-0.18	0.15	0.01	-0.50	**0.03**	**0.05**

(Continued.)

720	-0.36	0.21	-0.25	-0.10	0.08	-0.83	-0.07	0.00	0.36	-0.30	0.01	-0.13	-0.58	**-0.07**	**0.05**
740	-0.25	0.23	-0.21	-0.11	0.09	-0.78	-0.05	0.00	0.40	-0.25	-0.04	-0.09	-0.56	**-0.04**	**0.05**
760	-0.46	0.24	-0.32	-0.14	0.06	-0.79	-0.08	0.00	0.34	-0.27	-0.03	-0.14	-0.55	**-0.09**	**0.05**
780	-0.48	0.28	-0.22	-0.14	0.09	-0.72	-0.04	0.00	0.39	-0.22	0.10	-0.12	-0.45	**-0.05**	**0.05**
800	-0.45	0.25			0.04	-0.69	-0.10	0.00	0.44	-0.19		-0.10	-0.44	**-0.01**	**0.05**
820	-0.44	0.29			0.04	-0.70	-0.14	0.00	0.37	-0.21		-0.13	-0.57	**-0.04**	**0.05**

Table 13.2 Participants' reported uncertainties $u_{\mathrm{rel}}(\overline{R}_i)$ and the cut-off uncertainties in %.

Wave-length (nm)	CSIR-NML	HUT	IFA-CSIC	KRISS	MSL	NIM	NMIJ	NIST	NPL	NRC	OMH	PTB	VNIIOFI	Cut-off u
360	0.33	0.21			0.20	1.06	0.23	0.14	0.26	0.12	0.60	0.07	0.47	**0.16**
380	0.33	0.21	0.32	0.53	0.20	0.80	0.23	0.14	0.19	0.12	0.44	0.07	0.38	**0.17**
400	0.26	0.21	0.32	0.32	0.20	0.75	0.23	0.14	0.12	0.09	0.40	0.07	0.29	**0.15**
420	0.26	0.21	0.32	0.25	0.20	0.72	0.23	0.14	0.12	0.09	0.39	0.07	0.25	**0.15**
440	0.26	0.21	0.32	0.22	0.20	0.73	0.15	0.14	0.13	0.09	0.38	0.07	0.22	**0.14**
460	0.29	0.21	0.32	0.23	0.22	0.73	0.15	0.14	0.13	0.09	0.38	0.07	0.22	**0.14**
480	0.22	0.21	0.24	0.22	0.21	0.73	0.15	0.14	0.12	0.11	0.35	0.07	0.22	**0.15**
500	0.22	0.21	0.24	0.21	0.21	0.73	0.15	0.14	0.12	0.09	0.33	0.07	0.22	**0.14**
520	0.22	0.21	0.24	0.20	0.21	0.73	0.15	0.14	0.12	0.09	0.33	0.07	0.22	**0.14**
540	0.22	0.21	0.24	0.20	0.21	0.73	0.15	0.14	0.12	0.09	0.32	0.07	0.22	**0.14**
560	0.22	0.21	0.23	0.20	0.21	0.73	0.15	0.14	0.12	0.09	0.32	0.07	0.22	**0.14**
580	0.22	0.21	0.24	0.20	0.21	0.73	0.15	0.14	0.12	0.10	0.32	0.07	0.22	**0.14**
600	0.22	0.21	0.24	0.21	0.21	0.73	0.15	0.14	0.12	0.09	0.31	0.07	0.22	**0.14**
620	0.22	0.21	0.24	0.20	0.21	0.73	0.15	0.14	0.12	0.09	0.31	0.07	0.22	**0.14**
640	0.22	0.21	0.24	0.20	0.21	0.73	0.15	0.14	0.13	0.09	0.31	0.07	0.22	**0.14**
660	0.22	0.21	0.24	0.20	0.21	0.73	0.15	0.14	0.12	0.09	0.31	0.07	0.22	**0.14**
680	0.22	0.21	0.23	0.21	0.21	0.73	0.15	0.14	0.12	0.09	0.31	0.07	0.22	**0.14**
700	0.22	0.21	0.23	0.20	0.21	0.73	0.15	0.14	0.12	0.09	0.31	0.07	0.22	**0.14**
720	0.22	0.21	0.24	0.20	0.21	0.73	0.15	0.14	0.12	0.09	0.31	0.07	0.22	**0.14**
740	0.22	0.21	0.24	0.20	0.21	0.73	0.15	0.14	0.12	0.09	0.31	0.07	0.22	**0.14**
760	0.22	0.21	0.23	0.21	0.21	0.73	0.21	0.14	0.12	0.08	0.32	0.07	0.22	**0.15**
780	0.22	0.21	0.23	0.21	0.21	0.73	0.21	0.14	0.12	0.09	0.32	0.07	0.22	**0.15**
800	0.31	0.21			0.21	0.73	0.21	0.14	0.12	0.09		0.07	0.22	**0.13**
820	0.31	0.21			0.21	0.78	0.21	0.14	0.13	0.09		0.07	0.22	**0.13**

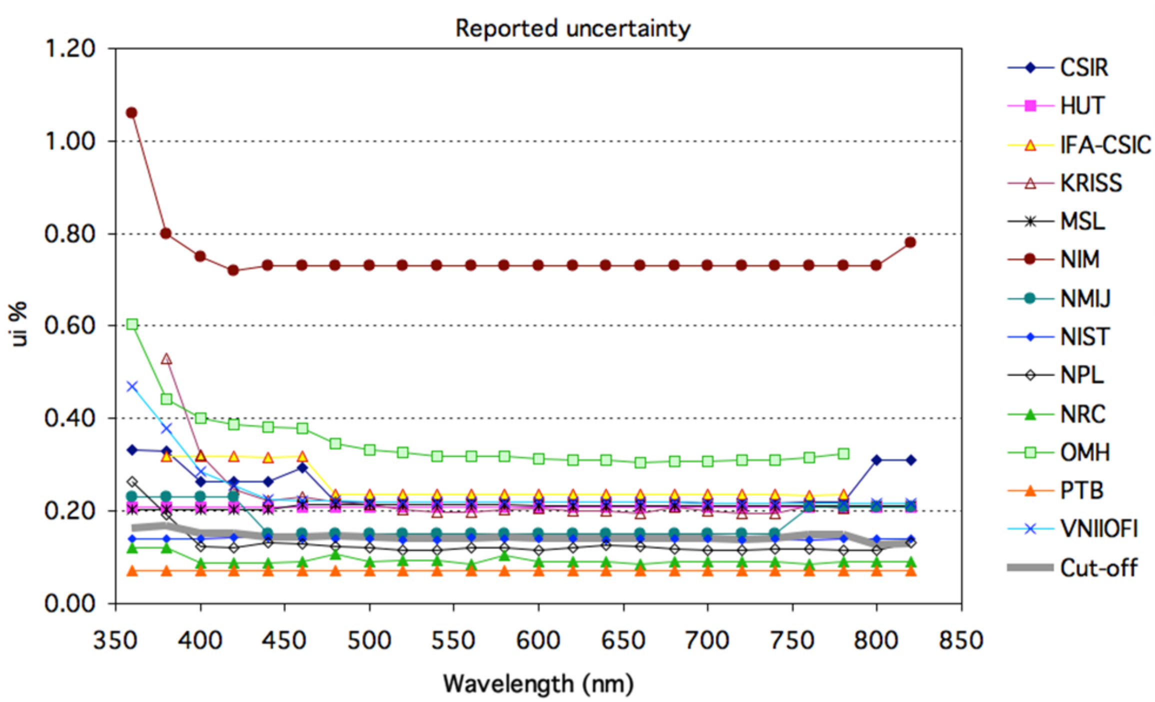
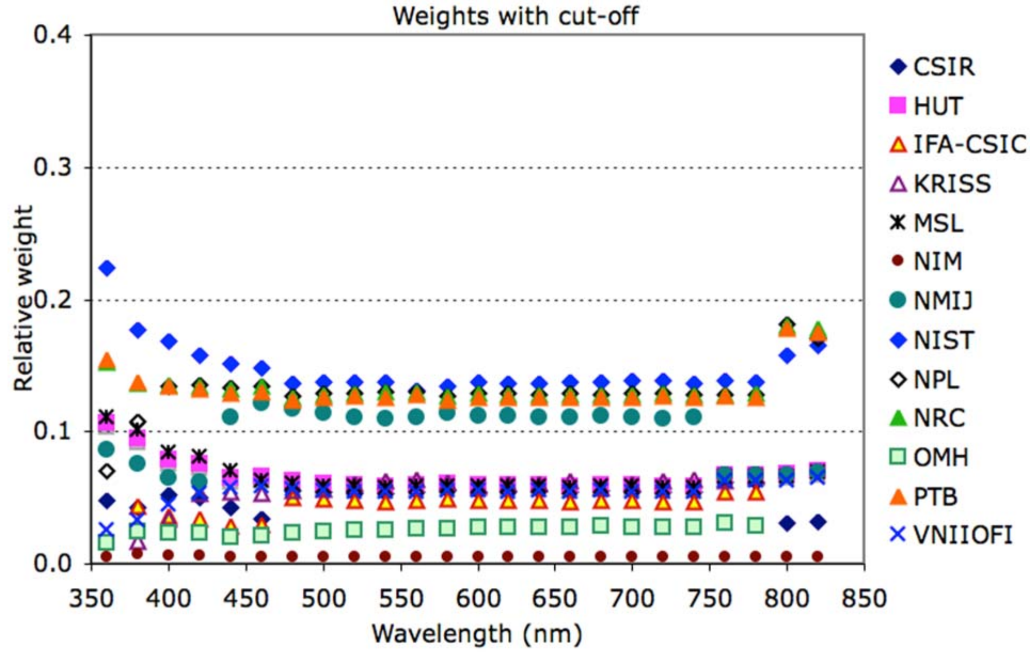


Figure 13.1 Participants reported uncertainties and the cut-off of the uncertainties



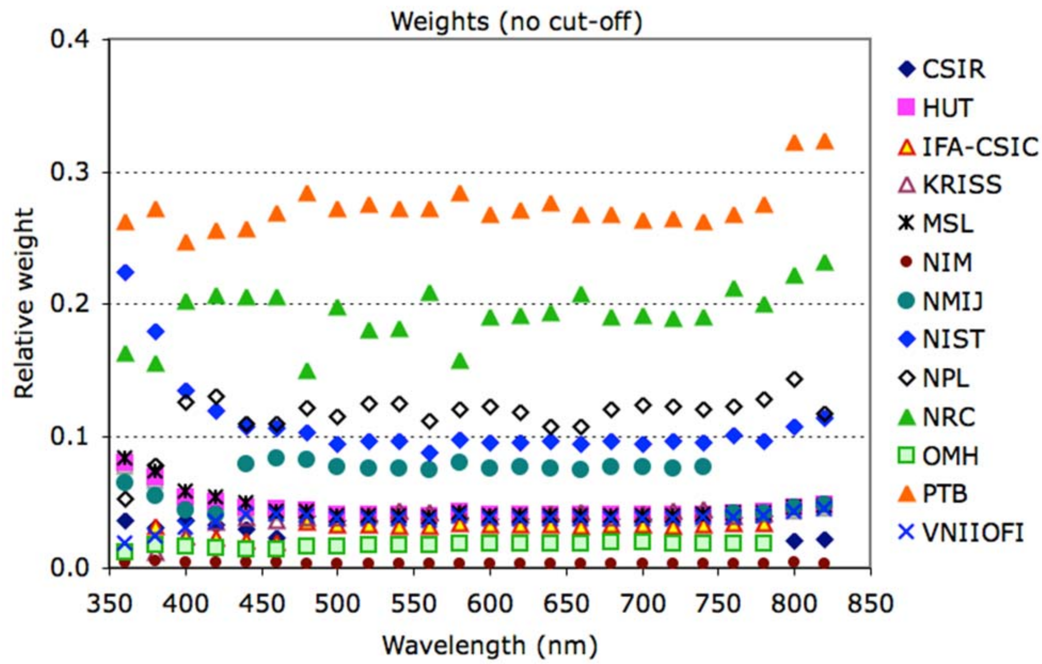


Figure 13.2 Weights with cut-off (upper) and without cut-off (lower).

Table 13.3 Unilateral Degree of Equivalence D_i, the values in percentage.

Wave-length [nm]	CSIR-NML	HUT	IFA-CSIC	KRISS	MSL	NIM	NMIJ	NIST	NPL	NRC	OMH	PTB	VNIIOFI
360	-0.10	0.27			0.12	-0.75	-0.02	-0.04	0.33	-0.08	-0.20	-0.18	-0.15
380	0.15	0.31	-1.38	-0.25	0.12	-0.72	-0.08	0.04	0.50	-0.10	-0.03	-0.09	-0.17
400	0.14	0.33	-1.40	-0.17	0.17	-0.69	-0.07	-0.18	0.73	-0.19	-0.04	-0.06	-0.32
420	0.03	0.26	-1.13	-0.19	0.14	-0.59	-0.19	0.02	0.71	-0.24	-0.02	-0.08	-0.46
440	-0.15	0.27	-0.92	-0.14	0.12	-0.40	-0.18	-0.01	0.73	-0.20	0.04	-0.02	-0.53
460	0.19	0.25	-0.82	-0.09	0.14	-0.66	-0.09	0.08	0.58	-0.10	0.09	-0.17	-0.71
480	0.06	0.27	-0.44	-0.10	0.15	-0.63	-0.11	0.10	0.55	-0.09	0.10	-0.16	-0.70
500	0.05	0.26	-0.69	-0.06	0.17	-0.62	-0.13	0.06	0.58	-0.11	0.09	-0.07	-0.61
520	0.14	0.21	-0.57	-0.04	0.11	-0.68	-0.13	0.03	0.58	-0.13	0.14	-0.10	-0.62
540	0.09	0.21	-0.56	-0.02	0.11	-0.71	-0.10	0.05	0.56	-0.15	0.13	-0.10	-0.59
560	-0.05	0.21	-0.34	-0.02	0.10	-0.73	-0.09	0.03	0.53	-0.15	0.09	-0.07	-0.56
580	-0.10	0.22	-0.45	-0.01	0.09	-0.66	-0.10	0.05	0.54	-0.07	0.08	-0.09	-0.57
600	-0.06	0.24	-0.38	0.03	0.13	-0.76	-0.09	0.03	0.47	-0.14	0.13	-0.08	-0.49
620	0.01	0.22	-0.40	0.00	0.12	-0.78	-0.06	0.01	0.47	-0.14	0.13	-0.08	-0.52
640	-0.13	0.22	-0.29	-0.03	0.13	-0.77	-0.06	0.05	0.49	-0.12	0.08	-0.08	-0.57
660	-0.15	0.23	-0.34	0.00	0.13	-0.78	-0.05	0.01	0.51	-0.15	0.12	-0.07	-0.56
680	-0.26	0.27	-0.26	0.01	0.14	-0.77	-0.02	0.06	0.47	-0.20	0.09	-0.07	-0.52
700	-0.16	0.29	-0.28	0.03	0.14	-0.76	-0.02	-0.03	0.48	-0.22	0.12	-0.02	-0.54
720	-0.29	0.28	-0.18	-0.03	0.15	-0.76	0.01	0.07	0.44	-0.23	0.08	-0.06	-0.51
740	-0.21	0.28	-0.17	-0.07	0.13	-0.73	0.00	0.04	0.45	-0.20	0.01	-0.05	-0.51
760	-0.37	0.33	-0.23	-0.05	0.15	-0.70	0.01	0.09	0.43	-0.18	0.06	-0.05	-0.46
780	-0.43	0.33	-0.17	-0.09	0.15	-0.67	0.01	0.05	0.45	-0.17	0.15	-0.07	-0.40
800	-0.45	0.26			0.05	-0.68	-0.10	0.01	0.44	-0.18		-0.09	-0.44
820	-0.40	0.33			0.08	-0.66	-0.10	0.04	0.41	-0.17		-0.09	-0.53

Table 13.4 The uncertainty U_i (k=2) of unilateral Degree of Equivalence, the values in percentage.

Wave-length [nm]	CSIR-NML	HUT	IFA-CSIC	KRISS	MSL	NIM	NMIJ	NIST	NPL	NRC	OMH	PTB	VNIIOFI
360	0.68	0.44			0.43	2.14	0.50	0.25	0.55	0.31	1.22	0.26	0.95
380	0.67	0.43	0.65	1.07	0.41	1.62	0.49	0.26	0.40	0.29	0.89	0.23	0.76
400	0.53	0.42	0.64	0.66	0.41	1.51	0.47	0.25	0.27	0.22	0.80	0.21	0.57
420	0.52	0.42	0.64	0.51	0.40	1.45	0.47	0.26	0.25	0.21	0.77	0.20	0.51
440	0.52	0.42	0.64	0.46	0.40	1.47	0.31	0.26	0.26	0.20	0.76	0.19	0.44
460	0.59	0.41	0.63	0.47	0.42	1.46	0.29	0.26	0.26	0.20	0.75	0.18	0.44
480	0.44	0.41	0.46	0.44	0.42	1.46	0.29	0.26	0.24	0.22	0.68	0.18	0.43
500	0.44	0.41	0.46	0.43	0.42	1.46	0.29	0.26	0.24	0.19	0.66	0.17	0.43
520	0.44	0.41	0.46	0.41	0.42	1.46	0.29	0.25	0.23	0.20	0.65	0.17	0.43
540	0.43	0.41	0.46	0.40	0.42	1.46	0.29	0.25	0.23	0.20	0.63	0.17	0.43
560	0.43	0.41	0.46	0.40	0.42	1.46	0.29	0.26	0.24	0.19	0.63	0.17	0.43
580	0.43	0.41	0.46	0.41	0.42	1.46	0.29	0.26	0.24	0.21	0.63	0.17	0.43
600	0.43	0.41	0.46	0.42	0.42	1.46	0.29	0.25	0.23	0.19	0.62	0.17	0.43
620	0.43	0.41	0.46	0.41	0.42	1.46	0.29	0.25	0.23	0.19	0.61	0.17	0.43
640	0.43	0.41	0.46	0.41	0.42	1.46	0.29	0.25	0.25	0.19	0.61	0.17	0.43
660	0.43	0.41	0.46	0.40	0.42	1.46	0.29	0.25	0.24	0.19	0.60	0.17	0.43
680	0.43	0.41	0.46	0.42	0.42	1.46	0.29	0.25	0.23	0.19	0.61	0.17	0.43
700	0.43	0.41	0.46	0.41	0.42	1.46	0.29	0.26	0.23	0.19	0.61	0.17	0.43
720	0.43	0.41	0.46	0.39	0.42	1.46	0.29	0.25	0.23	0.19	0.61	0.17	0.43
740	0.43	0.41	0.46	0.39	0.42	1.46	0.29	0.26	0.23	0.19	0.62	0.17	0.43
760	0.43	0.41	0.46	0.42	0.41	1.46	0.41	0.25	0.24	0.19	0.62	0.18	0.43
780	0.43	0.41	0.46	0.41	0.41	1.46	0.41	0.26	0.23	0.19	0.64	0.17	0.42
800	0.62	0.41			0.41	1.46	0.41	0.25	0.22	0.18		0.16	0.42
820	0.61	0.41			0.41	1.56	0.41	0.25	0.24	0.19		0.17	0.42

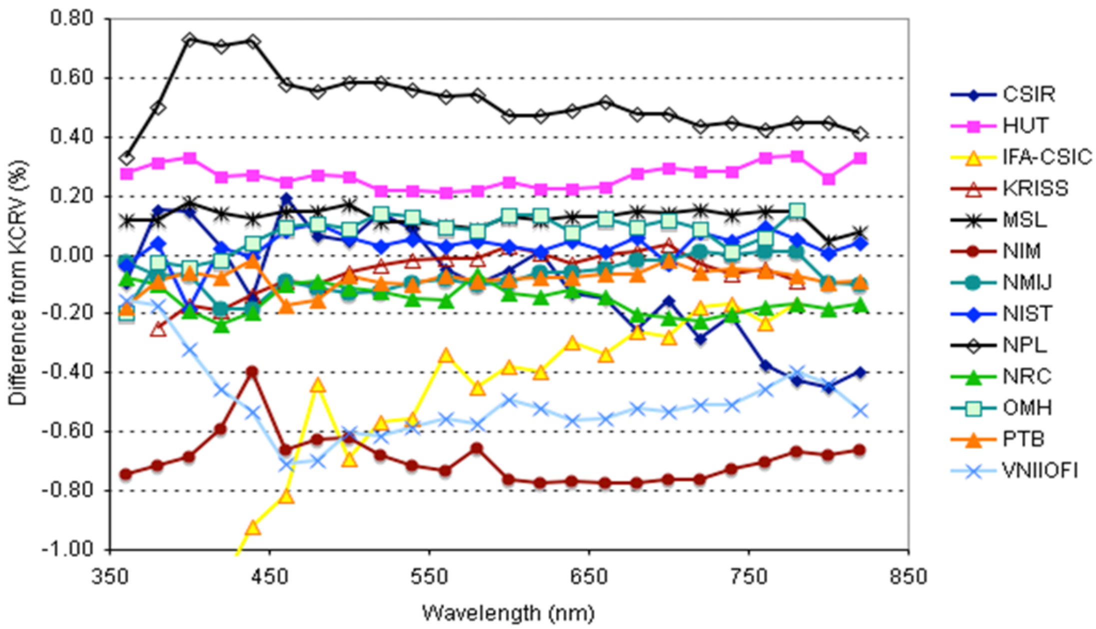


Figure 13.3 Participants' unilateral Degree of Equivalence

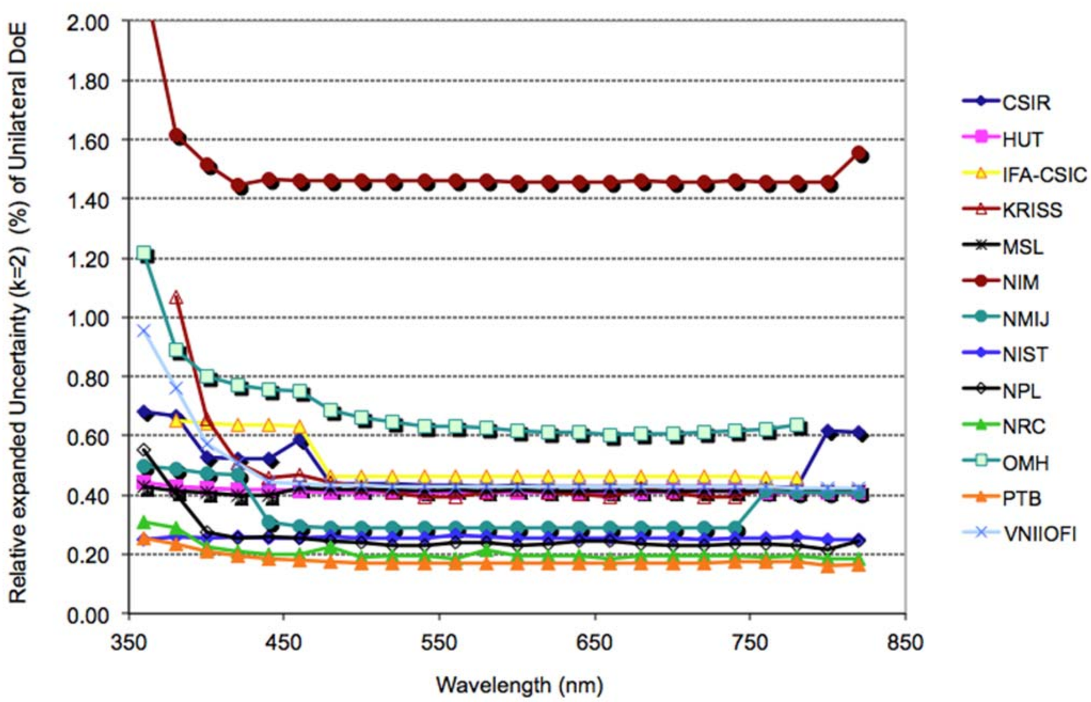


Figure 13.4 Relative expanded uncertainties (k=2) of participants' unilateral Degree of Equivalence.

The figures below are the plots of relative differences from KCRV for each participant. The bar indicates the relative expanded uncertainty (*k*=2) of each point. The expanded uncertainties (*k*=2) of the KCRV are also plotted in blue lines (gray lines in black and white print).

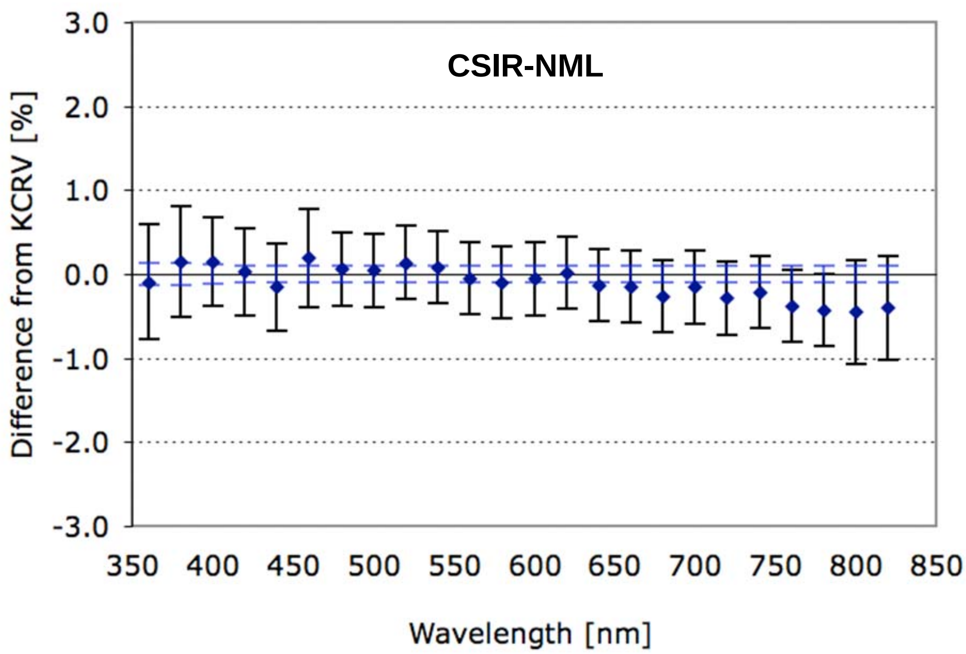


Figure 13.5 Relative differences from KCRV for CSIR-NML

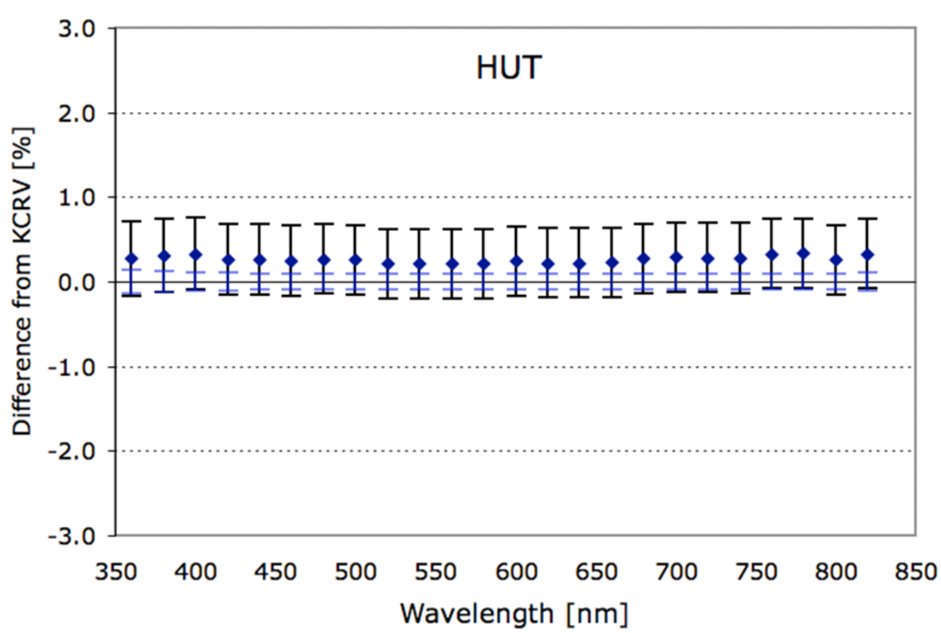


Figure 13.6 Relative differences from KCRV for HUT

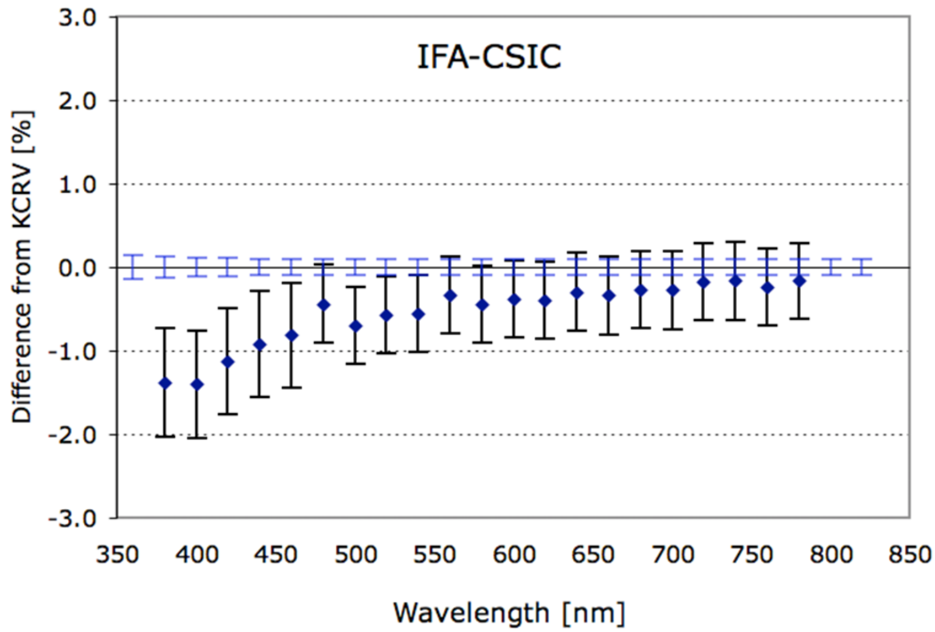


Figure 13.7 Relative differences from KCRV for IFA-CSIC

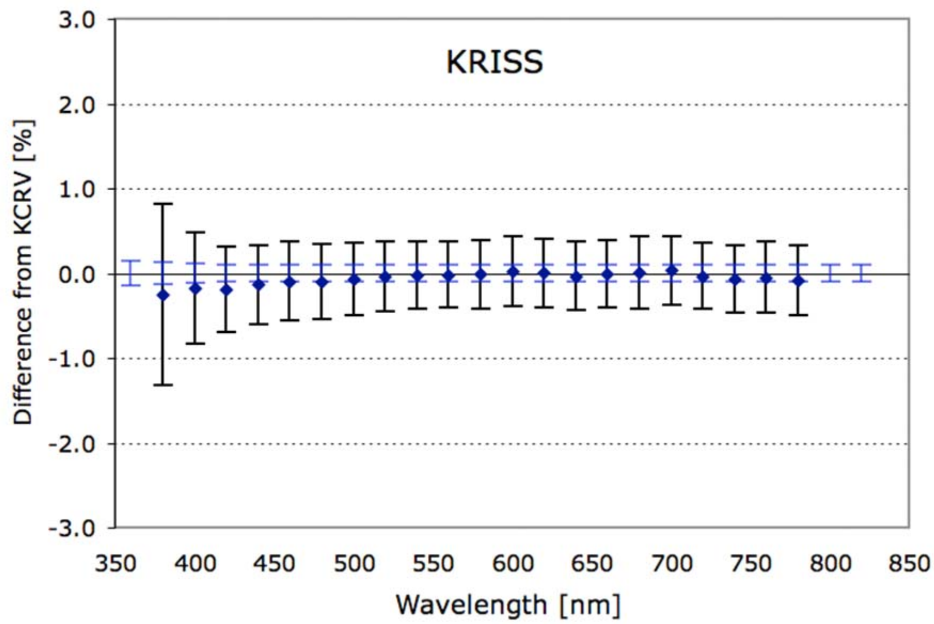


Figure 13.8 Relative differences from KCRV for KRISS

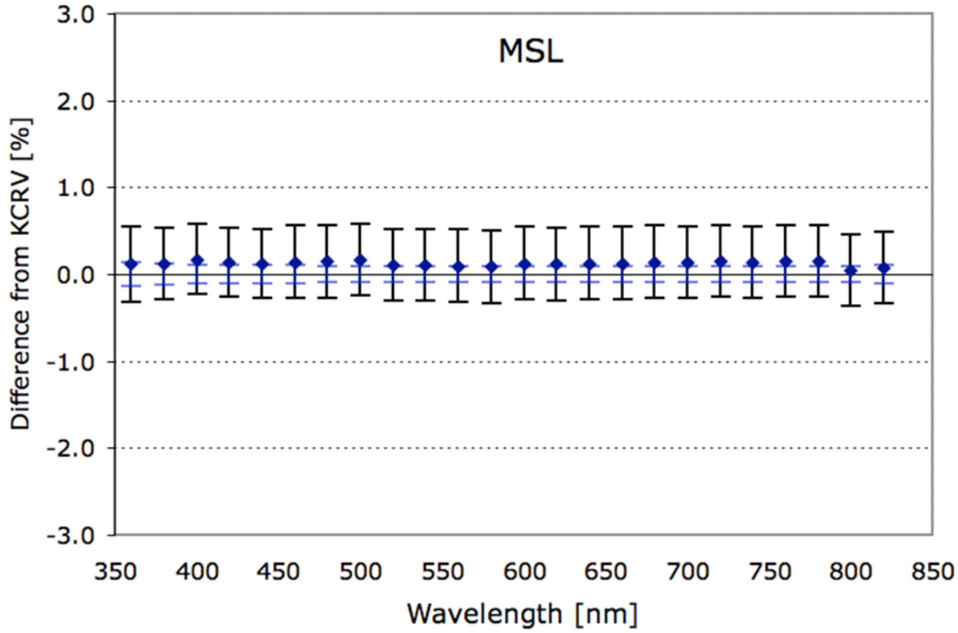


Figure 13.9 Relative differences from KCRV for MSL

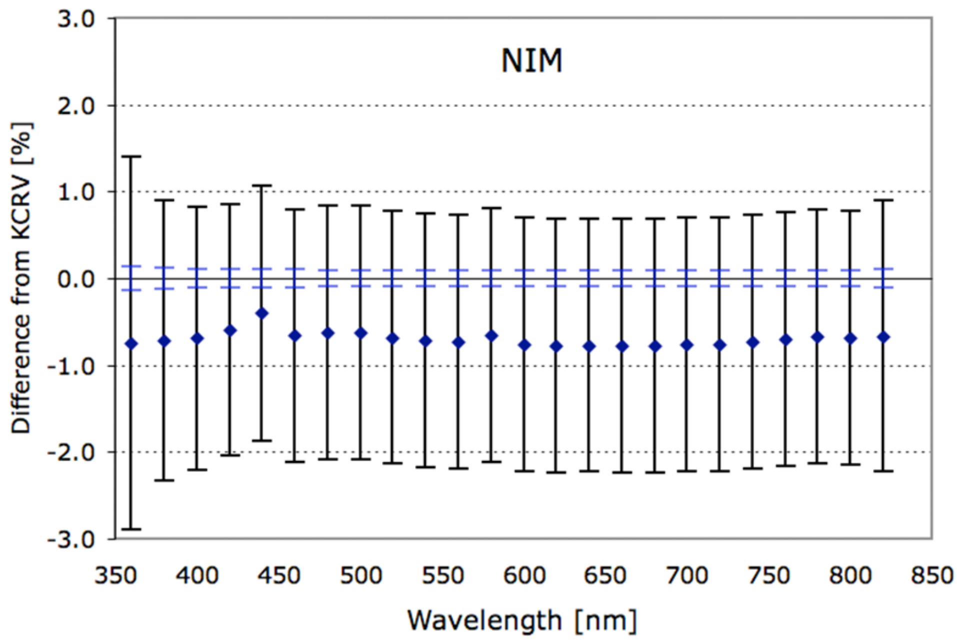


Figure 13.10 Relative differences from KCRV for NIM

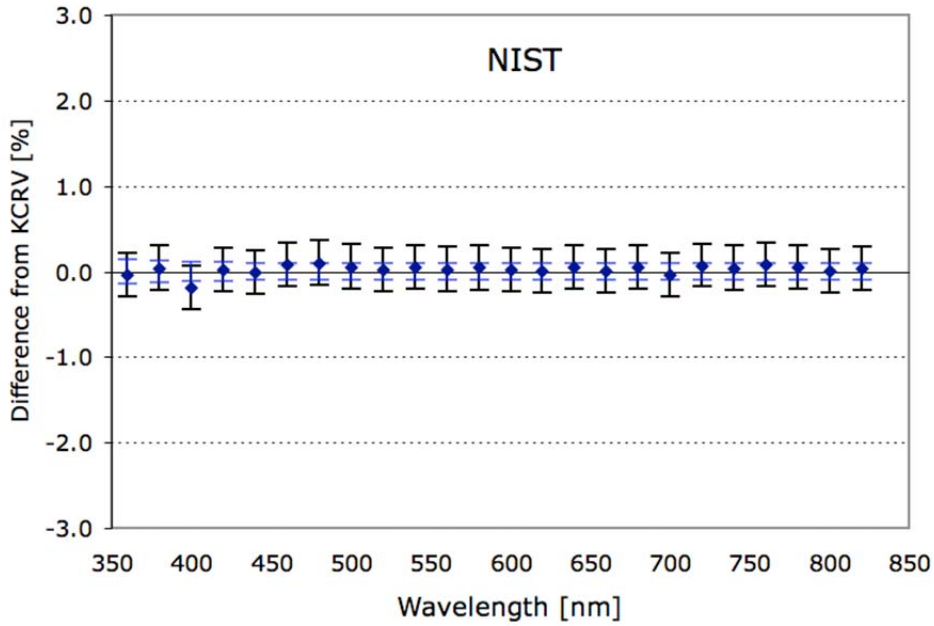


Figure 13.11 Relative differences from KCRV for NIST

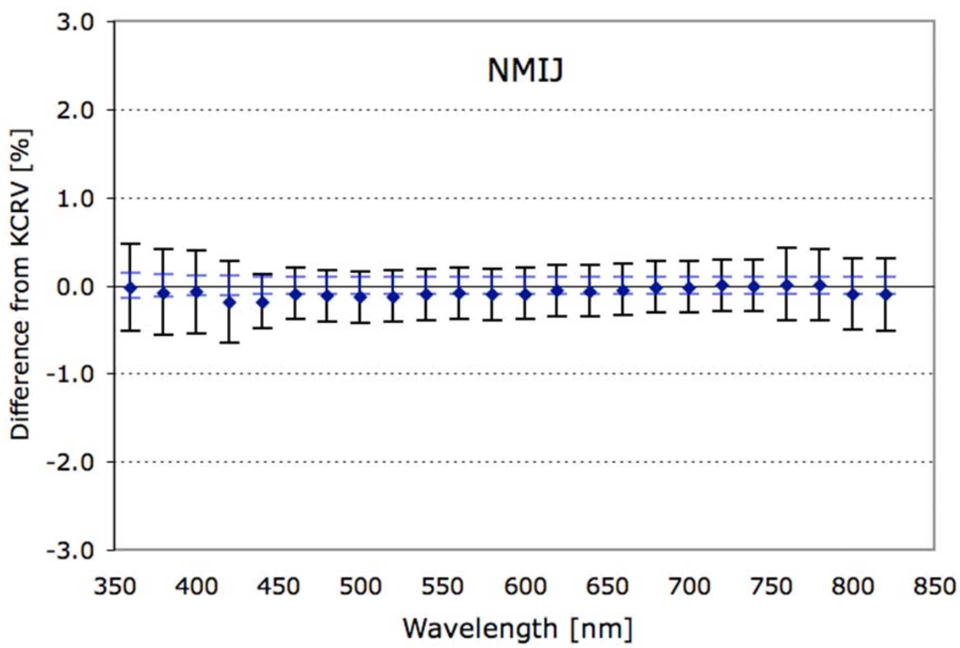


Figure 13.12 Relative differences from KCRV for NMIJ

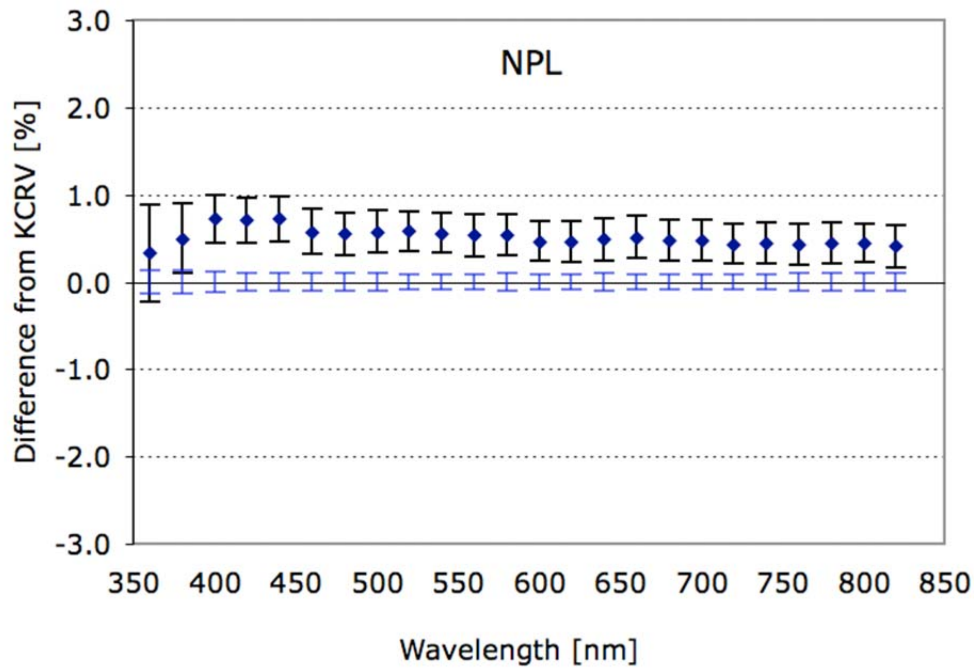


Figure 13.13 Relative differences from KCRV for NPL

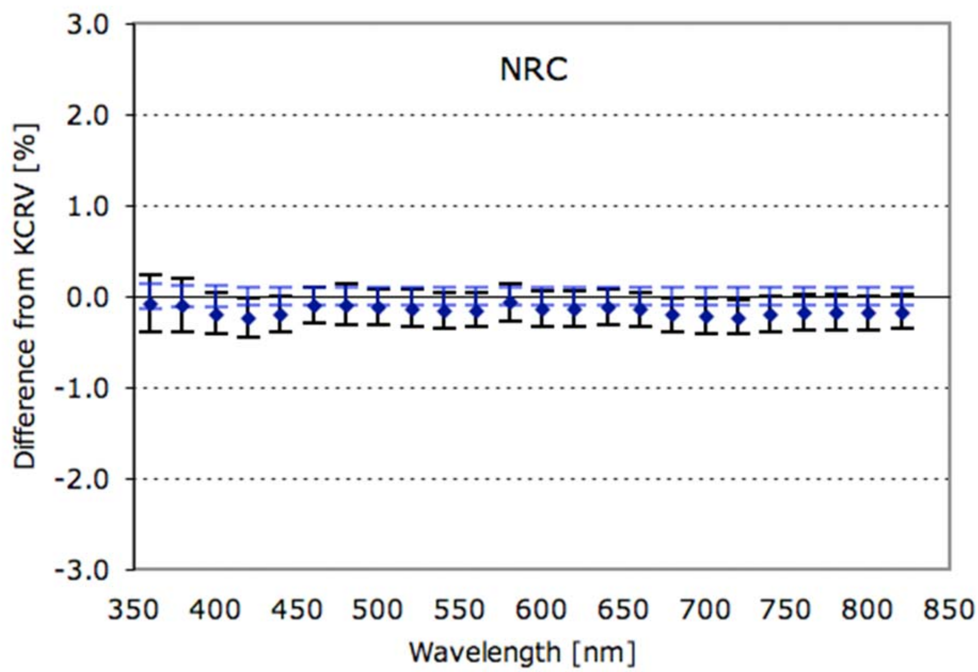


Figure 13.14 Relative differences from KCRV for NRC

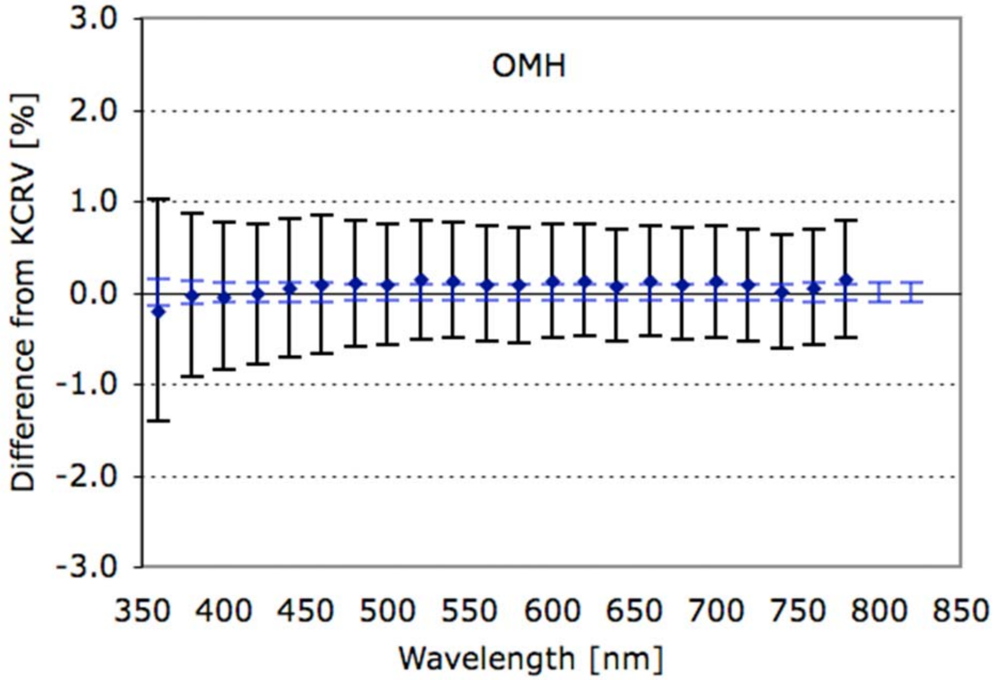


Figure 13.15 Relative differences from KCRV for OMH

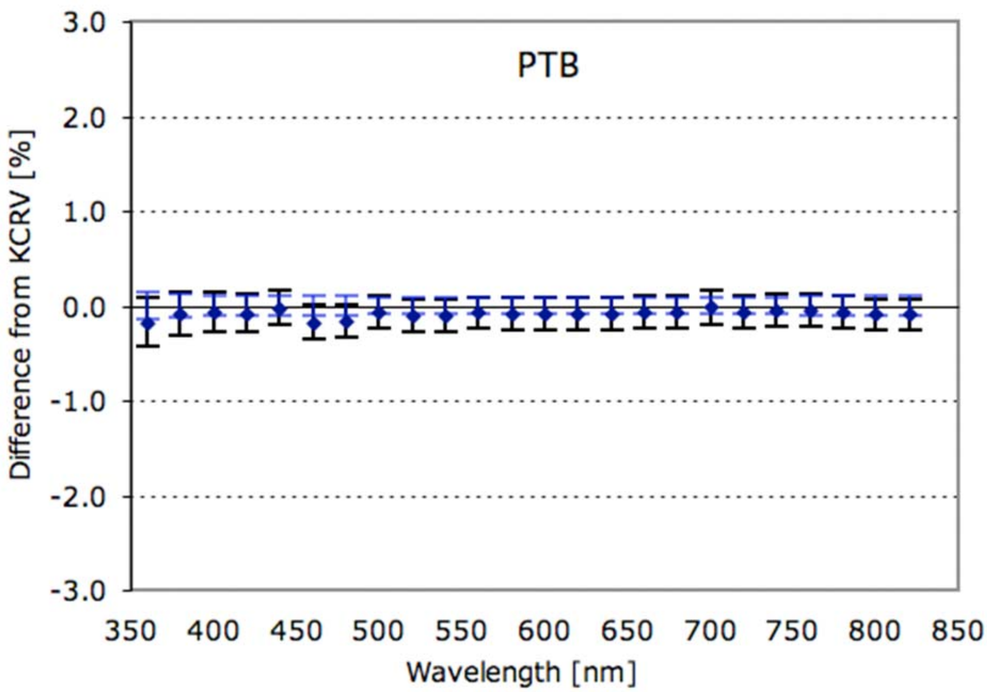


Figure 13.16 Relative differences from KCRV for PTB

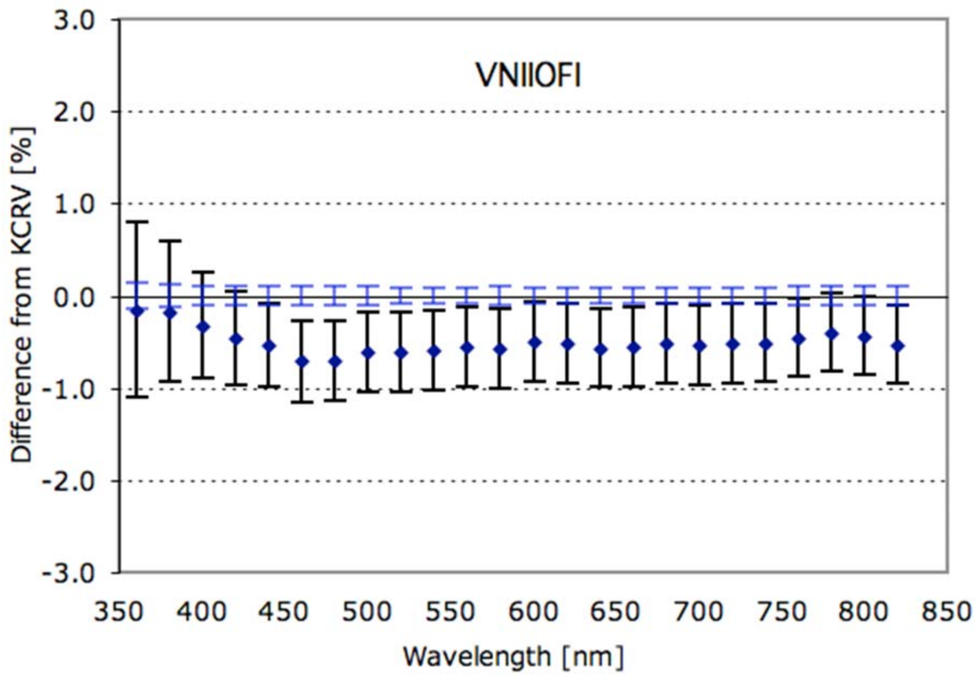


Figure 13.17 Relative differences from KCRV for VNIIOFI

14. Discussion and Conclusions

Thirteen laboratories participated in the international intercomparison of spectral diffuse reflectance measurements in the wavelength range 360 nm to 820 nm. The results showed overall good agreement among the participants. In most of the labs, the relative deviations from the KCRV are within their expanded uncertainty (k=2), with exception of one or two labs. In these final results, the data of 360 nm to 440 nm of Ceramic samples were excluded in the calculation of the KCRV, as decided in the Relative Data review process, not only because problems were observed but also because this comparison was intended for measurement of spectrally flat samples. However, the comparison of the results of these two different type of sample gives us some important implications. The difference in results might be attributed to the surface and volume modes of reflection of ceramic tiles and Spectralon, respectively.

Appendix A and Appendix B present the comparison results analyzed separately for Spectralon samples only and Ceramic samples only, respectively. The results in Appendix A (Spectralon samples only) are very similar to the final combined results and do not show general problems. The results in Appendix B (Ceramic samples only), however, clearly show that many of the participants, including the pilot lab, had notable problems in the short wavelength range of Ceramic samples. The large shifts of more than 1 % around 360 nm and 380 nm observed in several laboratories are difficult to understand. The shifts are too large for errors related to wavelength uncertainties and slope of the diffuse reflectance curve of the ceramic samples used. Effects of fluorescence were first suspected, but the measurements by NRC clarified that fluorescence from those ceramic samples used in this comparison was at the negligible level. The shifts of NIST results for ceramic samples, however, are not considered to have affected in the transfer measurements as the pilot lab, because all the NIST transfer measurements were strict substitution measurements using the same type of reference standards. We presume that some systematic error may have been introduced when the reference standards were initially calibrated by STARR. Again, it would affect the NIST results only as a participant, and not as the pilot. In any case, that portion of Ceramic sample results were excluded in the analysis of KCRV for the final results of this comparison. But these results indicate that there are some unknown issues in the measurement of ceramic samples. Further investigation on measurement of ceramic samples may be needed.

It is also observed in the results that the disparities between some participants' results may be related to the differences between the sphere-based realization and gonio-based realization of the scale. Further investigations in this respect are also expected.

15. References:

[1] P. Y. Barnes, E. A. Early, and A. C. Parr, "NIST Measurement Services: Spectral Reflectance," NIST Special Publication 250-48 (1998).

[2] W. H. Venable, Jr., J. J. Hsia, and V. R. Weidner, "Establishing a Scale of Directional–Hemispherical Reflectance Factor I: The Van den Akker Method," *J. Res. Natl. Bur. Stand.* **82**, 29 (1977).

[3] B. N. Taylor and C. E. Kuyatt, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results," NIST Technical Note 1297 (1994).

[4] V. R. Weidner and J. J. Hsia, "Reflection Properties of Pressed Polytetrafluoroethylene Powder," J. Opt. Soc. Am. 71, 856 (1981).

Appendix A. Comparison Results for Spectralon Samples Only

Table A.1 Relative Difference from KCRV for Spectralon Samples for all Participants, Values are in Percentage.

Wavelength [nm]	CSIR-NML	HUT	IFA-CSIC	KRISS	MSL	NIM	NMIJ	NIST	NPL	NRC	OMH	PTB	VNIIOFI
360	-0.10	0.27			0.12	-0.75	-0.02	-0.04	0.33	-0.08	-0.20	-0.18	-0.15
380	0.15	0.31	-1.38	-0.25	0.12	-0.72	-0.08	0.04	0.50	-0.10	-0.03	-0.09	-0.17
400	0.14	0.33	-1.40	-0.17	0.17	-0.69	-0.07	-0.18	0.73	-0.19	-0.04	-0.06	-0.32
420	0.03	0.26	-1.13	-0.19	0.14	-0.59	-0.19	0.02	0.71	-0.24	-0.02	-0.08	-0.46
440	-0.15	0.27	-0.92	-0.14	0.12	-0.40	-0.18	-0.01	0.73	-0.20	0.04	-0.02	-0.53
460	-0.12	0.28	-0.83	-0.14	0.13	-0.36	-0.16	-0.02	0.69	-0.17	0.07	-0.03	-0.55
480	-0.25	0.31	-0.48	-0.12	0.13	-0.33	-0.17	0.01	0.68	-0.16	0.08	-0.02	-0.56
500	-0.27	0.31	-0.78	-0.09	0.18	-0.31	-0.17	0.01	0.67	-0.15	0.08	0.02	-0.47
520	-0.17	0.30	-0.64	-0.08	0.14	-0.36	-0.17	-0.02	0.63	-0.16	0.14	0.01	-0.45
540	-0.21	0.28	-0.61	-0.06	0.14	-0.39	-0.16	0.00	0.61	-0.17	0.12	0.00	-0.44
560	-0.42	0.27	-0.39	-0.04	0.13	-0.40	-0.14	-0.06	0.62	-0.18	0.11	0.06	-0.42
580	-0.38	0.29	-0.51	-0.06	0.13	-0.41	-0.16	0.02	0.60	-0.18	0.12	0.04	-0.42
600	-0.39	0.30	-0.52	-0.04	0.14	-0.42	-0.15	-0.03	0.60	-0.18	0.15	0.05	-0.37
620	-0.32	0.28	-0.53	-0.07	0.14	-0.48	-0.13	-0.03	0.58	-0.19	0.15	0.06	-0.40
640	-0.44	0.30	-0.47	-0.06	0.17	-0.46	-0.13	0.00	0.56	-0.17	0.12	0.06	-0.43
660	-0.43	0.29	-0.42	-0.06	0.16	-0.49	-0.12	-0.04	0.55	-0.16	0.16	0.07	-0.42
680	-0.57	0.34	-0.39	-0.09	0.16	-0.51	-0.10	-0.01	0.55	-0.16	0.13	0.07	-0.41
700	-0.45	0.35	-0.40	-0.06	0.16	-0.52	-0.10	-0.08	0.55	-0.16	0.12	0.09	-0.45
720	-0.62	0.34	-0.33	-0.12	0.16	-0.52	-0.08	0.01	0.52	-0.16	0.09	0.09	-0.42
740	-0.52	0.33	-0.29	-0.15	0.15	-0.50	-0.10	-0.01	0.54	-0.16	0.06	0.07	-0.41
760	-0.67	0.39	-0.43	-0.15	0.16	-0.47	-0.09	0.04	0.53	-0.14	0.06	0.09	-0.36
780	-0.76	0.40	-0.42	-0.17	0.16	-0.42	-0.09	0.01	0.56	-0.13	0.16	0.09	-0.31
800	-0.82	0.31			0.03	-0.46	-0.22	-0.07	0.52	-0.22		-0.01	-0.36
820	-0.77	0.35			0.05	-0.46	-0.23	-0.04	0.52	-0.21		-0.02	-0.48

Table A.2 Relative Expanded Uncertainties (k=2) of the Relative Difference values in Table A.1. Values are in percentage.

Wavelength [nm]	CSIR-NML	HUT	IFA-CSIC	KRISS	MSL	NIM	NMIJ	NIST	NPL	NRC	OMH	PTB	VNIIOFI
360	0.68	0.44			0.43	2.14	0.50	0.25	0.55	0.31	1.22	0.26	0.95
380	0.67	0.43	0.65	1.07	0.41	1.62	0.49	0.26	0.40	0.29	0.89	0.23	0.76
400	0.53	0.42	0.64	0.66	0.41	1.51	0.47	0.25	0.27	0.22	0.80	0.21	0.57
420	0.52	0.42	0.64	0.51	0.40	1.45	0.47	0.26	0.25	0.21	0.77	0.20	0.51
440	0.52	0.42	0.64	0.46	0.40	1.47	0.31	0.26	0.26	0.20	0.76	0.19	0.44
460	0.41	0.41	0.63	0.46	0.40	1.46	0.30	0.26	0.24	0.20	0.75	0.18	0.42
480	0.41	0.41	0.47	0.44	0.39	1.46	0.29	0.26	0.24	0.19	0.68	0.17	0.42
500	0.41	0.41	0.47	0.42	0.39	1.46	0.29	0.26	0.23	0.19	0.66	0.17	0.42
520	0.41	0.41	0.46	0.42	0.39	1.46	0.30	0.26	0.22	0.19	0.65	0.17	0.42
540	0.41	0.41	0.46	0.40	0.39	1.46	0.30	0.26	0.22	0.19	0.63	0.17	0.42
560	0.41	0.41	0.46	0.40	0.39	1.46	0.30	0.26	0.22	0.18	0.63	0.17	0.42
580	0.41	0.41	0.46	0.40	0.39	1.46	0.29	0.26	0.22	0.17	0.63	0.17	0.42
600	0.41	0.41	0.46	0.42	0.39	1.46	0.29	0.26	0.22	0.18	0.62	0.18	0.42
620	0.41	0.41	0.46	0.40	0.39	1.46	0.29	0.26	0.22	0.18	0.61	0.17	0.42

(Continued.)

640	0.41	0.41	0.46	0.40	0.39	1.46	0.30	0.26	0.23	0.18	0.61	0.17	0.42
660	0.41	0.41	0.46	0.40	0.39	1.46	0.29	0.26	0.23	0.18	0.60	0.17	0.42
680	0.41	0.41	0.46	0.40	0.39	1.46	0.30	0.26	0.22	0.18	0.61	0.17	0.42
700	0.41	0.41	0.46	0.40	0.40	1.46	0.29	0.26	0.22	0.18	0.61	0.18	0.42
720	0.41	0.41	0.46	0.40	0.40	1.46	0.30	0.26	0.22	0.18	0.61	0.18	0.42
740	0.41	0.41	0.46	0.40	0.40	1.46	0.29	0.26	0.22	0.18	0.62	0.18	0.42
760	0.41	0.41	0.46	0.39	0.39	1.46	0.42	0.26	0.23	0.18	0.63	0.18	0.42
780	0.41	0.41	0.46	0.39	0.39	1.46	0.41	0.26	0.22	0.18	0.64	0.18	0.42
800	0.59	0.41			0.39	1.46	0.41	0.26	0.21	0.17		0.17	0.41
820	0.59	0.41			0.39	1.56	0.42	0.26	0.22	0.17		0.17	0.42

The figures below are the plots of relative differences from KCRV for each participant for Spectralon samples only. The bar indicates the relative expanded uncertainty (k=2) of each point. The expanded uncertainties (k=2) of the KCRV are also plotted in blue lines (gray lines in black and white print).

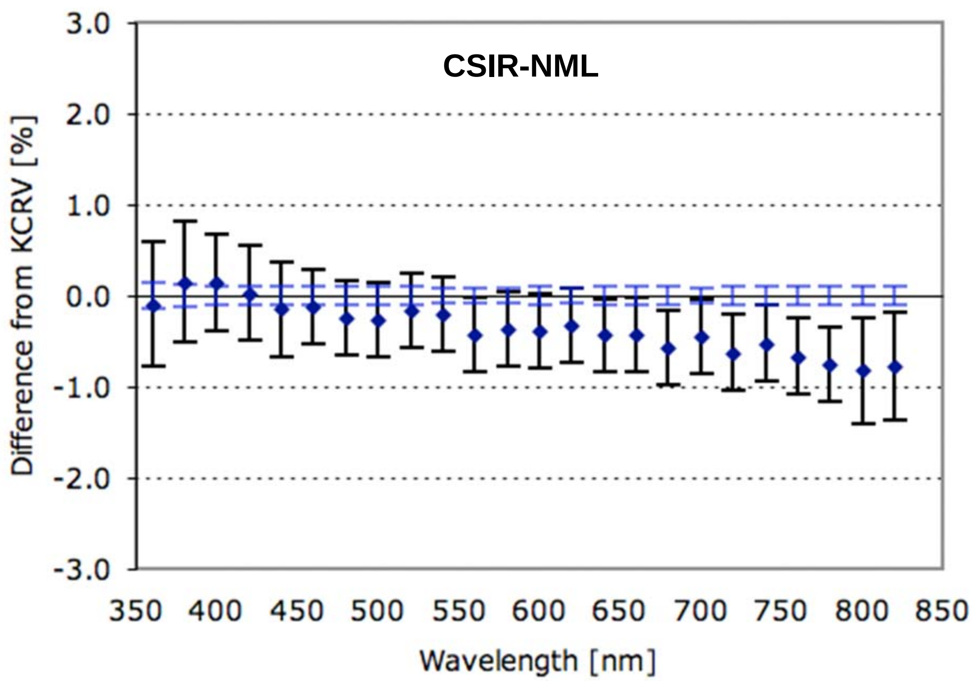


Figure A.1 Spectralon samples relative differences from KCRV for CSIR-NML

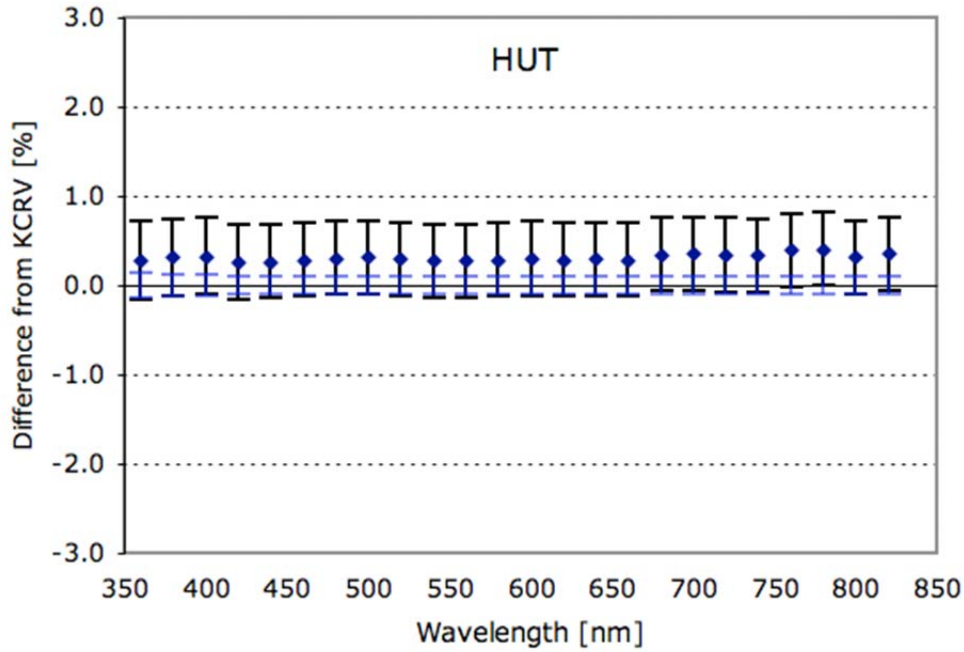


Figure A.2 Spectralon samples relative differences from KCRV for HUT

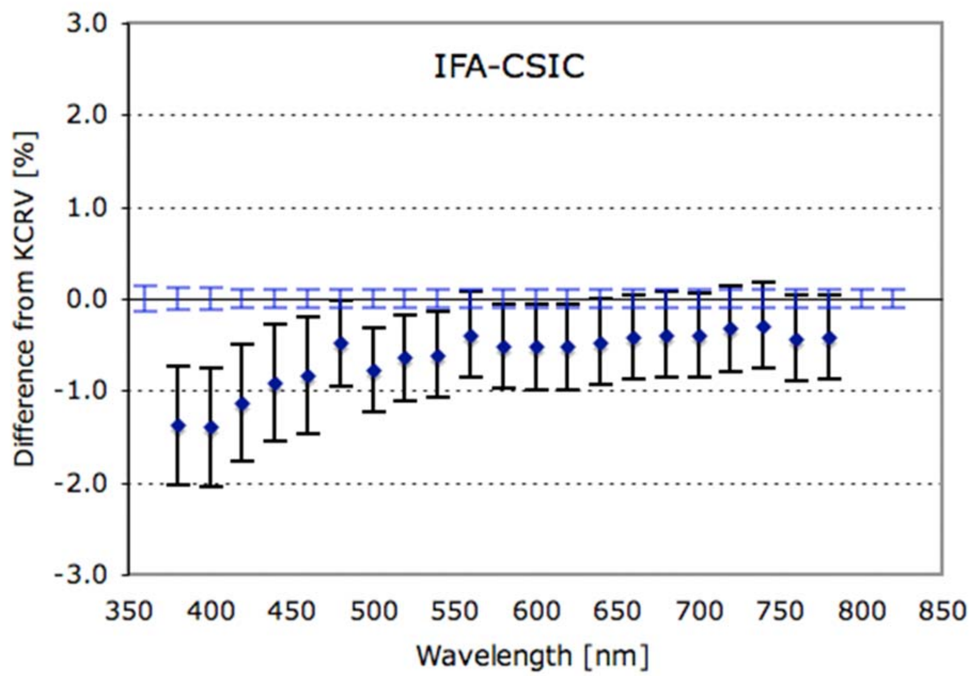


Figure A.3 Spectralon samples relative differences from KCRV for IFA-CSIC

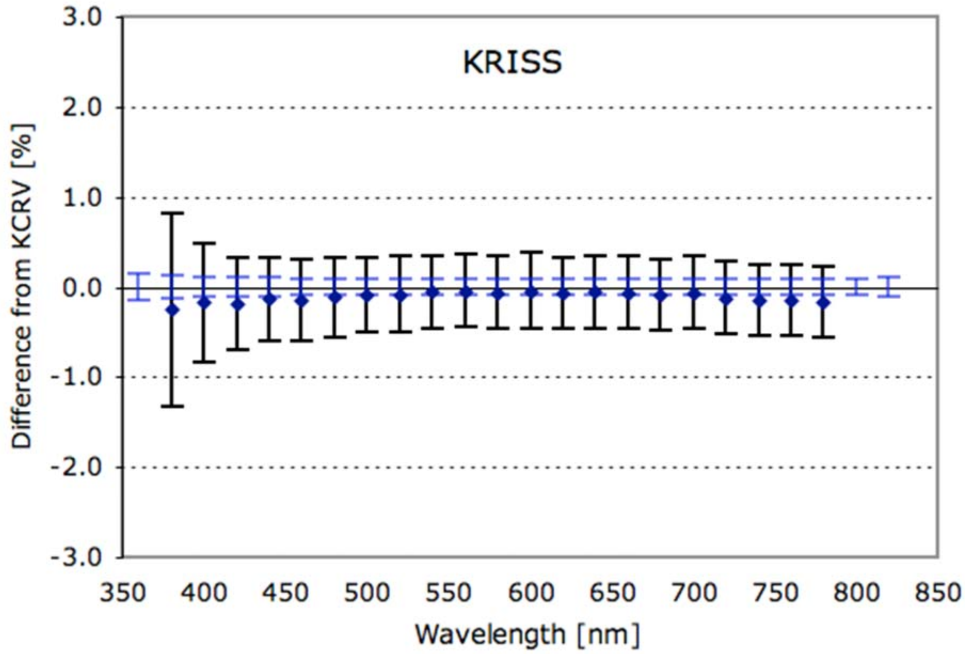


Figure A.4 Spectralon samples relative differences from KCRV for KRISS

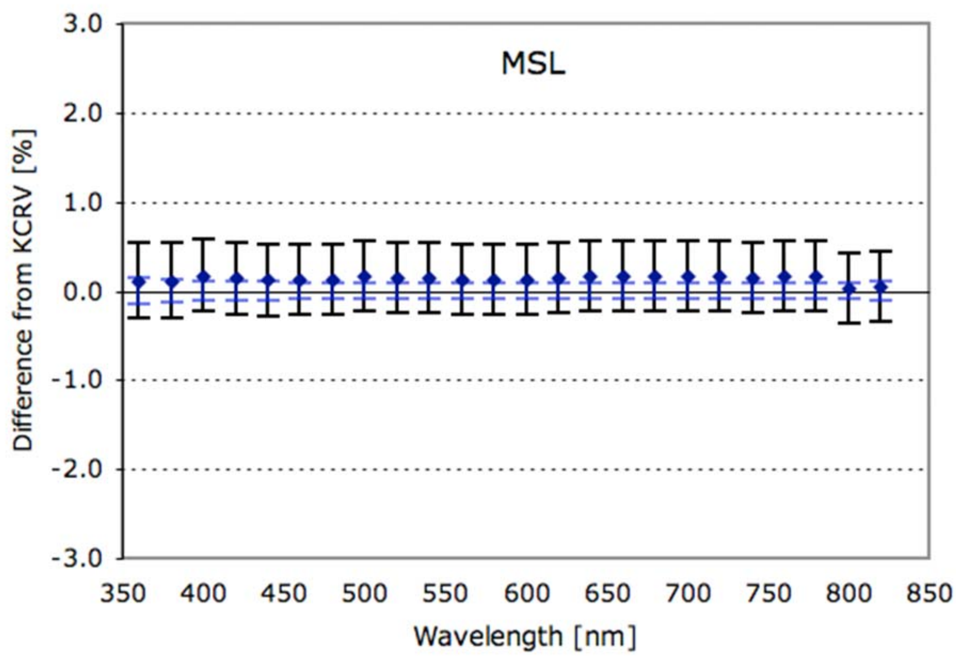


Figure A.5 Spectralon samples relative differences from KCRV for MSL

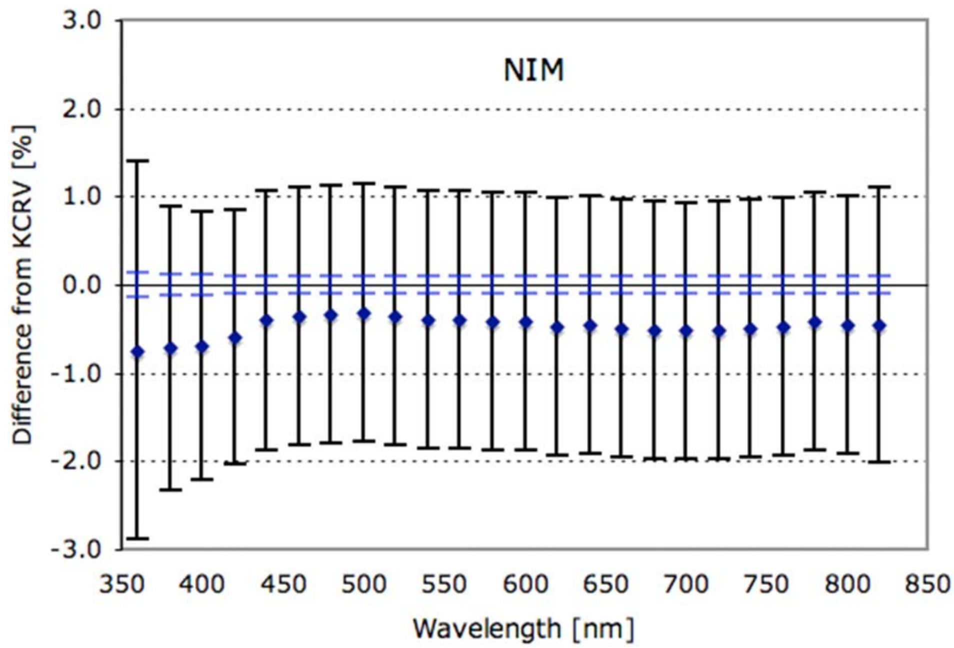


Figure A.6 Spectralon samples relative differences from KCRV for NIM

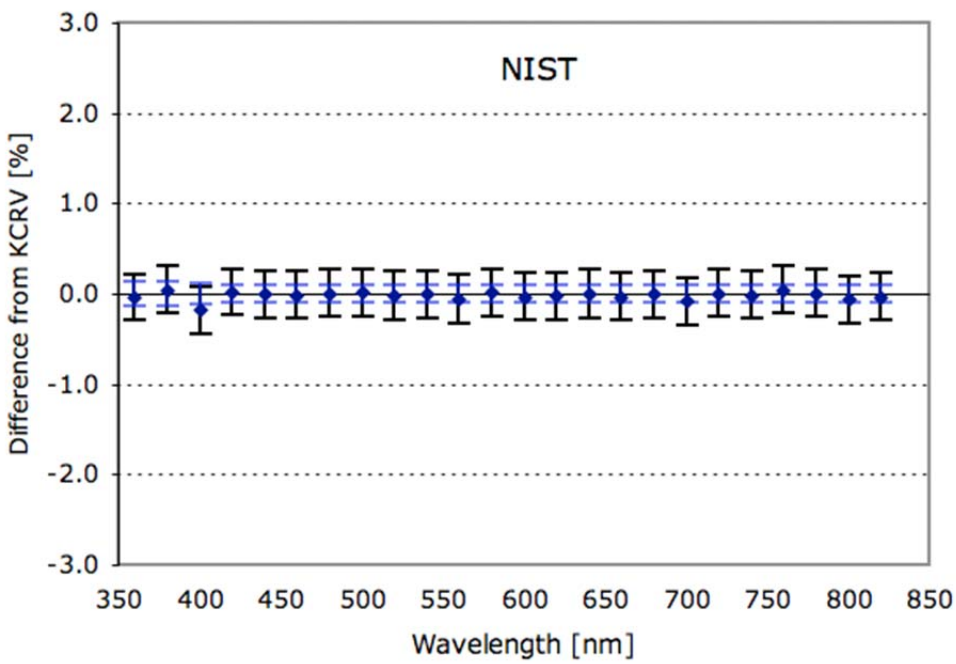


Figure A.7 Spectralon samples relative differences from KCRV for NIST

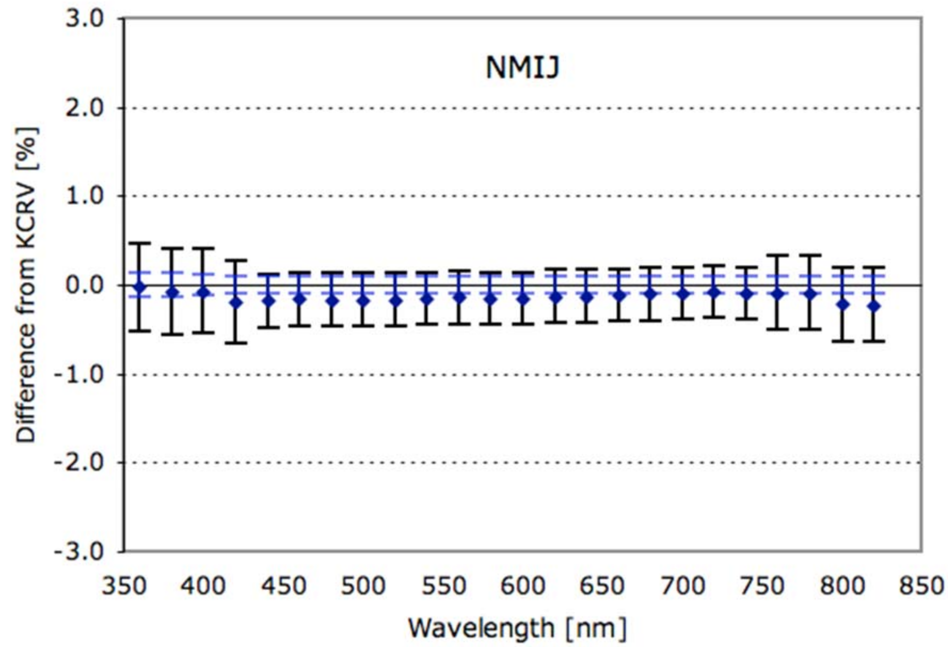


Figure A.8 Spectralon samples relative differences from KCRV for NMIJ

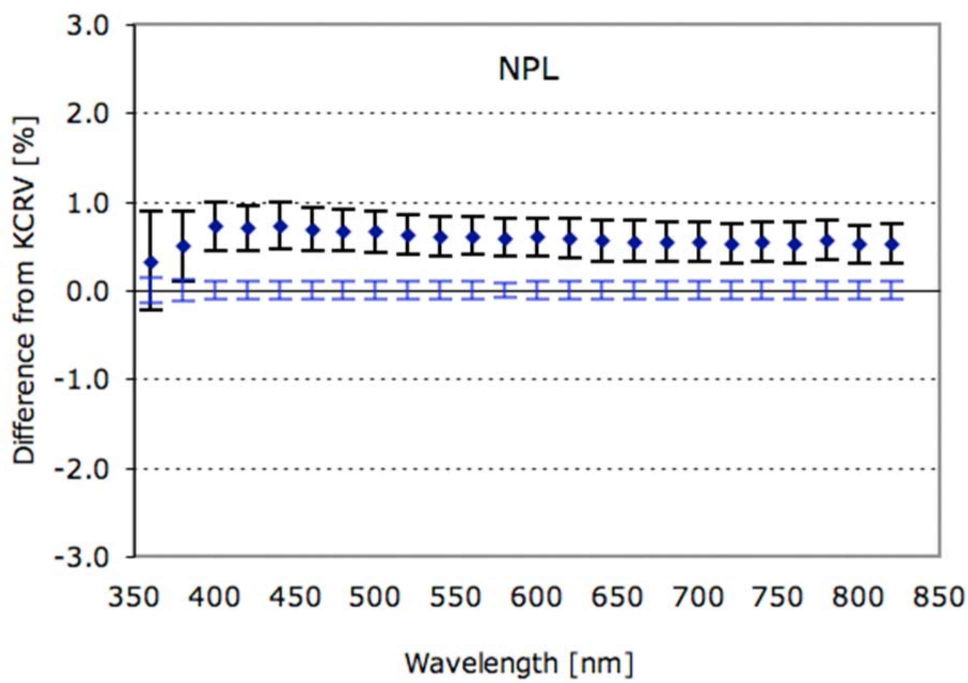


Figure A.9 Spectralon samples relative differences from KCRV for NPL

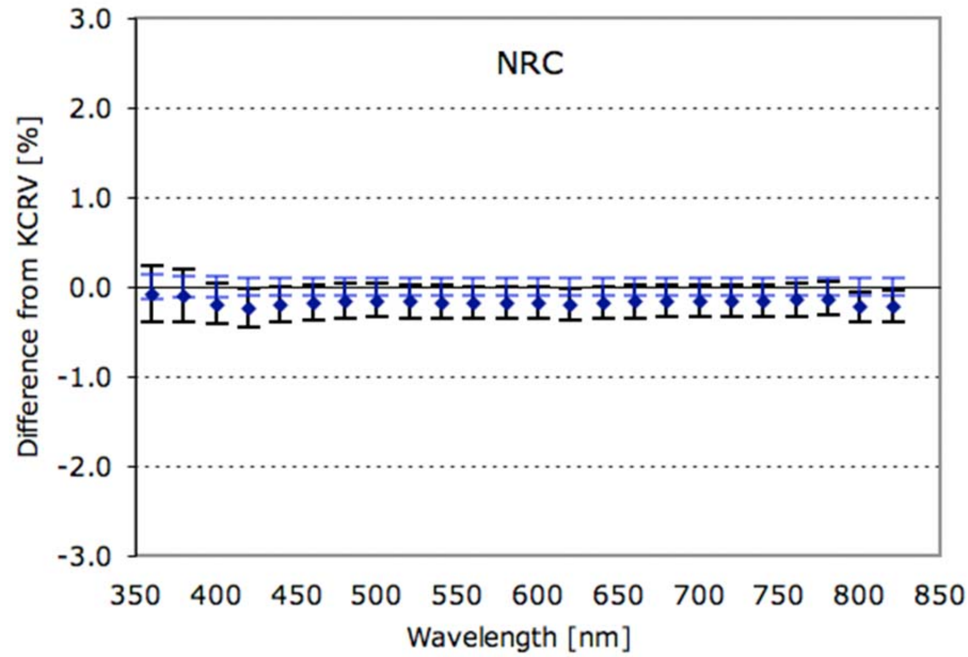


Figure A.10 Spectralon samples relative differences from KCRV for NRC

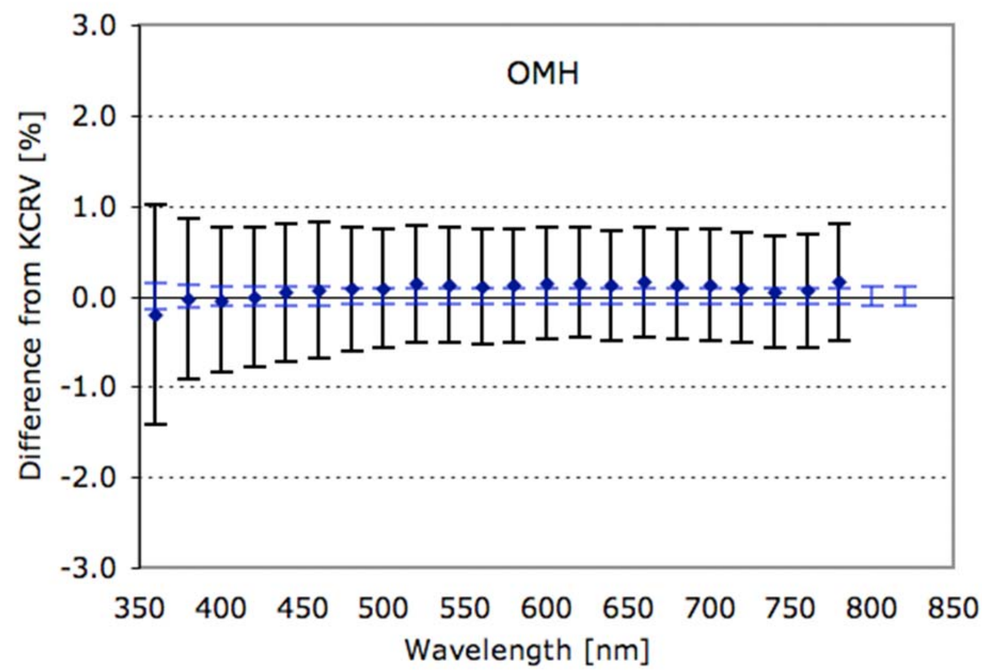


Figure A.11 Spectralon samples relative differences from KCRV for OMH

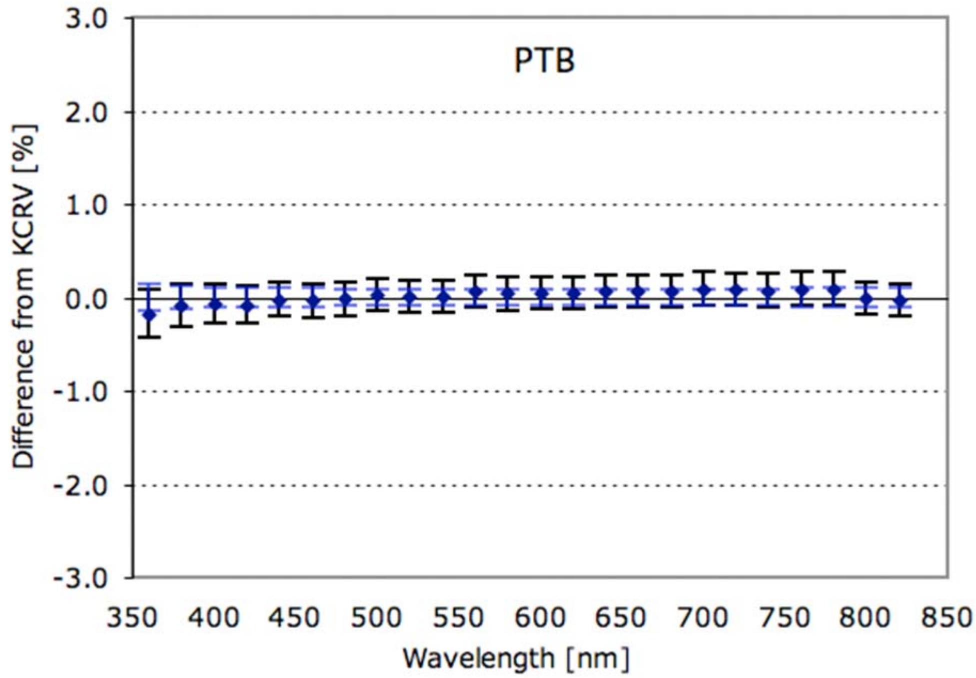


Figure A.12 Spectralon samples relative differences from KCRV for PTB

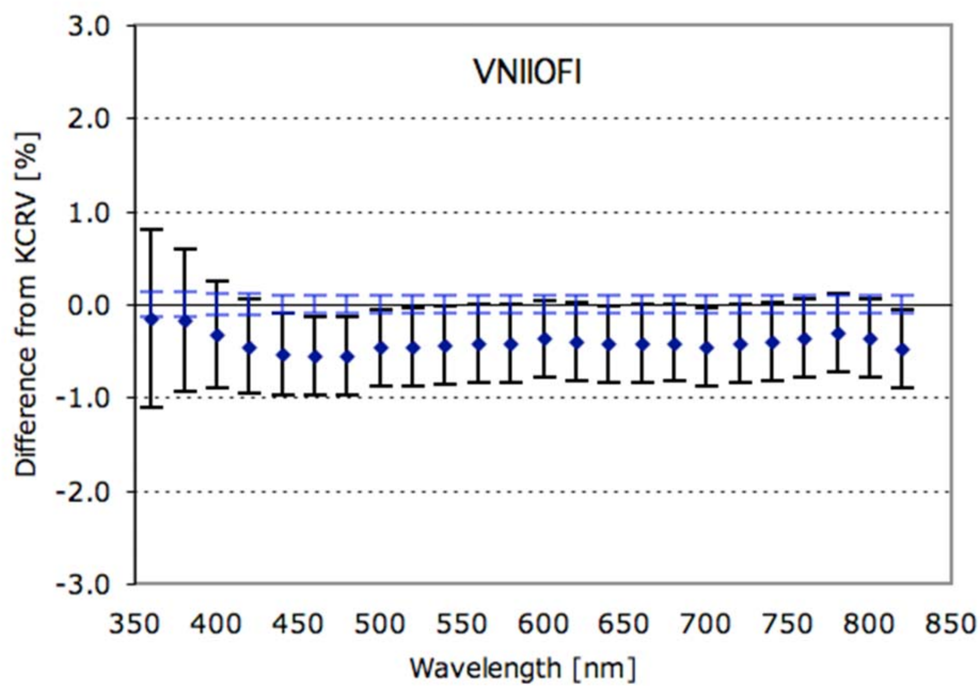


Figure A.13 Spectralon samples relative differences from KCRV for VNIIOFI

Appendix B. Comparison Results for Ceramic Samples Only

Table B.1 Relative differences from KCRV for ceramic samples for all participants. Values are in Percentage.

Wavelength [nm]	CSIR-NML	HUT	IFA-CSIC	KRISS	MSL	NIM	NMIJ	NIST	NPL	NRC	OMH	PTB	VNIIOFI
360	0.01	0.04			0.10	-1.33	-0.96	2.40	-0.40	1.71	0.22	-1.34	-1.82
380	0.44		-1.68	-0.79	0.16	-1.68	-0.54	1.03	0.97	0.65	0.21	-0.74	-1.08
400	0.72	0.28	-1.39	-0.33	0.26	-1.46	0.21	0.66	0.61	-0.36	0.10	-0.61	-0.85
420	0.76	0.22	-0.92	-0.24	0.22	-1.33	-0.06	0.41	0.46	0.01	0.03	-0.39	-0.87
440	0.41	0.20	-0.80	-0.15	0.19	-1.13	-0.10	0.26	0.62	0.15	0.05	-0.42	-0.94
460	0.51	0.22	-0.79	-0.03	0.17	-0.95	-0.02	0.19	0.47	-0.02	0.13	-0.30	-0.87
480	0.37	0.23	-0.39	-0.09	0.17	-0.92	-0.06	0.20	0.43	-0.03	0.13	-0.30	-0.84
500	0.37	0.21	-0.61	-0.03	0.16	-0.93	-0.09	0.11	0.50	-0.07	0.09	-0.17	-0.74
520	0.45	0.14	-0.49	0.01	0.08	-1.00	-0.08	0.08	0.54	-0.09	0.15	-0.20	-0.77
540	0.39	0.15	-0.50	0.02	0.08	-1.03	-0.04	0.11	0.51	-0.13	0.14	-0.21	-0.73
560	0.32	0.15	-0.28	0.01	0.07	-1.06	-0.02	0.12	0.45	-0.13	0.08	-0.21	-0.69
580	0.18	0.15	-0.38	0.04	0.04	-0.90	-0.05	0.08	0.48	0.04	0.04	-0.22	-0.73
600	0.27	0.19	-0.24	0.10	0.12	-1.10	-0.03	0.09	0.34	-0.09	0.11	-0.22	-0.62
620	0.34	0.17	-0.27	0.07	0.10	-1.08	0.01	0.05	0.36	-0.10	0.11	-0.21	-0.65
640	0.17	0.15	-0.12	-0.01	0.08	-1.08	0.01	0.09	0.41	-0.08	0.03	-0.22	-0.70
660	0.13	0.16	-0.26	0.05	0.09	-1.06	0.02	0.06	0.48	-0.13	0.09	-0.21	-0.69
680	0.05	0.21	-0.14	0.10	0.13	-1.03	0.06	0.12	0.40	-0.24	0.06	-0.20	-0.63
700	0.14	0.23	-0.16	0.12	0.12	-1.00	0.06	0.02	0.40	-0.27	0.11	-0.13	-0.62
720	0.05	0.22	-0.03	0.06	0.14	-1.01	0.09	0.14	0.35	-0.29	0.08	-0.21	-0.60
740	0.10	0.22	-0.04	0.02	0.12	-0.96	0.09	0.10	0.35	-0.24	-0.04	-0.17	-0.61
760	-0.08	0.26	-0.04	0.06	0.13	-0.94	0.11	0.14	0.32	-0.21	0.06	-0.19	-0.55
780	-0.09	0.26	0.09	-0.01	0.13	-0.92	0.11	0.10	0.33	-0.21	0.14	-0.23	-0.49
800	-0.07	0.21			0.06	-0.90	0.03	0.08	0.37	-0.14		-0.17	-0.52
820	-0.03	0.31			0.10	-0.86	0.02	0.11	0.30	-0.12		-0.16	-0.58

Table B.2 Relative expanded uncertainties (k=2) of the relative difference values in Table B.1. Values are in percentage.

Wavelength [nm]	CSIR-NML	HUT	IFA-CSIC	KRISS	MSL	NIM	NMIJ	NIST	NPL	NRC	OMH	PTB	VNIIOFI
360	1.10	0.42			0.65	2.14	0.55	0.28	1.12	0.57	1.21	0.31	1.34
380	0.92	0.42	0.63	1.05	0.55	1.61	0.50	0.28	0.68	0.44	0.89	0.30	0.84
400	0.84	0.42	0.63	0.65	0.49	1.51	0.46	0.27	0.40	0.32	0.80	0.29	0.63
420	0.80	0.41	0.63	0.49	0.46	1.44	0.45	0.27	0.33	0.27	0.78	0.28	0.55
440	0.78	0.41	0.63	0.46	0.46	1.46	0.30	0.27	0.34	0.33	0.76	0.20	0.49
460	0.76	0.41	0.63	0.47	0.45	1.46	0.28	0.26	0.27	0.20	0.75	0.18	0.45
480	0.47	0.41	0.46	0.44	0.44	1.46	0.28	0.26	0.25	0.25	0.68	0.17	0.45
500	0.47	0.41	0.46	0.44	0.44	1.46	0.28	0.26	0.24	0.19	0.66	0.17	0.45
520	0.46	0.41	0.46	0.40	0.44	1.46	0.28	0.26	0.24	0.21	0.65	0.17	0.44
540	0.46	0.41	0.46	0.39	0.44	1.46	0.28	0.26	0.24	0.21	0.63	0.17	0.44
560	0.46	0.41	0.46	0.39	0.44	1.46	0.29	0.26	0.26	0.19	0.63	0.17	0.44
580	0.45	0.41	0.46	0.41	0.44	1.46	0.28	0.26	0.26	0.25	0.63	0.17	0.44

(Continued.)

600	0.45	0.41	0.46	0.42	0.44	1.46	0.29	0.26	0.24	0.21	0.62	0.17	0.44
620	0.45	0.41	0.46	0.41	0.44	1.46	0.28	0.26	0.24	0.21	0.61	0.17	0.44
640	0.45	0.41	0.46	0.41	0.44	1.46	0.28	0.26	0.26	0.21	0.61	0.17	0.44
660	0.45	0.41	0.46	0.39	0.44	1.46	0.29	0.26	0.25	0.19	0.60	0.17	0.44
680	0.45	0.41	0.46	0.44	0.44	1.46	0.29	0.26	0.24	0.21	0.61	0.17	0.44
700	0.45	0.41	0.46	0.41	0.44	1.46	0.29	0.26	0.24	0.21	0.61	0.17	0.44
720	0.45	0.41	0.46	0.39	0.44	1.46	0.29	0.26	0.24	0.21	0.61	0.17	0.44
740	0.45	0.41	0.46	0.39	0.44	1.46	0.29	0.26	0.25	0.21	0.62	0.17	0.44
760	0.45	0.41	0.46	0.46	0.43	1.46	0.41	0.26	0.24	0.20	0.62	0.17	0.44
780	0.45	0.41	0.46	0.43	0.43	1.46	0.41	0.26	0.25	0.21	0.64	0.17	0.44
800	0.65	0.41			0.43	1.46	0.41	0.26	0.23	0.20		0.17	0.43
820	0.64	0.41			0.43	1.56	0.41	0.25	0.27	0.20		0.17	0.43

The figures below are the plots of relative differences from KCRV for each participant for Ceramic samples only. The bar indicates the relative expanded uncertainty (*k*=2) of each point. The expanded uncertainties (*k*=2) of the KCRV are also plotted in blue lines (gray lines in black and white print).

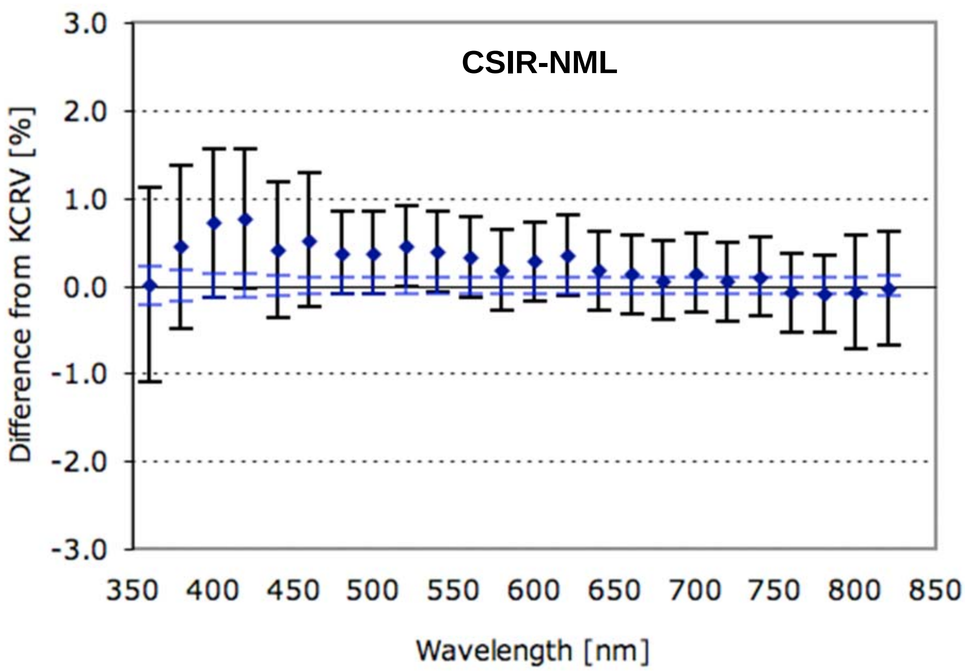


Figure B.1 Ceramic samples relative differences from KCRV for CSIR-NML

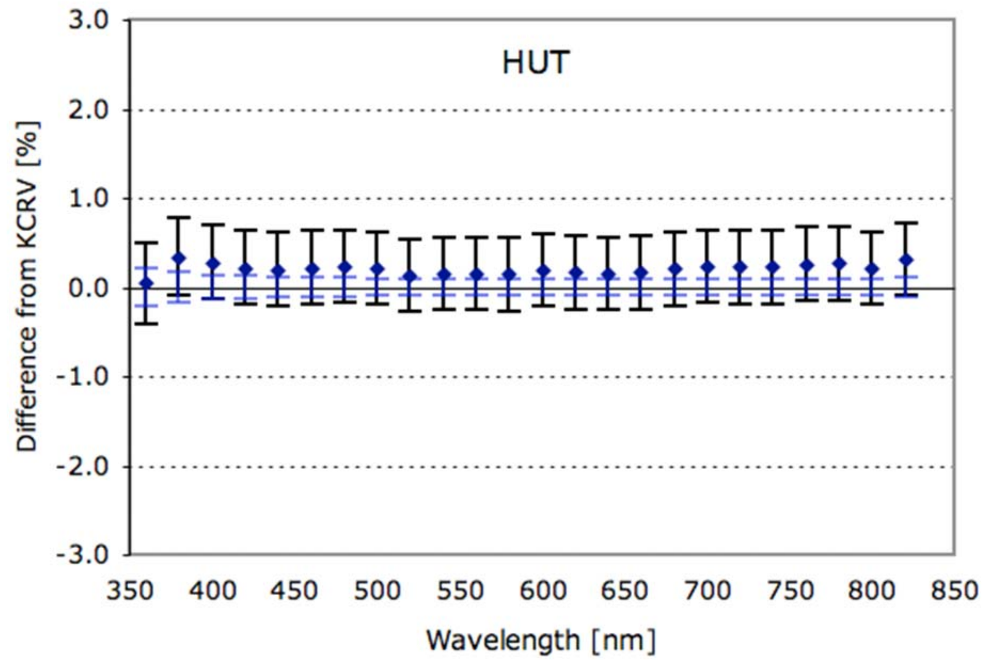


Figure B.2 Ceramic samples relative differences from KCRV for HUT

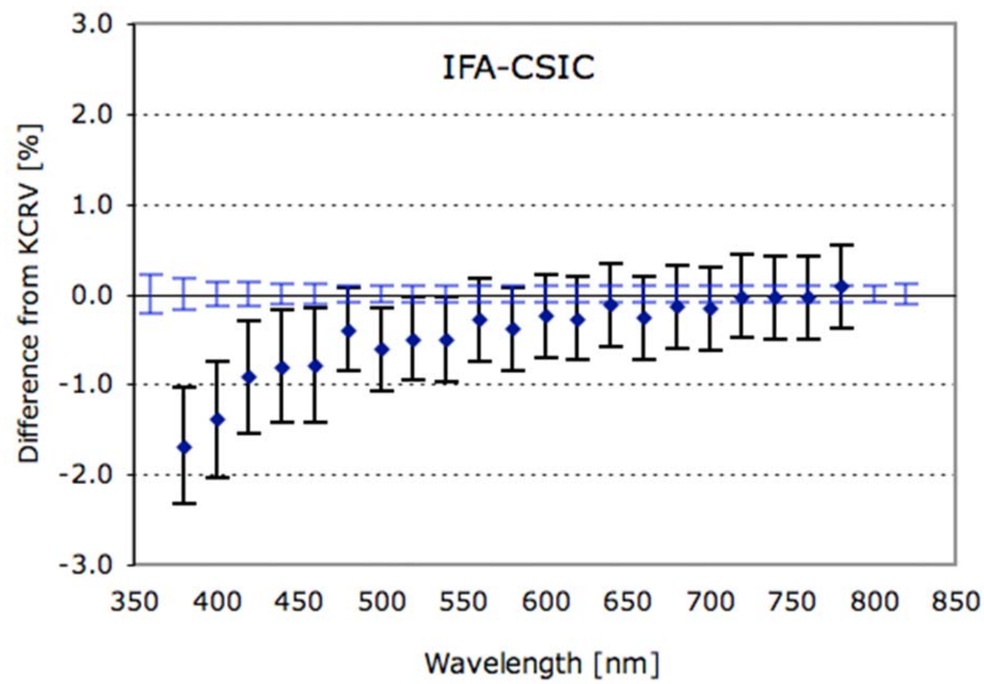


Figure B.3 Ceramic samples relative differences from KCRV for IFA-CSIC

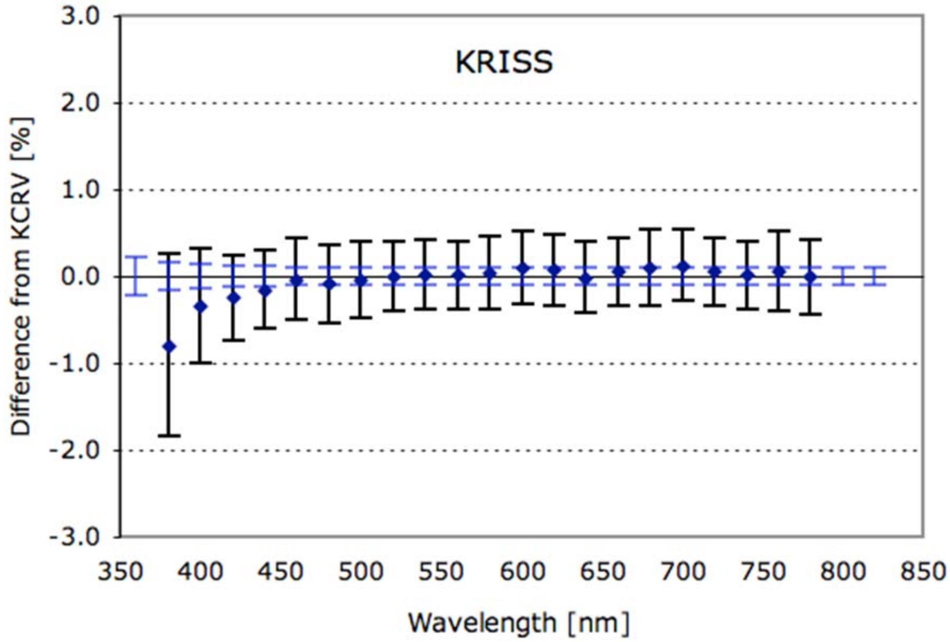


Figure B.4 Ceramic samples relative differences from KCRV for KRISS

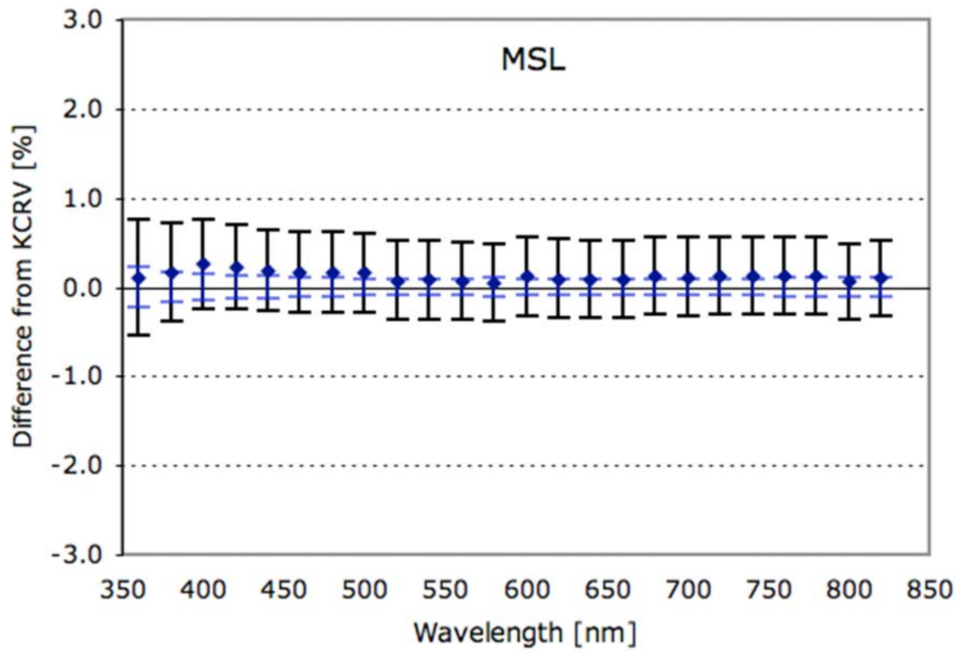


Figure B.5 Ceramic samples relative differences from KCRV for MSL

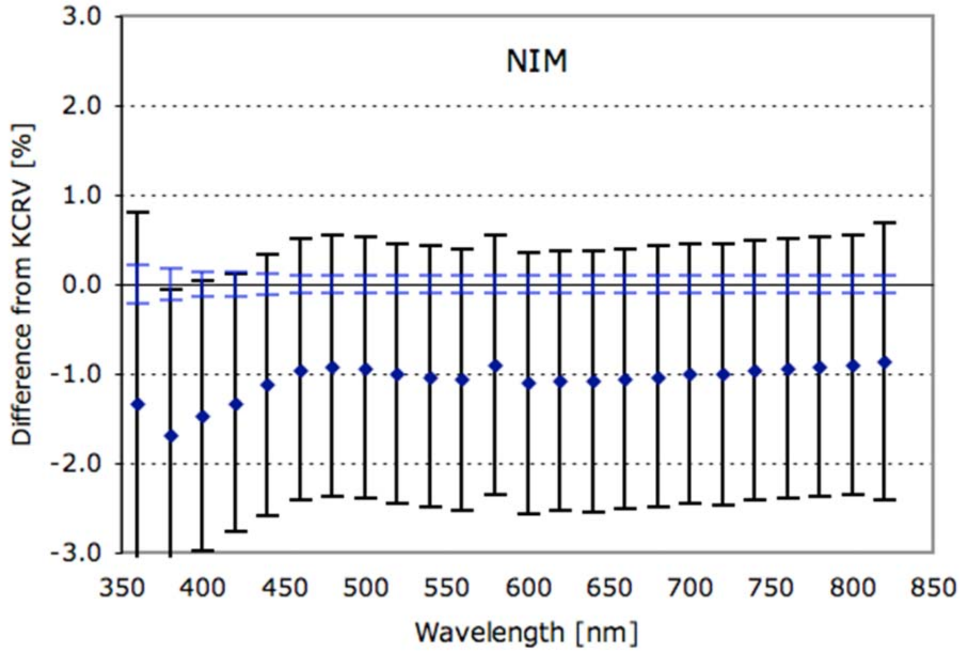


Figure B.6 Ceramic samples relative differences from KCRV for NIM

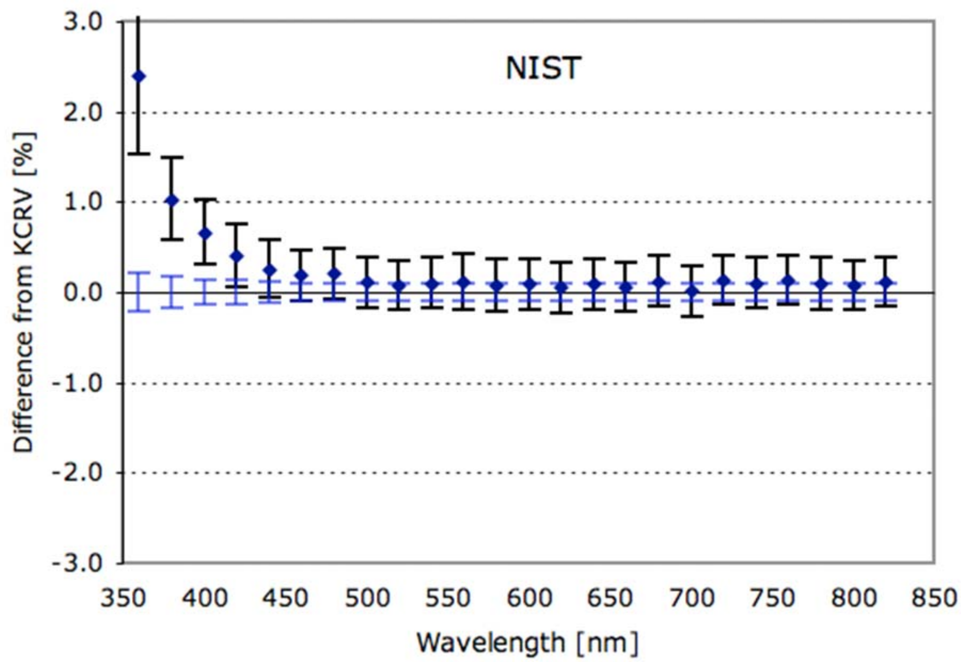


Figure B.7 Ceramic samples relative differences from KCRV for NIST

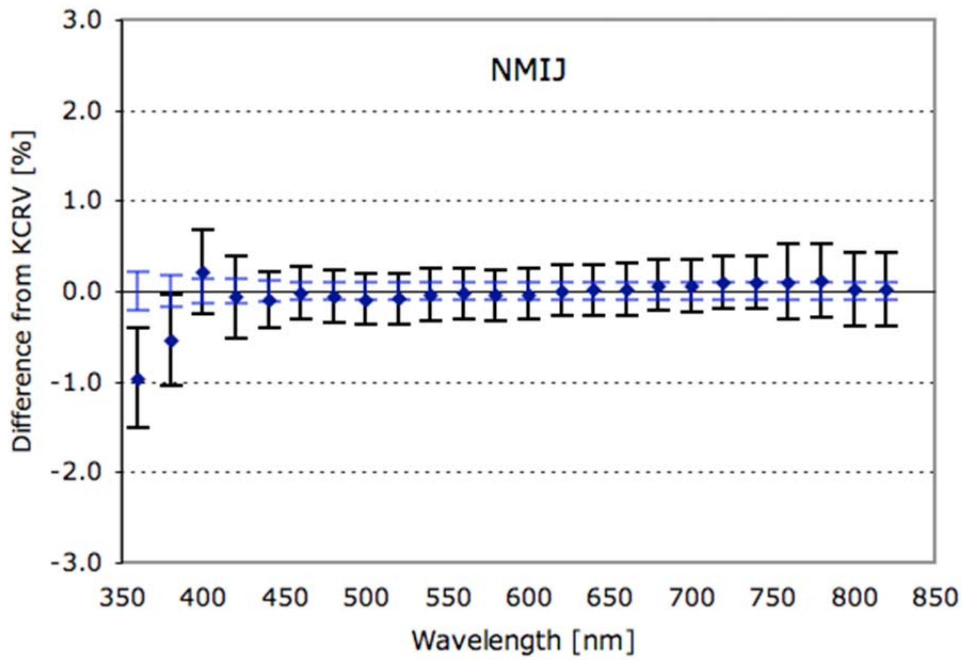


Figure B.8 Ceramic samples relative differences from KCRV for NMIJ

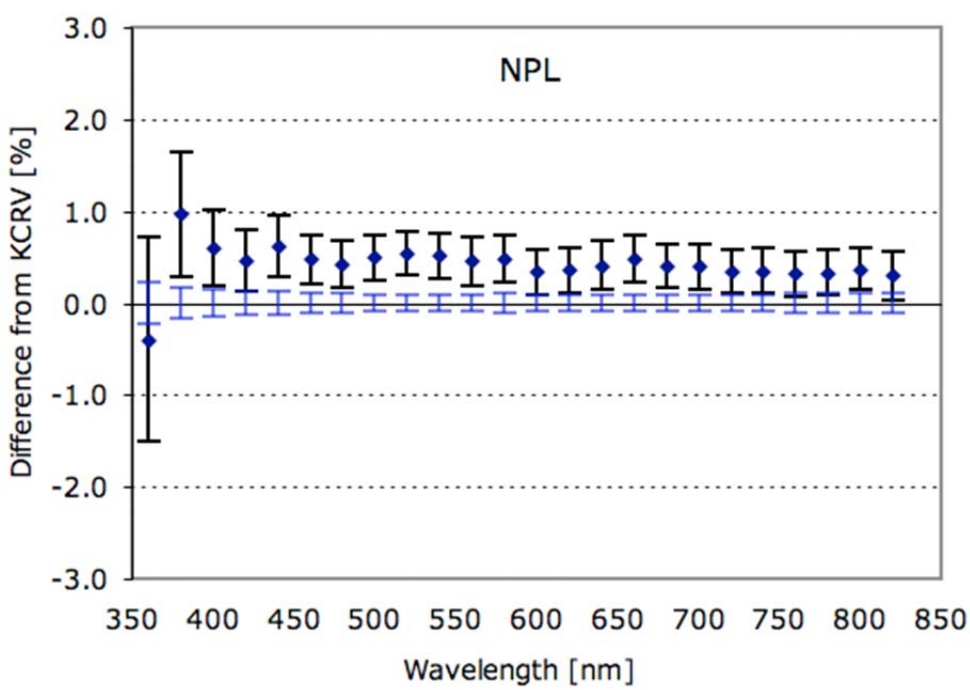


Figure B.9 Ceramic samples relative differences from KCRV for NPL

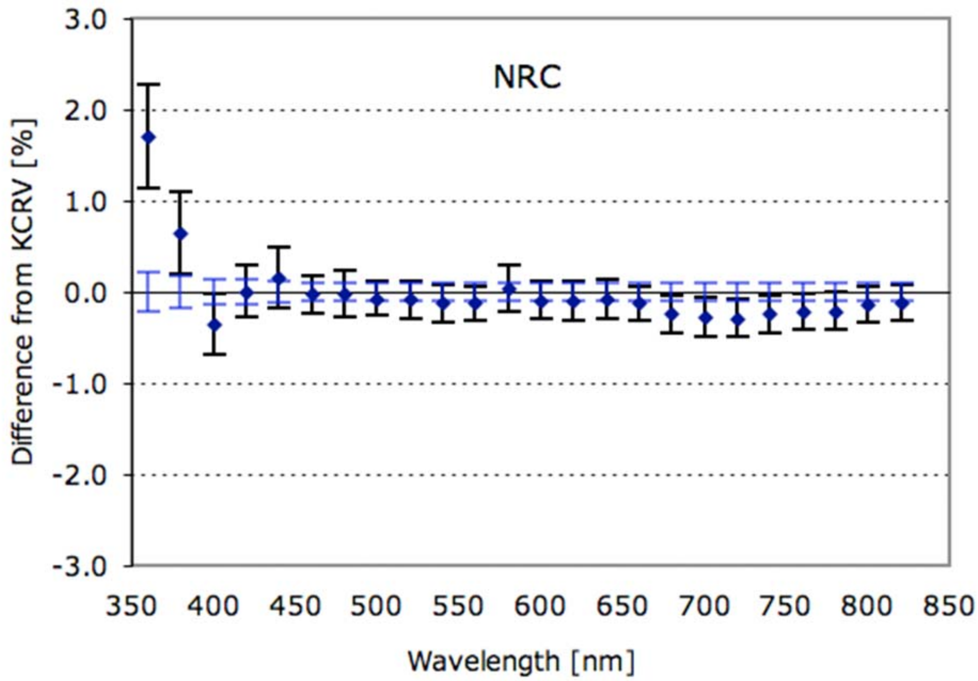


Figure B.10 Ceramic samples relative differences from KCRV for NRC

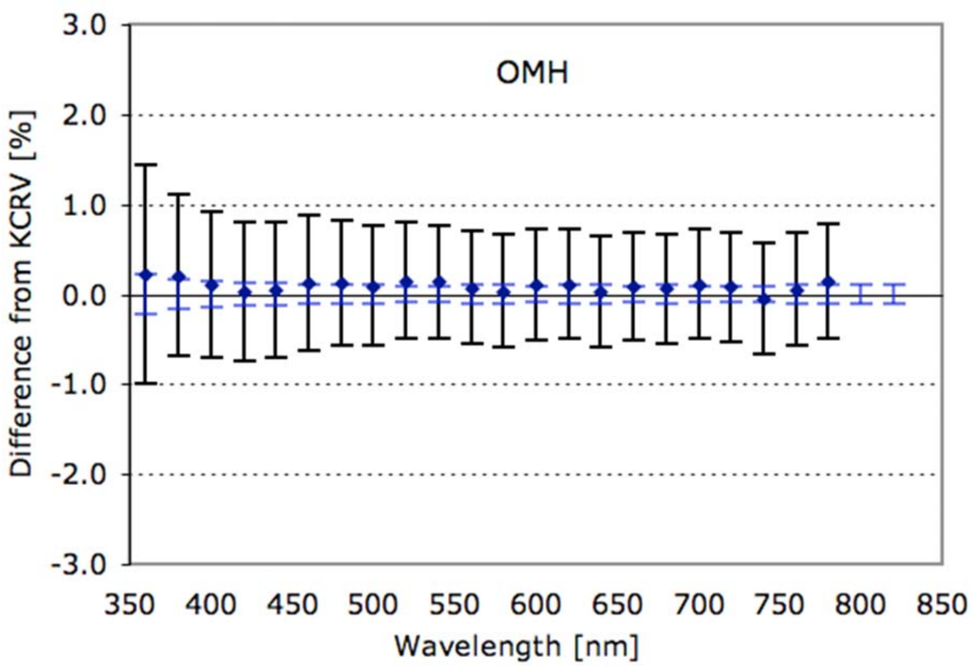


Figure B.11 Ceramic samples relative differences from KCRV for OMH

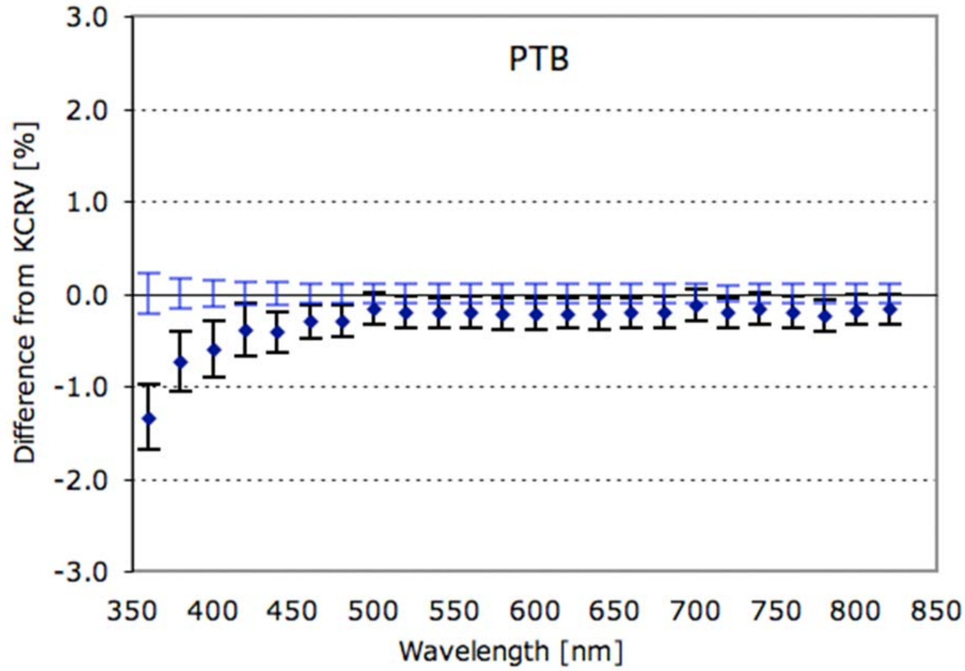


Figure B.12 Ceramic samples relative differences from KCRV for PTB

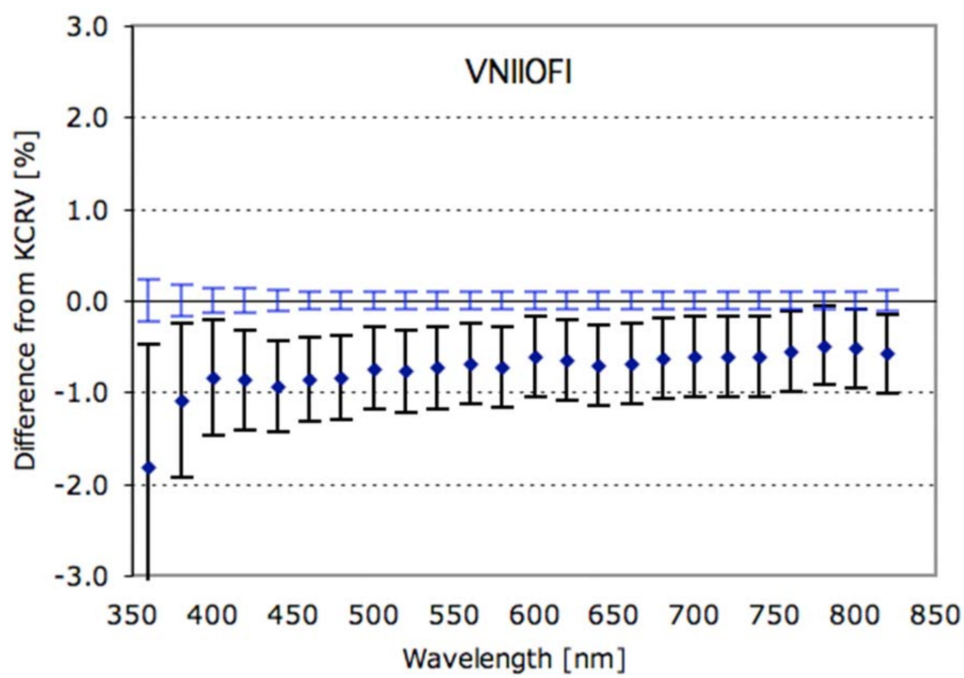


Figure B.13 Ceramic samples relative differences from KCRV for VNIIOFI

Appendix C. Changes of the Reported Uncertainties made after Uncertainty Review in Pre-Draft A process

(1) NMIJ revised the reported uncertainty values of ceramic tiles (C16) from 0.0014 to 0.0017 at 360 nm, and from 0.0017 to 0.0018 at 380 nm.

(2) VNIIOFI revised the reported uncertainty values as below.

	Originally submitted		**Revised**	
VNIIOFI	Spectralon (S04)	Ceramic Tile (C04)	Spectralon (S04)	Ceramic Tile (C04)
	S04	C04	S04	C04
Wavelength	Absolute (Reflectance Factor Units) Standard Uncertainty (k=1)	Absolute (Reflectance Factor Units) Standard Uncertainty (k=1)	Absolute (Reflectance Factor Units) Standard Uncertainty (k=1)	Absolute (Reflectance Factor Units) Standard Uncertainty (k=1)
360	0.0006	0.0004	0.0046	0.0040
380	0.0006	0.0005	0.0037	0.0030
400	0.0006	0.0005	0.0028	0.0025
420	0.0006	0.0005	0.0025	0.0023
440	0.0006	0.0005	0.0022	0.0021
460	0.0006	0.0005	0.0021	0.0020
480	0.0006	0.0005	0.0021	0.0020
500	0.0006	0.0006	0.0021	0.0020
520	0.0006	0.0006	0.0021	0.0020
540	0.0006	0.0006	0.0021	0.0020
560	0.0006	0.0006	0.0021	0.0020
580	0.0006	0.0006	0.0021	0.0020
600	0.0006	0.0006	0.0021	0.0020
620	0.0006	0.0006	0.0021	0.0020
640	0.0006	0.0006	0.0021	0.0020
660	0.0006	0.0006	0.0021	0.0020
680	0.0006	0.0006	0.0021	0.0020
700	0.0006	0.0006	0.0021	0.0020
720	0.0006	0.0006	0.0021	0.0020
740	0.0006	0.0006	0.0021	0.0020
760	0.0006	0.0006	0.0021	0.0020
780	0.0006	0.0006	0.0021	0.0020
800	0.0006	0.0006	0.0021	0.0020
820	0.0006	0.0006	0.0021	0.0020