COOMET TECHNICAL COMMITTEE TC 1.7
for PHOTOMETRY AND RADIOMETRY

Supplementary comparison

COLOUR TRANSMITTED

COOMET.PR- S10

(COOMET project 640/BY-a/14)

Final Report

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Minsk, 2026

CONTENT

1	INTRODUCTION ……..……..……..……	3
2	PARTICIPANTS …….	3
3	TRANSFER STANDARDS ……..……	5
4	FORM OF COMPARISON ……..…….	6
5	MEASURAND AND MEASUREMENT CONDITIONS ……..……	6
5.1	5.1 Measurement instructions ……..……...	7
6	STABILITY OF TRANSFER STANDARDS ……	7
7	METHOD of COMPARISON DATA ANALYSIS ……	8
7.1	Calculation of comparison Reference Value (RV) ……..……..….	8
7.2	Consistency check ……..……..……..	10
7.3	Calculation of Differences of participant results from RV ……..	10
8	MEASUREMENT RESULTS ……..…..……	11
9	PROCESSING OF MEASUREMENT DATA ……..……	13
9.1	Preliminary values of RV and DRV, and the consistency check ……	16
9.2	Applying Mandel-Paule method ……..……..…….	21
10	COMPARISON RESULTS. DIFFERENCES FROM RV …….	22
11	REFERENCES ……..……..……	32
Annex A	Calculation of tristimulus values ……..……..…….	33
Annex B	PARTICIPANT MEASUREMENT REPORTS ……..…….	35
B.1	BelGIM (pilot), Belarus ……..……	35
B.2	NSC IM, Ukraine ……..…….	44
B.3	TUBITAK UME, Türkiye ……..…….	48
B.4	NIM, China ……..……	56
B.5	INM-MD, Moldova ……..……..…….	62
B.6	NIMT, Tailand ……..…….	66
B .7	VNIIOFI, Russia …….	72

1 INTRODUCTION

This report describes the supplementary comparisons COOMET.PR-S10 of colour coordinates Y, x, y and L^*, a^*, b^* of transmitting materials.

The CIPM Mutual Recognition Arrangement (CIPM MRA) was signed in 1999 with the objectives of establishing the degree of equivalence of national measurement standards and providing for the mutual recognition of calibration and measurement certificates issued by National Metrology Institutes (NMIs) [1]. Under the CIPM MRA the equivalence of national measurement standards maintained by the NMIs is determined by a set of Key Comparisons organised by the Consultative Committees of the CIPM and Supplementary Comparisons organised by the Regional metrological organizations (RMOs).

The comparisons COOMET.PR-S10 was carried out by the Technical Committee for Photometry and Radiometry (TC1.7) of the RMO “Euro-Asian Cooperation of National Metrological Institutions” (COOMET) in accordance with the COOMET project 640/BY-a/14 and following the document CCPR-G7 “Guidelines for RMO PR Supplementary Comparisons” [2] of the Consultative Committee for Photometry and Radiometry (CCPR).

COOMET.PR-S10 was the first international comparison among all RMOs for the colour coordinates of transmitting materials. Seven NMIs took part in this comparison. The Belarusian State Institute of Metrology (BelGIM), the NMI of the Republic of Belarus, acted as a pilot laboratory.

Measurements within COOMET.PR-S10 were performed in the period from 2016 to 2018. Data analysis and the report preparation were done in accordance with the CCPR-G2 “Guidelines for CCPR Key Comparison Report Preparation” [3].

The COOMET.PR-S10 comparison supports the following CMCs of the Classification of Services in Photometry and Radiometry [4]:

6.3 Colour, transmitted, x, y, Y

6.4 Colour, transmitted, $L^*a^*b^*$.

2 PARTICIPANTS

The Technical committee TC1.7 of COOMET appointed BelGIM as a pilot laboratory. The pilot was responsible for:

- preparation of the technical protocol,
- preparation of transfer standards (artifacts),
- registration of comparisons,
- preparation of the "Draft A" report and all subsequent work.

Originally nine NMIs from three RMOs, COOMET, APMP and EURAMET, applied for participation, but finally only seven of them took part in the comparison. The list of the participants is presented in Table 1.

Table 1. Participants of the COOMET.PR-S10 comparison

NMI		**Address/Country**	**Contact person**
Full name	Short mane		
Belarusian State Institute of Metrology	**BelGIM (Pilot)**	93 Starovilensky tract, 220053 Minsk, **Republic of Belarus**	**Olga Tarasova** tarasowaolga@gmail.com Phone: +375 (029) 363 71 42 Fax: +375 017 233 57 99 **Aleksey Mironchyk** mironchyk@belgim.by Phone: +375 017 348 68 20 Fax: +375 017 233 57 99
National Scientific Center «Institute of Metrology».	**NSC IM**	Mironositskaya str. 42, 61002 Kharkov, **Ukraine**	**Mykola Huriev** nickgurev@gmail.com Phone: +38057-704-97-72 Fax: +38 057 700-34-47
All-Russian Research Institute of Optical and Physical Measurements	**VNIIOFI**	Ozernaya str.46, 119361, Moscow, **Russi**a	**Tatiana Gorshkova** gortb@vniiofi.ru **Stanislav Shirokov** shirokov@vniiofi.ru Phone: +7 495 437-33-11 Fax: +7 495 437-29-92
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3 TRANSFER STANDARDS (ARTIFACTS)

The transfer standards consisted of two identical sets of coloured glass filters, SET1 and SET2. Each set contained 7 filters made of transparent coloured glass. The dimensions of each filter were 40x40 mm. Each filter had an identification number written on its surface. The identifiers and colours of the filters are given in Table 2. The set filters are shown in Figure 1.

Table 2. Identifiers and colours of filters

SET 1	SET 2	Colour
6-00-79	043-00-83	Grey
6-13-79	043-13-83	Light green
6-15-79*	043-15-83	Light blue
6-26-79	043-26-83	Light red
6-22-79	043-22-83	Dark green
6-31-79	043-31-83	Dark blue
6-19-79	043-19-83	Dark red

* The filter 6-15-79 showed poor stability during measurements. Therefore, this filter results were finally excluded from the comparison.



Figure 1. Comparison transfer standards: set of coloured glass filters

4 FORM OF COMPARISON

All participants, except the pilot, were divided into two groups:

Group 1: NSC IM and VNIIOFI;

Group 2: UME, NIM, NIMT and INM-MD.

Each group measured only one set of filters. The group 1 measured SET 1, and the group 2 measured SET 2. Thus, comparison measurements were carried out in parallel by both groups. When all participants completed their measurements, both sets were returned to the pilot. The pilot measured both sets twice, in the beginning and at the end. The sequences of measurements were the following:

SET 1: BelGIM → NSC IM → VNIIOFI → BelGIM

SET 2: BelGIM → UME → NIM → NIM T → INM-MD → BelGIM.

5 MEASURAND AND MEASUREMENT CONDITIONS

The measurands are colour coordinates Y, x, y and L^*, a^*, b^* of each filter, which should have been measured under the following conditions:

- measurement area: the central area of a filter, 10 mm wide and 20 mm high;
- geometry of illumination/observation: $0^\circ/0^\circ$,
- illuminant: CIE D65,
- standard colorimetric observer: CIE 10°,
- filter temperature: 23 °C,
- relative humidity: not exceeding 60 %RH.

The colour coordinates Y, x, y are defined as follows:

$$Y = 100 \int S(\lambda)\bar{y}(\lambda)T(\lambda)d\lambda / \int S(\lambda)\bar{y}(\lambda)d\lambda \quad (1)$$

$$x = X/(X + Y + Z) \quad (2)$$

$$y = Y/(X + Y + Z) \quad (3)$$

where

$$X = 100 \int S(\lambda)\bar{x}(\lambda)T(\lambda)d\lambda / \int S(\lambda)\bar{y}(\lambda)d\lambda \quad (4)$$

$$Z = 100 \int S(\lambda)\bar{z}(\lambda)T(\lambda)d\lambda / \int S(\lambda)\bar{y}(\lambda)d\lambda \quad (5)$$

where

$T(\lambda)$ is the spectral transmittance of a filter,

$S(\lambda)$ is the relative spectral power distribution of the CIE standard illuminant D65 (CIE 15:2004, section 11.1, table T.1) [5],

$\bar{x}(\lambda), \bar{y}(\lambda), \bar{z}(\lambda)$ are colour matching functions of a standard colorimetric observer (CIE 1964, CIE 15:2004, section 11.5, table T.5) [5].

The values of L^*, a^*, b^* are uniquely related to the colour coordinates Y, x, y by the ratios (see Appendix A):

$$L^* = 116\left(\frac{Y}{100}\right)^{\frac{1}{3}} - 16 \quad (6)$$

$$a^* = 500\left[\left(\frac{xY}{y \cdot 94.81}\right)^{\frac{1}{3}} - \left(\frac{Y}{100}\right)^{\frac{1}{3}}\right] \quad (7)$$

$$b^* = 200\left[\left(\frac{Y}{100}\right)^{\frac{1}{3}} - \left(\frac{(1-x-y)Y}{y \cdot 107.32}\right)^{\frac{1}{3}}\right] \quad (8)$$

and for the filter 19 “Dark red”

$$b^* = 200\left[\left(\frac{Y}{100}\right)^{\frac{1}{3}} - \frac{841}{108}\frac{(1-x-y)Y}{y \cdot 107.32} - \frac{16}{116}\right] \quad (9)$$

Therefore, a participant values of L^*, a^* and b^* were calculated by the above equations from the values of Y, x and y submitted by the participant.

5.1 Measurement instructions

Orientation of a filter in a measuring facility should be as it shown below:

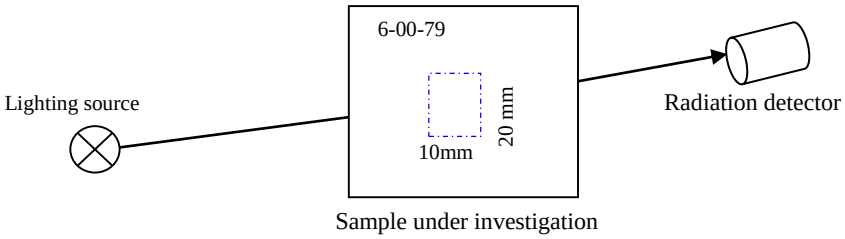

Figure 2. Filter orientation

Before measurements were taken, each filter was inspected for damage or contamination. Any damage or cleaning should be documented using the appropriate form.

If colour coordinates are based on measurement of spectral transmittance of filters, spectral measurements should be performed in the wavelength range from 360 nm to 780 nm with the step of 1 nm. The preferred spectral bandwidth is 1 nm. The spectral range and the bandwidth should be stated in the measurement report.

Each filter must be measured independently several times. The number of measurements used should be stated in the measurement report but only the mean or final declared value of each filter of the set is required to be included.

6 STABILITY OF TRANSFER STANDARDS

The pilot laboratory, BelGIM, measured each filter twice: before sending the artifacts to other participants and after receiving the artifacts from the participants. Differences between the first and the second pilot measurements were generally smaller that or comparable with the standard deviation of the pilot measurements. Therefore, all filters, except the filter 6-15-79, were considered stable. No correction related with the filter stability were applied. The stability uncertainty, u_{stab}, were estimated as the pilot standard deviation (Table 3).

The filter 6-15-79 behaved unstable even within one participant measurements. For instance, at VNIIOFI during a few-day measurements the coordinate Y was drifting from 61.604 down to 60.932, that is 1.1% (relative) while the other filters with the same level of Y value were varied within 0.3%. Therefore, the filter 6-15-79 “Light blue” was finally excluded from the comparison analysis.

Table 3. Uncertainties, $u_{j,\mathrm{stab}}(V)$, associated with the stability of transfer standards

Quan-tity	Filter						
	xx-00-xx Grey	xx-13-xx Light green	xx-15-xx Light blue	xx-26-xx Light red	xx-22-xx Dark green	xx-31-xx Dark blue	xx-19-xx Dark red
Y	0.015	0.015	0.032	0.026	0.02	0.034	0.024
x	0.00003	0.00008	0.00002	0.00003	0.00017	0.00004	0.00005
y	0.00005	0.00006	0.00004	0.00007	0.00012	0.00003	0.00003
L*	0.007	0.01	0.042	0.019	0.028	0.023	0.057
a*	0.005	0.015	0.011	0.006	0.053	0.014	0.053
b*	0.005	0.017	0.0082	0.0082	0.028	0.021	0.11

7 METHOD of COMPARISON DATA ANALYSIS

The analysis of the comparison data follows the approach described in the Appendix B of the Guidelines for CCPR Key Comparison Report Preparation, CCPR-G2 Rev.4 [3].

7.1 Calculation of comparison Reference Value (RV)

For each participating NMI *i* for each filter *j*, the difference between NMI measurement result $V_{i,j}$ and the Pilot measurement result, designation V_j^{P} or $V_{1,j}$ ($V_j^{\mathrm{P}} \equiv V_{1,j}$; *i*=1 is the index of pilot) is given by

$$\Delta_{i,j}(V) = V_{i,j} - V_j^{\mathrm{P}} \tag{10}$$

where *V* relates to a value of one of six colour coordinates Y, x, y, L*, a* or b*. The standard uncertainty of $\Delta_{i,j}(V)$ is given by

$$u\left(\Delta_{i,j}(V)\right) = \sqrt{u_{\mathrm{c}}^2\left(V_{i,j}\right) + u_{\mathrm{A}}^2\left(V_j^{\mathrm{P}}\right) + u_{j,\mathrm{stab}}^2(V)} \tag{11}$$

where $u_{\mathrm{c}}\left(V_{i,j}\right)$ is the combined standard uncertainty submitted by the NMI, $u_{\mathrm{A}}\left(V_j^{\mathrm{P}}\right)$ is the random (type A) component of the pilot uncertainty and $u_{j,\mathrm{stab}}(V)$ is the uncertainty associated with stability of the transfer standards (Table 3).

Note, for pilot, *i*=1, the differences $\Delta_{1,j}(V) = 0$ for all filters and all coordinates, and the uncertainty is given by

$$u\left(\Delta_{1,j}(V)\right) = u_{\mathrm{c}}\left(V_{1,j}\right) \tag{12}$$

The comparison reference value (RV) is calculated using weighted mean with cut-off. The cut-off value $u_{\text{cut-off}}(V)$ for the filter *j* is calculated by

$$u_{j,\text{cut-off}}(V) = \text{average}\left\{u_c(V_{i,j})\right\} \text{ for } u_c(V_{i,j}) \le \text{median}\left\{u_c(V_{i,j})\right\} \tag{13}$$

where *j* is constant, and averaging is performed only over the variable *i*.

The reported uncertainty of each NMI *i* is adjusted by the cut-off:

$$\begin{aligned} u_{\text{adj}}(V_{i,j}) &= u_c(V_{i,j}) \text{ for } u_c(V_{i,j}) \ge u_{j,\text{cut-off}}(V) \\ u_{\text{adj}}(V_{i,j}) &= u_{j,\text{cut-off}}(V) \text{ for } u_c(V_{i,j}) < u_{j,\text{cut-off}}(V) \end{aligned} \tag{14}$$

The uncertainty of $\Delta_{i,j}(V)$ after cut-off is given by

$$u_{\text{adj}}\left(\Delta_{i,j}(V)\right) = \sqrt{u_{\text{adj}}^2(V_{i,j}) + u_A^2(V_{i,j}^P) + u_{j,\text{stab}}^2(V) + s_j^2(V)} \tag{15}$$

where $s_j(V)$ is the Mandel-Paule addition (see below). At the first step $s_j(V) = 0$.

For the pilot, the uncertainty of $\Delta_{1,j}(V)$ after cut-off is given by

$$u_{\text{adj}}\left(\Delta_{1,j}(V)\right) = \sqrt{u_{\text{adj}}^2(V_{1,j}) + s_j^2(V)} \tag{16}$$

The weights $w_{i,j}(V)$ for NMI *i* for the coordinate *V* of the filter *j* is determined by

$$w_{i,j}(V) = u_{\text{adj}}^{-2}\left(\Delta_{i,j}(V)\right) \Big/ \sum_{i=1}^{N} u_{\text{adj}}^{-2}\left(\Delta_{i,j}(V)\right) \tag{17}$$

where *N* is the number of participants, whose results are included in calculating RV.

The RV, $\Delta_{j,\text{RV}}(V)$, is determined as a weighted mean with cut-off and has a form of difference from the pilot:

$$\Delta_{j,\text{RV}}(V) = \sum_{i=1}^{N} w_{i,j}(V) \cdot \Delta_{i,j}(V) \tag{18}$$

The uncertainty of the RV is given by

$$u\left(\Delta_{j,\text{RV}}(V)\right) = \sqrt{\sum_{i=1}^{N} \frac{u^2\left(\Delta_{i,j}(V)\right)}{u_{\text{adj}}^4\left(\Delta_{i,j}(V)\right)}} \Big/ \sum_{i=1}^{N} u_{\text{adj}}^{-2}\left(\Delta_{i,j}(V)\right) \tag{19}$$

7.2 Consistency check

Calculate the Chi-square value χ^2_{obs} for consistency check:

$$\chi^2_{\text{obs}} = \sum_{i=1}^{N} \frac{\left(\Delta_{i,j}(V) - \Delta_{j,\text{RV}}(V)\right)^2}{u^2_{\text{adj}}\left(\Delta_{i,j}(V)\right)} \tag{20}$$

Determine $\chi^2_{0.05}(\nu)$ value from the Table 4. $\nu = N - 1$

Table 4. $\chi^2_{0.05}(\nu)$ value

ν	1	2	3	4	5	6	7
$\chi^2_{0.05}(\nu)$	3.841	5.991	7.815	9.488	11.070	12.592	14.067

If $\chi^2_{\text{obs}} > \chi^2_{0.05}(\nu)$, consistency fails. In this case, following the Mandel-Paule method, add the $s_j^2(V)$ term in Eq. (14). The value of $s_j(V)$ can be determined by iterative process so that $\chi^2_{\text{obs}} = \chi^2_{0.05}(\nu)$.

If $\chi^2_{\text{obs}} \leq \chi^2_{0.05}(\nu)$, consistency is satisfied, $s_j(V)$= 0.

7.3 Calculation of Differences of participant results from RV

Differences of the participant results from the RV (DRV) of the NMI *i*, filter *j* and coordinate *V* is given by

$$D_{i,j}(V) = \Delta_{i,j}(V) - \Delta_{j,\text{RV}}(V) \tag{21}$$

The expanded uncertainty of $D_{i,j}(V)$ is given by

$$U_{\text{p}}\left(D_{i,j}(V)\right) = k\sqrt{u^2\left(\Delta_{i,j}(V)\right) + u^2\left(\Delta_{j,\text{RV}}(V)\right) - 2\left(\frac{u^2\left(\Delta_{i,j}(V)\right)}{u^2_{\text{adj}}\left(\Delta_{i,j}(V)\right)}\Big/\sum_{i=1}^{N} u^{-2}_{\text{adj}}\left(\Delta_{i,j}(V)\Delta_i\right)\right)} \tag{22}$$

$k = 2$

Equation (22) takes into account the effect of correlation between $\Delta_{i,j}(V)$ and $\Delta_{j,\text{RV}}(V)$. For any labs that are excluded from RV calculation, the uncertainty $U_{\text{p}}\left(D_{i,j}(V)\right)$ is given by:

$$U_{\text{p}}\left(D_{i,j}(V)\right) = k\sqrt{u^2\left(\Delta_{i,j}(V)\right) + u^2\left(\Delta_{j,\text{RV}}(V)\right)}\,;\ k = 2 \tag{23}$$

8 MEASUREMENT RESULTS

The participant measurement reports are presented in Appendix B. The measurement results are summarized in Table 5 and Table 6. Note, that values of the coordinates L^*, a^* and b^* are calculated by Equations 6 – 9 from the values of Y, x and y submitted by participants.

Table 5. Participant measurement data, $V_{i,j}$. Values of Y, x and y are as submitted by the participants. Values of L^*, a^* and b^* are calculated by Eq. 6 – 9.

Filter	Coordinate	BelGIM (pilot)		NSC IM	VNIIOFI	UME	NIM	NIMT	INM-MD
		Set 1	Set 2	Set 1		Set 2			
xx-00-xx Gray	Y	60.026	60.501	60.045	59.990	60.400	60.400	60.480	60.5682
	x	0.3084	0.3084	0.3085	0.30852	0.3084	0.30828	0.3084	0.30825
	y	0.3301	0.3295	0.3303	0.33032	0.32957	0.32945	0.3295	0.32932
	L^*	81.852	82.110	81.863	81.833	82.055	82.055	82.098	82.146
	a^*	-2.062	-1.812	-2.102	-2.101	-1.841	-1.844	-1.812	-1.804
	b^*	-1.141	-1.342	-1.060	-1.050	-1.318	-1.376	-1.341	-1.425
xx-13-xx Light green	Y	29.644	73.874	29.707	29.543	73.94	73.870	73.89	73.7542
	x	0.42273	0.37129	0.4227	0.422715	0.3714	0.37140	0.3713	0.37174
	y	0.48050	0.45120	0.4804	0.480404	0.45102	0.45121	0.4510	0.45144
	L^*	61.346	88.863	61.401	61.258	88.894	88.861	88.870	88.806
	a^*	-8.209	-20.843	-8.200	-8.182	-20.749	-20.803	-20.777	-20.734
	b^*	57.007	51.403	57.008	56.908	51.384	51.432	51.341	51.566
xx-15-xx Light blue	Y		62.548			62.43	62.540	62.55	63.4510
	x		0.24230			0.2428	0.2424	0.2425	0.24236
	y		0.30430			0.3040	0.30411	0.3041	0.30389
	L^*		83.204			83.142	83.200	83.205	83.679
	a^*		-24.168			-23.743	-24.028	-23.969	-24.068
	b^*		-19.768			-19.791	-19.820	-19.811	-19.999
xx-26-xx Light red	Y	65.971	65.111	66.002	66.048	65.210	64.82	65.09	65.1607
	x	0.32222	0.3228	0.3225	0.322227	0.3228	0.32262	0.3227	0.32247
	y	0.32120	0.321	0.3215	0.321224	0.3208	0.32083	0.3210	0.32067
	L^*	84.981	84.541	84.997	85.021	84.592	84.391	84.530	84.566
	a^*	8.270	8.591	8.262	8.266	8.687	8.574	8.544	8.594
	b^*	-1.976	-1.941	-1.826	-1.967	-2.011	-2.026	-1.957	-2.110
xx-22-xx Dark green	Y	11.765	12.531	11.776	11.746	12.58	12.53	12.52	12.4900
	x	0.27960	0.28340	0.2796	0.279664	0.2834	0.28383	0.2835	0.28482
	y	0.65585	0.65290	0.6558	0.655697	0.651	0.65293	0.6527	0.65257
	L^*	40.840	42.048	40.858	40.810	42.123	42.046	42.031	41.985
	a^*	-57.302	-57.366	-57.316	-57.243	-57.253	-57.270	-57.307	-56.950
	b^*	53.806	55.081	53.810	53.753	54.665	55.189	55.037	55.271
xx-31-xx Dark blue	Y	36.804	36.182	36.917	36.766	36.17	36.16	36.19	36.3515
	x	0.22459	0.22310	0.2245	0.224619	0.2229	0.22317	0.2232	0.22325
	y	0.23435	0.23269	0.2342	0.234337	0.2327	0.23270	0.2324	0.23248
	L^*	67.130	66.659	67.215	67.101	66.650	66.642	66.665	66.788
	a^*	1.287	1.334	1.317	1.309	1.221	1.366	1.536	1.524
	b^*	-41.697	-42.254	-41.807	-41.684	-42.269	-42.234	-42.356	-42.383
xx-19-xx Dark red	Y	5.003	5.603	4.9996	4.983	5.632	5.653	5.60	5.5275
	x	0.69950	0.67600	0.6999	0.699890	0.6757	0.67570	0.6764	0.67645
	y	0.30029	0.32300	0.3001	0.300109	0.3225	0.32300	0.3230	0.32308
	L^*	26.743	28.388	26.734	26.686	28.464	28.520	28.380	28.188
	a^*	64.367	57.792	64.453	64.377	57.983	57.926	57.831	57.566
	b^*	46.058	48.693	46.092	46.011	48.620	48.842	48.780	48.483

In the Table 6 the last column presents the median of the measurement uncertainties. Red-coloured uncertainty values are less than or equal to the median.

Table 6. Submitted standard uncertainties of measurements, $u_c(V_{i,j})$

Filter	Coor-dinate	BelGIM (pilot)	NSC IM	VNIIOFI	UME	NIM	NIMT	INM-MD	***Median***
xx-00-xx Gray	Y	5.41E-02	9.55E-02	4.48E-02	3.70E-02	5.18E-02	1.80E-01	3.90E-01	***5.41E-02***
	x	8.41E-05	3.00E-04	3.20E-05	7.80E-05	3.20E-05	8.21E-05	6.39E-04	***8.21E-05***
	y	1.33E-04	3.01E-04	3.40E-05	8.30E-05	1.93E-04	1.19E-04	7.48E-04	***1.33E-04***
	L^*	3.90E-02	1.00E-01	2.24E-02	7.01E-02	2.81E-02	9.74E-02	3.48E-01	***7.01E-02***
	a^*	2.11E-02	5.05E-02	1.32E-02	2.21E-02	9.46E-03	4.68E-02	3.56E-01	***2.21E-02***
	b^*	2.43E-02	5.05E-02	1.36E-02	2.14E-02	1.06E-02	4.64E-02	6.55E-02	***2.43E-02***
xx-13-xx Light green	Y	5.58E-02	1.00E-01	3.98E-02	3.83E-02	6.59E-02	2.00E-01	3.66E-01	***6.59E-02***
	x	4.25E-04	3.10E-04	1.54E-04	4.23E-04	9.97E-05	5.70E-04	7.20E-04	***4.23E-04***
	y	3.16E-04	3.00E-04	1.70E-04	4.36E-04	9.51E-05	5.74E-04	5.36E-04	***3.16E-04***
	L^*	5.31E-02	1.50E-01	2.56E-02	7.54E-02	3.13E-02	9.46E-02	2.29E-01	***7.54E-02***
	a^*	4.77E-02	5.39E-02	3.20E-02	2.72E-02	1.55E-02	7.21E-02	3.88E-01	***4.77E-02***
	b^*	3.19E-02	1.01E-01	6.79E-02	3.02E-02	5.09E-02	3.14E-01	4.54E-02	***5.09E-02***
xx-15-xx Light blue	Y	9.76E-02			5.72E-02	5.28E-02	2.11E-01	5.03E-01	***9.76E-02***
	x	4.84E-04			3.37E-04	4.57E-05	2.60E-04	5.50E-04	***3.37E-04***
	y	5.88E-04			5.78E-04	3.73E-05	2.60E-04	7.75E-04	***5.78E-04***
	L^*	8.24E-02			1.44E-01	2.78E-02	1.12E-01	4.26E-01	***1.12E-01***
	a^*	7.67E-02			1.78E-02	9.45E-03	5.73E-02	4.37E-01	***5.73E-02***
	b^*	9.13E-02			1.31E-01	1.73E-02	1.10E-01	8.28E-02	***9.13E-02***
xx-26-xx Light red	Y	6.05E-02	5.88E-02	4.88E-02	5.69E-02	1.79E-01	1.87E-01	4.22E-01	***6.05E-02***
	x	2.58E-04	3.01E-04	4.47E-05	3.15E-04	4.23E-05	1.45E-04	6.37E-04	***2.58E-04***
	y	1.94E-04	3.01E-04	4.74E-05	1.07E-04	3.60E-05	1.83E-04	7.76E-04	***1.83E-04***
	L^*	4.38E-02	5.25E-02	2.28E-02	4.92E-02	4.08E-02	9.66E-02	3.36E-01	***4.92E-02***
	a^*	2.96E-02	5.02E-02	1.80E-02	1.02E-02	8.39E-03	4.66E-02	3.38E-01	***2.96E-02***
	b^*	2.33E-02	7.07E-02	1.94E-02	3.51E-02	1.91E-02	8.36E-02	6.89E-02	***3.51E-02***
xx-22-xx Dark green	Y	4.39E-02	5.55E-02	3.52E-02	5.34E-02	3.08E-02	5.92E-02	1.11E-01	***5.34E-02***
	x	5.19E-04	3.61E-04	4.82E-04	4.37E-04	2.98E-04	6.84E-04	1.66E-03	***4.82E-04***
	y	2.92E-04	4.21E-04	5.55E-04	8.98E-04	6.71E-04	9.69E-04	3.26E-03	***5.55E-04***
	L^*	5.87E-02	6.34E-02	2.44E-02	6.38E-02	4.75E-02	9.13E-02	8.42E-01	***6.34E-02***
	a^*	1.59E-01	1.25E-01	1.40E-01	8.70E-02	1.20E-01	1.71E-01	4.56E-01	***1.40E-01***
	b^*	1.02E-01	1.04E-01	6.82E-02	8.17E-02	1.45E-01	2.23E-01	1.66E-01	***1.04E-01***
xx-31-xx Dark blue	Y	6.39E-02	9.03E-02	4.84E-02	6.51E-02	3.96E-02	1.63E-01	4.14E-01	***6.39E-02***
	x	2.71E-04	3.01E-04	9.92E-05	3.08E-04	7.64E-05	2.09E-04	4.58E-04	***2.71E-04***
	y	3.93E-04	3.01E-04	1.26E-04	3.08E-04	8.54E-05	2.78E-04	7.78E-04	***3.01E-04***
	L^*	4.78E-02	7.02E-02	3.18E-02	7.90E-02	3.02E-02	1.24E-01	6.80E-01	***7.02E-02***
	a^*	3.99E-02	6.11E-02	8.22E-02	4.41E-02	1.55E-02	9.90E-02	3.62E-01	***6.11E-02***
	b^*	6.67E-02	1.21E-01	4.41E-02	2.70E-02	4.72E-02	7.21E-02	1.01E-01	***6.67E-02***
xx-19-xx Dark red	Y	3.96E-02	6.16E-02	3.89E-02	6.09E-02	2.81E-02	4.91E-02	8.75E-02	***4.91E-02***
	x	4.78E-04	4.00E-04	3.70E-04	6.12E-04	8.26E-04	1.21E-03	3.95E-03	***6.12E-04***
	y	3.98E-04	4.00E-04	7.97E-04	4.01E-04	4.16E-05	1.61E-04	2.41E-03	***4.00E-04***
	L^*	7.90E-02	1.44E-01	6.52E-02	1.04E-01	7.39E-02	1.30E-01	1.33E-01	***1.04E-01***
	a^*	9.60E-02	1.53E-01	3.78E-01	2.77E-02	1.04E-01	1.31E-01	3.62E-01	***1.31E-01***
	b^*	1.60E-01	2.10E-01	1.08E-01	1.68E-01	1.81E-01	2.44E-01	5.05E+00	***1.81E-01***

9 PROCESSING OF MEASUREMENT RESULTS

Table 7 presents the cut-off values, $u_{j,\mathrm{cut-off}}(V)$ (Eq. 13), and the cut-off adjusted uncertainties, $u_{\mathrm{adj}}(V_{i,j})$ (Eq. 14). Table 8 and Table 9 shows the differences from the pilot, $\Delta_{i,j}(V)$ (Eq. 10), and their uncertainties, $u\left(\Delta_{i,j}(V)\right)$ (Eq. 11 and 12), respectively.

Table 7. Cut-off values, $u_{j,\mathrm{cut-off}}(V)$, and adjusted uncertainties, $u_{\mathrm{adj}}(V_{i,j})$

Filter	Coor-dinate	cut-off $u_{j,\mathrm{cut-off}}(V)$	BelGIM (pilot)	NSC IM	VNIIOFI	UME	NIM	NIMT	INM-MD
xx-00-xx Gray	Y	4.69E-02	5.41E-02	9.55E-02	4.69E-02	4.69E-02	5.18E-02	1.80E-01	3.90E-01
	x	5.60E-05	8.41E-05	3.00E-04	5.60E-05	7.80E-05	5.60E-05	8.21E-05	6.39E-04
	y	9.22E-05	1.33E-04	3.01E-04	9.22E-05	9.22E-05	1.93E-04	1.19E-04	7.48E-04
	L*	3.99E-02	3.99E-02	1.00E-01	3.99E-02	7.01E-02	3.99E-02	9.74E-02	3.48E-01
	a*	1.64E-02	2.11E-02	5.05E-02	1.64E-02	2.21E-02	1.64E-02	4.68E-02	3.56E-01
	b*	1.75E-02	2.43E-02	5.05E-02	1.75E-02	2.14E-02	1.75E-02	4.64E-02	6.55E-02
xx-13-xx Light green	Y	4.99E-02	5.58E-02	1.00E-01	4.99E-02	4.99E-02	6.59E-02	2.00E-01	3.66E-01
	x	2.47E-04	4.25E-04	3.10E-04	2.47E-04	4.23E-04	2.47E-04	5.70E-04	7.20E-04
	y	2.20E-04	3.16E-04	3.00E-04	2.20E-04	4.36E-04	2.20E-04	5.74E-04	5.36E-04
	L*	4.63E-02	5.31E-02	1.50E-01	4.63E-02	7.54E-02	4.63E-02	9.46E-02	2.29E-01
	a*	3.06E-02	4.77E-02	5.39E-02	3.20E-02	3.06E-02	3.06E-02	7.21E-02	3.88E-01
	b*	3.96E-02	3.96E-02	1.01E-01	6.79E-02	3.96E-02	5.09E-02	3.14E-01	4.54E-02
xx-15-xx Light blue	Y	6.92E-02	9.76E-02			6.92E-02	6.92E-02	2.11E-01	5.03E-01
	x	2.14E-04	4.84E-04			3.37E-04	2.14E-04	2.60E-04	5.50E-04
	y	2.92E-04	5.88E-04			5.78E-04	2.92E-04	2.92E-04	7.75E-04
	L*	7.41E-02	8.24E-02			1.44E-01	7.41E-02	1.12E-01	4.26E-01
	a*	2.82E-02	7.67E-02			2.82E-02	2.82E-02	5.73E-02	4.37E-01
	b*	6.38E-02	9.13E-02			1.31E-01	6.38E-02	1.10E-01	8.28E-02
xx-26-xx Light red	Y	5.62E-02	6.05E-02	5.88E-02	5.62E-02	5.69E-02	1.79E-01	1.87E-01	4.22E-01
	x	1.23E-04	2.58E-04	3.01E-04	1.23E-04	3.15E-04	1.23E-04	1.45E-04	6.37E-04
	y	9.35E-05	1.94E-04	3.01E-04	9.35E-05	1.07E-04	9.35E-05	1.83E-04	7.76E-04
	L*	3.92E-02	4.38E-02	5.25E-02	3.92E-02	4.92E-02	4.08E-02	9.66E-02	3.36E-01
	a*	1.66E-02	2.96E-02	5.02E-02	1.80E-02	1.66E-02	1.66E-02	4.66E-02	3.38E-01
	b*	2.42E-02	2.42E-02	7.07E-02	2.42E-02	3.51E-02	2.42E-02	8.36E-02	6.89E-02
xx-22-xx Dark green	Y	4.08E-02	4.39E-02	5.55E-02	4.08E-02	5.34E-02	4.08E-02	5.92E-02	1.11E-01
	x	3.95E-04	5.19E-04	3.95E-04	4.82E-04	4.37E-04	3.95E-04	6.84E-04	1.66E-03
	y	4.85E-04	4.85E-04	4.85E-04	5.55E-04	8.98E-04	6.71E-04	9.69E-04	3.26E-03
	L*	4.85E-02	5.87E-02	6.34E-02	4.85E-02	6.38E-02	4.85E-02	9.13E-02	8.42E-01
	a*	1.18E-01	1.59E-01	1.25E-01	1.40E-01	1.18E-01	1.20E-01	1.71E-01	4.56E-01
	b*	8.90E-02	1.02E-01	1.04E-01	8.90E-02	8.90E-02	1.45E-01	2.23E-01	1.66E-01
xx-31-xx Dark blue	Y	5.43E-02	6.39E-02	9.03E-02	5.43E-02	6.51E-02	5.43E-02	1.63E-01	4.14E-01
	x	1.64E-04	2.71E-04	3.01E-04	1.64E-04	3.08E-04	1.64E-04	2.09E-04	4.58E-04
	y	1.98E-04	3.93E-04	3.01E-04	1.98E-04	3.08E-04	1.98E-04	2.78E-04	7.78E-04
	L*	4.50E-02	4.78E-02	7.02E-02	4.50E-02	7.90E-02	4.50E-02	1.24E-01	6.80E-01
	a*	3.52E-02	3.99E-02	6.11E-02	8.22E-02	4.41E-02	3.52E-02	9.90E-02	3.62E-01
	b*	4.62E-02	6.67E-02	1.21E-01	4.62E-02	4.62E-02	4.72E-02	7.21E-02	1.01E-01
xx-19-xx Dark red	Y	3.89E-02	3.96E-02	6.16E-02	3.89E-02	6.09E-02	3.89E-02	4.91E-02	8.75E-02
	x	4.65E-04	4.78E-04	4.65E-04	4.65E-04	6.12E-04	8.26E-04	1.21E-03	3.95E-03
	y	2.50E-04	3.98E-04	4.00E-04	7.98E-04	4.01E-04	2.50E-04	2.50E-04	2.41E-03
	L*	7.81E-02	7.90E-02	1.44E-01	7.81E-02	1.04E-01	7.81E-02	1.30E-01	1.33E-01
	a*	8.97E-02	9.60E-02	1.53E-01	3.76E-01	8.97E-02	1.04E-01	1.31E-01	3.62E-01
	b*	1.50E-01	1.60E-01	2.10E-01	1.50E-01	1.68E-01	1.81E-01	2.44E-01	5.14E-01

Table 8. Differences from Pilot, $\Delta_{i,j}(V)$

Filter	Coor-dinate	BelGIM (pilot)	NSC IM	VNIIOFI	UME	NIM	NIMT	INM-MD
			Set 1		Set 2			
xx-00-xx Gray	Y	0	0.0190	-0.0360	-0.1012	-0.1012	-0.0212	0.0670
	x	0	0.0001	0.0001	0.0000	-0.0001	0.0000	-0.0001
	y	0	0.0002	0.0002	0.0001	0.0000	0.0000	-0.0002
	L^*	0	0.0103	-0.0196	-0.0547	-0.0547	-0.0115	0.0362
	a^*	0	-0.0396	-0.0388	-0.0288	-0.0323	0.0002	0.0077
	b^*	0	0.0812	0.0910	0.0238	-0.0345	0.0002	-0.0834
xx-13-xx Light green	Y	0	0.0630	-0.1010	0.0660	-0.0040	0.0160	-0.1198
	x	0	-0.0000	-0.0000	0.0001	0.0001	0.0000	0.0005
	y	0	-0.0001	-0.0001	-0.0002	0.0000	-0.0002	0.0002
	L^*	0	0.0548	-0.0879	0.0312	-0.0019	0.0076	-0.0567
	a^*	0	0.0091	0.0271	0.0938	0.0398	0.0661	0.1089
	b^*	0	0.0009	-0.0990	-0.0189	0.0292	-0.0616	0.1629
xx-15-xx Light blue	Y	0			-0.1180	-0.0080	0.0020	0.9030
	x	0			0.0005	0.0001	0.0002	0.0001
	y	0			-0.0003	-0.0002	-0.0002	-0.0004
	L^*	0			-0.0624	-0.0042	0.0011	0.4751
	a^*	0			0.4250	0.1405	0.1992	0.0999
	b^*	0			-0.0222	-0.0515	-0.0420	-0.2302
xx-26-xx Light red	Y	0	0.0314	0.0774	0.0994	-0.2906	-0.0206	0.0501
	x	0	0.0003	0.0000	0.0000	-0.0002	-0.0001	-0.0003
	y	0	0.0003	0.0000	-0.0002	-0.0002	0.0000	-0.0003
	L^*	0	0.0160	0.0395	0.0511	-0.1498	-0.0106	0.0258
	a^*	0	-0.0083	-0.0046	0.0962	-0.0169	-0.0465	0.0030
	b^*	0	0.1500	0.0087	-0.0702	-0.0853	-0.0162	-0.1689
xx-22-xx Dark green	Y	0	0.0110	-0.0190	0.0490	-0.0010	-0.0110	-0.0410
	x	0	0.0000	0.0001	0.0000	0.0004	0.0001	0.0014
	y	0	0.0000	-0.0002	-0.0019	0.0000	-0.0002	-0.0003
	L^*	0	0.0177	-0.0306	0.0756	-0.0015	-0.0170	-0.0634
	a^*	0	-0.0131	0.0598	0.1130	0.0961	0.0592	0.4163
	b^*	0	0.0042	-0.0527	-0.4162	0.1078	-0.0442	0.1902
xx-31-xx Dark blue	Y	0	0.1130	-0.0380	-0.0120	-0.0220	0.0080	0.1695
	x	0	-0.0001	0.0000	-0.0002	0.0001	0.0001	0.0002
	y	0	-0.0002	0.0000	0.0000	0.0000	-0.0003	-0.0002
	L^*	0	0.0850	-0.0286	-0.0091	-0.0168	0.0061	0.1289
	a^*	0	0.0301	0.0217	-0.1122	0.0320	0.2023	0.1902
	b^*	0	-0.1096	0.0128	-0.0142	0.0203	-0.1015	-0.1284
xx-19-xx Dark red	Y	0	-0.0034	-0.0200	0.0290	0.0500	-0.0030	-0.0755
	x	0	0.0004	0.0004	-0.0003	-0.0003	0.0004	0.0004
	y	0	-0.0002	-0.0002	-0.0005	0.0000	0.0000	0.0001
	L^*	0	-0.0097	-0.0570	0.0764	0.1316	-0.0079	-0.2003
	a^*	0	0.0852	0.0102	0.1915	0.1344	0.0388	-0.2262
	b^*	0	0.0341	-0.0478	-0.0726	0.1485	0.0871	-0.2103

Table 9. Uncertainties of Differences from Pilot, $u\left(\Delta_{i,j}(V)\right)$

Filter	Coor-dinate	BelGIM (pilot)	NSC IM	VNIIOFI	UME	NIM	NIMT	INM-MD
xx-00-xx Gray	Y	5.4E-02	9.8E-02	5.0E-02	4.3E-02	5.6E-02	1.8E-01	3.9E-01
	x	8.4E-05	3.0E-04	5.3E-05	8.8E-05	5.3E-05	9.2E-05	6.4E-04
	y	1.3E-04	3.1E-04	8.0E-05	1.1E-04	2.1E-04	1.4E-04	7.5E-04
	L^*	3.9E-02	1.0E-01	2.5E-02	7.1E-02	3.0E-02	9.8E-02	3.5E-01
	a^*	2.1E-02	5.1E-02	1.5E-02	2.3E-02	1.2E-02	4.7E-02	3.6E-01
	b^*	2.4E-02	5.1E-02	1.5E-02	2.3E-02	1.3E-02	4.7E-02	6.6E-02
xx-13-xx Light green	Y	5.6E-02	1.0E-01	4.5E-02	4.4E-02	6.9E-02	2.0E-01	3.7E-01
	x	4.3E-04	3.3E-04	2.0E-04	4.4E-04	1.6E-04	5.8E-04	7.3E-04
	y	3.2E-04	3.1E-04	1.8E-04	4.4E-04	1.1E-04	5.8E-04	5.4E-04
	L^*	5.3E-02	1.5E-01	2.9E-02	7.7E-02	3.4E-02	9.6E-02	2.3E-01
	a^*	4.8E-02	5.8E-02	3.8E-02	3.4E-02	2.6E-02	7.5E-02	3.9E-01
	b^*	3.2E-02	1.0E-01	7.2E-02	3.9E-02	5.6E-02	3.2E-01	5.1E-02
xx-15-xx Light blue	Y	9.8E-02			7.3E-02	7.0E-02	2.2E-01	5.1E-01
	x	4.8E-04			3.4E-04	5.2E-05	2.6E-04	5.5E-04
	y	5.9E-04			5.8E-04	6.4E-05	2.7E-04	7.8E-04
	L^*	8.2E-02			1.6E-01	6.6E-02	1.3E-01	4.3E-01
	a^*	7.7E-02			2.4E-02	1.8E-02	5.9E-02	4.4E-01
	b^*	9.1E-02			1.3E-01	2.1E-02	1.1E-01	8.4E-02
xx-26-xx Light red	Y	6.0E-02	6.9E-02	6.1E-02	6.8E-02	1.8E-01	1.9E-01	4.2E-01
	x	2.6E-04	3.0E-04	6.0E-05	3.2E-04	5.9E-05	1.5E-04	6.4E-04
	y	1.9E-04	3.2E-04	1.1E-04	1.4E-04	1.0E-04	2.1E-04	7.8E-04
	L^*	4.4E-02	5.9E-02	3.5E-02	5.6E-02	4.9E-02	1.0E-01	3.4E-01
	a^*	3.0E-02	5.1E-02	2.0E-02	1.3E-02	1.2E-02	4.7E-02	3.4E-01
	b^*	2.3E-02	7.2E-02	2.3E-02	3.7E-02	2.2E-02	8.4E-02	7.0E-02
xx-22-xx Dark green	Y	4.4E-02	6.2E-02	4.5E-02	6.0E-02	4.2E-02	6.6E-02	1.1E-01
	x	5.2E-04	4.3E-04	5.4E-04	5.0E-04	3.8E-04	7.3E-04	1.7E-03
	y	2.9E-04	4.5E-04	5.8E-04	9.1E-04	6.9E-04	9.8E-04	3.3E-03
	L^*	5.9E-02	7.5E-02	4.7E-02	7.5E-02	6.2E-02	9.9E-02	8.4E-01
	a^*	1.6E-01	1.5E-01	1.6E-01	1.1E-01	1.4E-01	1.9E-01	4.6E-01
	b^*	1.0E-01	1.1E-01	7.9E-02	9.1E-02	1.5E-01	2.3E-01	1.7E-01
xx-31-xx Dark blue	Y	6.4E-02	1.0E-01	6.8E-02	8.1E-02	6.2E-02	1.7E-01	4.2E-01
	x	2.7E-04	3.1E-04	1.1E-04	3.1E-04	9.5E-05	2.2E-04	4.6E-04
	y	3.9E-04	3.0E-04	1.3E-04	3.1E-04	9.6E-05	2.8E-04	7.8E-04
	L^*	4.8E-02	7.7E-02	4.6E-02	8.5E-02	4.4E-02	1.3E-01	6.8E-01
	a^*	4.0E-02	6.4E-02	8.5E-02	4.8E-02	2.5E-02	1.0E-01	3.6E-01
	b^*	6.7E-02	1.2E-01	5.3E-02	4.0E-02	5.6E-02	7.8E-02	1.1E-01
xx-19-xx Dark red	Y	4.0E-02	7.0E-02	5.2E-02	7.0E-02	4.4E-02	6.0E-02	9.4E-02
	x	4.8E-04	4.1E-04	3.7E-04	6.2E-04	8.3E-04	1.2E-03	4.0E-03
	y	4.0E-04	4.0E-04	8.0E-04	4.0E-04	5.9E-05	1.7E-04	2.4E-03
	L^*	7.9E-02	1.6E-01	9.8E-02	1.3E-01	1.1E-01	1.5E-01	1.6E-01
	a^*	9.6E-02	1.7E-01	3.8E-01	8.0E-02	1.3E-01	1.5E-01	3.7E-01
	b^*	1.6E-01	2.6E-01	1.8E-01	2.3E-01	2.4E-01	2.9E-01	5.4E+00

9.1 Preliminary values of RV and DRV, and the consistency check

Table 10 presents the uncertainties of $\Delta_{i,j}(V)$ after cut-off, $u_{\text{adj}}\left(\Delta_{i,j}(V)\right)$, calculated using Eq. 15 and 16. At this stage $s_j(V)$ = 0 (The Mandel-Paule procedure is not yet applied).

Table 10. Uncertainties of Differences from Pilot after cut-off, $u_{\text{adj}}\left(\Delta_{i,j}(V)\right)$. Preliminary

Filter	Coor-dinate	BelGIM (pilot)	NSC IM	VNIIOFI	UME	NIM	NIMT	INM-MD
xx-00-xx Gray	Y	5.4E-02	9.8E-02	5.2E-02	5.2E-02	5.6E-02	1.8E-01	3.9E-01
	x	8.4E-05	3.0E-04	7.0E-05	8.8E-05	7.0E-05	9.2E-05	6.4E-04
	y	1.3E-04	3.1E-04	1.2E-04	1.2E-04	2.1E-04	1.4E-04	7.5E-04
	L^*	4.0E-02	1.0E-01	4.1E-02	7.1E-02	4.1E-02	9.8E-02	3.5E-01
	a^*	2.1E-02	5.1E-02	1.8E-02	2.3E-02	1.8E-02	4.7E-02	3.6E-01
	b^*	2.4E-02	5.1E-02	1.9E-02	2.3E-02	1.9E-02	4.7E-02	6.6E-02
xx-13-xx Light green	Y	5.6E-02	1.0E-01	5.4E-02	5.4E-02	6.9E-02	2.0E-01	3.7E-01
	x	4.3E-04	3.3E-04	2.7E-04	4.4E-04	2.7E-04	5.8E-04	7.3E-04
	y	3.2E-04	3.1E-04	2.3E-04	4.4E-04	2.3E-04	5.8E-04	5.4E-04
	L^*	5.3E-02	1.5E-01	4.8E-02	7.7E-02	4.8E-02	9.6E-02	2.3E-01
	a^*	4.8E-02	5.8E-02	3.8E-02	3.7E-02	3.7E-02	7.5E-02	3.9E-01
	b^*	4.0E-02	1.0E-01	7.2E-02	4.6E-02	5.6E-02	3.2E-01	5.1E-02
xx-15-xx Light blue	Y	9.8E-02			8.3E-02	8.3E-02	2.2E-01	5.1E-01
	x	4.8E-04			3.4E-04	2.2E-04	2.6E-04	5.5E-04
	y	5.9E-04			5.8E-04	3.0E-04	3.0E-04	7.8E-04
	L^*	8.2E-02			1.6E-01	9.5E-02	1.3E-01	4.3E-01
	a^*	7.7E-02			3.2E-02	3.2E-02	5.9E-02	4.4E-01
	b^*	9.1E-02			1.3E-01	6.5E-02	1.1E-01	8.4E-02
xx-26-xx Light red	Y	6.0E-02	6.9E-02	6.7E-02	6.8E-02	1.8E-01	1.9E-01	4.2E-01
	x	2.6E-04	3.0E-04	1.3E-04	3.2E-04	1.3E-04	1.5E-04	6.4E-04
	y	1.9E-04	3.2E-04	1.3E-04	1.4E-04	1.3E-04	2.1E-04	7.8E-04
	L^*	4.4E-02	5.9E-02	4.7E-02	5.6E-02	4.9E-02	1.0E-01	3.4E-01
	a^*	3.0E-02	5.1E-02	2.0E-02	1.8E-02	1.8E-02	4.7E-02	3.4E-01
	b^*	2.4E-02	7.2E-02	2.7E-02	3.7E-02	2.7E-02	8.4E-02	7.0E-02
xx-22-xx Dark green	Y	4.4E-02	6.2E-02	5.0E-02	6.0E-02	5.0E-02	6.6E-02	1.1E-01
	x	5.2E-04	4.6E-04	5.4E-04	5.0E-04	4.6E-04	7.2E-04	1.7E-03
	y	4.8E-04	5.1E-04	5.8E-04	9.1E-04	6.9E-04	9.8E-04	3.3E-03
	L^*	5.9E-02	7.5E-02	6.3E-02	7.5E-02	6.3E-02	9.9E-02	8.4E-01
	a^*	1.6E-01	1.5E-01	1.6E-01	1.4E-01	1.4E-01	1.9E-01	4.6E-01
	b^*	1.0E-01	1.1E-01	9.7E-02	9.7E-02	1.5E-01	2.3E-01	1.7E-01
xx-31-xx Dark blue	Y	6.4E-02	1.0E-01	7.2E-02	8.1E-02	7.2E-02	1.7E-01	4.2E-01
	x	2.7E-04	3.1E-04	1.7E-04	3.1E-04	1.7E-04	2.2E-04	4.6E-04
	y	3.9E-04	3.0E-04	2.0E-04	3.1E-04	2.0E-04	2.8E-04	7.8E-04
	L^*	4.8E-02	7.7E-02	5.6E-02	8.5E-02	5.6E-02	1.3E-01	6.8E-01
	a^*	4.0E-02	6.4E-02	8.5E-02	4.8E-02	4.0E-02	1.0E-01	3.6E-01
	b^*	6.7E-02	1.2E-01	5.5E-02	5.5E-02	5.6E-02	7.8E-02	1.1E-01
xx-19-xx Dark red	Y	4.0E-02	7.0E-02	5.2E-02	7.0E-02	5.2E-02	6.0E-02	9.4E-02
	x	4.8E-04	4.7E-04	4.7E-04	6.2E-04	8.3E-04	1.2E-03	4.0E-03
	y	4.0E-04	4.0E-04	8.0E-04	4.0E-04	2.5E-04	2.5E-04	2.4E-03
	L^*	7.9E-02	1.6E-01	1.1E-01	1.3E-01	1.1E-01	1.5E-01	1.6E-01
	a^*	9.6E-02	1.7E-01	3.8E-01	1.2E-01	1.3E-01	1.5E-01	3.7E-01
	b^*	1.6E-01	2.6E-01	2.2E-01	2.3E-01	2.4E-01	2.9E-01	5.4E+00

Table 11 presents the weights $w_{i,j}(V)$ (Eq. 17), RV $\Delta_{j,\mathrm{RV}}(V)$ (Eq. 18) and uncertainty of RV $u\left(\Delta_{j,\mathrm{RV}}(V)\right)$ (Eq. 19). Not that these are preliminary but NOT FINAL values.

Table 11. Weights, RV and uncertainty of RV. Preliminary.

Filter	Coor-dinate	BelGIM (pilot)	NSC IM	VNII-OFI	UME	NIM	NIMT	INM-MD	RV	Uncertainty of RV
xx-00-xx Gray	Y	0.219	0.067	0.242	0.242	0.205	0.020	0.004	-0.0529	2.4E-02
	x	0.175	0.013	0.253	0.158	0.253	0.146	0.003	0.000001	3.1E-05
	y	0.196	0.036	0.251	0.251	0.081	0.179	0.006	0.000075	5.4E-05
	L^*	0.283	0.044	0.266	0.090	0.266	0.047	0.004	-0.0247	1.8E-02
	a^*	0.203	0.035	0.278	0.166	0.278	0.040	0.001	-0.0259	8.3E-03
	b^*	0.163	0.037	0.271	0.190	0.271	0.044	0.022	0.0210	8.6E-03
xx-13-xx Light green	Y	0.241	0.071	0.254	0.254	0.156	0.018	0.006	-0.0054	2.5E-02
	x	0.108	0.177	0.260	0.101	0.260	0.058	0.037	0.000048	1.2E-04
	y	0.142	0.151	0.271	0.073	0.271	0.043	0.049	-0.000048	9.9E-05
	L^*	0.229	0.028	0.275	0.110	0.275	0.070	0.012	-0.0199	2.1E-02
	a^*	0.144	0.098	0.223	0.237	0.237	0.058	0.002	0.0427	1.7E-02
	b^*	0.305	0.044	0.092	0.223	0.151	0.005	0.181	0.0203	2.0E-02
xx-15-xx Light blue	Y	0.248	0.000	0.000	0.346	0.346	0.051	0.009	-0.0351	4.4E-02
	x	0.081	0.000	0.000	0.167	0.410	0.279	0.063	0.000184	1.1E-04
	y	0.095	0.000	0.000	0.098	0.376	0.376	0.055	-0.000198	1.4E-04
	L^*	0.401	0.000	0.000	0.113	0.302	0.169	0.015	-0.0011	4.8E-02
	a^*	0.071	0.000	0.000	0.404	0.404	0.119	0.002	0.2523	1.5E-02
	b^*	0.188	0.000	0.000	0.090	0.372	0.127	0.224	-0.0780	3.2E-02
xx-26-xx Light red	Y	0.278	0.211	0.225	0.221	0.030	0.028	0.006	0.037	3.1E-02
	x	0.074	0.054	0.296	0.049	0.296	0.219	0.012	-0.000062	5.1E-05
	y	0.121	0.045	0.251	0.218	0.251	0.105	0.007	-0.000069	6.0E-05
	L^*	0.248	0.137	0.211	0.152	0.200	0.047	0.004	-0.0120	2.1E-02
	a^*	0.110	0.037	0.245	0.282	0.282	0.043	0.001	0.0189	8.1E-03
	b^*	0.296	0.034	0.241	0.127	0.241	0.024	0.036	-0.0287	1.2E-02
xx-22-xx Dark green	Y	0.239	0.119	0.187	0.126	0.187	0.107	0.035	0.0011	2.1E-02
	x	0.163	0.205	0.151	0.176	0.205	0.083	0.016	0.000128	2.0E-04
	y	0.276	0.246	0.192	0.077	0.135	0.067	0.006	-0.000200	2.2E-04
	L^*	0.230	0.142	0.203	0.141	0.203	0.080	0.001	0.0052	2.7E-02
	a^*	0.151	0.180	0.152	0.196	0.192	0.110	0.018	0.0613	6.0E-02
	b^*	0.198	0.166	0.217	0.217	0.092	0.040	0.071	-0.0795	4.3E-02
xx-31-xx Dark blue	Y	0.268	0.105	0.208	0.167	0.208	0.038	0.006	-0.0013	3.2E-02
	x	0.107	0.084	0.262	0.081	0.262	0.168	0.037	0.000025	7.3E-05
	y	0.071	0.119	0.269	0.114	0.269	0.139	0.018	-0.000062	8.4E-05
	L^*	0.301	0.115	0.223	0.094	0.223	0.042	0.001	-0.0008	2.4E-02
	a^*	0.291	0.113	0.065	0.198	0.284	0.046	0.004	0.0015	2.0E-02
	b^*	0.147	0.042	0.217	0.217	0.211	0.108	0.059	-0.0192	2.4E-02
xx-19-xx Dark red	Y	0.291	0.092	0.171	0.094	0.171	0.128	0.052	0.0033	2.1E-02
	x	0.240	0.248	0.248	0.144	0.080	0.037	0.004	0.000145	2.2E-04
	y	0.123	0.120	0.030	0.120	0.302	0.302	0.003	-0.000088	1.0E-04
	L^*	0.322	0.074	0.160	0.116	0.160	0.086	0.083	0.0028	4.4E-02
	a^*	0.324	0.103	0.020	0.218	0.181	0.131	0.022	0.0753	5.1E-02
	b^*	0.308	0.115	0.169	0.150	0.138	0.094	0.027	0.0079	8.6E-02

Table 12 (a and b) presents the differences from RV (DRV), $D_{i,j}(V)$, calculated using the Eq. 21, and the expanded uncertainties of DRV (U(DRV)), $U_{\mathrm{p}}\left(D_{i,j}(V)\right)$, calculated using the Eq. 22, as well as the Chi-square value χ^2_{obs} (Eq. 20), shown in the last column. Marked in red bold are the χ^2_{obs} values larger than $\chi^2_{0.05}(\nu)$. $\nu = 4$ for the filter #15 "Light blue" and $\nu = 6$ for all other filters. Therefore, $\chi^2_{0.05}(4)$ =9.488 and $\chi^2_{0.05}(6)$ =12.592.

Table 12a. Differences from RV (DRV), $D_{i,j}(V)$, Eq. 21, **expanded uncertainties of DRV** (U(DRV)), $U_{\mathrm{p}}\left(D_{i,j}(V)\right)$, Eq. 22, **and the Chi-square value** χ^2_{obs} , Eq. 20. **Preliminary values**, $s_j(V)$ = 0. $\chi^2_{0.05}(\nu = 4)$ =9.488 for the filter #15 "Light blue", and $\chi^2_{0.05}(\nu = 6)$ =12.592 for all other filters.

Filter	Coor-dinate	BelGIM (pilot)		NSC IM		VNIIOFI		UME		NIM		NIMT		INM-MD		χ^2_{obs}
		DRV	*U*(DRV)	DRV	*U*(DRV)	DRV	*U*(DRV)	DRV	*U*(DRV)	DRV	*U*(DRV)	DRV	*U*(DRV)	DRV	*U*(DRV)	
xx-00-xx Gray	Y	5.3E-02	*9.4E-02*	7.2E-02	*1.9E-01*	1.7E-02	*8.6E-02*	-4.8E-02	*7.8E-02*	-4.8E-02	*9.9E-02*	3.2E-02	*3.6E-01*	1.2E-01	*7.8E-01*	3.352
	x	-6.4E-07	*1.5E-04*	9.9E-05	*6.0E-04*	1.2E-04	*9.7E-05*	-6.4E-07	*1.6E-04*	-1.2E-04	*9.7E-05*	-6.4E-07	*1.7E-04*	-1.5E-04	*1.3E-03*	6.016
	y	-7.5E-05	*2.3E-04*	1.3E-04	*6.1E-04*	1.5E-04	*1.6E-04*	-4.9E-06	*1.9E-04*	-1.2E-04	*3.9E-04*	-7.5E-05	*2.5E-04*	-2.5E-04	*1.5E-03*	2.777
	L*	2.5E-02	*6.2E-02*	3.5E-02	*2.0E-01*	5.1E-03	*4.9E-02*	-3.0E-02	*1.3E-01*	-3.0E-02	*5.4E-02*	1.3E-02	*1.9E-01*	6.1E-02	*6.9E-01*	1.283
	a*	2.6E-02	*3.6E-02*	-1.4E-02	*1.0E-01*	-1.3E-02	*2.6E-02*	-2.9E-03	*4.1E-02*	-6.4E-03	*2.3E-02*	2.6E-02	*9.2E-02*	3.4E-02	*7.1E-01*	2.551
	b*	-1.9E-02	*4.3E-02*	6.2E-02	*1.0E-01*	7.2E-02	*2.7E-02*	4.8E-03	*3.9E-02*	-5.4E-02	*2.4E-02*	-1.9E-02	*9.1E-02*	-1.0E-01	*1.3E-01*	**27.297**
xx-13-xx Light green	Y	5.4E-03	*9.5E-02*	6.8E-02	*2.0E-01*	-9.6E-02	*8.1E-02*	7.1E-02	*7.9E-02*	1.4E-03	*1.3E-01*	2.1E-02	*4.0E-01*	-1.1E-01	*7.3E-01*	5.400
	x	-4.8E-05	*7.9E-04*	-7.8E-05	*5.8E-04*	-6.3E-05	*3.6E-04*	6.2E-05	*8.2E-04*	6.2E-05	*3.2E-04*	-3.8E-05	*1.1E-03*	4.0E-04	*1.4E-03*	0.499
	y	4.8E-05	*5.7E-04*	-5.2E-05	*5.5E-04*	-4.8E-05	*3.2E-04*	-1.3E-04	*8.4E-04*	5.8E-05	*2.5E-04*	-1.5E-04	*1.1E-03*	2.9E-04	*1.0E-03*	0.604
	L*	2.0E-02	*8.9E-02*	7.5E-02	*3.0E-01*	-6.8E-02	*5.8E-02*	5.1E-02	*1.4E-01*	1.8E-02	*6.2E-02*	2.7E-02	*1.8E-01*	-3.7E-02	*4.6E-01*	3.049
	a*	-4.3E-02	*8.7E-02*	-3.4E-02	*1.1E-01*	-1.6E-02	*6.6E-02*	5.1E-02	*6.0E-02*	-2.9E-03	*5.1E-02*	2.3E-02	*1.5E-01*	6.6E-02	*7.8E-01*	3.318
	b*	-2.0E-02	*5.6E-02*	-1.9E-02	*2.0E-01*	-1.2E-01	*1.4E-01*	-3.9E-02	*7.0E-02*	8.9E-03	*1.0E-01*	-8.2E-02	*6.3E-01*	1.4E-01	*9.1E-02*	11.546
xx-15-xx Light blue	Y	3.5E-02	*1.6E-01*					-8.3E-02	*1.2E-01*	2.7E-02	*1.2E-01*	3.7E-02	*4.2E-01*	9.4E-01	*1.0E+00*	4.721
	x	-1.8E-04	*9.1E-04*					3.2E-04	*5.9E-04*	-8.4E-05	*2.2E-04*	1.6E-05	*4.1E-04*	-1.2E-04	*1.1E-03*	1.226
	y	2.0E-04	*1.1E-03*					-1.0E-04	*1.1E-03*	8.4E-06	*2.8E-04*	-1.6E-06	*3.8E-04*	-2.1E-04	*1.5E-03*	0.220
	L*	1.1E-03	*1.2E-01*					-6.1E-02	*2.9E-01*	-3.1E-03	*1.3E-01*	2.2E-03	*2.3E-01*	4.8E-01	*8.5E-01*	1.383
	a*	-2.5E-01	*1.5E-01*					1.7E-01	*3.7E-02*	-1.1E-01	*3.4E-02*	-5.3E-02	*1.1E-01*	-1.5E-01	*8.7E-01*	**52.547**
	b*	7.8E-02	*1.6E-01*					5.6E-02	*2.5E-01*	2.6E-02	*6.8E-02*	3.6E-02	*2.0E-01*	-1.5E-01	*1.4E-01*	4.499
xx-26-xx Light red	Y	-3.7E-02	*1.0E-01*	-5.5E-03	*1.2E-01*	4.0E-02	*1.1E-01*	6.2E-02	*1.2E-01*	-3.3E-01	*3.6E-01*	-5.8E-02	*3.8E-01*	1.3E-02	*8.5E-01*	4.896
	x	6.2E-05	*4.9E-04*	3.4E-04	*5.8E-04*	6.9E-05	*1.3E-04*	6.2E-05	*6.1E-04*	-1.2E-04	*1.3E-04*	-3.8E-05	*2.5E-04*	-2.7E-04	*1.3E-03*	2.729
	y	6.9E-05	*3.6E-04*	3.7E-04	*6.1E-04*	9.3E-05	*1.9E-04*	-1.3E-04	*2.5E-04*	-1.0E-04	*1.9E-04*	6.9E-05	*3.9E-04*	-2.6E-04	*1.6E-03*	3.590
	L*	1.2E-02	*7.5E-02*	2.8E-02	*1.1E-01*	5.1E-02	*6.8E-02*	6.3E-02	*1.0E-01*	-1.4E-01	*8.6E-02*	1.4E-03	*2.0E-01*	3.8E-02	*6.7E-01*	10.715
	a*	-1.9E-02	*5.5E-02*	-2.7E-02	*9.9E-02*	-2.4E-02	*3.3E-02*	7.7E-02	*2.4E-02*	-3.6E-02	*2.2E-02*	-6.5E-02	*9.2E-02*	-1.6E-02	*6.8E-01*	**25.355**
	b*	2.9E-02	*3.8E-02*	1.8E-01	*1.4E-01*	3.7E-02	*4.1E-02*	-4.2E-02	*6.8E-02*	-5.7E-02	*4.0E-02*	1.3E-02	*1.7E-01*	-1.4E-01	*1.4E-01*	**19.325**

Table 12b. Differences from RV (DRV), $\left(D_{i,j}(V)\right)$, Eq. 21, **expanded uncertainties of DRV** (U(DRV)), $U_{\mathrm{p}}\left(D_{i,j}(V)\right)$, Eq. 22, **and the Chi-square value** χ^2_{obs} , Eq. 20. **Preliminary values,** $s_j(V)$ = 0. $\chi^2_{0.05}(\nu = 6)$ =12.592.

Filter	Coor-dinate	BelGIM (pilot)		NSC IM		VNIIOFI		UME		NIM		NIMT		INM-MD		χ^2_{obs}
		DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	
xx-22-xx Dark green	Y	-1.1E-03	*7.6E-02*	9.9E-03	*1.2E-01*	-2.0E-02	*8.2E-02*	4.8E-02	*1.1E-01*	-2.1E-03	*7.8E-02*	-1.2E-02	*1.2E-01*	-4.2E-02	*2.3E-01*	0.988
	x	-1.3E-04	*9.4E-04*	-1.3E-04	*7.8E-04*	-6.4E-05	*9.9E-04*	-1.3E-04	*9.0E-04*	3.0E-04	*7.1E-04*	-2.8E-05	*1.4E-03*	1.3E-03	*3.3E-03*	1.239
	y	2.0E-04	*5.9E-04*	1.5E-04	*7.9E-04*	4.7E-05	*1.0E-03*	-1.7E-03	*1.7E-03*	2.3E-04	*1.3E-03*	3.0E-07	*1.9E-03*	-1.3E-04	*6.5E-03*	3.832
	L^*	-5.2E-03	*1.0E-01*	1.3E-02	*1.4E-01*	-3.6E-02	*9.0E-02*	7.0E-02	*1.4E-01*	-6.7E-03	*1.1E-01*	-2.2E-02	*1.9E-01*	-6.9E-02	*1.7E+00*	1.308
	a^*	-6.1E-02	*2.9E-01*	-7.4E-02	*2.6E-01*	-1.6E-03	*2.9E-01*	5.2E-02	*2.2E-01*	3.5E-02	*2.5E-01*	-2.2E-03	*3.5E-01*	3.6E-01	*9.2E-01*	1.196
	b^*	6.9E-02	*1.8E-01*	7.4E-01	*2.0E-01*	1.7E-02	*1.5E-01*	-3.5E-01	*1.6E-01*	1.8E-01	*2.8E-01*	2.5E-02	*4.4E-01*	2.6E-01	*3.3E-01*	**17.277**
xx-31-xx Dark blue	Y	1.3E-03	*1.1E-01*	1.1E-01	*1.9E-01*	-3.7E-02	*1.2E-01*	-1.1E-02	*1.5E-01*	-2.1E-02	*1.1E-01*	9.3E-03	*3.3E-01*	1.7E-01	*8.3E-01*	1.776
	x	-2.5E-05	*5.0E-04*	-1.1E-04	*5.8E-04*	4.4E-06	*2.1E-04*	-2.2E-04	*5.9E-04*	4.5E-05	*2.0E-04*	7.5E-05	*3.8E-04*	1.3E-04	*9.0E-04*	0.928
	y	6.2E-05	*7.5E-04*	-8.8E-05	*5.6E-04*	4.9E-05	*2.5E-04*	7.2E-05	*5.7E-04*	7.2E-05	*2.1E-04*	-2.3E-04	*5.1E-04*	-1.5E-04	*1.5E-03*	1.037
	L^*	7.7E-04	*7.7E-02*	8.6E-02	*1.4E-01*	-2.8E-02	*8.3E-02*	-8.4E-03	*1.6E-01*	-1.6E-02	*8.2E-02*	6.9E-03	*2.5E-01*	1.3E-01	*1.4E+00*	1.612
	a^*	-1.5E-03	*6.5E-02*	2.9E-02	*1.2E-01*	2.0E-02	*1.6E-01*	-1.1E-01	*8.5E-02*	3.0E-02	*5.1E-02*	2.0E-01	*2.0E-01*	1.9E-01	*7.2E-01*	10.579
	b^*	1.9E-02	*1.2E-01*	-9.0E-02	*2.4E-01*	3.2E-02	*9.3E-02*	5.0E-03	*7.7E-02*	3.9E-02	*9.8E-02*	-8.2E-02	*1.5E-01*	-1.1E-01	*2.0E-01*	3.644
xx-19-xx Dark red	Y	-3.3E-03	*6.6E-02*	-6.7E-03	*1.3E-01*	-2.3E-02	*9.4E-02*	2.6E-02	*1.3E-01*	4.7E-02	*8.3E-02*	-6.3E-03	*1.1E-01*	-7.9E-02	*1.8E-01*	1.889
	x	-1.5E-04	*8.1E-04*	2.5E-04	*7.2E-04*	2.4E-04	*6.9E-04*	-4.5E-04	*1.1E-03*	-4.5E-04	*1.6E-03*	2.5E-04	*2.4E-03*	3.0E-04	*7.9E-03*	1.518
	y	8.8E-05	*7.2E-04*	-1.0E-04	*7.3E-04*	-9.3E-05	*1.6E-03*	-4.1E-04	*7.3E-04*	8.8E-05	*2.2E-04*	8.8E-05	*2.9E-04*	1.7E-04	*4.8E-03*	1.415
	L^*	-3.8E-03	*1.3E-01*	-1.2E-02	*3.2E-01*	-6.0E-02	*1.8E-01*	7.4E-02	*2.5E-01*	1.3E-01	*2.0E-01*	-1.1E-02	*2.9E-01*	-2.0E-01	*3.0E-01*	3.623
	a^*	-7.5E-02	*1.5E-01*	9.9E-03	*3.2E-01*	-6.5E-02	*7.6E-01*	1.2E-01	*1.6E-01*	5.9E-02	*2.3E-01*	-3.7E-02	*2.8E-01*	-3.0E-01	*7.3E-01*	2.571
	b^*	-7.9E-03	*2.6E-01*	2.6E-02	*4.9E-01*	-5.6E-02	*3.4E-01*	-8.1E-02	*4.2E-01*	1.4E-01	*4.4E-01*	7.9E-02	*5.5E-01*	-2.2E-01	*1.1E+00*	0.789

9.2 Applying Mandel-Paule method

For the most cases the consistency was satisfied, i.e. $\chi^2_{\text{obs}} \leq \chi^2_{0.05}(\nu)$. But for the following coordinate/filter combination the consistency check failed (If $\chi^2_{\text{obs}} > \chi^2_{0.05}(\nu)$): for value b* of the filter #0 "Gray", a* of the filter #15 "Light blue", a* and b* of the filter #26 "Light red", y of the filter #22 "Dark green" and b* of the filter #22 "Dark green". For these cases the Mandel-Paule method was applied: the $s_j^2(V)$ term was added in the Equation 14. The values of $s_j(V)$ were determined by iterative process so that $\chi^2_{\text{obs}} = \chi^2_{0.05}(\nu)$.

The values of $s_j(V)$, Chi-square value χ^2_{obs} and the final values of RV and uncertainty of RV after applying the Mandel-Paule method are presented in Table 13. The corresponding new values of $u_{\text{adj}}\left(\Delta_{i,j}(V)\right)$ and weights are presented in Table 14 and Table 15, respectively. The values for the other combinations of coordinate/filter are unchanged, i.e. the same as in the tables above.

Table 13. $s_j(V)$, χ^2_{obs} and RV after applying Mandel-Paule method

Filter	Coordinate	$s_j(V)$	χ^2_{obs}	RV	Uncertainty of RV
xx-00-xx Gray	b*	2.37E-02	**12.589**	0.0190	1.4E-02
xx-15-xx Light blue	a*	8.60E-02	**9.448**	0.2097	4.8E-02
xx-26-xx Light red	a*	2.00E-02	**12.570**	0.0148	1.3E-02
	b*	3.12E-02	**12.583**	-0.0301	1.9E-02
xx-22-xx Dark green	b*	6.56E-02	**12.590**	-0.0693	5.1E-02

Table 14. Uncertainties $u_{\text{adj}}\left(\Delta_{i,j}(V)\right)$ after applying Mandel-Paule method

Filter	Coordinate	BelGIM (pilot)	NSC IM	VNIIOFI	UME	NIM	NIMT	INM-MD
xx-00-xx Gray	b*	3.4E-02	5.6E-02	3.0E-02	3.3E-02	3.0E-02	5.3E-02	7.0E-02
xx-15-xx Light blue	a*	1.2E-01			9.2E-02	9.2E-02	1.0E-01	4.5E-01
xx-26-xx Light red	a*	3.6E-02	5.5E-02	2.8E-02	2.7E-02	2.7E-02	5.1E-02	3.4E-01
	b*	3.9E-02	7.8E-02	4.1E-02	4.8E-02	4.1E-02	9.0E-02	7.7E-02
xx-22-xx Dark green	b*	1.2E-01	1.3E-01	1.2E-01	1.2E-01	1.6E-01	2.4E-01	1.8E-01

Table 15. Weights after applying Mandel-Paule method

Filter	Coordinate	BelGIM (pilot)	NSC IM	VNIIOFI	UME	NIM	NIMT	INM-MD
xx-00-xx Gray	b*	0.178	0.065	0.224	0.192	0.224	0.075	0.042
xx-15-xx Light blue	a*	0.184	0.000	0.000	0.290	0.290	0.224	0.012
xx-26-xx Light red	a*	0.143	0.061	0.231	0.247	0.247	0.069	0.002
	b*	0.237	0.060	0.218	0.158	0.218	0.046	0.063
xx-22-xx Dark green	b*	0.190	0.167	0.202	0.202	0.104	0.050	0.083

10 COMPARISON RESULTS. DIFFERENCES FROM RV

The final values of differences from RV and associated expended uncertainties, as well as the values $s_j(V)$ of the Mandel-Paule addition, are summarized in Tables 16a and 16b. The nominal values of colour coordinates are also included in the tables.

Table 16a. Differences from RV (DRV), $D_{i,j}(V)$ and **expanded uncertainties of DRV** (U(DRV)), $U_{\mathrm{p}}\left(D_{i,j}(V)\right)$**. Final values.**

Filter	Coordi-nate	Mandel-Paule addition $s_j(V)$	BelGIM (pilot)		NSC IM		VNIIOFI		UME		NIM		NIMT		INM-MD	
			DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*
xx-00-xx Gray	Y = 60	0	5.3E-02	*9.4E-02*	7.2E-02	*1.9E-01*	1.7E-02	*8.6E-02*	-4.8E-02	*7.8E-02*	-4.8E-02	*9.9E-02*	3.2E-02	*3.6E-01*	1.2E-01	*7.8E-01*
	x =0.31	0	-6.4E-07	*1.5E-04*	9.9E-05	*6.0E-04*	1.2E-04	*9.7E-05*	-6.4E-07	*1.6E-04*	-1.2E-04	*9.7E-05*	-6.4E-07	*1.7E-04*	-1.5E-04	*1.3E-03*
	y = 0.33	0	-7.5E-05	*2.3E-04*	1.3E-04	*6.1E-04*	1.5E-04	*1.6E-04*	-4.9E-06	*1.9E-04*	-1.2E-04	*3.9E-04*	-7.5E-05	*2.5E-04*	-2.5E-04	*1.5E-03*
	L^* = 82	0	2.5E-02	*6.2E-02*	3.5E-02	*2.0E-01*	5.1E-03	*4.9E-02*	-3.0E-02	*1.3E-01*	-3.0E-02	*5.4E-02*	1.3E-02	*1.9E-01*	6.1E-02	*6.9E-01*
	a^* = -1.8	0	2.6E-02	*3.6E-02*	-1.4E-02	*1.0E-01*	-1.3E-02	*2.6E-02*	-2.9E-03	*4.1E-02*	-6.4E-03	*2.3E-02*	2.6E-02	*9.2E-02*	3.4E-02	*7.1E-01*
	b^* = -1.3	0.0237	-1.9E-02	*6.1E-02*	6.2E-02	*1.1E-01*	7.2E-02	*5.0E-02*	4.8E-03	*5.8E-02*	-5.4E-02	*4.9E-02*	-1.9E-02	*1.0E-01*	-1.0E-01	*1.4E-01*
xx-13-xx Light green	Y = 74	0	5.4E-03	*9.5E-02*	6.8E-02	*2.0E-01*	-9.6E-02	*8.1E-02*	7.1E-02	*7.9E-02*	1.4E-03	*1.3E-01*	2.1E-02	*4.0E-01*	-1.1E-01	*7.3E-01*
	x = 0.37	0	-4.8E-05	*7.9E-04*	-7.8E-05	*5.8E-04*	-6.3E-05	*3.6E-04*	6.2E-05	*8.2E-04*	6.2E-05	*3.2E-04*	-3.8E-05	*1.1E-03*	4.0E-04	*1.4E-03*
	y = 0.45	0	4.8E-05	*5.7E-04*	-5.2E-05	*5.5E-04*	-4.8E-05	*3.2E-04*	-1.3E-04	*8.4E-04*	5.8E-05	*2.5E-04*	-1.5E-04	*1.1E-03*	2.9E-04	*1.0E-03*
	L^* = 89	0	2.0E-02	*8.9E-02*	7.5E-02	*3.0E-01*	-6.8E-02	*5.8E-02*	5.1E-02	*1.4E-01*	1.8E-02	*6.2E-02*	2.7E-02	*1.8E-01*	-3.7E-02	*4.6E-01*
	a^* = -21	0	-4.3E-02	*8.7E-02*	-3.4E-02	*1.1E-01*	-1.6E-02	*6.6E-02*	5.1E-02	*6.0E-02*	-2.9E-03	*5.1E-02*	2.3E-02	*1.5E-01*	6.6E-02	*7.8E-01*
	b^* = 51	0	-2.0E-02	*5.6E-02*	-1.9E-02	*2.0E-01*	-1.2E-01	*1.4E-01*	-3.9E-02	*7.0E-02*	8.9E-03	*1.0E-01*	-8.2E-02	*6.3E-01*	1.4E-01	*9.1E-02*
xx-15-xx Light blue	Y = 63	0	3.5E-02	*1.6E-01*					-8.3E-02	*1.2E-01*	2.7E-02	*1.2E-01*	3.7E-02	*4.2E-01*	9.4E-01	*1.0E+00*
	x = 0.24	0	-1.8E-04	*9.1E-04*					3.2E-04	*5.9E-04*	-8.4E-05	*2.2E-04*	1.6E-05	*4.1E-04*	-1.2E-04	*1.1E-03*
	y = 0.30	0	2.0E-04	*1.1E-03*					-1.0E-04	*1.1E-03*	8.4E-06	*2.8E-04*	-1.6E-06	*3.8E-04*	-2.1E-04	*1.5E-03*
	L^* = 83	0	1.1E-03	*1.2E-01*					-6.1E-02	*2.9E-01*	-3.1E-03	*1.3E-01*	2.2E-03	*2.3E-01*	4.8E-01	*8.5E-01*
	a^* = -24	0.0860	-2.1E-01	*2.1E-01*					2.2E-01	*1.5E-01*	-6.9E-02	*1.5E-01*	-1.1E-02	*1.8E-01*	-1.1E-01	*8.9E-01*
	b^* = -20	0	7.8E-02	*1.6E-01*					5.6E-02	*2.5E-01*	2.6E-02	*6.8E-02*	3.6E-02	*2.0E-01*	-1.5E-01	*1.4E-01*
xx-26-xx Light red	Y = 65	0	-3.7E-02	*1.0E-01*	-5.5E-03	*1.2E-01*	4.0E-02	*1.1E-01*	6.2E-02	*1.2E-01*	-3.3E-01	*3.6E-01*	-5.8E-02	*3.8E-01*	1.3E-02	*8.5E-01*
	x = 0.32	0	6.2E-05	*4.9E-04*	3.4E-04	*5.8E-04*	6.9E-05	*1.3E-04*	6.2E-05	*6.1E-04*	-1.2E-04	*1.3E-04*	-3.8E-05	*2.5E-04*	-2.7E-04	*1.3E-03*
	y = 0.32	0	6.9E-05	*3.6E-04*	3.7E-04	*6.1E-04*	9.3E-05	*1.9E-04*	-1.3E-04	*2.5E-04*	-1.0E-04	*1.9E-04*	6.9E-05	*3.9E-04*	-2.6E-04	*1.6E-03*
	L^* = 85	0	1.2E-02	*7.5E-02*	2.8E-02	*1.1E-01*	5.1E-02	*6.8E-02*	6.3E-02	*1.0E-01*	-1.4E-01	*8.6E-02*	1.4E-03	*2.0E-01*	3.8E-02	*6.7E-01*
	a^* = 8.5	0.0200	-1.5E-02	*6.6E-02*	-2.3E-02	*1.1E-01*	-1.9E-02	*4.8E-02*	8.1E-02	*4.2E-02*	-3.2E-02	*4.2E-02*	-6.1E-02	*9.9E-02*	-1.2E-02	*6.8E-01*
	b^* = -2.0	0.0312	3.0E-02	*6.8E-02*	1.8E-01	*1.5E-01*	3.9E-02	*6.9E-02*	-4.0E-02	*8.8E-02*	-5.5E-02	*6.9E-02*	1.4E-02	*1.8E-01*	-1.4E-01	*1.5E-01*

Table 16b. Differences from RV (DRV), $D_{i,j}(V)$ and **expanded uncertainties of DRV** (U(DRV)), $U_p\left(D_{i,j}(V)\right)$**. Final values.**

Filter	Coordi-nate	Mandel-Paule addition $s_j(V)$	BelGIM (pilot)		NSC IM		VNIIOFI		UME		NIM		NIMT		INM-MD	
			DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*	DRV	*U(DRV)*
xx-22-xx Dark green	Y = 13	0	-1.1E-03	*7.6E-02*	9.9E-03	*1.2E-01*	-2.0E-02	*8.2E-02*	4.8E-02	*1.1E-01*	-2.1E-03	*7.8E-02*	-1.2E-02	*1.2E-01*	-4.2E-02	*2.2E-01*
	x = 0.28	0	-1.3E-04	*9.4E-04*	-1.3E-04	*7.8E-04*	-6.4E-05	*9.9E-04*	-1.3E-04	*9.0E-04*	3.0E-04	*7.1E-04*	-2.8E-05	*1.4E-03*	1.3E-03	*3.3E-03*
	y = 0.65	0	2.0E-04	*5.9E-04*	1.5E-04	*7.9E-04*	4.7E-05	*1.0E-03*	-1.7E-03	*1.7E-03*	2.3E-04	*1.3E-03*	3.0E-07	*1.9E-03*	-1.3E-04	*6.5E-03*
	L^* = 42	0	-5.2E-03	*1.0E-01*	1.3E-02	*1.4E-01*	-3.6E-02	*9.0E-02*	7.0E-02	*1.4E-01*	-6.7E-03	*1.1E-01*	-2.2E-02	*1.9E-01*	-6.9E-02	*1.7E+00*
	a^* = -57	0	-6.1E-02	*2.9E-01*	-7.4E-02	*2.6E-01*	-1.6E-03	*2.9E-01*	5.2E-02	*2.2E-01*	3.5E-02	*2.5E-01*	-2.2E-03	*3.5E-01*	3.6E-01	*9.2E-01*
	b^* = 55	0.0656	6.9E-02	*2.2E-01*	7.4E-02	*2.3E-01*	1.7E-02	*2.0E-01*	-3.5E-01	*2.0E-01*	1.8E-01	*3.1E-01*	2.5E-02	*4.6E-01*	2.6E-01	*3.5E-01*
xx-31-xx Dark blue	Y = 36	0	1.3E-03	*1.1E-01*	1.1E-01	*1.9E-01*	-3.7E-02	*1.2E-01*	-1.1E-02	*1.5E-01*	-2.1E-02	*1.1E-01*	9.3E-03	*3.3E-01*	1.7E-01	*8.3E-01*
	x = 0.22	0	-2.5E-05	*5.0E-04*	-1.1E-04	*5.8E-04*	4.4E-06	*2.1E-04*	-2.2E-04	*5.9E-04*	4.4E-05	*2.0E-04*	7.5E-05	*3.8E-04*	1.3E-04	*9.0E-04*
	y = 0.23	0	6.2E-05	*7.5E-04*	-8.8E-05	*5.6E-04*	4.9E-05	*2.5E-04*	7.2E-05	*5.7E-04*	7.2E-05	*2.1E-04*	-2.3E-04	*5.1E-04*	-1.5E-04	*1.5E-03*
	L^* = 67	0	7.7E-04	*7.7E-02*	8.6E-02	*1.4E-01*	-2.8E-02	*8.3E-02*	-8.4E-03	*1.6E-01*	-1.6E-02	*8.2E-02*	6.9E-03	*2.5E-01*	1.3E-01	*1.4E+00*
	a^* = 1.5	0	-1.5E-03	*6.5E-02*	2.9E-02	*1.2E-01*	2.0E-02	*1.6E-01*	-1.1E-01	*8.5E-02*	3.0E-02	*5.1E-02*	2.0E-01	*2.0E-01*	1.9E-01	*7.2E-01*
	b^* = -42	0	1.9E-02	*1.2E-01*	-9.0E-02	*2.4E-01*	3.2E-02	*9.3E-02*	5.0E-03	*7.7E-02*	3.9E-02	*9.8E-02*	-8.2E-02	*1.5E-01*	-1.1E-01	*2.0E-01*
xx-19-xx Dark red	Y = 5.5	0	-3.3E-03	*6.6E-02*	-6.7E-03	*1.3E-01*	-2.3E-02	*9.4E-02*	2.6E-02	*1.3E-01*	4.7E-02	*8.3E-02*	-6.3E-03	*1.1E-01*	-7.9E-02	*1.8E-01*
	x = 0.68	0	-1.5E-04	*8.1E-04*	2.5E-04	*7.2E-04*	2.4E-04	*6.9E-04*	-4.5E-04	*1.1E-03*	-4.5E-04	*1.6E-03*	2.5E-04	*2.4E-03*	3.0E-04	*7.9E-03*
	y = 0.32	0	8.8E-05	*7.2E-04*	-1.0E-04	*7.3E-04*	-9.3E-05	*1.6E-03*	-4.1E-04	*7.3E-04*	8.8E-05	*2.2E-04*	8.8E-05	*2.9E-04*	1.7E-04	*4.8E-03*
	L^* = 28	0	-2.8E-03	*1.3E-01*	-1.2E-02	*3.2E-01*	-6.0E-02	*1.8E-01*	7.4E-02	*2.5E-01*	1.3E-01	*2.0E-01*	-1.1E-02	*2.9E-01*	-2.0E-01	*3.0E-01*
	a^* = 57	0	-7.5E-02	*1.5E-01*	9.9E-03	*3.2E-01*	-6.5E-02	*7.6E-01*	1.2E-01	*1.6E-01*	5.9E-02	*2.3E-01*	-3.7E-02	*2.8E-01*	-3.0E-01	*7.3E-01*
	b^* = 48	0	-7.9E-03	*2.6E-01*	2.6E-02	*4.9E-01*	-5.6E-02	*3.4E-01*	-8.1E-02	*4.2E-01*	1.4E-01	*4.4E-01*	7.9E-02	*5.5E-01*	-2.2E-01	*1.1E+00*

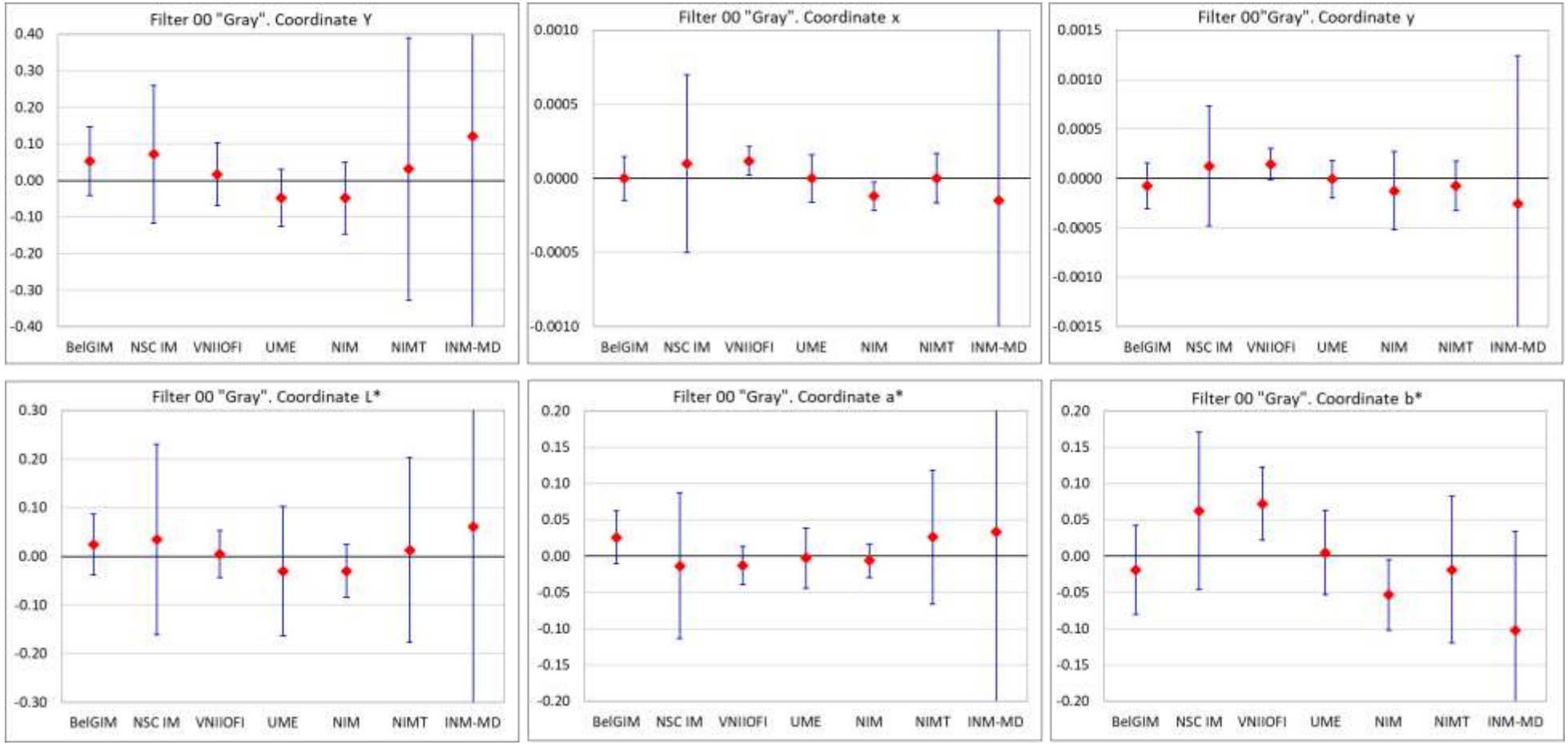

Figure 3. Differences from the comparison Reference Values and associated expended uncertainties, $k = 2$.
Filter #00 “Gray”. Coordinate nominal values: Y = 60, x = 0.31, y = 0.33, L^* = 82, a^* = -1.8, b^* = -1.3.

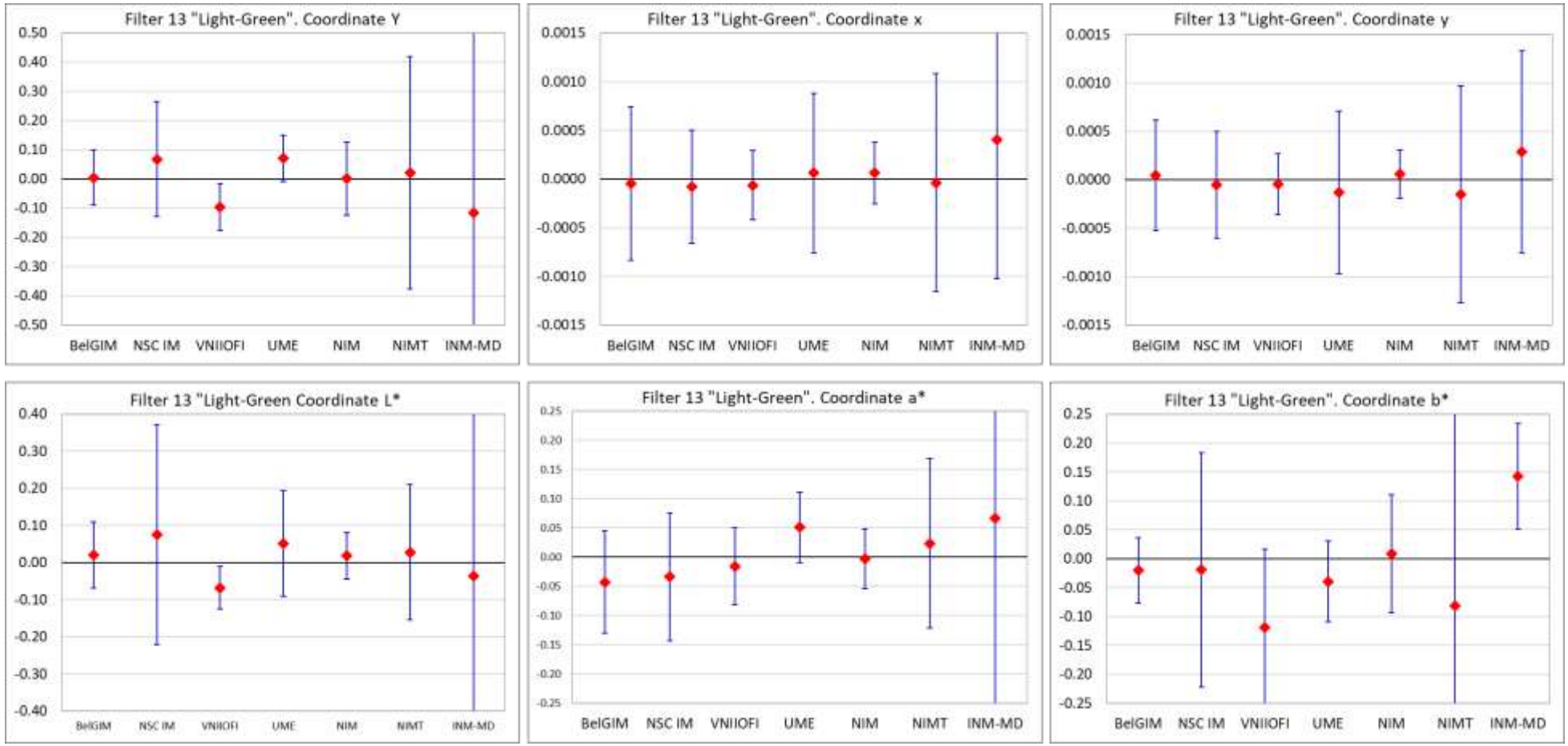

Figure 4. Differences from the comparison Reference Values and associated expended uncertainties, $k = 2$.
Filter #13 “Light green”. Coordinate nominal values: Y = 74, x = 0.37, y = 0.45, L^* = 89, a^* = -21, b^* = 51.

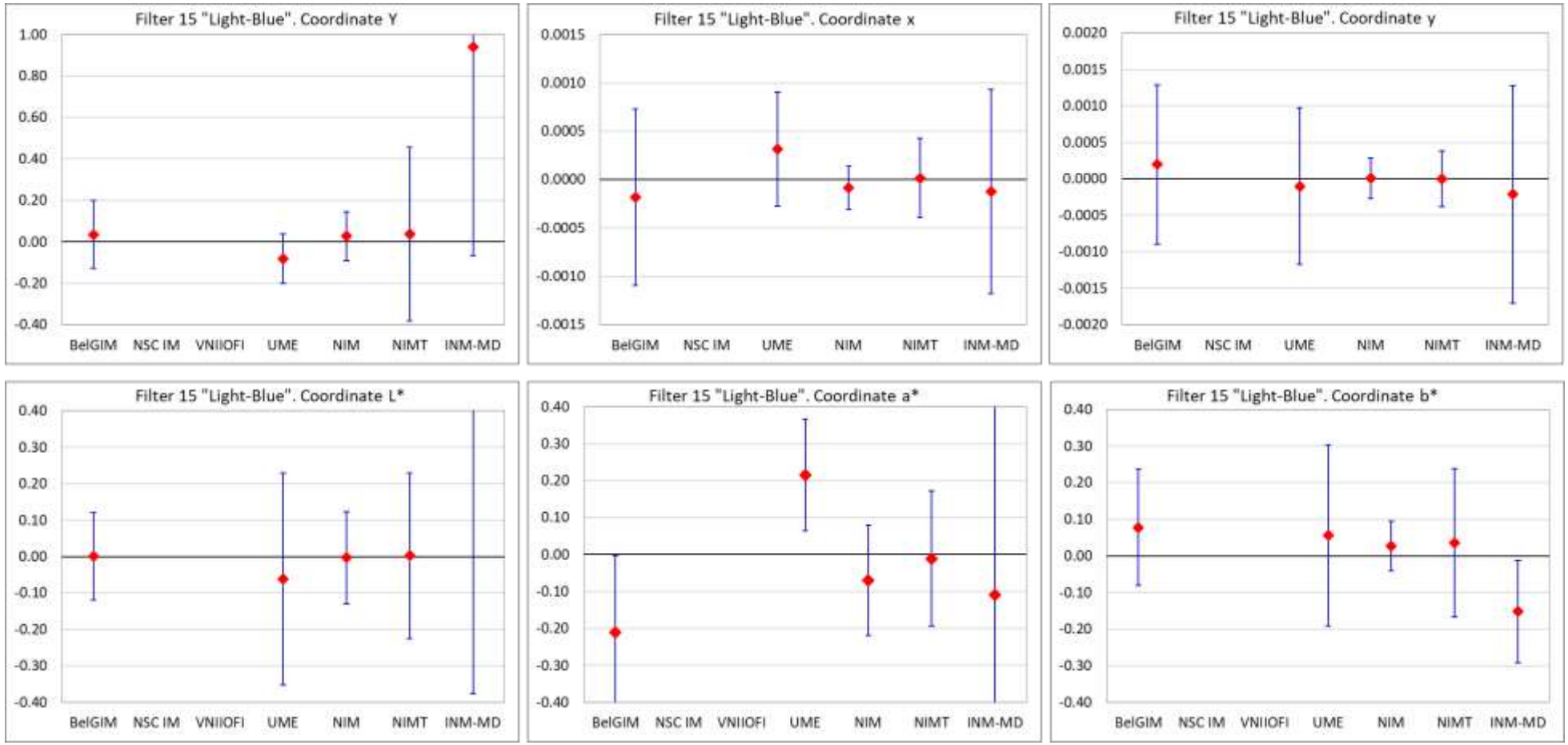

Figure 5. Differences from the comparison Reference Values and associated expended uncertainties, $k = 2$.
Filter #15 “Light blue”. Coordinate nominal values: Y = 63, x = 0.24, y = 0.30, $L^* = 83$, $a^* = -24$, $b^* = -20$.

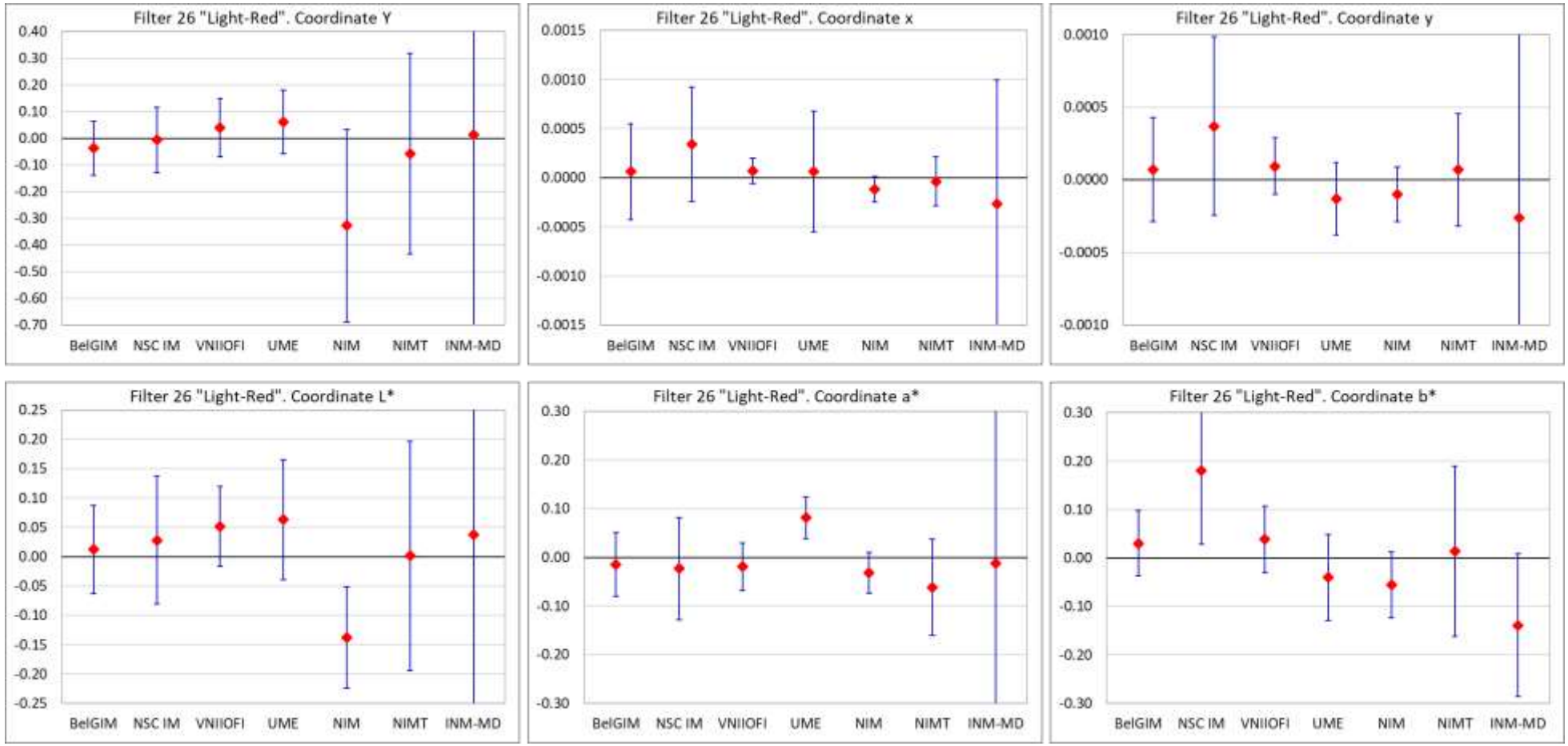

Figure 6. Differences from the comparison Reference Values and associated expended uncertainties, $k = 2$.
Filter #26 “Light red”. Coordinate nominal values: Y = 65, x = 0.32, y = 0.32, L^* = 85, a^* = 8.5, b^* = -2.0.

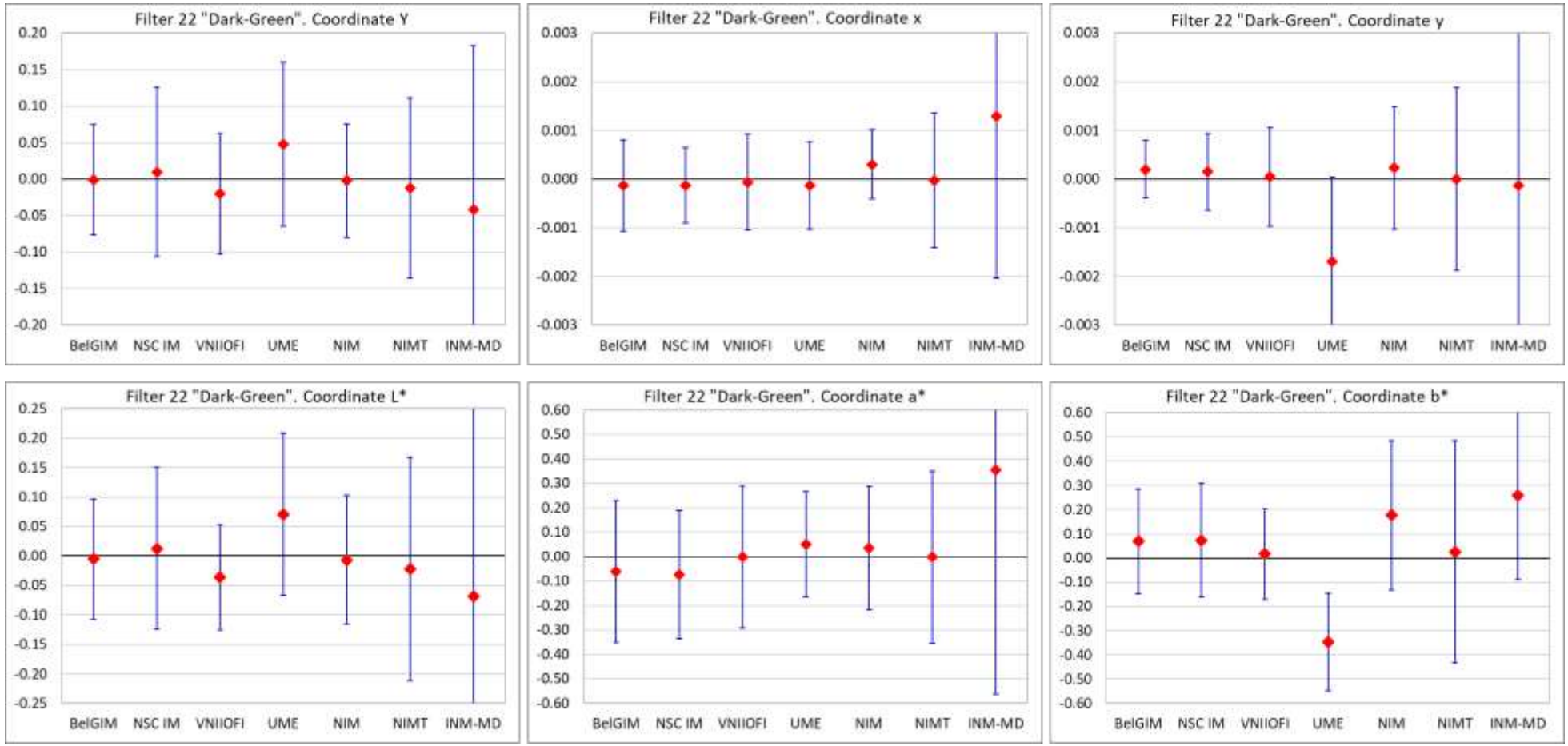

Figure 7. Differences from the comparison Reference Values and associated expended uncertainties, $k = 2$.
Filter #22 “Dark green”. Coordinate nominal values: Y = 13, x = 0.28, y = 0.65, L^* = 42, a^* = -57, b^* = 55.

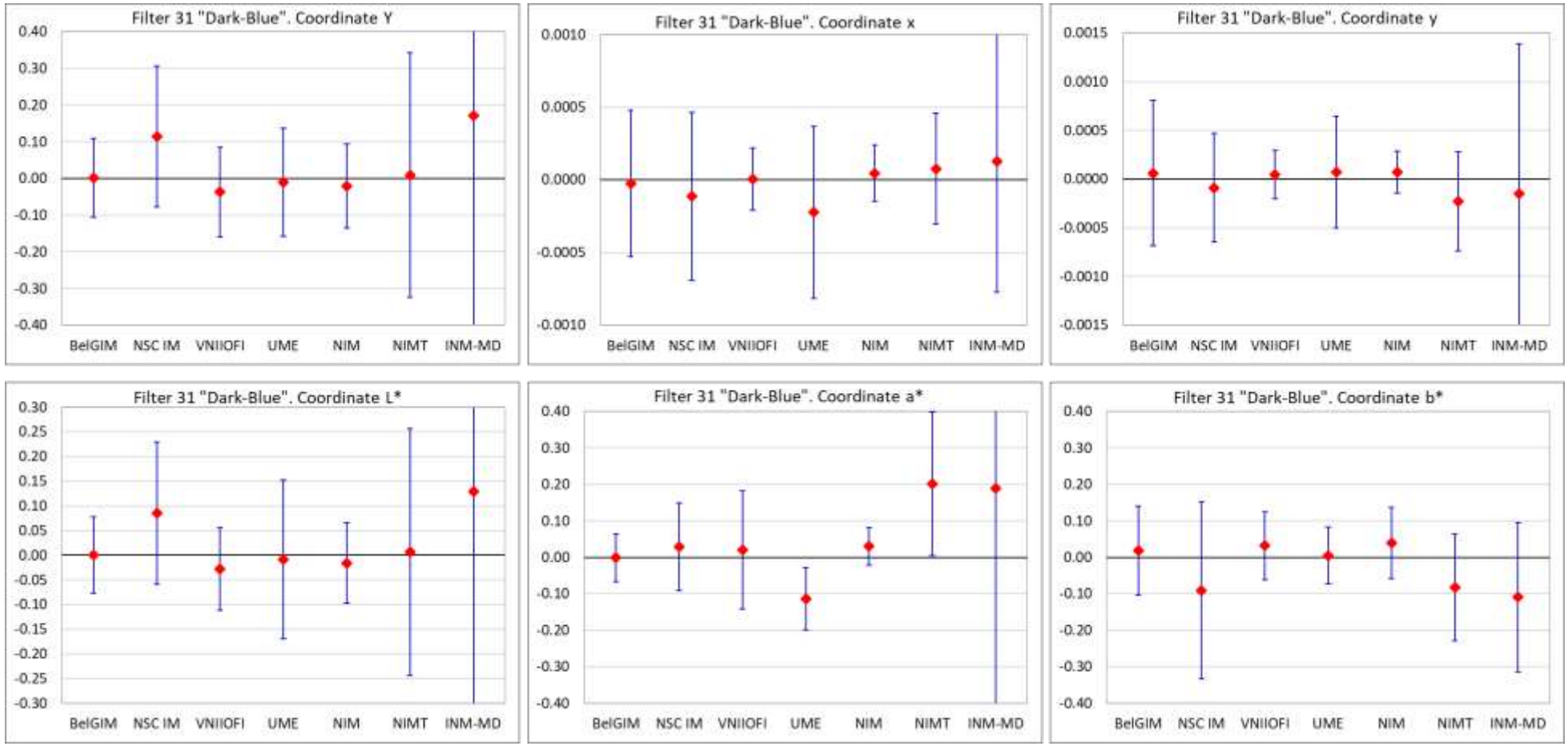

Figure 8. Differences from the comparison Reference Values and associated expended uncertainties, $k = 2$.
Filter #31 "Dark blue". Coordinate nominal values: Y = 36, x = 0.22, y = 0.23, $L^* = 67$, $a^* = 1.5$, $b^* = -42$.

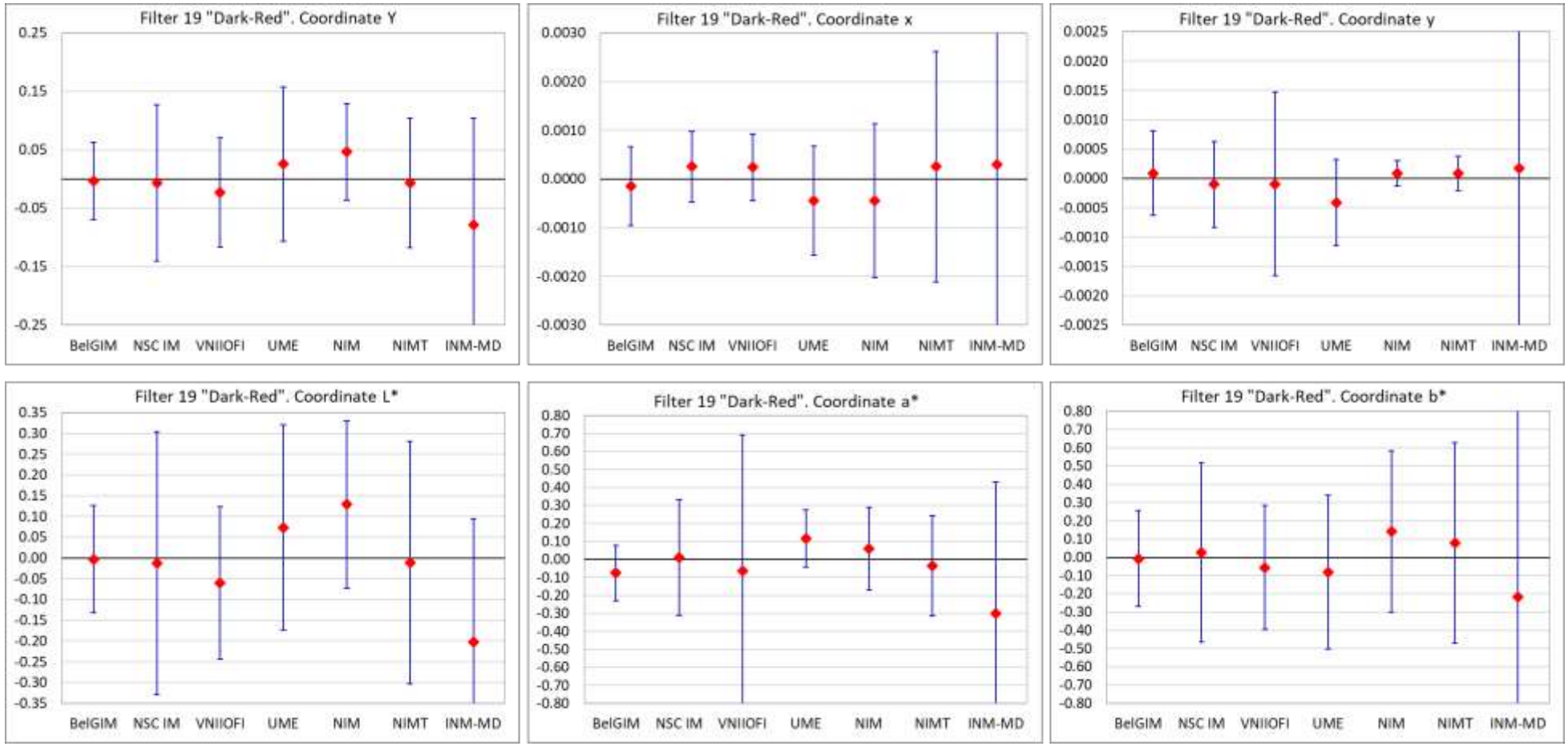

Figure 9. Differences from the comparison Reference Values and associated expended uncertainties, $k = 2$.
Filter #19 “Dark blue”. Coordinate nominal values: Y = 5.5, x = 0.68, y = 0.32, $L^* = 28$, $a^* = 57$, $b^* = 48$.

11 REFERENCES

[1] https://www.bipm.org/en/cipm-mra

[2] Guidelines for RMO PR Supplementary Comparisons, *CCPR-G7*, Dec 14, 2018, available from www.bipm.org.

[3] Guidelines for CCPR Comparison Report Preparation, *CCPR-G2*, Rev.4, January 8, 2019 available from www.bipm.org.

[4] Classification of Services in Photometry and Radiometry, Version No 17, 10 July 2023, available from www.bipm.org/en/cipm-mra/cipm-mra-documents

[5] CIE 15:2004

Annex A. Calculation of tristimulus values

In accordance with document CIE 15:2004

$$\mathrm{X} = k \int S(\lambda)\bar{x}(\lambda)T(\lambda)d\lambda \quad \text{(A1)}$$

$$\mathrm{Y} = k \int S(\lambda)\bar{y}(\lambda)T(\lambda)d\lambda \quad \text{(A2)}$$

$$\mathrm{Z} = k \int S(\lambda)\bar{z}(\lambda)T(\lambda)d\lambda \quad \text{(A3)}$$

$$\mathrm{x} = \frac{\mathrm{X}}{\mathrm{X+Y+Z}} \quad \text{(A4)}$$

$$\mathrm{y} = \frac{\mathrm{Y}}{\mathrm{X+Y+Z}} \quad \text{(A5)}$$

where

$T(\lambda)$ is the spectral transmittance of a sample,

$S(\lambda)$ is the relative spectral power distribution of the illuminant (in our case standard source D65, CIE 15:2004, section 11.1, table T.1),

$\bar{x}(\lambda), \bar{y}(\lambda), \bar{z}(\lambda)$ are colour matching functions of a standard colorimetric observer (CIE 1964, CIE 15:2004, section 11.5, table T.5),

and k is the constant

$$k = \frac{100}{\int S(\lambda)\bar{y}(\lambda)d\lambda} \quad \text{(A6)}$$

Redefine X, Y, and Z in terms of x, y, and Y:

The ratio of the Eq. A4 and A5 gives $\frac{\mathrm{x}}{\mathrm{y}} = \frac{\mathrm{X}}{\mathrm{Y}}$. Therefore:

$$\mathrm{X} = \frac{\mathrm{x}}{\mathrm{y}}\mathrm{Y} \quad \text{(A7)}$$

Substituting A7 into Eq. A5, we obtain: $\mathrm{Z} = \frac{\mathrm{Y}}{\mathrm{y}} - \mathrm{X} - \mathrm{Y} = \frac{\mathrm{Y}}{\mathrm{y}} - \frac{\mathrm{x}}{\mathrm{y}}\mathrm{Y} - \mathrm{Y}$, or

$$\mathrm{Z} = \frac{1-\mathrm{x}-\mathrm{y}}{\mathrm{y}}\mathrm{Y} \quad \text{(A8)}$$

Calculation of L*, a*, b*

The coordinates L^*, $\mathrm{a}^*$and b^* are defined as

$$\mathrm{L}^* = 116F(\mathrm{Y}) - 16 \quad \text{(A9)}$$

$$\mathrm{a}^* = 500[F(\mathrm{X}) - F(\mathrm{Y})] \quad \text{(A10)}$$

$$\mathrm{b}^* = 200[F(\mathrm{Y}) - F(\mathrm{Z})] \quad \text{(A11)}$$

where,

$$F(\mathrm{X}) = (\mathrm{X}/\mathrm{X}_N)^{\frac{1}{3}} \text{ if } (\mathrm{X}/\mathrm{X}_N) > (24/116)^3 \text{ else } F(\mathrm{X}) = (841/108) \cdot (\mathrm{X}/\mathrm{X}_N) + 16/116$$

$$F(\mathrm{Y}) = (\mathrm{Y}/\mathrm{Y}_N)^{\frac{1}{3}} \text{ if } (\mathrm{Y}/\mathrm{Y}_N) > (24/116)^3 \text{ else } F(\mathrm{Y}) = (841/108) \cdot (\mathrm{Y}/\mathrm{Y}_N) + 16/116$$

$$F(\mathrm{Z}) = (\mathrm{Z}/\mathrm{Z}_N)^{\frac{1}{3}} \text{ if } (\mathrm{Z}/\mathrm{Z}_N) > (24/116)^3 \text{ else } F(\mathrm{Z}) = (841/108) \cdot (\mathrm{Z}/\mathrm{Z}_N) + 16/116$$

Note: the conditions $(\mathrm{X}/\mathrm{X}_N) > (24/116)^3$ and $(\mathrm{Y}/\mathrm{Y}_N) > (24/116)^3$ are true for all filters used in this comparison. The condition $(\mathrm{Z}/\mathrm{Z}_N) > (24/116)^3$ is true for all filters except the filter 19 "Dark red".

For the D65 standard light source $\mathrm{X}_N = 94.81$, $\mathrm{Y}_N = 100$ and $\mathrm{Z}_N = 107.32$, therefore:

$$F(\mathrm{X}) = \left(\frac{\mathrm{xY}}{\mathrm{y} \cdot 94.81}\right)^{\frac{1}{3}} \tag{A12}$$

$$F(\mathrm{Y}) = \left(\frac{\mathrm{Y}}{100}\right)^{\frac{1}{3}} \tag{A13}$$

$$F(\mathrm{Z}) = \left(\frac{(1-\mathrm{x}-\mathrm{y})\mathrm{Y}}{\mathrm{y} \cdot 107.32}\right)^{\frac{1}{3}} \tag{A14}$$

and for the filter 19 "Dark red"

$$F(\mathrm{Z}) = \frac{841}{108}\frac{(1-\mathrm{x}-\mathrm{y})\mathrm{Y}}{\mathrm{y} \cdot 107.32} + \frac{16}{116} \tag{A15}$$

Substituting Eq. A12 – A15 in A9 – A11, one can obtain:

$$\mathrm{L}^* = 116\left(\frac{\mathrm{Y}}{100}\right)^{\frac{1}{3}} - 16 \tag{A16}$$

$$\mathrm{a}^* = 500\left[\left(\frac{\mathrm{xY}}{\mathrm{y} \cdot 94.81}\right)^{\frac{1}{3}} - \left(\frac{\mathrm{Y}}{100}\right)^{\frac{1}{3}}\right] \tag{A17}$$

$$\mathrm{b}^* = 200\left[\left(\frac{\mathrm{Y}}{100}\right)^{\frac{1}{3}} - \left(\frac{(1-\mathrm{x}-\mathrm{y})\mathrm{Y}}{\mathrm{y} \cdot 107.32}\right)^{\frac{1}{3}}\right] \tag{A18}$$

and for the filter 19 "Dark red"

$$\mathrm{b}^* = 200\left[\left(\frac{\mathrm{Y}}{100}\right)^{\frac{1}{3}} - \frac{841}{108}\frac{(1-\mathrm{x}-\mathrm{y})\mathrm{Y}}{\mathrm{y} \cdot 107.32} - \frac{16}{116}\right] \tag{A19}$$

Annex B. PARTICIPANT MEASUREMENT REPORTS

B.1 Participant: **BelGIM (pilot), Belarus**

Address : Starovilensky trakt, 93, Minsk

Details of Measurement Setup

Make and type of spectrophotometer	The measuremenst have been done with Cary 500 UV-Vis-NIR spectrophotometer manufactured by Varian. It is double beam spectrophotometer with double out-of-plane Littrow monochromator and dual double sided gratings
Additional stray light rejection	Filter wheel with three order sorting filters
Source drift monitoring	Built-in double beam feature
Detector	Photomultiplier R6872 for UV-VIS, PbS, cooled for NIR
Temperature [(a)]	The laboratory uses an air-conditioning system to ensure accurately control of the temperature. The temperature was set on 22 ºC +/- 1 ºC
Humidity	During the measurements the humidity was about (64 -65)% RH
Beam Size	Size of beam imaged on the sample: 13.35 mm vertically and 5.1 mm horizontally
Measurement sequence[(b)]	All filters were mounted in metal holders and then placed in position with engraved orientations facing the incident beam. For each placement, the laboratory performed ten measurements under repeatable and reproducible conditions.
Bandwidth	The spectral bandwidth used was 1 nm.

Measuring performance conditions:

– Ambient performance, ^{0}C : from 22 to 22,6

–Relative humidity, % : from 58 to 65-56

–Type of standard source CIE: D65

–Spectral bandwidth, 1 nm.

–Step, 1 nm.

The measurements of spectral transmittance of achromatic standards are obtained by the absolute method using reference, double-beam CARY 500 spectrophotometer manufactured by Varian.

Description and diagram of the standard measuring instrument

The measuremenst have been done with Cary 500 UV-Vis-NIR spectrophotometer manufactured by Varian

Photometric Linearity: At 1,0 Abs 0,001; At 2,0 Abs 0,0018; At 3,0 Abs 0,0081

Wavelength Accuracy VIS (nm): ± 0,2

Photometric Range (Abs): 7.



Figure B1.1. Spectrophotometer Cary 500 UV-Vis-NIR

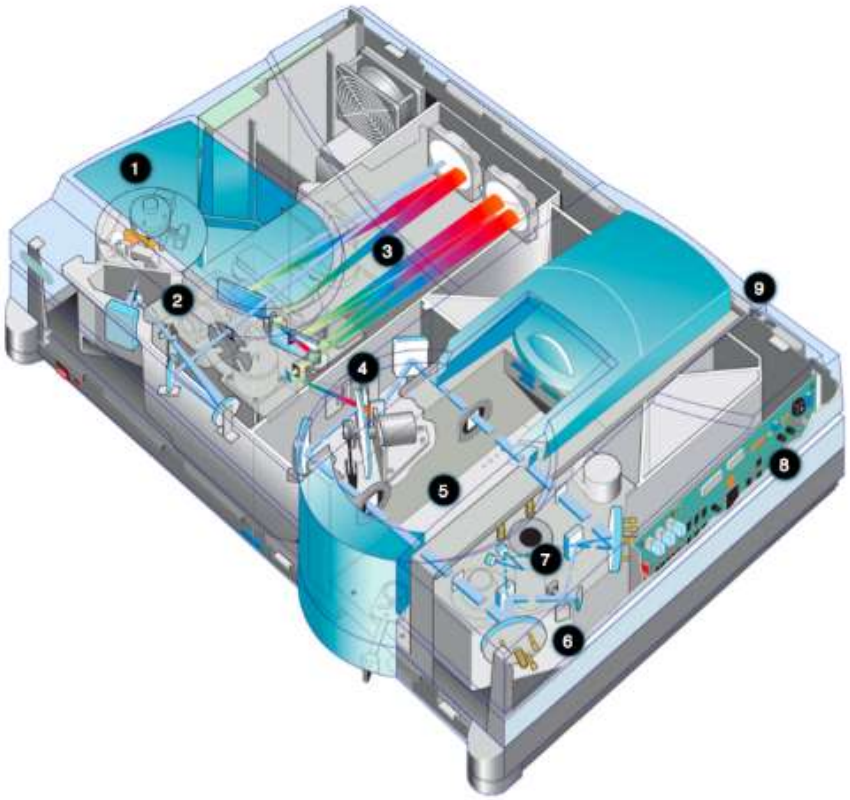

Figure B1.2. Spectrophotometer Cary 500 UV-Vis-NIR. optical design

1 – light sources: tungsten halogen, D2 and Hg lamps; 2 – Schwarzschild communication optics; 3 – monochromator: out-of-plane double Littrow monochromator; 4 – beam splitting system with a spinning chopper; 5 – sample compartment; 6 – refocusing optics: two triplets of mirrors refocus both beams onto the sensor array; 7 - sensor array: the PMT and PbS detectors; 8 – control electronics interfaces: the instrument with its PC application (Cary WinUV; 9 – gas purge lines: the instrument chassis and the sample compartment can be filled with various gases.

MEASUREMENT RESULTS

Note: The values of L^*, $a^*$and b^* are calculated from the values of Y, x and y using Eq. 6-9 of the main body of the comparison report (page 7)

Filter identifier: 6-00-79 (Colour: GREY)

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	10	10	10	10	10	10
Value	60.026	0.30840	0.33010	81.852	-2.062	-1.141
Type A	0.015	0.000029	0.000053	0.007	0.0052	0.0051
Type B	0.052	0.000079	0.000122	0.0383	0.0204	0.0238
Total C un-certainty u (k = 1)	0.0541	0.000084	0.000133	0.039	0.0211	0.0243

Filter identifier: 043-00-83 (Color: GREY)

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	10	10	10	10	10	10
Value	60.501	0.3084	0.3295	82.110	-1.812	-1.342
Type A	0.015	0.000029	0.000053	0.007	0.0052	0.0051
Type B	0.052	0.000079	0.000122	0.0383	0.0204	0.0238
Total C uncertainty u (k = 1)	0.0541	0.000084	0.000133	0.039	0.0211	0.0243

Uncertainty budget

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	0.02	0.00005	0.00071	0.009	0.0410	0.0238
Temperature	0.002	0.00003	0.00001	0.0094	0.00041	0.00021
Wavelength	0.009	0.00004	0.00006	0.00003	0.00003	0.00004
Stray Light	0.000	0.00001	0.00000	0.00000	0.00000	0.00000
Beam size & position	0.047	0.000032	0.000077	0.035	0.02	0.00048
Source drift & fluctuation	0.002	0.00001	0.00001	0.0087	0.00019	0.00010
Bandwidth	0.001	0.00000	0.00000	0.00032	0.0002	0.00014
Total type B	0.052	0.000079	0.00012271	0.0383	0.0204	0.0238

Filter identifier : 6-13-79 (Colour: Light - GREEN)

Property	**Y**	**x**	**y**	**L***	**a***	**b***
Number of measurements	10	10	10	10	10	10
Value	29.644	0.42273	0.48050	61.346	-8.209	57.007
Type A uncertainty	0.015	0.0000885	0.00001	0.01	0.015	0.017
Type B uncertainty	0.0538	0.000425	0.000316	0.0521	0.0453	0.027
Total uncer-tainty u(k = 1)	0.0558	0.000425	0.000316	0.0531	0.0477	0.0319

Filter identifier : 043-13-83 (Colour: Light - GREEN)

Property	**Y**	**x**	**y**	**L***	**a***	**b***
Number of measurements	10	10	10	10	10	10
Value	73.874	0.37129	0.45120	88.863	-20.843	51.403
Type A uncertainty	0.015	0.0000885	0.00001	0.01	0.015	0.017
Type B uncertainty	0.0538	0.000425	0.000316	0.0521	0.0453	0.027
Total uncertainty u(k = 1)	0.0558	0.000425	0.000316	0.0531	0.0477	0.0319

Uncertainty budget

Property	**Y**	**x**	**y**	**L***	**a***	**b***
Nonlinearity	0.0392	0.000409	0.0004	0.0497	0.045	0.0259
Temperature	0.0022	0.000027	0.000012	0.00001	0.00041	0.00021
Wavelength	0.0071	0.000051	0.000058	0.000034	0.00003	0.000064
Stray Light	0.000011	0.000010	0.00000	0.000001	0.00000	0.000000
Beam size & position	0.036	0.000047	0.000079	0.013	0.0051	0.0075
Source drift & fluctuation	0.00210	0.000008	0.000011	0.0087	0.00019	0.000097
Bandwidth	0.00058	0.00000	0.000001	0.00032	0.00020	0.00014
Total type B	0.0538	0.000416	0.000316	0.0531	0.0453	0.0319

Filter identifier : 043-15-83 (Colour: Light – BLUE)

Property	**Y**	**x**	**y**	**L***	**a***	**b***
Number of measurements	10	10	10	10	10	10
Value	62.548	0.24230	0.30430	83.204	-24.168	-19.768
Type A uncertainty	0.032	0.000015	0.000034	0.042	0.011	0.0082
Type B uncertainty	0.0922	0.000484	0.000587	0.0709	0.0759	0.0909
Total uncertainty u(k = 1)	0.0976	0.000484	0.000588	0.0824	0.0767	0.0913

Uncertainty budget

Property	**Y**	**x**	**y**	**L***	**a***	**b***
Nonlinearity	0.0857	0.00048	0.00058	0.0312	0.0758	0.0909
Temperature	0.0022	0.00003	0.00001	0.00094	0.00041	0.00021
Wavelength	0.0071	0.00005	0.00005	0.00004	0.00005	0.00006
Stray Light	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000
Beam size & position	0.033	0.000022	0.000075	0.063	0.0036	0.0029
Source drift & fluctuation	0.0021	0.00001	0.00001	0.0087	0.00019	0.00010
Bandwidth	0.00058	0.00000	0.00000	0.00032	0.00020	0.00014
Total type B	0.0922	0.000484	0.000587	0.0709	0.0759	0.0913

Filter identifier : 6-26-79 (Colour: Light - RED)

Property	**Y**	**x**	**y**	**L***	**a***	**b***
Number of measure-ments	10	10	10	10	10	10
Value	65.971	0.32222	0.32120	84.981	8.270	-1.976
Type A uncertainty	0,026	0,0000275	0,000066	0,019	0,0055	0,0082
Type B uncertainty	0,0547	0,000256	0,000182	0,0395	0,0291	0,0218
Total uncer-tainty u (k = 1)	0,0605	0,000258	0,000194	0,0438	0,0296	0,0233

Filter identifier : 043-26-83 (Colour: Light - RED)

Property	Y	x	y	L*	a*	b*
Number of measurements	10	10	10	10	10	10
Value	65.111	0.32280	0.32100	84.541	8.591	-1.941
Type A uncertainty	0,026	0,0000275	0,000066	0,019	0,0055	0,0082
Type B uncertainty	0,0547	0,000256	0,000182	0,0395	0,0291	0,0218
Total uncertainty u (k = 1)	0,0605	0,000258	0,000194	0,0438	0,0296	0,0233

Uncertainty budget

Property	Y	x	y	L*	a*	b*
Nonlinearity	0.047	0.00025	0.00016	0.0295	0.0288	0.0212
Temperature	0.0022	0.00003	0.00001	0.00940	0.00041	0.00021
Wavelength	0.0081	0.00004	0.00006	0.00003	0.00003	0.00003
Stray Light	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000
Beam size & position	0.026	0.000024	0.000062	0.023	0.004	0.0052
Source drift & fluctuation	0.00210	0.00001	0.00001	0.0087	0.00019	0.00010
Bandwidth	0.00058	0.00000	0.00000	0.00032	0.0002	0.00014
Total type B	0.0547	0.000256	0.000182	0.0395	0.0291	0.0218

Filter identifier : 6-22-79 (Colour: Dark– GREEN)

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	10	10	10	10	10	10
Value	11.765	0.27960	0.65585	40.840	-57.302	53.806
Type A uncertainty	0.020	0.00017	0.00012	0.028	0.053	0.028
Type B uncertainty	0.039	0.00049	0.000266	0.0516	0.15	0.098
Total uncer-tainty u(k = 1)	0.0439	0.000519	0.000292	0.0578	0.159	0.102

Filter identifier : 043-22-83 (Colour: Dark– GREEN)

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	10	10	10	10	10	10
Value	12.531	0.28340	0.65290	42.048	-57.366	55.081
Type A uncertainty	0.020	0.00017	0.00012	0.028	0.053	0.028
Type B uncertainty	0.039	0.00049	0.000266	0.0516	0.15	0.098
Total uncer-tainty u(k = 1)	0.0439	0.000519	0.000292	0.0578	0.159	0.102

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	0.035	0.00047	0.00025	0.047	0.15	0.098
Temperature	0.0022	0.00003	0.00001	0.0094	0.00041	0.00021
Wavelength	0.00083	0.00004	0.00006	0.00003	0.00003	0.00004
Stray Light	0.00001	0.00001	0.00000	0.000001	0.00000	0.00000
Beam size & position	0.017	0.00013	0.000068	0.017	0.011	0.0023
Source drift & fluctuation	0.00210	0.00001	0.00001	0.0087	0.00019	0.0001
Bandwidth	0.00058	0.00000	0.000001	0.00032	0.00020	0.00014
Total type B	0.039	0.00049	0.000266	0.0516	0.15	0.098

Filter identifier : 6-31-79 (Colour: Dark– BLUE)

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	10	10	10	10	10	10
Value	36.804	0.22459	0.23435	67.130	1.287	-41.697
Type A uncertainty	0.034	0.00004	0.000033	0.023	0.014	0.021
Type B uncertainty	0.0541	0.000268	0.000392	0.0419	0.0373	0.0633
Total uncer-tainty u(k = 1)	0.0639	0.000271	0.0003930	0.0478	0.0399	0.0667

Filter identifier : 043-31-83 (Colour: Dark– BLUE)

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	10	10	10	10	10	10
Value	36.182	0.22310	0.23269	66.659	1.334	-42.254
Type A uncertainty	0.034	0.00004	0.000033	0.023	0.014	0.021
Type B uncertainty	0.0541	0.000268	0.000392	0.0419	0.0373	0.0633
Total uncer-tainty u(k = 1)	0.0639	0.000271	0.0003930	0.0478	0.0399	0.0667

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	0.0419	0.00024	0.00038	0.029	0.0370	0.06300
Temperature	0.0022	0.00003	0.00001	0.0094	0.00041	0.00021
Wavelength	0.00076	0.00007	0.00006	0.00005	0.00003	0.00004
Stray Light	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000
Beam size & position	0.034	0.000092	0.000072	0.027	0.0048	0.0062
Source drift & fluctuation	0.0021	0.00001	0.00001	0.0093	0.00019	0.00010
Bandwidth	0.00058	0.00000	0.00000	0.00032	0.00020	0.00014
Total type B	0.0541	0.000268	0.000392	0.0419	0.0372	0.0633

Filter identifier : 6-19-79 (Colour: Dark– RED)

Property	Y	x	y	L^*	a^*	b^*
Value	5.003	0.69950	0.30029	26.743	64.367	46.058
Type A uncertainty	0.024	0.00005	0.00003	0.057	0.053	0.11
Type B uncertainty	0.0315	0.000475	0.000396	0.0547	0.0801	0.116
Total uncertainty u (k = 1)	0.0396	0.000478	0.000398	0.079	0.096	0.16

Filter identifier : 043-19-83 (Colour: Dark – RED)

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	10	10	10	10	10	10
Value	5.603	0.67600	0.32300	28.388	57.792	48.693
Type A uncertainty	0.024	0.00005	0.00003	0.057	0.053	0.11
Type B uncertainty	0.0315	0.000475	0.000396	0.0547	0.0801	0.116
Total uncer-tainty u(k = 1)	0.0396	0.000478	0.000398	0.079	0.096	0.16

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	0.0221	0.00047	0.00039	0.0497	0.070	0.116
Temperature	0.0022	0.00003	0.00001	0.00094	0.00041	0.00021
Wavelength	0.0071	0.00005	0.00006	0.00004	0.00005	0.00006
Stray Light	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000
Beam size & position	0.021	0.000036	0.000035	0.021	0.035	0.0055
Source drift & fluctuation	0.00210	0.00001	0.00001	0.00870	0.00019	0.00010
Bandwidth	0.00058	0.00000	0.00000	0.00032	0.00020	0.00014
Total type B	0.0315	0.000475	0.000396	0.0547	0.0801	0.116

Signature: Olga Tarasova

B.2 Participant: **NSC IM, Ukraine**

NSC "Institute of Metrology" reproduces the units of colour and chromaticity coordinates independently.

Measurements were carried out on installations which are a part of the State primary measurement standard of units of spectral coefficients of directional transmission, directional and diffuse reflection in a range of wavelengths from 0.2 μm to 25 μm. The scheme of the first installation is shown in Figure 1.

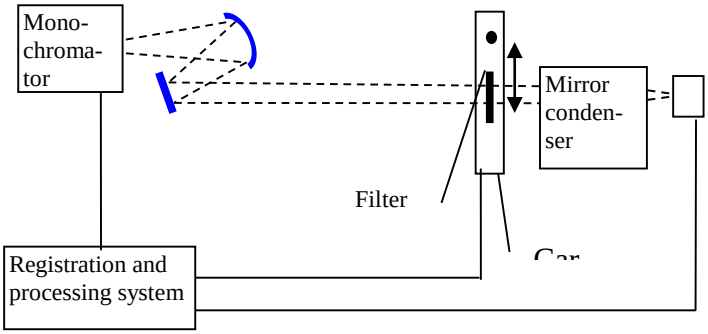

Figure 1: Scheme of measurements of spectral transmittance coefficients on the state primary measurement standard of the units of spectral coefficients of directional transmittance, directional and diffuse reflection in the range of wavelengths from 0.2 μm to 25 μm.

The results were processed in accordance with the Guide to the Expression of Uncertainty in Measurement. The results are presented in accordance with Annex A.2 of the Protocol.

Measurement Results

The results are presented in Tables A1 to A7.

Note: The values of L^*, $a^*$and b^* are calculated from the values of Y, x and y using Eq. 6-9 of the main body of the comparison report (page 7)

6-19-79	**Dark red**			**A.1**		
Property	Y	x	y	L^*	a^*	b^*
Value	4.9996	0.6999	0.3001	26.734	64.453	46.092
Type A Uncertainty (a)	0.036	0.000010	0.000010	0.103	0.116	0.185
Type B Uncertainty (b)	0.05	0.0004	0.0004	0.1	0.1	0.1
Total Uncertainty (c)	0.062	0.0004	0.0004	0.144	0.153	0.210
Property	Y	x	y	L^*	a^*	b^*
Nonlinearity, Stray Light, Inter-reflection, Polarization, Bandwidth	0.000371	0	0	0.000727	0.00102	0.001191
Temperature	0.04451	0.0001	0.0001	0.090075	0.090119	0.092114
Wavelength	0.006429	1.83E-05	1.83E-05	0.012576	0.010435	0.010181
Beam size & position	0.019782	0.000383	0.000383	0.03739	0.037945	0.033937
Other method uncetainty	0.009397	2.83E-05	1.67E-05	0.018695	0.017391	0.01616
Total type B uncertainty (b)	0.05	0.0004	0.0004	0.1	0.1	0.1

6-31-79 **Dark blue** **A.2**

Property	Y	x	y	L^*	a^*	b^*
Value	36.917	0.2245	0.2342	67.215	1.3171	-41.807
Type A Uncertainty [(a)]	0.006924	0.00002	0.00003	0.005202	0.011317	0.013592
Type B Uncertainty [(b)]	0.09	0.0003	0.0003	0.07	0.06	0.12
Total Uncertainty [(c)]	0.09	0.0003	0.0003	0.070	0.061	0.121

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity. Stray Light. Inter-reflection. Polarization. Bandwidth	0.01107	0	0	0.001891	0.000705	0.001001
Temperature	0.038	0.00003	3.78E-05	0.009227	0.00672	0.441951
Wavelength	0.026	2.61E-06	6.52E-06	0.006364	0.00768	0.001756
Beam size & position	0.08	0.0003	0.0003	0.07	0.0576	0.11122
Other method uncertainty	0.0040	0	0	0.005727	0.01272	0.001756
Total type B uncertainty (b)	0.09	0.0003	0.0003	0.07	0.06	0.0003

6-22-79 **Dark green** **A.3**

Property	Y	x	y	L^*	a^*	b^*
Value	11.776	0.2796	0.6558	40.858	-57.316	53.810
Type A Uncertainty [(a)]	0.024	0.0002	0.00013	0.039	0.075	0.029
Type B Uncertainty [(b)]	0.05	0.0003	0.0004	0.05	0.1	0.1
Total Uncertainty [(c)]	0.055	0.0004	0.0004	0.063	0.125	0.104

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity. Stray Light. Inter-reflection. Polarization. Bandwidth	0.001264	0	0	0.000981	0.000541	0.000656
Temperature	0.039286	0.000127	5.22E-05	0.031034	0.084906	0.002439
Wavelength	0.003571	6.92E-05	0	0.002586	0.020755	0.031707
Beam size & position	0.028571	0.000265	0.0004	0.037931	0.045283	0.092683
Other method uncertainty	0.007143	2.19E-05	3.3E-05	0.00569	0.010189	0.01439
Total type B uncertainty (b)	0.05	0.0003	0.0004	0.05	0.1	0.1

6-26-79 Light red A.4

Property	Y	x	y	L^*	a^*	b^*
Value	66.002	0.3225	0.3215	84.997	8.262	-1.826
Type A Uncertainty (a)	0.031	0.000018	0.000022	0.016	0.004	0.010
Type B Uncertainty (b)	0.05	0.0003	0.0003	0.05	0.05	0.07
Total Uncertainty (c)	0.059	0.0003	0.0003	0.052	0.050	0.071

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity. Stray Light. Inter-reflection. Polarization. Bandwidth	0.007071	0	0	0.002174	0.00034	0.001008
Temperature	0.014286	0	0	0.004348	0.002083	0.002947
Wavelength	0.003	5.22E-06	7.83E-06	0.00087	0.00125	0.004974
Beam size & position	0.028571	0.0003	0.0003	0.047826	0.05	0.07
Other method uncertainty	0.035714	0	0	0.011304	0.000625	0.00276
Total type B uncertainty (b)	0.05	0.0003	0.0003	0.05	0.05	0.05

6-13-79 Light green A.6

Property	Y	x	y	L^*	a^*	b^*
Value	29.707	0.4227	0.4804	61.401	-8.200	57.008
Type A Uncertainty (a)	0.0066	0.000078	0.000003	0.0057	0.020	0.017
Type B Uncertainty (b)	0.10	0.0003	0.0003	0.15	0.05	0.1
Total Uncertainty (c)	0.10	0.0003	0.0003	0.150	0.054	0.101

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity. Stray Light. Inter-reflection. Polarization. Bandwidth	0.00891	0	0	0.001683	0.000324	0.000695
Temperature	0.064799	6.75E-05	3.91E-06	0.03674	0.024509	0.027041
Wavelength	0.01099	2.88E-05	1.57E-05	-0.00652	0.005893	0.02122
Beam size & position	0.08	0.000288	0.0003	0.143478	0.042857	0.092683
Other method uncertainty	0.0012	0	0	0.000717	0.000929	0.005854
Total type B uncertainty (b)	0.10	0.0003	0.0003	0.15	0.05	0.1

6-00-79 Grey A.7

Property	Y	x	y	L^*	a^*	b^*
Value	60.045	0.3085	0.3303	81.863	-2.102	-1.060
Type A Uncertainty [(a)]	0.017	0.000006	0.000021	0.0093	0.0074	0.0074
Type B Uncertainty [(b)]	0.094	0.0003	0.0003	0.1	0.05	0.05
Total Uncertainty [(c)]	0.095	0.0003	0.0003	0.100	0.051	0.051

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity, Stray Light, Interreflection, Polarization, Bandwidth	0.018	0	0	0.002227	0.000229	0
Temperature	0.039581	1.3E-05	6.52E-06	0.009778	0.007654	1.3E-05
Wavelength	0.0027	0	1.3E-06	0.000455	0.000833	0
Beam size & position	0.08	0.0003	0.0003	0.1	0.05	0.0003
Other method uncertainty	0.02169	0	0	0.005364	0.006386	0
Total type B uncertainty (b)	0.094	0.0003	0.0003	0.1	0.05	0.05

B.3 Participant: **TUBITAK UME, TÜRKIYE**

Details of Measurement Setup

Make and type of spectrophotometer	The Spectrophotometer is grating based Monochromator (Bentham DTMc 300) with 300 mm focal length. It has Tungsten and Deuterium light sources, triple gratings with 2400 g/mm blazed at 250 nm, 1200 g/mm blazed at 500 nm and 600 g/mm blazed at 1600 nm. Moreover it also has order sorting filters at 400 nm, 700 nm, 1250 nm, 2000 nm, 3600 nm and 6000 nm wavelengths. **Parameters Used in the Measurement for this Comparision are:** • The monochromator is grating based Monochromator (Bentham DTMc 300), • Light Sources:Tungsten • Grating: Grating with 1200 g/mm blazed at 500 nm • Focal Length: 300 mm
Additional stray light rejection	No
Source drift monitoring	No
Detector	Si Dedector
Temperature (a)	23 °C
Humidity	(45± 10) % RH
Beam Size	4 mm x 12 mm
Measurement sequence(b)	Filter orientation kept the same between the measurements
Bandwidth	1 nm

(a) i.e describe method of temperature monitoring of filters and range of temperatures;
(b) i.e describe number of measurements and whether filter orientation with respect to beam changes between measurements

Date of Measurement: 19.12.2016-03.03.2017

Measuring conditions:

1.1 Ambient temperature (^{O}C):	23 °C
1.2 Relative humidity (%RH) :	(45± 10) % RH
1.3 Type of illuminant (specified according to CIE standard illu- minant. default is CIE D65)	CIE D65
1.4 Spectral bandwidth (nm), if applicable:	1 nm
1.5 Spectral range (nm), default range is from 360 nm to 780 nm	360 nm to 780 nm
1.6 Spectral interval (nm), if applicable:	1 nm

Description and procedure of independent realization of the unit (or traceability of the results to another named NMI)

The instruments used for these measurements are monochromator, detector and amplifier. Monochromator's wavelength calibration, detector's responsivity and amplifier's gain calibrations are traceble to TUBITAK UME.

Description and diagram of the standard measuring instrument

The measurement set up used for the transmittance measurements of filters is shown in the Figure 1. This system consist of tungsten light source, grating based monochromator (Bentham DTMc 300), output optics, filter and detector holders and electronic system.

The grating based monochromator in its turret has triple gratings with 2400 g/mm blazed at 250 nm, 1200 g/mm blazed at 500 nm and 600 g/mm blazed at 1600 nm. The monochromator has also 300 mm focal length and order sorting filters at 400 nm, 700 nm, 1250 nm, 2000 nm, 3600 nm and 6000 nm.

The output optics consists of off axis mirror and apertures that are used to to colimate the beam and adjust its diameter. The whole system was enclosed in a light tight box .

This light box has fan cooling so as to keep temperature inside it to be same as the temperature of laboratory.

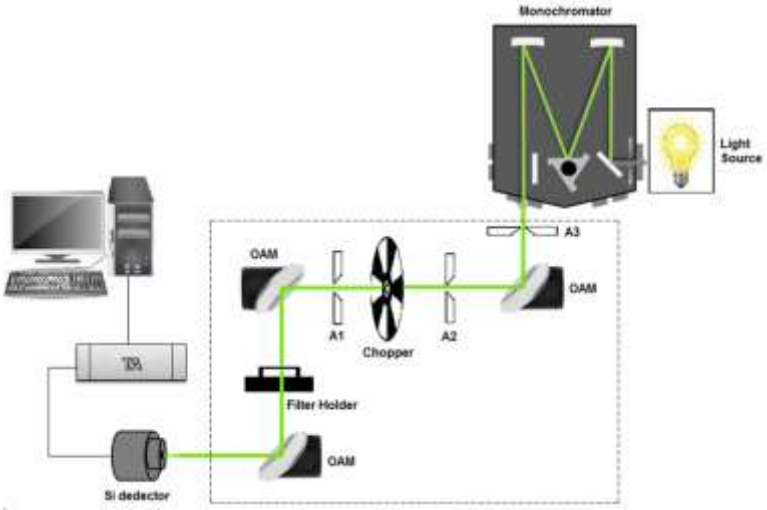

Figure 1 The experimental setup for the spectral transmittance measurement.
A1, A2 and A3 are apertures; OAM: Off axis mirror; TA: transimpedance amplif

Measurement Conditions and Parameters

The conditions at wich the measurements were carried out can be summarised as follows. Light sources, gratings, the wavelengths at which measurements need to be done were programmed and automatically controlled by software. The grating with 1200 g/mm was used for the measurements.

The beam dimention manually was adjusted approxiamtely to 4 mm x 12 mm. The temperature and humidity of the laboratory in which the measurements were performed are set to 23 ºC ± 2 ºC and 45 ± 10 RH.

Moreover, during the measurements the temperature of inside the light tight enclosure was aslo recorded. For the measurements the wavelegths at which filters to be measurements were defined into the software and the measurements were performed at the defined wavelengths with and without filters.

Measurement Results

Note: The values of L^*, $a^*$and b^* are calculated from the values of Y, x and y using Eq. 6-9 of the main body of the comparison report (page 7)

Dark Blue 043-31-83

Property	Y	x	y	L*	a*	b*
Number of measurements	20	20	20	20	20	20
Average	36.17	0.2229	0.2327	66.65	1.221	-42.269
Type A Uncertainty (a)	6.48E-02	3.05E-04	3.05E-04	7.81E-02	4.41E-02	2.59E-02
Type B Uncertainty (b)	6.53E-03	3.96E-05	4.12E-05	1.19E-02	3.09E-04	7.61E-03
Total Uncertainty (c)	6.51E-02	3.08E-04	3.08E-04	7.90E-02	4.41E-02	2.70E-02

Dark Red: 043-19-83

Property	Y	x	y	L*	a*	b*
Number of measurements	20	20	20	20	20	20
Average	5.632	0.6757	0.3225	28.464	57.983	48.620
Type A Uncertainty (a)	6.09E-02	6.01E-04	3.97E-04	1.04E-01	2.57E-02	1.68E-01
Type B Uncertainty (b)	1.05E-03	1.18E-04	5.71E-05	5.18E-03	1.03E-02	9.21E-03
Total Uncertainty (c)	6.09E-02	6.12E-04	4.01E-04	1.04E-01	2.77E-02	1.68E-01

Light Blue: 043-15-83

Property	Y	x	y	L*	a*	b*
Number of measurements	20	20	20	20	20	20
Average	62.43	0.2428	0.3040	83.142	-23.743	-19.791
Type A Uncertainty (a)	5.61E-02	3.34E-04	5.75E-04	1.43E-01	1.73E-02	1.31E-01
Type B Uncertainty (b)	1.14E-02	4.29E-05	5.38E-05	1.49E-02	4.30E-03	3.64E-03
Total Uncertaint (c)	5.72E-02	3.37E-04	5.78E-04	1.44E-01	1.78-02	1.31E-01

Light Green:043-13-83

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	20	20	20	20	20	20
Average	73.94	0.3714	0.45102	88.894	-20.749	51.384
Type A Uncertainty (a)	3.59E-02	4.18E-04	4.29E-04	7.37E-02	2.69E-02	2.88E-02
Type B Uncertainty (b)	1.33E-02	6.58E-05	7.99E-05	1.59E-02	3.70E-03	9.05E-03
Total Uncertainty (c)	3.83E-02	4.23E-04	4.36E-04	7.54E-02	2.72E-02	3.02E-02

Light Red:043-26-83

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	20	20	20	20	20	20
Average	65.210	0.3228	0.3208	84.592	8.687	-2.011
Type A Uncertainty (a)	5.57E-02	3.10E-04	9.08E-05	4.68E-02	1.01E-02	3.51E-02
Type B Uncertainty (b)	1.18E-02	5.72E-05	5.69E-05	1.51E-02	1.54E-03	3.99E-04
Total Uncertainty (c)	5.69E-02	3.15E-04	1.07E-04	4.92E-02	1.02E-02	3.51E-02

Grey: 043-00-83

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	20	20	20	20	20	20
Average	60.400	0.3084	0.32957	82.055	-1.841	-1.318
Type A Uncertainty (a)	3.54E-02	5.56E-05	5.90E-05	6.85E-02	2.21E-02	2.14E-02
Type B Uncertainty (b)	1.09E-02	5.47E-05	5.84E-05	1.47E-02	3.28E-04	2.92E-04
Total Uncertainty (c)	3.70E-02	7.80E-05	8.30E-05	7.01E-02	2.21E-02	2.14E-02

Dark Green : 043-22-83

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	20	20	20	20	20	20
Average	12.58	0.2834	0.651	42.123	-57.253	54.665
Type A Uncertainty (a)	5.34E-02	4.34E-04	8.91E-04	6.34E-02	8.64E-02	8.11E-02
Type B Uncertainty (b)	2.24E-03	5.03E-05	1.15E-04	7.49E-03	1.02E-02	9.67E-03
Total Uncertainty (c)	5.34E-02	4.37E-04	8.98E-04	6.38E-02	8.70E-02	8.17E-02

Type B uncertainty budget

Dark Blue

Property	Y	x	y	L*	a*	b*
Nonlinearity	3.68E-03	2.23E-05	2.32E-05	6.71E-03	1.74E-04	4.29E-03
Temperature	-	-	-	-	-	-
Wavelength	2.21E-03	1.34E-05	1.39E-05	4.03E-03	1.05E-04	2.57E-03
Stray Light	3.68E-06	2.23E-08	2.32E-08	6.71E-06	1.74E-07	4.29E-06
Beam size & position	2.94E-03	1.78E-05	1.85E-05	5.37E-03	1.39E-04	3.43E-03
Inter-reflection	2.38E-03	1.44E-05	1.50E-05	4.35E-03	1.13E-04	2.78E-03
Obliquity	4.41E-04	2.68E-06	2.78E-06	8.05E-04	2.09E-05	5.14E-04
Polarization	2.94E-03	1.78E-05	1.85E-05	5.37E-03	1.39E-04	3.43E-03
Source drift & fluctuation	7.35E-04	4.46E-06	4.63E-06	1.34E-03	3.48E-05	8.57E-04
Bandwidth	7.35E-04	4.46E-06	4.63E-06	1.34E-03	3.48E-05	8.57E-04
Total type B uncertainty (b)	6.53E-03	3.96E-05	4.12E-05	1.19E-02	3.09E-04	7.61E-03

Dark Red

Property	Y	x	y	L*	a*	b*
Nonlinearity	5.89E-04	6.66E-05	3.21E-05	2.91E-03	5.79E-03	5.19E-03
Temperature	-	-	-	-	-	-
Wavelength	3.54E-04	3.99E-05	1.93E-05	1.75E-03	3.47E-03	3.11E-03
Stray Light	5.89E-07	6.66E-08	3.21E-08	2.91E-06	5.79E-06	5.19E-06
Beam size & position	4.72E-04	5.33E-05	2.57E-05	2.33E-03	4.63E-03	4.15E-03
Inter-reflection	3.82E-04	4.31E-05	2.08E-05	1.89E-03	3.75E-03	3.36E-03
Obliquity	7.07E-05	7.99E-06	3.86E-06	3.50E-04	6.95E-04	6.22E-04
Polarization	4.72E-04	5.33E-05	2.57E-05	2.33E-03	4.63E-03	4.15E-03
Source drift & fluctuation	1.18E-04	1.33E-05	6.43E-06	5.83E-04	1.16E-03	1.04E-03
Bandwidth	1.18E-04	1.33E-05	6.43E-06	5.83E-04	1.16E-03	1.04E-03
Total type B uncertainty (b)	1.05E-03	1.18E-04	5.71E-05	5.18E-03	1.03E-02	9.21E-03

Light Blue

Property	Y	x	y	L*	a*	b*
Nonlinearity	6.42E-03	2.42E-05	3.03E-05	8.41E-03	2.42E-03	2.05E-03
Temperature	-	-	-	-	-	-
Wavelength	3.85E-03	1.45E-05	1.82E-05	5.05E-03	1.45E-03	1.23E-03
Stray Light	6.42E-06	2.42E-08	3.03E-08	8.41E-06	2.42E-06	2.05E-06
Beam size & position	5.14E-03	1.93E-05	2.42E-05	6.73E-03	1.94E-03	1.64E-03
Inter-reflection	4.16E-03	1.57E-05	1.96E-05	5.45E-03	1.57E-03	1.33E-03
Obliquity	7.71E-04	2.90E-06	3.64E-06	1.01E-03	2.90E-04	2.46E-04
Polarization	5.14E-03	1.93E-05	2.42E-05	6.73E-03	1.94E-03	1.64E-03
Source drift & fluctuation	1.28E-03	4.83E-06	6.06E-06	1.68E-03	4.84E-04	4.10E-04
Bandwidth	1.28E-03	4.83E-06	6.06E-06	1.68E-03	4.84E-04	4.10E-04
Total type B uncertainty (b)	1.14E-02	4.29E-05	5.38E-05	1.49E-02	4.30E-03	3.64E-03

Light Green

Property	Y	x	y	L*	a*	b*
Nonlinearity	7.49E-03	3.70E-05	4.50E-05	8.94E-03	2.08E-03	5.10E-03
Temperature	-	-	-	-	-	-
Wavelength	4.50E-03	2.22E-05	2.70E-05	5.36E-03	1.25E-03	3.06E-03
Stray Light	7.49E-06	3.70E-08	4.50E-08	8.94E-06	2.08E-06	5.10E-06
Beam size & position	6.00E-03	2.96E-05	3.60E-05	7.15E-03	1.67E-03	4.08E-03
Inter-reflection	4.86E-03	2.40E-05	2.91E-05	5.79E-03	1.35E-03	3.30E-03
Obliquity	8.99E-04	4.44E-06	5.40E-06	1.07E-03	2.50E-04	6.12E-04
Polarization	6.00E-03	2.96E-05	3.60E-05	7.15E-03	1.67E-03	4.08E-03
Source drift & fluctuation	1.50E-03	7.41E-06	9.00E-06	1.79E-03	4.17E-04	1.02E-03
Bandwidth	1.50E-03	7.41E-06	9.00E-06	1.79E-03	4.17E-04	1.02E-03
Total type B uncertainty (b)	1.33E-02	6.58E-05	7.99E-05	1.59E-02	3.70E-03	9.05E-03

Light Red

Property	Y	x	y	L*	a*	b*
Nonlinearity	6.64E-03	3.22E-05	3.20E-05	8.52E-03	8.69E-04	2.25E-04
Temperature	-	-	-	-	-	-
Wavelength	3.98E-03	1.93E-05	1.92E-05	5.11E-03	5.21E-04	1.35E-04
Stray Light	6.64E-06	3.22E-08	3.20E-08	8.52E-06	8.69E-07	2.25E-07
Beam size & position	5.31E-03	2.58E-05	2.56E-05	6.82E-03	6.95E-04	1.80E-04
Inter-reflection	4.30E-03	2.09E-05	2.08E-05	5.52E-03	5.63E-04	1.46E-04
Obliquity	7.97E-04	3.87E-06	3.84E-06	1.02E-03	1.04E-04	2.70E-05
Polarization	5.31E-03	2.58E-05	2.56E-05	6.82E-03	6.95E-04	1.80E-04
Source drift & fluctuation	1.33E-03	6.45E-06	6.41E-06	1.70E-03	1.74E-04	4.50E-05
Bandwidth	1.33E-03	6.45E-06	6.41E-06	1.70E-03	1.74E-04	4.50E-05
Total type B uncertainty (b)	1.18E-02	5.72E-05	5.69E-05	1.51E-02	1.54E-03	3.99E-04

Light Gray

Property	Y	x	y	L*	a*	b*
Nonlinearity	6.13E-03	3.08E-05	3.29E-05	8.26E-03	1.85E-04	1.64E-04
Temperature	-	-	-	-	-	-
Wavelength	3.68E-03	1.85E-05	1.97E-05	4.95E-03	1.11E-04	9.87E-05
Stray Light	6.13E-06	3.08E-08	3.29E-08	8.26E-06	1.85E-07	1.64E-07
Beam size & position	4.91E-03	2.46E-05	2.63E-05	6.60E-03	1.48E-04	1.32E-04
Inter-reflection	3.97E-03	1.99E-05	2.13E-05	5.35E-03	1.20E-04	1.07E-04
Obliquity	7.36E-04	3.69E-06	3.95E-06	9.91E-04	2.22E-05	1.97E-05
Polarization	4.91E-03	2.46E-05	2.63E-05	6.60E-03	1.48E-04	1.32E-04
Source drift & fluctuation	1.23E-03	6.16E-06	6.58E-06	1.65E-03	3.69E-05	3.29E-05
Bandwidth	1.23E-03	6.16E-06	6.58E-06	1.65E-03	3.69E-05	3.29E-05
Total type B uncertainty (b)	1.09E-02	5.47E-05	5.84E-05	1.47E-02	3.28E-04	2.92E-04

Dark green

Property	Y	x	y	L*	a*	b*
Nonlinearity	1.26E-03	2.83E-05	6.50E-05	4.22E-03	5.72E-03	5.45E-03
Temperature	-	-	-	-	-	-
Wavelength	7.57E-04	1.70E-05	3.90E-05	2.53E-03	3.43E-03	3.27E-03
Stray Light	1.26E-06	2.83E-08	6.50E-08	4.22E-06	5.72E-06	5.45E-06
Beam size & position	1.01E-03	2.27E-05	5.20E-05	3.37E-03	4.58E-03	4.36E-03
Inter-reflection	8.17E-04	1.84E-05	4.21E-05	2.73E-03	3.71E-03	3.53E-03
Obliquity	1.51E-04	3.40E-06	7.80E-06	5.06E-04	6.87E-04	6.53E-04
Polarization	1.01E-03	2.27E-05	5.20E-05	3.37E-03	4.58E-03	4.36E-03
Source drift & fluctuation	2.52E-04	5.67E-06	1.30E-05	8.43E-04	1.14E-03	1.09E-03
Bandwidth	2.52E-04	5.67E-06	1.30E-05	8.43E-04	1.14E-03	1.09E-03
Total type B uncertainty (b)	2.24E-03	5.03E-05	1.15E-04	7.49E-03	1.02E-02	9.67E-03

Signature: 03.03.2017:

B.4 Participant: **NIM, CHINA**

Details of Measurement Setup

Make and type of spectrophotometer	CARY-5000
Additional stray light rejection	Built in filter wheel with a series of cut-off filters for stray light rejection
Source drift monitoring	Double optical paths compensation for source drift monitoring
Detector	PMT
Temperature [a]	A calibrated PT100 for temperature monitoring (23±1)°C
Humidity	<50%RH
Beam Size	4 × 12 mm
Measurement sequence[b]	Baseline-zero-filter1- filter2- filter3- filter4- filter5- filter6- filter7-finished Baseline-zero- filter7- filter6- filter5- filter4- filter3- filter2- filter1-finished Then averaged
Bandwidth	1 nm

[a] i.e describe method of temperature monitoring of filters and range of temperatures; [b] i.e describe number of measurements and whether filter orientation with respect to beam changes between measurements

If any damage, contamination or cleaning of filters was carried out, please give details

Laboratory: _National Institute of Metrology of China (NIM)_____

Address _No.18, Bei San Huan Donglu Rd., Bldg 13, Rm 107, Chaoyang District, Beijing, P. R. China_____

Date of measurement performance _2017- AUG -12 ~ 2017- DEC -28_____

1 Measuring performance conditions:
1.1 Ambient temperature, (23±1)°C
1.2 Relative humidity, ＜50%RH
1.4 Type of illuminant CIE: D65
1.5 Spectral bandwidth: 1 nm
1.6 Spectral range: 360 nm to 780 nm
1.7 Step: 1 nm
2 Description and procedure of independent realization of the unit (or traceability of the results to another named NMI)

Trace to the primary standard on NIM Changping campus in Beijing. The procedure of realization of the unit is below:

The measurements were conducted using a spectrophotometer based on a single beam, single monochromator (Type 2061, McPherson) with 2400 g/mm diffraction gratings. A tungsten halogen lamp (Type Osram 300 W) was used as the light source for the measurements over the whole spectral range. A series of band-pass filters were placed at the exit slit of the monochromator. A small portion of the light from the band-pass filters was directed onto a monitor detector (silicon detector, Type S1337-1010BQ,

Hamamatsu) using a beam splitter. A same type of silicon detector was used as the main detector. The monitor detector was used to minimize the impact from the drift of the source. The photocurrents of both detectors were measured using two Keithley 6485 Picoampmeters synchronously. The filter was mounted with a sample holder on a translation and rotary stage.

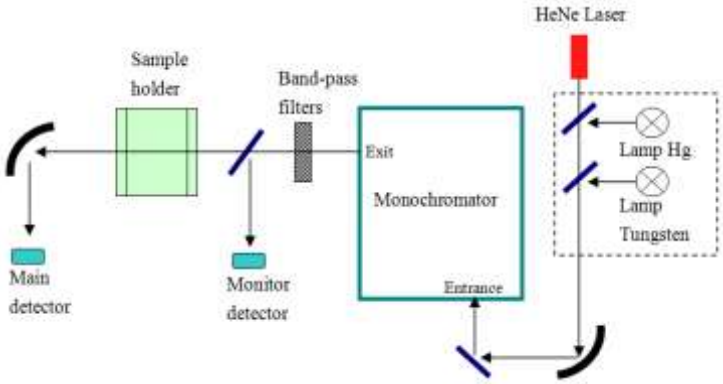

Figure 1. Schematic diagram of the spectral regular transmittance measurement facility at NIM.

3 Description and diagram of the standard measuring instrument

Baseline-zero-filter1- filter2- filter3- filter4- filter5- filter6- filter7-finished, baseline-zero- filter7- filter6- filter5- filter4- filter3- filter2- filter1-finished, then averaged.

Measurement Results

Note: The values of L^*, a^* and b^* are calculated from the values of Y, x and y using Eq. 6-9 of the main body of the comparison report (page 7)

Property	Y	x	y	L^*	a^*	b^*
043-00-83	60.40	0.30828	0.32945	82.055	-1.844	-1.376
Total Uncertainty [c]	5.18E-02	3.20E-05	1.93E-04	2.81E-02	9.46E-03	1.06E-02
043-13-83	73.87	0.37140	0.45121	88.861	-20.803	51.432
Total Uncertainty [c]	6.59E-02	9.97E-05	9.51E-05	3.13E-02	1.55E-02	5.09E-02
043-15-83	62.54	0.2424	0.30411	83.200	-24.028	-19.820
Total Uncertainty [c]	5.28E-02	4.57E-05	3.73E-05	2.78E-02	9.45E-03	1.73E-02
043-19-83	5.653	0.67570	0.32300	28.520	57.926	48.842
Total Uncertainty [c]	2.81E-02	8.26E-04	4.16E-05	7.39E-02	1.04E-01	1.81E-01
043-22-83	12.53	0.28383	0.65293	42.046	-57.270	55.189
Total Uncertainty [c]	3.08E-02	2.98E-04	6.71E-04	4.75E-02	1.20E-01	1.45E-01
043-26-83	64.82	0.32262	0.32083	84.391	8.574	-2.026
Total Uncertainty [c]	1.79E-01	4.23E-05	3.60E-05	4.08E-02	8.39E-03	1.91E-02
043-31-83	36.16	0.22317	0.23270	66.642	1.366	-42.234
Total Uncertainty [c]	3.96E-02	7.64E-05	8.54E-05	3.02E-02	1.55E-02	4.72E-02

[a] The uncertainty associated with the values attributed to reproducibility of the measurement.
[b] The uncertainty associated with the values attributed to all type B source.
[c] The total of the measurement for a coverage factor of $k = 1$.

Uncertainty budget

043-00-83

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	1.7321E-03	1.5855E-07	4.4186E-08	9.3860E-04	3.2284E-05	3.3781E-05
Temperature	1.1547E-02	1.0567E-06	2.9449E-07	6.2568E-03	2.1517E-04	2.2516E-04
Wavelength	9.4268E-04	1.4536E-06	6.8304E-06	5.1085E-04	2.2318E-03	2.4664E-03
Stray Light	1.7321E-03	1.5855E-07	4.4186E-08	9.3860E-04	3.2284E-05	3.3781E-05
Beam size & position	2.5555E-02	2.0440E-05	1.6209E-05	1.3849E-02	4.2875E-03	8.1890E-03
Inter-reflection	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Obliquity	3.6050E-02	9.2920E-06	3.0019E-06	1.9535E-02	2.5076E-03	2.3164E-03
Polarization	5.7735E-04	5.2851E-08	1.4729E-08	3.1287E-04	1.0762E-05	1.1261E-05
Source drift & fluctuation	5.7735E-03	5.2843E-07	1.4727E-07	3.1286E-03	1.0760E-04	1.1259E-04
Bandwidth	5.0903E-06	2.4387E-07	9.2083E-07	2.7585E-06	2.8060E-04	3.3960E-04
Other	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Total type B uncertainty (b)	4.6114E-02	2.2534E-05	1.7871E-05	2.4989E-02	5.4580E-03	8.8707E-03

043-13-83

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	5.7735E-04	6.1683E-07	1.2876E-06	2.7416E-04	1.1570E-04	4.4611E-04
Temperature	1.1547E-02	1.2332E-05	2.5742E-05	5.4828E-03	2.3135E-03	8.9186E-03
Wavelength	3.0392E-03	7.6808E-05	7.1083E-05	1.4432E-03	7.3545E-03	4.1744E-02
Stray Light	5.7735E-04	6.1683E-07	1.2876E-06	2.7416E-04	1.1570E-04	4.4611E-04
Beam size & position	2.5811E-02	3.4788E-05	1.1256E-05	1.2254E-02	7.7504E-03	1.7739E-02
Inter-reflection	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Obliquity	4.6670E-02	1.8767E-05	4.4106E-05	2.2149E-02	2.2963E-03	8.3860E-03
Polarization	1.7321E-03	1.8504E-06	3.8626E-06	8.2248E-04	3.4710E-04	1.3383E-03
Source drift & fluctuation	5.7735E-03	6.1673E-06	1.2874E-05	2.7415E-03	1.1569E-03	4.4602E-03
Bandwidth	2.7721E-04	9.6641E-08	1.9494E-06	1.3164E-04	6.0860E-04	7.4456E-04
Other	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Total type B uncertainty [(b)]	5.4990E-02	8.7500E-05	8.9305E-05	2.6101E-02	1.1253E-02	4.7220E-02

043-15-83

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	1.7321E-03	1.8103E-06	6.8177E-07	9.1374E-04	4.7894E-04	3.1630E-04
Temperature	1.1547E-02	1.2065E-05	4.5440E-06	6.0910E-03	3.1922E-03	2.1082E-03
Wavelength	1.4690E-02	3.0847E-05	3.1159E-05	7.7504E-03	1.4333E-03	1.3684E-02
Stray Light	1.7321E-03	1.8103E-06	6.8177E-07	9.1374E-04	4.7894E-04	3.1630E-04
Beam size & position	1.4948E-02	1.4474E-05	1.3631E-05	7.8836E-03	3.0054E-03	6.2980E-03
Inter-reflection	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Obliquity	2.2640E-02	2.2413E-05	8.1985E-06	1.1942E-02	5.8824E-03	3.7116E-03
Polarization	5.7735E-04	6.0344E-07	2.2726E-07	3.0458E-04	1.5965E-04	1.0543E-04
Source drift & fluctuation	5.7735E-03	6.0336E-06	2.2723E-06	3.0457E-03	1.5963E-03	1.0542E-03
Bandwidth	9.1251E-05	3.6367E-07	1.7287E-07	4.8140E-05	2.9016E-04	1.8414E-07
Other	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Total type B uncertainty [(b)]	3.3538E-02	4.3040E-05	3.5366E-05	1.7691E-02	7.6809E-03	1.5699E-02

043-19-83

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	1.7321E-03	1.0869E-04	2.4056E-06	4.5547E-03	8.0671E-03	1.8736E-02
Temperature	1.1547E-02	7.2246E-04	1.5990E-05	3.0334E-02	5.3685E-02	1.2496E-01
Wavelength	7.9993E-03	1.4106E-05	1.3787E-05	2.1029E-02	2.2031E-02	3.6005E-02
Stray Light	1.7321E-03	1.0869E-04	2.4056E-06	4.5547E-03	8.0671E-03	1.8736E-02
Beam size & position	9.1664E-03	2.7794E-05	2.6354E-05	2.4144E-02	3.1236E-02	4.1060E-02
Inter-reflection	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Obliquity	8.3447E-03	1.9851E-05	1.9457E-05	2.1910E-02	2.4129E-02	3.7504E-02
Polarization	5.7735E-04	6.2653E-05	1.3879E-06	2.6266E-03	4.6528E-03	1.0822E-02
Source drift & fluctuation	5.7735E-03	3.6185E-04	8.0090E-06	1.5176E-02	2.6871E-02	6.2464E-02
Bandwidth	2.8783E-04	1.9404E-06	1.9010E-06	7.5701E-04	2.5534E-04	1.2897E-03
Other	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Total type B uncertainty [(b)]	1.9767E-02	8.2572E-04	4.0002E-05	5.2006E-02	7.6152E-02	1.5725E-01

043-22-83

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	1.7321E-03	8.1779E-06	8.7778E-05	2.6752E-03	7.8442E-03	1.8182E-02
Temperature	1.1547E-02	5.4374E-05	5.8363E-04	1.7826E-02	5.2202E-02	1.2047E-01
Wavelength	2.8845E-03	2.0121E-04	4.0807E-05	4.4558E-03	4.5159E-02	4.1056E-02
Stray Light	1.7321E-03	8.1779E-06	8.7778E-05	2.6752E-03	7.8442E-03	1.8182E-02
Beam size & position	5.6424E-03	5.7617E-05	1.4152E-05	8.7088E-03	2.2976E-02	1.8433E-03
Inter-reflection	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Obliquity	1.0282E-02	6.0476E-05	5.1442E-05	1.5867E-02	2.5344E-02	1.6096E-02
Polarization	5.7735E-04	2.7268E-06	2.9269E-05	8.9177E-04	2.6153E-03	6.0650E-03
Source drift & fluctuation	5.7735E-03	2.7230E-05	2.9227E-04	8.9155E-03	2.6128E-02	6.0453E-02
Bandwidth	1.6226E-04	2.9877E-06	1.1311E-05	2.5063E-04	2.0373E-03	2.4569E-03
Other	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Total type B uncertainty [(b)]	1.7858E-02	2.2651E-04	6.6854E-04	2.7566E-02	8.2166E-02	1.4429E-01

043-26-83

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	1.7321E-03	2.2795E-07	2.6342E-07	8.9416E-04	1.5135E-04	4.2833E-05
Temperature	1.1547E-02	1.5193E-06	1.7557E-06	5.9605E-03	1.0088E-03	2.8550E-04
Wavelength	2.8483E-03	1.6342E-05	2.1157E-05	1.4704E-03	2.1269E-03	9.9237E-03
Stray Light	1.7321E-03	2.2795E-07	2.6342E-07	8.9416E-04	1.5135E-04	4.2833E-05
Beam size & position	3.7743E-02	3.5757E-05	2.6153E-05	1.9502E-02	5.1505E-03	1.4743E-02
Inter-reflection	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Obliquity	4.4822E-02	8.4330E-06	6.1946E-06	2.3154E-02	4.7707E-03	3.5195E-03
Polarization	5.7735E-04	7.5985E-08	8.7810E-08	2.9806E-04	5.0451E-05	1.4278E-05
Source drift & fluctuation	5.7735E-03	7.5975E-07	8.7798E-07	2.9804E-03	5.0445E-04	1.4276E-04
Bandwidth	6.1676E-05	2.5989E-07	4.6838E-08	3.1841E-05	9.4336E-05	5.8838E-05
Other	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Total type B uncertainty [(b)]	6.0122E-02	4.0247E-05	3.4263E-05	3.1060E-02	7.4257E-03	1.8120E-02

043-31-83

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	1.7321E-03	3.0490E-06	3.3157E-06	1.3195E-03	5.2459E-05	9.2953E-04
Temperature	1.1547E-02	2.0320E-05	2.2097E-05	8.7956E-03	3.4960E-04	6.1951E-03
Wavelength	9.4561E-03	4.1679E-06	1.9660E-05	7.2049E-03	1.2196E-02	3.3161E-03
Stray Light	1.7321E-03	3.0490E-06	3.3157E-06	1.3195E-03	5.2459E-05	9.2953E-04
Beam size & position	1.6604E-02	2.0632E-05	2.2778E-05	1.2652E-02	8.1530E-03	1.4680E-02
Inter-reflection	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Obliquity	1.8489E-02	2.2083E-05	2.2862E-05	1.4089E-02	3.1131E-03	7.5307E-03
Polarization	5.7735E-04	1.0164E-06	1.1053E-06	4.3985E-04	1.7487E-05	3.0985E-04
Source drift & fluctuation	5.7735E-03	1.0162E-05	1.1051E-05	4.3982E-03	1.7484E-04	3.0981E-03
Bandwidth	1.3909E-04	6.7132E-07	1.2419E-06	1.0597E-04	2.7665E-04	4.8994E-04
Other	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Total type B uncertainty [(b)]	2.9664E-02	3.8301E-05	4.5422E-05	2.2602E-02	1.5005E-02	1.8255E-02

Signature: Date

B.5 Participant: **INM-MD, MOLDOVA**

Laboratory: National Institute of Metrology of Republic of Moldova (INM-MD)
Address: 28, E. Coca str., Chişinău, MD 2064, Republic of Moldova

Description of measurement facility and measurement method

Details of Measurement Setup

Make and type of spectrophotometer	The reference spectrophotometer used for this comparison is a double beam spectrophotometer, type Lambda950, manufacturing by PerkinElmer
Additional stray light rejection	No
Source drift monitoring	Source drift effects was mostly removed by the measurement sequence
Detector	Photomultiplier and photodiode
Temperature [(a)]	(23.1±1)°C, measured very close to the sample compartment.
Humidity	(52.7±10)%, measured very close to the sample compartment.
Beam Size	4x12 mm
Measurement sequence[(b)]	9 measurements in repeatability condition without changing the filter orientation
Bandwidth	5 nm

[(a)] i.e describe method of temperature monitoring of filters and range of temperatures; [(b)] i.e describe number of measurements and whether filter orientation with respect to beam changes between measurements

Date of measurement performance ___03 ... 07 JUNE 2017_____

1 Measuring performance conditions:

1.1 Ambient performance, ^{0}C (23.1±1)°C, measured very close to the sample compartment

1.2 Relative humidity, % (52.7±10)%, measured very close to the sample compartment

1.4 Type of standard source CIE: D65 ? Yes

1.5 Separable spectral interval, nm. 5 ? Yes

1.6 Scanning step (if spectral device is used), nm. 5 ? Yes

2 Description and procedure of independent realization of the unit (or traceability of the results to another named NMI)

*Traceability of Lambda950 was estimated in 2016 by using neutral glass filters with traceability at CMI and its 3.93E-03 at transmittance. After by using methods of recalculation from regular transmittance al measurements was convert in tristimulus values and L*a*b.*

3 Description and diagram of the standard measuring instrument

As measurement device in this comparison was used National Standard of Republic of Moldova, spectrophotometer Lambda 950. Optic scheme are present below in figure 1.

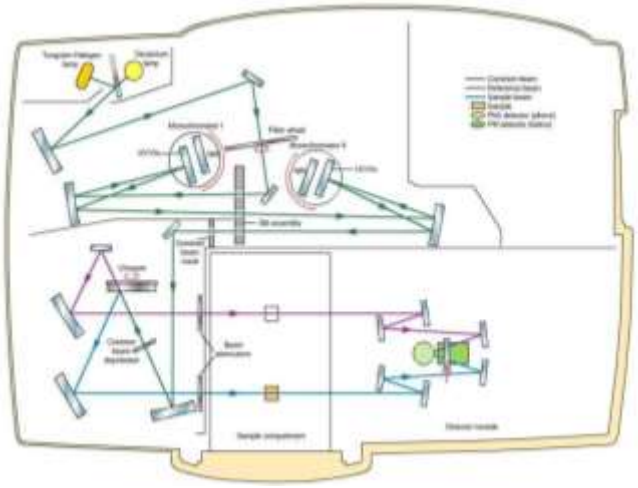

Figure 1. Optic scheme of spectrophotometer Lambda 950

Measurement Results

Note: The values of L^*, $a^*$and b^* are calculated from the values of Y, x and y using Eq. 6-9 of the main body of the comparison report (page 7)

Filter number 00

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	9	9	9	9	9	9
Value	60.5682	0.30825	0.32932	82.146	-1.804	-1.425
Type A Uncertainty (a)	1.32E-02	4.82E-06	5.12E-06	7.15E-03	1.68E-03	2.28E-03
Type B Uncertainty (b)	3.90E-01	6.39E-04	7.48E-04	3.48E-01	3.56E-01	6.55E-02
Total Uncertainty (c)	3.90E-01	6.39E-04	7.48E-04	3.48E-01	3.56E-01	6.55E-02

Filter number 19

Property	Y	X	y	L^*	a^*	b^*
Number of measurements	9	9	9	9	9	9
Value	5.5275	0.67645	0.32308	28.188	57.566	48.483
Type A Uncertainty (a)	1.41E-02	7.63E-06	1.24E-05	3.78E-02	4.88E-02	9.38E-02
Type B Uncertainty (b)	8.64E-02	3.95E-03	2.41E-03	1.28E-01	3.59E-01	5.05E-01
Total Uncertainty (c)	8.75E-02	3.95E-03	2.41E-03	1.33E-01	3.62E-01	5.14-01

Filter number 22

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	9	9	9	9	9	9
Value	12.4900	0.28482	0.65257	41.9845	-56.950	55.271
Type A Uncertainty (a)	4.44E-03	4.53E-05	1.73E-05	6.87E-03	1.80E-02	4.67E-03
Type B Uncertainty (b)	1.11E-01	1.66E-03	3.26E-03	8.42E-01	4.56E-01	1.66E-1
Total Uncertainty (c)	1.11E-01	1.66E-03	3.26E-03	8.42E-01	4.56E-01	1.66E-1

Filter number 31

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	9	9	9	9	9	9
Value	36.3515	0.22325	0.23248	66.788	1.524	-42.383
Type A Uncertainty [(a)]	9.18E-03	9.52E-06	1.18E-05	6.97E-03	1.43E-03	5.20E-03
Type B Uncertainty [(b)]	4.14E-01	4.58E-04	7.78E-04	6.80E-01	3.62E-01	1.01E-01
Total Uncertainty [(c)]	4.14E-01	4.58E-04	7.78E-04	6.80E-01	3.62E-01	1.01E-01

Filter number 26

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	9	9	9	9	9	9
Value	65.1607	0.32247	0.32067	84.566	8.594	-2.110
Type A Uncertainty [(a)]	9.35E-03	7.03E-06	6.83E-06	4.81E-03	1.81E-03	3.72E-03
Type B Uncertainty [(b)]	4.22E-01	6.37E-04	7.76E-04	3.36E-01	3.38E-01	6.88E-02
Total Uncertainty [(c)]	4.22E-01	6.37E-04	7.76E-04	3.36E-01	3.38E-01	6.89E-02

Filter number 13

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	9	9	9	9	9	9
Value	73.7542	0.37174	0.45144	88.806	-20.734	51.566
Type A Uncertainty [(a)]	1.00E-02	2.51E-05	1.65E-05	4.75E-03	4.24E-03	1.31E-02
Type B Uncertainty [(b)]	3.66E-01	7.20E-04	5.36E-04	2.29E-01	3.88E-01	4.35E-02
Total Uncertainty [(c)]	3.66E-01	7.20E-04	5.36E-04	2.29E-01	3.88E-01	4.54E-02

Filter number 15

Property	Y	x	y	L^*	a^*	b^*
Number of measurements	9	9	9	9	9	9
Value	63.4510	0.24236	0.30389	83.6791	-24.068	-19.999
Type A Uncertainty [(a)]	5.91E-03	1.15E-05	1.68E-05	3.09E-03	2.91E-03	7.70E-03
Type B Uncertainty [(b)]	5.03E-01	5.50E-04	7.75E-04	4.26E-01	4.37E-01	8.24E-02
Total Uncertainty [(c)]	5.03E-01	5.50E-04	7.75E-04	4.26E-01	4.37E-01	8.28E-02

[(a)] The uncertainty associated with the values attributed to reproducibility of the measurement. [(b)] The uncertainty associated with the values attributed to all type B sourse. [(c)] The total of the measurement for a coverage factor of k = 1.

Type B uncertainty budget[a]

Property	Y	x	y	L^*	a^*	b^*
Nonlinearity	2.03E-01	3.52E-04	6.37E-04	3.67E-01	2.76E-01	4.25E-2
Temperature	0	0	0	0	0	0
Wavelength	4.61E-01	4.22E-04	4.41E-04	2.17E-01	3.39E-01	7.06E-02
Stray Light	5.02E-05	5.02E-05	5.02E-05	5.02E-05	5.02E-05	5.02E-05
Beam size & position	4.37E-05	4.37E-05	4.37E-05	4.37E-05	4.37E-05	4.37E-05
Inter-reflec-tion	0	0	0	0	0	0
Obliquity	0	0	0	0	0	0
Polarization	0	0	0	0	0	0
Source drift & fluctuation	0	0	0	0	0	0
Bandwidth	0	0	0	0	0	0
Other	0	0	0	0	0	0
Total type B uncertainty [b]	5.03E-01	5.50E-04	7.75E-04	4.26E-01	4.37E-01	8.24E-02

Signature:  Date 26.07.2018

B.6 Participant: **NIM T, Tailand**

Laboratory: National Institute of Metrology (Thailand)
¾-5 Moo 3 Klong 5 Klong Luang Pathumthani THAILAND
Details of Measurement Setup

Make and type of spectrophotometer	Perkin-Elmer Lambda 1050
Additional stray light rejection	Not applicable
Source drift monitoring	The double beam instrument was used based on the single-beam method. The reference beam is used for monitoring source drift.
Detector	PMT R6872
Temperature [(a)]	The temperature of the filter was not monitored only the ambient temperature of the room was monitored. The ambient temperature was controlled and monitored to be within 23±2 ºC.
Humidity	The relative humidity of the room was controlled to be within 50±15 %RH
Beam Size	The beam size used was approximately 13 mm in height and 2 mm in width
Measurement sequence[(b)]	In a series: 100%T >0%T> Sample > BlankRef> Sample. One set of measurement comprised two series with two perpen- dicular orientations of the filter. Two sets of measurements were performed for each filter except for 043-15-83. The filter 043-15-83 seemed to be contaminated and the wet cleaning was applied. Additional two sets of measurements were performed before and after cleaning.
Bandwidth	1 nm

Date of Measurement: 05/08/2017, 08/08/2017, 22/11/2017, 23/11/2017, 29/11/2017

Measuring conditions:

1.1 Ambient temperature (ºC):	23±2 ºC.
1.2 Relative humidity (%RH) :	50±15 %RH
1.3 Type of illuminant (specified according to CIE standard illuminant. default is CIE D65)	Use spectral method. The colorimetric parameters are calculated based on stand- ard illuminant D65
1.4 Spectral bandwidth (nm), if applicable:	1 nm
1.5 Spectral range (nm), default range is from 360 nm to 780 nm	380 nm to 780 nm for calculation Measurements were done from 360 nm to 860 nm
1.6 Spectral interval (nm), if applicable:	4 nm

Description and procedure of independent realization of the unit or traceability of the results to another named NMI.

The absolute method using single beam substitution method. The accuracy of the scale was confirmed using three ND filters traceable to the spectral transmittance scale of NPL.

Description and diagram of the standard measuring instrument

Even though the spectrophotometer used for the measurement is a double-beam spectrophotometer, the single beam method is adopted. In each series (round), the signal (which is the ratio of the sample beam to the reference beam) is measured in the series: dark, sam- ple, blank, sample.

The transmittance is calculated for each round of measurement by di- viding the average dark corrected signal of the sample by the dark corrected signal of the blank. The diagrams of the spectrophotometer used are as followed

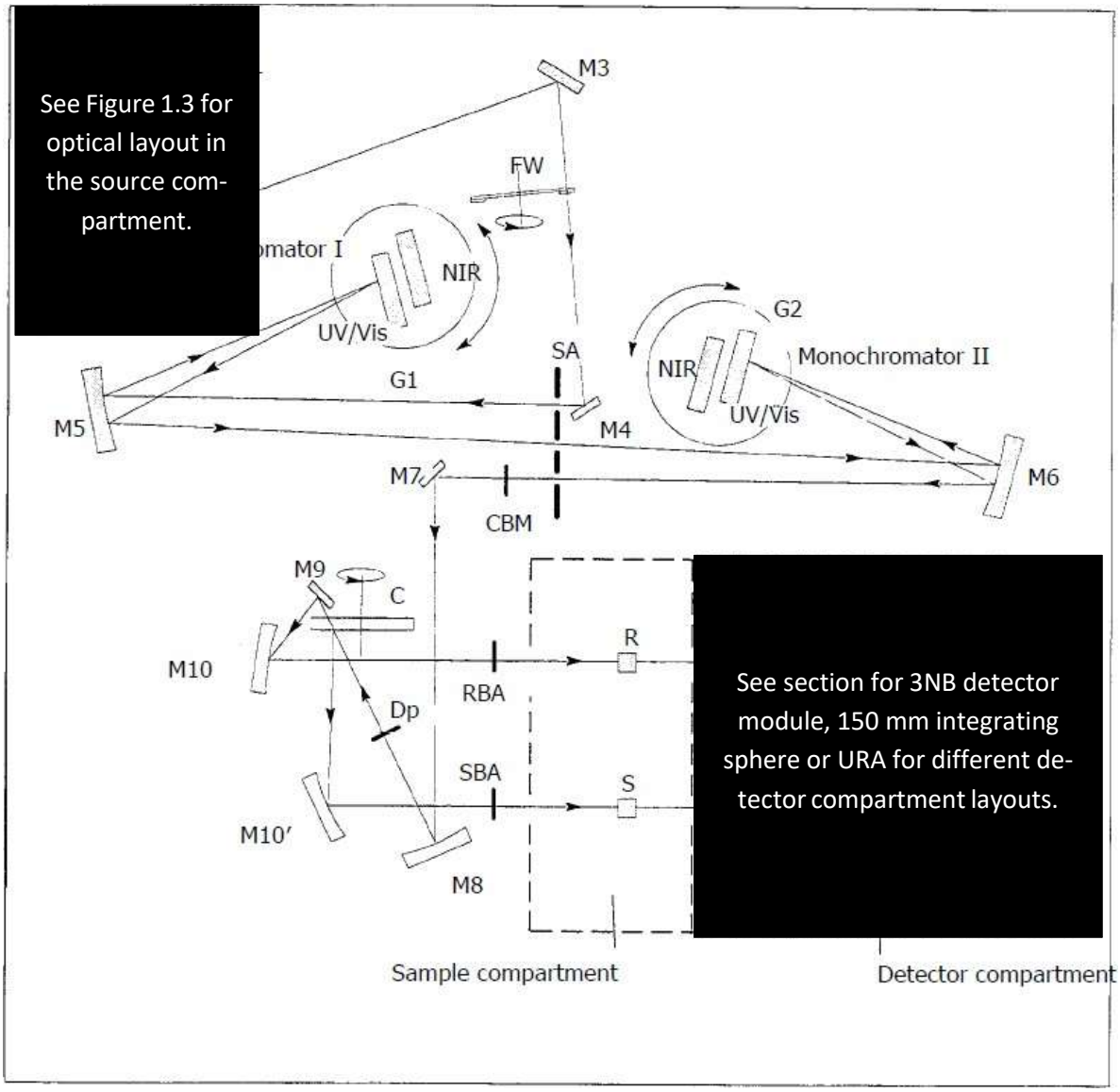

Figure 1.1 Schematic of the Lambda optical system.

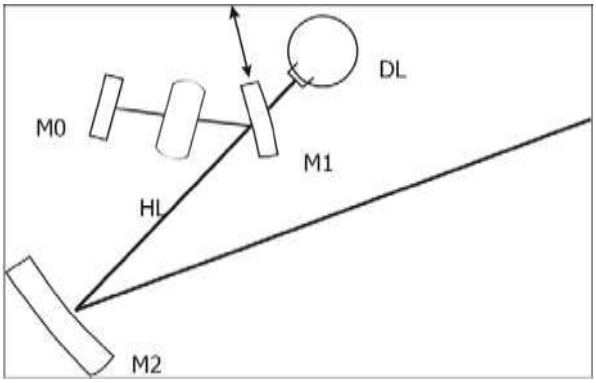

Figure 1.2 Optical system in the Lambda 1050 spectrometer lamp compartment showing the source doubling mirror M0.

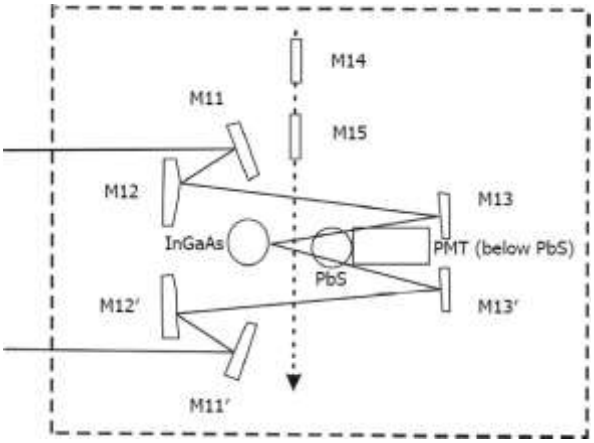

Figure 1.3 Optical system in the 3NB detector module of Lambda 1050 spectrometer detector compartment

The colorimetric parameters were calculated from spectral data at 5 nm interval using the tabulated data for standard illuminant D65 and the tristimulus values for the standard observer 10°

Pleas reproduce the following table for each of the seven filters. All uncertainties should be reported as absolute measurement uncertainties

Measurement Results

Note: The values of L^*, $a^*$and b^* are calculated from the values of Y, x and y using Eq. 6-9 of the main body of the comparison report (page 7)

Property	Y%	x	y	L^*(%)	a^*	b^*
Number of measurements	4	4	4	4	4	4
Value for **043-00-83**	60.48	0.308 4	0.3295	82.098	-1.812	-1.341
Type A uncertainty	0.0110	0.000031	0.000042	0.0060	0.0171	0.0168
Type B uncertainty	0.1797	0.000076	0.000111	0.0972	0.0436	0.0432
Standard uncertainty	0.180	0.00008	0.00012	0.097	0.047	0.046

Property	Y%	x	y	L^*(%)	a^*	b^*
Number of measurements	4	4	4	4	4	4
Value for **043-13-83**	73.89	0.3713	0.4510	88.870	-20.777	51.341
Type A uncer-tainty	0.0141	0.000033	0.000035	0.0067	0.0179	0.0156
Type B uncer-tainty	0.1995	0.000569	0.000573	0.0944	0.0698	0.314
Standard uncertainty	0.20	0.00057	0.00057	0.095	0.072	0.31

Property	Y%	x	y	L^*(%)	a^*	b^*
Number of measurements	6	6	6	6	6	6
Value for **043-15-83**	62.55	0.2425	0.3041	83.205	-23.969	-19.811
Type A uncer-tainty	0.0125	0.000027	0.000050	0.0067	0.0206	0.0188
Type B uncer-tainty	0.2103	0.000259	0.000255	0.1118	0.0535	0.1088
Standard uncertainty	0.21	0.00026	0.00026	0.112	0.057	0.11
Property	**Y%**	**x**	**y**	**L^*(%)**	**a^***	**b^***
Number of measurements	4	4	4	4	4	4
Value for **043-19-83**	5.60	0.6764	0.3230	28.380	57.831	48.780
Type A uncer-tainty	0.0027	0.00013	0.000080	0.0071	0.017	0.045
Type B uncer-tainty	0.049	0.0012	0.00014	0.13	0.13	0.24
Standard uncertainty	0.049	0.0012	0.00016	0.13	0.13	0.24
Property	**Y%**	**x**	**y**	**L^*(%)**	**a^***	**b^***
Number of measurements	4	4	4	4	4	4
Value for **043-22-83**	12.52	0.2835	0.6527	42.031	-57.307	55.037
Type A uncer-tainty	0.0045	0.000070	0.00013	0.0069	0.020	0.039
Type B uncer-tainty	0.059	0.00069	0.00096	0.091	0.17	0.22
Standard uncertainty	0.059	0.00069	0.00097	0.091	0.17	0.22
Property	**Y%**	**x**	**y**	**L^*(%)**	**a^***	**b^***
Number of measurements	4	4	4	4	4	4
Value for **043-26-83**	65.09	0.3227	0.3210	84.530	8.5644	-1.957
Type A Uncer-tainty	0.0115	0.000032	0.000040	0.0059	0.0169	0.0170
Type B Uncer-tainty	0.1871	0.000141	0.000179	0.0964	0.0434	0.0819
Type A uncertainty	0.19	0.00015	0.00018	0.097	0.047	0.084
Type B uncertainty						
Standard uncertainty						

Property	Y%	x	y	L*(%)	a*	b*
Number of measurements	4	4	4	4	4	4
Value for **043-31-83**	36.19	0.2232	0.2324	66.665	1.536	-42.356
Type A uncertainty	0.0065	0.000022	0.000042	0.0050	0.0171	0.0164
Type B uncertainty	0.1628	0.000208	0.000275	0.124	0.0975	0.0702
Standard uncertainty	0.16	0.00021	0.00028	0.12	0.099	0.072

Type B uncertainty budget

Filter: 043-00-83

Property	Y%	x	y	L*(%)	a*	b*
Nonlinearity	0.0600	0.000005	0.000001	0.0325	0.0012	0.0009
Temperature	0.0018	0.000005	0.000007	0.0010	0.0028	0.0027
Wavelength	0.0068	0.000011	0.000049	0.0037	0.0161	0.0178
Source drift & fluctuation	0.0014	0.000004	0.000005	0.0008	0.0022	0.0021
Other (Scale Bias: Stray Light + Inter-reflection + Obliquity + Polarization + Bandwidth)	0.1692	0.000075	0.000099	0.0915	0.0404	0.0392
Total type B uncertainty	**0.1797**	**0.000076**	**0.000111**	**0.0972**	**0.0436**	**0.0432**

Filter: 043-15-83

Property	Y%	x	y	L*(%)	a*	b*
Nonlinearity	0.0600	0.000064	0.000024	0.0321	0.0170	0.0108
Temperature	0.0018	0.000005	0.000006	0.0009	0.0029	0.0023
Wavelength	0.1058	0.000222	0.000228	0.0561	0.0092	0.0996
Source drift & fluctuation	0.0014	0.000004	0.000005	0.0008	0.0023	0.0018
Other (Scale Bias: Stray Light + Inter-reflection + Obliquity + Polarization + Bandwidth)	0.1716	0.000117	0.000111	0.0912	0.0498	0.0423
Total type B uncertainty	**0.2103**	**0.000259**	**0.000255**	**0.1118**	**0.0535**	**0.1088**

Filter: 043-19-83

Property	Y%	x	y	L*(%)	a*	b*
Nonlinearity	0.028	0.000	0.000	0.074	0.096	0.13
Temperature	0.0018	0.000118	0.000070	0.0047	0.0133	0.0392
Wavelength	0.027	0.000049	0.000049	0.070	0.074	0.12
Source drift & fluctuation	0.0014	0.000094	0.000056	0.0037	0.011	0.031
Other (Scale Bias: Stray Light + Interreflection + Obliquity + Polarization + Bandwidth)	0.030	0.0012	0.0001	0.080	0.051	0.16
Total type B uncertainty	**0.049**	**0.00012**	**0.0014**	**0.13**	**0.13**	**0.24**

Filter: 043-22-83

Property	Y%	x	y	L^*(%)	a^*	b^*
Nonlinearity	0.036	0.000	0.000	0.056	0.055	0.053
Temperature	0.0018	0.000049	0.000111	0.0027	0.0127	0.0333
Wavelength	0.0098	0.00067	0.00014	0.015	0.15	0.14
Source drift & fluctuation	0.0014	0.000039	0.000089	0.0022	0.0102	0.0266
Other (Scale Bias: Stray Light + Inter-reflection + Obliquity +Po-larization + Bandwidth)	0.045	0.00013	0.00094	0.070	0.052	0.16
Total type B uncertainty	**0.059**	**0.00069**	**0.00096**	**0.091**	**0.17**	**0.22**

Filter: 043-26-83

Property	Y%	x	y	L^*(%)	a^*	b^*
Nonlinearity	0.0600	0.000008	0.000009	0.0309	0.0051	0.0012
Temperature	0.0018	0.000005	0.000006	0.0009	0.0026	0.0025
Wavelength	0.0208	0.000118	0.000152	0.0107	0.0150	0.0717
Source drift & fluctuation	0.0014	0.000004	0.000005	0.0007	0.0021	0.0020
Other (Scale Bias: Stray Light + Inter-reflection + Obliquity + Po- larization + Bandwidth)	0.1760	0.000076	0.000094	0.0907	0.0402	0.0395
Total type B uncertainty	**0.1871**	**0.000141**	**0.000179**	**0.0964**	**0.0434**	**0.0819**

Filter: 043-31-83

Property	Y%	x	y	L^*(%)	a^*	b^*
Nonlinearity	0.0600	0.000106	0.000115	0.0458	0.0017	0.0320
Temperature	0.0018	0.000006	0.000008	0.0013	0.0039	0.0028
Wavelength	0.0680	0.000031	0.000139	0.0517	0.0865	0.0231
Source drift & fluctuation	0.0014	0.000005	0.000006	0.0011	0.0031	0.0023
Other (Scale Bias: Stray Light + Inter-reflection + Obliquity + Po- larization + Bandwidth)	0.1352	0.000176	0.000207	0.1030	0.0447	0.0579
Total type B uncertainty	**0.1628**	**0.000208**	**0.000275**	**0.1240**	**0.0975**	**0.0702**



Signature: Date (dd/MM/yyyy): 13/07/2017

B.7 Participant: **VNIIOFI, Russia**

Laboratory: VNIIOFI
Address: Russia, Moscow, Ozernaya str., 46
Date of Measurement: 11.12.2017 – 29.12.2017

1. **Measuring conditions:**

1.1 Ambient temperature (oC):	from 21.7 to 23.9 (average 22.9)
1.2 Relative humidity (%RH) :	from 28 to 47 (average 39)
1.3 Type of illuminant	CIE D65, spectral data from ISO 10527-2007
1.4 Spectral bandwidth (nm), if applicable:	0.5 nm
1.5 Spectral range (nm),	from 380 nm to 780 nm
1.6 Spectral interval (nm), if applicable:	1 nm

2. Description and procedure of independent realization of the unit
Independent realization of the colour was scale based on measurement of spectral transmittance using a double-beam spectrophotometer with mathematic calculation of different colour systems. Measurement setup for colorimetric scale take apart in our comparisons with national spectral transmittance standard and DoE was less than uncertainties of each facilities.

3. Measurement results

Note: The values of L^*, $a^*$and b^* are calculated from the values of Y, x and y using Eq. 6-9 of the main body of the comparison report (page 7)

6-00-79	Y	x	y	L^*	a^*	b^*
1	60.084	0.308487	0.330277	81.884	-2.098	-1.070
2	60.026	0.308484	0.330286	81.852	-2.103	-1.067
3	60.017	0.308514	0.330304	81.848	-2.097	-1.056
4	60.001	0.308483	0.330308	81.839	-2.112	-1.060
5	60.044	0.308517	0.330313	81.862	-2.099	-1.053
6	59.889	0.308528	0.330356	81.778	-2.111	-1.036
7	59.973	0.308546	0.330341	81.824	-2.097	-1.039
8	59.954	0.308546	0.330338	81.813	-2.096	-1.040
9	59.984	0.308552	0.330337	81.830	-2.093	-1.039
10	59.926	0.308531	0.330337	81.798	-2.102	-1.042
Average	59.990	0.308519	0.330320	81.833	-2.101	-1.050
Type A Uncertainty	0.018	0.000008	0.000008	0.010	0.002	0.004
Type B Uncertainty	0.041	0.000031	0.000033	0.020	0.013	0.013
Total Uncertainty	0.045	0.000032	0.000034	0.022	0.013	0.013

6-13-79	Y	x	y	L^*	a^*	b^*
1	29.584	0.422603	0.480399	61.293	-8.214	56.903
2	29.606	0.422713	0.480440	61.313	-8.197	56.959
3	29.645	0.422415	0.480365	61.347	-8.260	56.883
4	29.511	0.422639	0.480359	61.230	-8.189	56.853
5	29.440	0.422832	0.480431	61.168	-8.149	56.881
6	29.570	0.422694	0.480383	61.281	-8.186	56.913
7	29.526	0.422812	0.480414	61.243	-8.158	56.925
8	29.527	0.422865	0.480447	61.244	-8.152	56.951

9	29.503	0.422848	0.480433	61.223	-8.151	56.926
10	29.515	0.422728	0.480369	61.234	-8.169	56.882
Average	29.543	0.422715	0.480404	61.258	-8.182	56.908
Type A Uncertainty	0.019	0.000044	0.000011	0.016	0.011	0.011
Type B Uncertainty	0.035	0.000148	0.000170	0.020	0.030	0.067
Total Uncertainty	0.040	0.000154	0.000170	0.026	0.032	0.068

6-19-79	Y	x	Y	L^*	a^*	b^*
1	4.938	0.700050	0.299950	26.557	64.246	45.789
2	4.993	0.699887	0.300113	26.716	64.421	46.062
3	4.993	0.699863	0.300137	26.716	64.411	46.061
4	4.953	0.699985	0.300015	26.600	64.284	45.862
5	4.990	0.699842	0.300158	26.706	64.389	46.045
6	4.964	0.699946	0.300054	26.632	64.317	45.917
7	5.076	0.699628	0.300372	26.951	64.672	46.466
8	4.958	0.699981	0.300019	26.616	64.307	45.890
9	4.997	0.699798	0.300202	26.727	64.402	46.081
10	4.964	0.699919	0.300069	26.633	64.312	45.917
Average	4.983	0.699890	0.300109	26.686	64.377	46.011
Type A Uncertainty	0.012	0.000038	0.000038	0.035	0.038	0.060
Type B Uncertainty	0.037	0.000366	0.000797	0.043	0.374	0.067
Total Uncertainty	0.039	0.000368	0.000798	0.055	0.376	0.090

6-22-79	Y	x	Y	L^*	a^*	b^*
1	11.767	0.279964	0.655637	40.844	-57.204	53.839
2	11.797	0.279328	0.655740	40.891	-57.405	53.765
3	11.767	0.279678	0.655697	40.843	-57.273	53.788
4	11.747	0.279811	0.655683	40.811	-57.210	53.785
5	11.736	0.279706	0.655725	40.794	-57.221	53.756
6	11.717	0.279761	0.655669	40.762	-57.171	53.724
7	11.739	0.279531	0.655726	40.799	-57.264	53.720
8	11.761	0.279491	0.655714	40.834	-57.308	53.741
9	11.723	0.279649	0.655714	40.772	-57.210	53.718
10	11.707	0.279727	0.655669	40.747	-57.163	53.702
Average	11.746	0.279664	0.655697	40.810	-57.243	53.753
Type A Uncertainty	0.009	0.000057	0.000010	0.014	0.023	0.013
Type B Uncertainty	0.034	0.000479	0.000555	0.020	0.138	0.067
Total Uncertainty	0.035	0.000483	0.000555	0.024	0.140	0.068

6-26-79	Y	x	Y	L^*	a^*	b^*
1	66.036	0.322221	0.321219	85.015	8.265	-1.970
2	66.055	0.322235	0.321229	85.025	8.267	-1.964
3	65.994	0.322223	0.321234	84.993	8.257	-1.964
4	66.023	0.322247	0.321228	85.008	8.272	-1.962
5	66.022	0.322233	0.321230	85.008	8.264	-1.963
6	65.932	0.322284	0.321265	84.962	8.268	-1.942
7	66.031	0.322228	0.321227	85.012	8.264	-1.965

8	66.105	0.322192	0.321193	85.050	8.266	-1.984
9	66.131	0.322199	0.321200	85.063	8.267	-1.981
10	66.151	0.322209	0.321210	85.073	8.268	-1.976
Average	66.048	0.322227	0.321224	85.021	8.266	-1.967
Type A Uncertainty	0.021	0.000008	0.000006	0.011	0.001	0.004
Type B Uncertainty	0.044	0.000044	0.000047	0.020	0.018	0.019
Total Uncertainty	0.049	0.000045	0.000047	0.023	0.018	0.019

6-31-79	Y	x	y	L^*	a^*	b^*
1	36.873	0.224506	0.234167	67.182	1.337	-41.802
2	36.755	0.224645	0.234371	67.093	1.305	-41.664
3	36.770	0.224570	0.234254	67.104	1.325	-41.722
4	36.830	0.224565	0.234277	67.149	1.312	-41.737
5	36.818	0.224656	0.234371	67.140	1.312	-41.687
6	36.809	0.224557	0.234238	67.133	1.327	-41.745
7	36.806	0.224624	0.234350	67.131	1.305	-41.694
8	36.787	0.224682	0.234450	67.117	1.284	-41.643
9	36.658	0.224703	0.234433	67.020	1.304	-41.598
10	36.550	0.224677	0.234465	66.938	1.272	-41.548
Average	36.766	0.224619	0.234337	67.101	1.309	-41.684
Type A Uncertainty	0.030	0.000021	0.000032	0.023	0.006	0.024
Type B Uncertainty	0.038	0.000097	0.000122	0.022	0.082	0.037
Total Uncertainty	0.048	0.000099	0.000126	0.032	0.082	0.044

Type B uncertainty budget

6-00-79	Y	x	Y	L^*	a^*	b^*
Nonlinearity	0.0222	0.000000	0.000000	0.0066	0.0003	0.0014
Wavelength	0.0016	0.000024	0.000022	0.0009	0.0109	0.0065
Beam size & position	0.0340	0.000009	0.000003	0.0185	0.0060	0.0006
Bandwidth	0.00006	0.000018	0.000024	0.0000	0.0022	0.0107
Total type B uncertainty	0.041	0.000031	0.000033	0.020	0.013	0.013

6-13-79	Y	x	Y	L^*	a^*	b^*
Nonlinearity	0.0055	0.000000	0.000000	0.0042	0.0000	0.0030
Wavelength	0.0067	0.000148	0.000169	0.0059	0.0298	0.0671
Beam size & position	0.0340	0.000009	0.000003	0.0185	0.0060	0.0006
Bandwidth	0.00008	0.000010	0.000009	0.0000	0.0005	0.0058
Total type B uncertainty	0.035	0.000148	0.000170	0.0200	0.030	0.067

6-19-79	Y	x	y	L^*	a^*	b^*
Nonlinearity	0.0001	0.000000	0.000000	0.0012	0.0027	0.0036
Wavelength	0.0136	0.000366	0.000797	0.0389	0.3735	0.0668
Beam size & position	0.0340	0.000009	0.000003	0.0185	0.0060	0.0006
Bandwidth	0.00052	0.000004	0.000002	0.0012	0.0029	0.0030
Total type B uncertainty	0.03	0.000366	0.000797	0.043	0.374	0.067

6-22-79	Y	x	y	L^*	a^*	b^*
Nonlinearity	0.0008	0.000000	0.000000	0.0020	0.0015	0.0016
Wavelength	0.0046	0.000479	0.000555	0.0075	0.1379	0.0673
Beam size & position	0.0340	0.000009	0.000003	0.0185	0.0060	0.0006
Bandwidth	0.00039	0.000004	0.000008	0.0007	0.0024	0.0015
Total type B uncertainty	0.034	0.000479	0.000555	0.020	0.138	0.067

6-26-79	Y	x	y	L^*	a^*	b^*
Nonlinearity	0.0269	0.000000	0.000000	0.0070	0.0001	0.0016
Wavelength	0.0046	0.000040	0.000043	0.0023	0.0167	0.0158
Beam size & position	0.0340	0.000009	0.000003	0.0185	0.0060	0.0006
Bandwidth	0.00019	0.000016	0.000020	0.0001	0.0020	0.0095
Total type B uncertainty	0.044	0.000044	0.000047	0.0200	0.018	0.019

6-31-79	Y	x	y	L^*	a^*	b^*
Nonlinearity	0.0082	0.000000	0.000000	0.0046	0.0010	0.0001
Wavelength	0.0155	0.000096	0.000120	0.0117	0.0812	0.0351
Beam size & position	0.0340	0.000009	0.000003	0.0185	0.0060	0.0006
Bandwidth	0.00037	0.000013	0.000024	0.0003	0.0053	0.0107
Total type B uncertainty	0.038	0.000097	0.000122	0.022	0.082	0.037