COOMET Supplementary Comparison

COOMET.PR-S5

Spectral Regular Transmittance

250 nm to 635 nm

(COOMET Project 429/CU/08)

Final report

Pilot Laboratory:

National Research Institute of Metrology,

Cuba

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ABSTRACT

This report gives the results of the COOMET Supplementary Comparison COOMET.PR-S5 of Regular Spectral Transmittance 250 nm to 635 nm (COOMET Project 429/CU/08).

The NIM participating in the comparison are: National Metrology Research Institute of Cuba (INIMET), Brazilian National Institute of Metrology, Standardization and Industrial Quality (INMETRO), State Institute of Metrology of Belarus (BelGIM), SMU Slovak Institute of Metrology (Slovakia), and the National Scientific Center "Ukrainian Institute of Metrology" (NSC IM. Ukraine).

Ukraine's designated institute in this area of Photometry and Radiometry field is NSC IM, thus, the standard measurement data of the Ukrmetrteststandard (All-Ukrainian state research and production center for standardization, metrology, certification and protection of consumer rights) are not included in the main part of this report, and were not used to evaluate the comparison reference values (RV) and RV differences. They are only presented in the Annex.

INMETRO of Brazil participates with two spectrophotometers. INIMET was the pilot for the comparison.

The comparison object was a set of four neutral glass filters with different values of regular spectral transmittance. The comparison is performed following the requirements of program participation sequential measurements. The pilot measured twice, at the beginning and at the end.

Content

Introduction

Today the main focus lies on the implementation of the Mutual Recognition Agreement(MRA) of the National Measurement Standards and calibration and measurement certificates issued by national metrology institutes of the International Conference on Weights and Measures (CIPM).Therefore, most of the projects of the regional body to which we belong are aimed at making information about the capabilities of calibration and measurement, participation in key comparisons of national measurement standards organized by the CIPM and the organization of regional comparison so measurement standards, and the creation and implementation of management quality systems of National Metrology Institutes fall Member Countries

The Euro - Asian Cooperation National Metrology Institutes whose initials are COOMET is a regional organization that originally set the cooperation of national metrology institutions in the countries of Central and Eastern Europe. It was founded in June 1991 and renamed Euro - Asia National Metrology Institutes Cooperation in May, 2000. COOMET is open for all metrology institutions from other regions to join as associate members and Cuba is such an Associate member

The additional comparisons to national patterns are performed in order to confirm the calibration and measurement capabilities (CMC) for the National Institutes of Metrology (INM), so the National Metrology Institute of the Republic of Cuba (National Research Institute of metrology, INIMET), in 2008 after receiving the first peer group of regional metrology requested participation in an international comparison in the magnitude of regular spectral transmittance in order to publish their Calibration and Measurement Capabilities in addition to checking the equivalence of their measurements.

The Technical Committee of Photometry and Radiometry is a comparison group for which Cuba was designated as pilot laboratory for the firt time. This choice was a challenge for the country and the specialists involved

Among the first steps that were performed were the request by the country to the regional body 's to propose a comparison project which was approved at the meeting of the Technical Committee (TC) of photometry and radiometry , where countries made their request to be included in the project : At this TC the type of comparison was chosen and who was the pilot laboratory, which developed a Technical Protocol and circulated among participants.

The President of the TC recorded supplementary comparison in Appendix B of the Agreement through interactive forms on the website of the International Bureau of Weights and Measures.

The laboratory pilot took decisions on all cases listed below:

- Developed a list of participants on their emails , addresses and emails ;
- Selected transfer patterns ;
- Features patterns ;
- Schema comparison;
- Detailed movement patterns for each of the participants Timeline ;Participants in the comparison laboratories were responsible for transporting the next participant patterns according to the accepted scheme in comparison within the terms specified in the program of the comparisons.

2. Participants and time schedule

Each country will have 2 weeks to perform the calibration of the filters and to transfer the the filters to a next laboratory. The list of participants and the time schedule are presented in Tab. 1.

Table.1- Participants

Participant	Country	**Laboratory Name**	**Acronym**
Pilot	Cuba	National Research Institute of Metrology	INIMET
Participant 1	Brazil	INMETRO Brazilian National Institute of Metrology, Standardization and Industrial Quality –	INMETRO
Participant 2			
Participant 3	Belarus	National Unitary Institution "Belarussian State Institute of Metrology" (BelGIM)	BELGIM
Participant 4	Slovakia	SMU Slovak Institute of Metrology	SMU
Participant 5	Ukraine	NSC “IM” National Scientific Centre “Institute of Metrology”	NSC “Institute of Metrology”
Participant 6	Ukraine	GP “Ukrmetrteststandart”,	GP “Ukrmetrteststandart”,

Note: INMETRO of Brazil participates with two spectrophotometers.

Table.2 Participants and schedule

Laboratories	e-mail telephone Fax	Data calibration	Responsible
INIMET	sandra@inimet.cu 53-7 862 3041	January 2008	Mrs.Sandra Pedro Valdés
INMETRO	jfgomes@inmetro.gov.br 55 21 2679 9203	March 2008	Mrs.Juliana F. S. Gomes
BELGIM	khairova@belgim.by +375 17 334 98 20	January 2010	Mrs. Olga Tarasova
SMU	tunegova@smu.gov.sk +421 2 602 94 230, krempasky@smu.gov.sk +421 2 602 94 432	May 2011	Mrs. Zuzana Tunegova Mr. Marian Krempasky
NSC "Institute of Metrology"	mykola.huriev@metrology.kharkov.ua +38 057 704 97 72	September 2011	Mr. Mykola Huriev
GP "Ukrmetrteststandart"	optic@ukrcsm.kiev.ua +38 (044) 526 36 98	July 2011	Mrs. Nataliya Parkhomenko

Note.

Ukraine's designated institute in this area of Photometry and Radiometry field is NSC IM, thus, the standard measurement data of the Ukrmetrteststandard (All-Ukrainian state research and production center for standardization, metrology, certification and protection of consumer rights) are not included in the main part of this report, and were not used to evaluate the comparison reference values (RV) and RV differences. They are only presented in the Annex.

3. Principle of the comparison

The comparison was organized in the following way:

- The aim of this supplementary comparison in this field was restricted to check only the accuracy of the Photometric scale of the reference spectrophotometers of National Metrological Institutes.
- The comparison is performed following the requirements of program participation sequential measurements were performed as follows

Pilot ⇨Participant 1⇨Participant 2⇨Participant 3⇨ Participant 4⇨ Participant 5 ⇨Participant 6 ⇨Pilot

3.1. Description of the standard

The filter set to check the photometric scale is constituted by 4 neutral filter, the cell dimensions are: 12 mm wide by 12 mm deep and 57 mm high, the light passage area is 8 mm by 29 mm. The cell optical density neutral glass has a rectangular shape with dimensions of 3 mm by 8 mm wide and 30 mm high (Fig.1). The nominal transmittance, at the wavelength of 546 nm, is approximately 93 %, 50%, 30 %and 5,0 %. Each filter is identified in the upper part. The filters

identified as KA102 -1, KA102 – 3, KA102-4, KA102 -7. The main characteristics of the filters are summarized in the following Table 3.

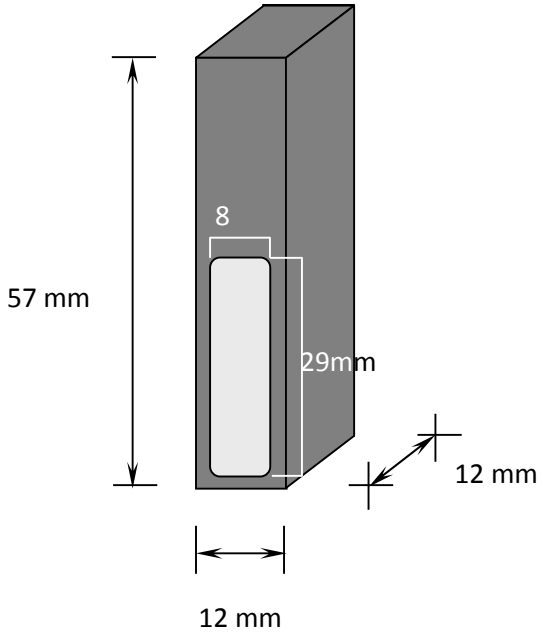


Fig. 1 Neutral filter cell

The characteristics of the filters are described below:

Table.3Filter characteristics

Filter	Glass type	Nominal transmittance **546 nm**
KA102-1	Neutral	0,05
KA102-3	Neutral	0,30
KA102-4	Neutral	0,50
KA102-7	Neutral	0,93

3.2. Measurements before dispatching

At the pilot laboratory, measurements before dispatching the filters have been carried out on the reference spectrophotometer of the laboratory. The complete description of the experiment is detailed in the following paragraph.

3.3. INIMET

Make and type of the spectrophotometer

The reference spectrophotometer used for this comparison is a double beam automated. It is UV-VIS spectrophotometer UV 3101PC UV-VIS-NIR manufactured by SHIMADZU, wavelength range is (190 to 3200) nm, with holographic grating monochromator with 1440 lines/mm. The UV-VIS detector is a high performance photomultiplier, and the NIR detectors a PbS. The deuterium lamp is used as radiation source in the UV range, while in the VIS/NIR spectral ranges a tungsten halogen lamp is used.

Description of the measuring technique:

Each filter was mounted in a holder on the sample carriage.The materials will be measured in the same way that in the normal practice.

The beam of light should have a normal incidence to the filter surface.

The measurement will be made by spectral sweepings.

In each measurement carry out a baseline using the air as reference.

The measurement parameters will be: Spectral Bandwidth 1 nm and 2 nm.

Neutral density filters will be carried out ten transmittance measurements wavelength of 440 nm, 465 nm, 546 nm, 590 nm and 635 nm for the identified filters as KA102-1, KA102-3, KA102-4, KA 102-7. For the filter KA102-7 besides the wavelength before mentioned, will be measured to 250 nm, 280 nm, 340 nm, 360 nm, 400 nm and 500 nm.

Method of characterization of the spectrophotometer:

The spectrophotometer is characterized periodically, considering all uncertainty sources and influence parameters during the measuring process. Extensive measurements tests were realized for the photometric scale characterization and evaluation Type B uncertainty component considering the follow contributions:

- wavelength
- photometric stability
- reproducibility
- repeatability
- stray light
- resolution
- baseline

Description of calibration laboratory conditions and specifications

Ambient temperature: (23,0 ± 3,0)°C

Relative humidity: (56±10) %

Typical uncertainties

The uncertainties are absolute uncertainties

Table 4 Type A uncertainties

1 nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	3,79E-06	9,73E-05	2,71E-04
465	6,15E-06	9,94E-05	2,42E-04
546	5,76E-06	1,18E-04	1,36E-04
590	9,92E-07	1,23E-04	1,50E-04
635	2,71E-06	1,08E-04	1,09E-04

λ(nm)	KA102-7
250	5,53E-05
280	1,16E-04
340	4,06E-05
360	8,33E-05
400	1,20E-04
440	1,20E-04
465	1,31E-04
500	1,68E-04
546	1,73E-04
590	1,55E-04
635	2,08E-04

2 nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	5,93E-06	4,83E-05	1,42E-05
465	0,00E+00	5,27E-05	1,52E-05
546	1,19E-06	7,25E-05	2,21E-05
590	8,72E-06	5,40E-05	2,66E-05
635	4,47E-06	6,21E-05	2,24E-05

λ(nm)	KA102-7
250	2,53E-05
280	1,77E-05
340	1,97E-05
360	1,23E-05
400	8,13E-06
440	8,13E-06
465	1,36E-05
500	1,44E-05
546	1,86E-05
590	2,96E-05
635	3,50E-05

Table 5 Type B uncertainties

1 nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	2,53E-03	2,53E-03	2,53E-03
465	2,53E-03	2,53E-03	2,53E-03
546	2,53E-03	2,53E-03	2,53E-03
590	2,53E-03	2,53E-03	2,53E-03
635	2,53E-03	2,53E-03	2,53E-03

λ(nm)	KA102-7
250	2,53E-03
280	2,53E-03
340	2,53E-03
360	2,53E-03
400	2,53E-03
440	2,53E-03
465	2,53E-03
500	2,53E-03
546	2,53E-03
590	2,53E-03
635	2,53E-03

2 nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	2,53E-03	2,53E-03	2,53E-03
465	2,53E-03	2,53E-03	2,53E-03
546	2,53E-03	2,53E-03	2,53E-03
590	2,53E-03	2,53E-03	2,53E-03
635	2,53E-03	2,53E-03	2,53E-03

λ(nm)	KA102-7
250	2,53E-03
280	2,53E-03
340	2,53E-03
360	2,53E-03
400	2,53E-03
440	2,53E-03
465	2,53E-03
500	2,53E-03
546	2,53E-03
590	2,53E-03
635	2,53E-03

3.4 Measurements after return of the filters

The measurement after the return of the filters to verify the stability of those same, they were carried out exactly in the same way as the measurement before dispatching and without any cleaning.

3.5 Stability of the filters

The stability of the filters during the comparison was checked by calculating the absolute deviation of the transmittance of the filter according to the equation :

Δ_λ = transmittance after – transmittance before (1)

Because measurements have been done in exactly the same conditions in both cases, most of the uncertainties determined by type B methods cancelled out or have a negligible effect. The results for the filters used in the comparison are given in Figure 2 to Figure 5.

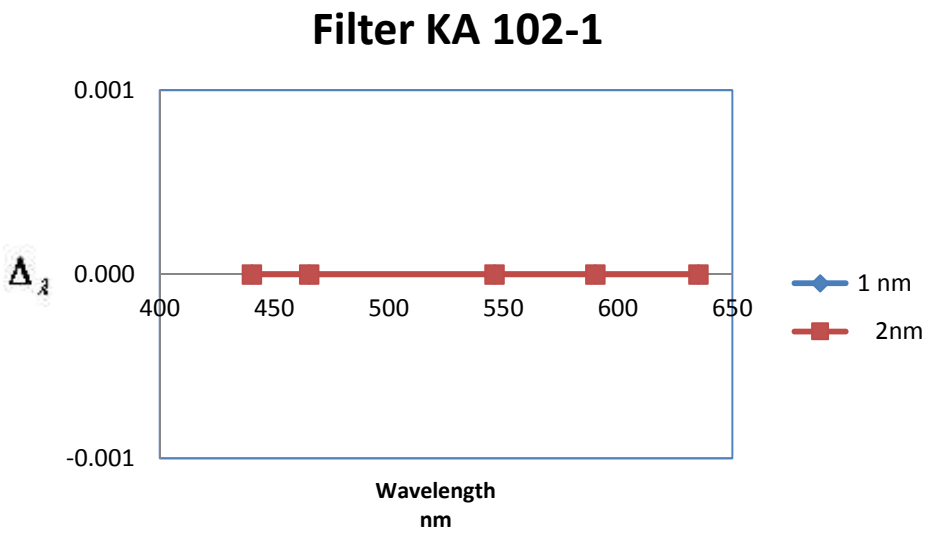


Figure 2 – Stability of filter KA 102-1 during the comparison

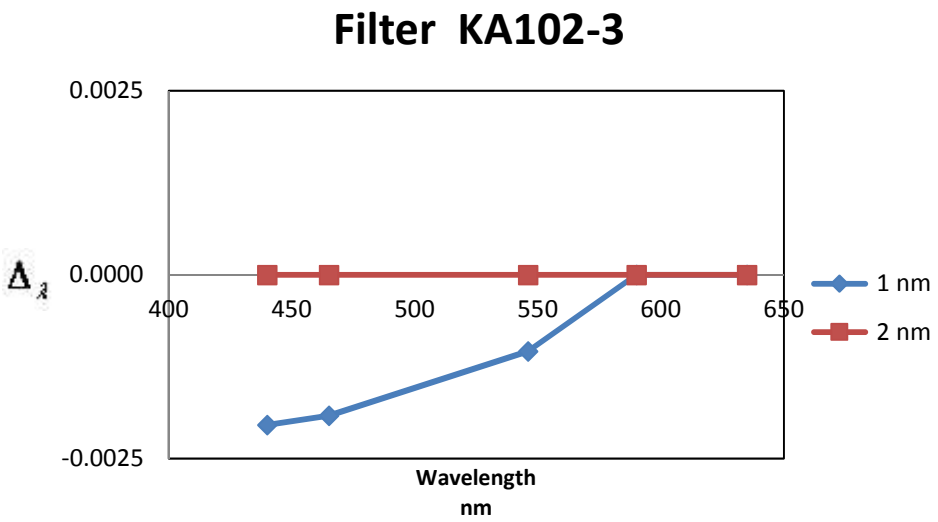


Figure 3 – Stability of filter KA 102-3 during the comparison

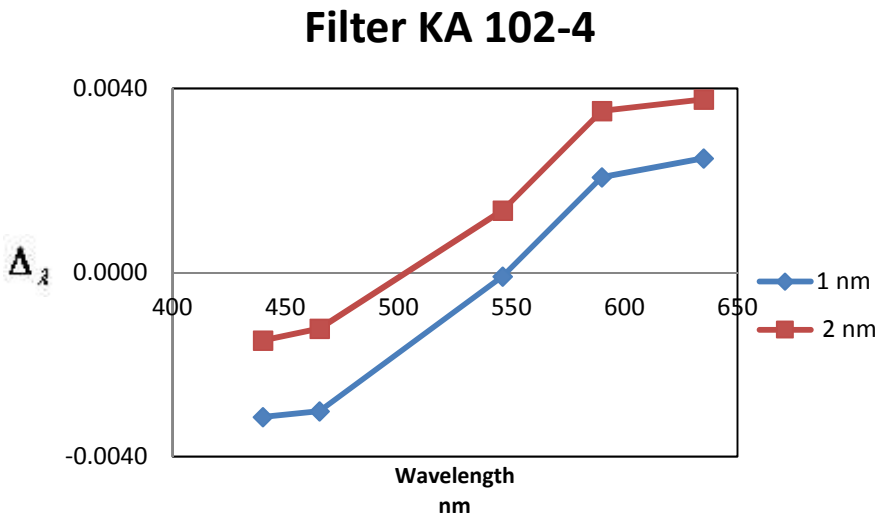


Figure 4– Stability of filter KA 102-4 during the comparison

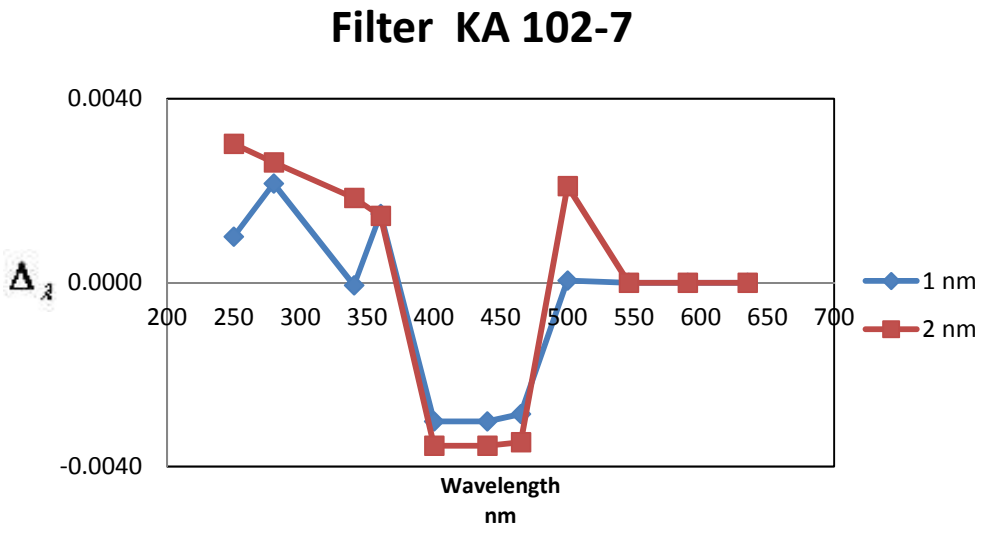


Figure 5 – Stability of filter KA 102-7 during the comparison

As can be seen from the preceding graphs, the stability of the filters KA 102-3 with spectral bandwidth1 nm, KA 102-4 and KA 102-7 for both bandwidths was rather poor. The drift was wavelength dependent. The uncertainty due to the drift of the filters during the comparison is the major cause of uncertainty. The filters KA 102-1 and KA 102-3 2 nm, which exhibited a very small drift, give results with an uncertainty much smaller than the uncertainty value for the other filters.

3.6 INIMET transmittance value

The transmittance value adopted by the INIMET for the filter was the mean value of measurements before and after the circulation of the filters.

4. Facilities, measurement methods and conditions, and uncertainties from the participating laboratories

Each participating laboratory has returned its transmission measurements with a brief description of the experimental set up and a detailed uncertainties budget.
For each participating lab, we report:

- The make and type of the spectrophotometer:
- The description of the measuring technique.
- The description of calibration laboratory conditions
- The Type A and Type B uncertainties for each filter and each wavelength.

4.1 INMETRO 1

Make and Type of the spectrophotometer

The INMETRO 1 spectrophotometer is a Lambda 19 UV-VIS-NIR spectrophotometer manufactured by Perkin Elmer. It is a double sided gratings spectrophotometer, centrally controlled by a PC, with holographic grating monochromator with 1440 lines/mm. The UV-VIS detector is a high performance R955 photomultiplier, and the NIR detectors a PbS. A pre-aligned deuterium lamp is used as radiation source in the UV range, while in the VIS/NIR spectral ranges a tungsten halogen lamp is used.

The reference spectrophotometer has CENAM/LNE/France traceability through reference materials: wavelength standard, holmium oxide glass filter, and photometric standards, optically neutral glass filters with nominal percent transmittance of 10 %, 30 % and 90 %.
The spectrophotometer characteristics were checked during the comparison with the use of special filters: spectral wavelength filter (SRM 2034 NIST) and spectral transmittance optical density of three filters(SRM 2031a NIST). The comparison of our results with the certified values showed good agreement.

Description of the measuring technique

Each sample was mounted in a holder on the sample carriage. The beam was horizontally imaged in the center of the filter compartment and aligned normal to the beam, with polarization identical in reference and sample beams.
The filter transmittance at a given wavelength was measured ten times, in repeatability conditions. The reported values of standard deviation are values of experimental standard deviation of the mean. The U_A uncertainty component is the square root of the sum of experimental standard deviations of the mean in repeatability conditions. The reported data reflects only repeatability component. There was air conditioning in the calibration room.

Method of characterization of the spectrophotometer:

The knowledge about measurement results accuracy realized on the spectrophotometer is obtained by its periodic characterization, considering all uncertainty sources and influence parameters during the measuring process. The periodicity of this characterization should be respected considering the existence of various factors that modify instrument and reference materials characteristics along the time.

Extensive measurements tests were realized for the photometric scale characterization and evaluation of the U_B uncertainty component considering the follow contributions:

- Wavelength
- Photometric stability
- Reproducibility
- Repeatability
- Stray light
- Temperature
- Traceability
- Resolution
- Baseline

The evaluations of uncertainty in measurement are made according to the GUM.

Description of calibration laboratory conditions

The ambient temperature was measured in the sample compartment. The temperature 10) %.

Uncertainties

The uncertainties are absolute uncertainties

Table 6 Type A uncertainties

		1 nm			2 nm	
λ(nm)	KA 102- 1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102 -3	KA 102- 4
440	9,36E-18	7,89E-05	8,43E-05	0,00E+00	7,89E-05	8,43E-05
465	5,27E-05	7,89E-05	8,23E-05	5,27E-05	7,89E-05	8,23E-05
546	5,27E-05	7,89E-05	4,22E-05	5,27E-05	7,89E-05	4,22E-05
590	9,36E-18	8,23E-05	5,68E-05	0,00E+00	8,23E-05	5,68E-05
635	5,27E-05	9,19E-05	7,38E-05	5,27E-05	9,19E-05	7,38E-05

	1 nm	2nm
λ(nm)	KA 102 -7	
250	2,23E-04	2,23E-04
280	1,89E-04	1,89E-04
340	3,06E-04	3,06E-04
360	2,31E-04	2,31E-04
400	3,27E-04	3,27E-04
440	2,12E-04	2,12E-04
465	1,57E-04	1,57E-04
500	1,18E-04	1,18E-04
546	1,29E-04	1,29E-04
590	1,40E-04	1,40E-04
635	1,77E-04	1,77E-04

Table 7 Type B uncertainties

		1 nm			2 nm	
λ(nm)	KA 102- 1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	2,47E-04	1,06E-03	1,43E-03	2,47E-04	1,06E-03	1,43E-03
465	2,49E-04	1,06E-03	1,42E-03	2,49E-04	1,06E-03	1,42E-03
546	2,54E-04	1,04E-03	1,40E-03	2,54E-04	1,04E-03	1,40E-03
590	2,54E-04	1,03E-03	1,39E-03	2,54E-04	1,03E-03	1,39E-03
635	2,53E-04	1,02E-03	1,38E-03	2,53E-04	1,02E-03	1,38E-03

	1 nm	2nm
λ(nm)	KA 102- 7	
250	2,10E-03	2,10E-03
280	2,11E-03	2,11E-03
340	2,12E-03	2,12E-03
360	2,12E-03	2,12E-03
400	2,13E-03	2,13E-03
440	2,13E-03	2,13E-03
465	2,13E-03	2,13E-03
500	2,13E-03	2,13E-03
546	2,13E-03	2,13E-03
590	2,13E-03	2,13E-03
635	2,13E-03	2,13E-03

4.2 INMETRO 2

Make and Type of the spectrophotometer

The reference spectrophotometer at INMETRO is a Cary 5000 UV-VIS-NIR spectrophotometer manufactured by Varian. It is a double sided gratings spectrophotometer, centrally controlled by a PC. The UV-VIS detector is a high performance R928 photomultiplier, and the NIR detector is an electrothermally controlled lead sulphide photocell incorporating PbS mart technology for the optimum low noise and ultimate linearity performance. Light sources are a deuterium lamp (UV source) and tungsten halogen visible source with quartz window. There is an Hg lamp module

for automatic wavelength accuracy validation. The reference spectrophotometer has CENAM/LNE/France traceability through reference materials: wavelength standard, holmium oxide glass filter, and photometric standards, optically neutral glass filters with nominal percent transmittance of 10 %, 30 % and 90 %**.**

The spectrophotometer characteristics were checked during the comparison with the use of special filters: spectral wavelength filter (SRM 2034 NIST) and spectral transmittance optical density of three filters (SRM 2031a NIST) which were measured and certified by CENAM/LNE/France. The comparison of our results with the certified values showed good agreement.

Description of the measuring technique

Each sample was mounted in a holder on the sample carriage. The beam was horizontally imaged in the centre of the filter compartment and aligned normal to the beam, with polarization identical in reference and sample beams.

The filter transmittance at a given wavelength was measured ten times, in repeatability conditions. The reported values of standard deviation are values of experimental standard deviation of the mean. The U_A uncertainty component is the square root of the sum of experimental standard deviations of the mean in repeatability conditions. The reported data reflects only repeatability component. There was air conditioning in the calibration room.

The ambient temperature was measured in the sample compartment. The temperature 10) %.

Method of characterization of the spectrophotometer*:*

The knowledge about measurement results accuracy realized on the spectrophotometer is obtained by its periodic characterization, considering all uncertainty sources and influence parameters during the measuring process. The periodicity of this characterization should be respected considering the existence of various factors that modify instrument and reference materials characteristics along the time.

Extensive measurements tests were realized for the photometric scale characterization and evaluation of the U_B uncertainty component considering the follow contributions:

- Wavelength
- Photometric stability
- Reproducibility
- Repeatability
- Stray light
- Temperature
- Traceability
- Resolution

- Baseline

The evaluations of uncertainty in measurement are made according to the GUM.

Uncertainties

The uncertainties are absolute uncertainties

Table 8 Type A uncertainties

		1 nm			2 nm	
λ(nm)	KA 102- 1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	4,83E-05	1,16E-04	4,83E-05	4,83E-05	1,16E-04	4,83E-05
465	4,83E-05	1,14E-04	8,43E-05	4,83E-05	1,14E-04	8,43E-05
546	0,00E+00	6,75E-05	4,71E-05	0,00E+00	6,75E-05	4,71E-05
590	4,83E-05	5,16E-05	4,83E-05	4,83E-05	5,16E-05	4,83E-05
635	5,27E-05	6,75E-05	0,00E+00	5,27E-05	6,75E-05	0,00E+00

	1 nm	2nm
λ(nm)	KA 102- 7	
250	1,03E-04	1,03E-04
280	7,89E-05	7,89E-05
340	1,56E-04	1,56E-04
360	5,16E-05	5,16E-05
400	5,16E-05	5,16E-05
440	8,50E-05	8,50E-05
465	5,68E-05	5,68E-05
500	6,32E-05	6,32E-05
546	5,16E-05	5,16E-05
590	6,32E-05	6,32E-05
635	6,32E-05	6,32E-05

Table 9 Type B uncertainties

		1 nm			2 nm	
λ(nm)	KA 102 -1	KA 102 -3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	2,12E-04	9,18E-04	1,24E-03	2,12E-04	9,18E-04	1,24E-03
465	2,14E-04	9,13E-04	1,24E-03	2,14E-04	9,13E-04	1,24E-03
546	2,18E-04	8,99E-04	1,22E-03	2,18E-04	8,99E-04	1,22E-03
590	2,18E-04	8,92E-04	1,21E-03	2,18E-04	8,92E-04	1,21E-03
635	2,17E-04	8,85E-04	1,20E-03	2,17E-04	8,85E-04	1,20E-03

	1 nm	2nm
	KA 102- 7	
250	1,82E-03	1,82E-03
280	1,83E-03	1,83E-03
340	1,84E-03	1,84E-03
360	1,84E-03	1,84E-03
400	1,85E-03	1,85E-03
440	1,85E-03	1,85E-03
465	1,85E-03	1,85E-03
500	1,85E-03	1,85E-03

546	1,85E-03	1,85E-03
590	1,85E-03	1,85E-03
635	1,85E-03	1,85E-03

4.3 BELGIM

Make and type of the spectrophotometer:

Instrument: Spectrophotometer Marks Perkin Elmer: "Cary-500Scan

Model: Lambda 19

No. of Series: EL 980535530

Description of the measuring technique.

Operating conditions
Spectral bandwidth: 1 nm and 2 nm

Data Interval: 0,05 nm

Sweeping speed:

Response time: 0,667 s

Method of characterization of the spectrophotometer:

- Wavelength:0,02 (UV); 0,05 (VIS); 0,4 (NIR)
- Transmittance:0,15 (UV); 0,12 (VIS)
- Stray Light
- Baseline
- Photometric linearity
- Zero-line
- Photometric Reproducibility

Description of calibration laboratory conditions

Ambient temperature: 23,0 °C

Relative humidity: 54,0 %

Uncertainties

The uncertainties are absolute uncertainties

Table 10 Type A uncertainties

	1 nm			2 nm		
λ(nm)	KA 102-1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	4,76E-03	1,56E-03	1,46E-03	4,76E-03	1,56E-03	1,46E-03
465	1,27E-03	1,27E-03	9,53E-04	1,27E-03	1,27E-03	9,53E-04
546	9,53E-04	1,27E-03	9,53E-04	9,53E-04	1,27E-03	9,53E-04
590	9,53E-04	1,27E-03	1,46E-03	9,53E-04	1,27E-03	1,46E-03
635	3,11E-03	9,53E-04	1,42E-03	3,11E-03	9,53E-04	1,42E-03

	1 nm	2nm
λ(nm)	KA 102- 7	
250	2,64E-03	2,64E-03
280	2,64E-03	2,64E-03
340	2,48E-03	2,48E-03
360	1,27E-03	1,27E-03
400	1,46E-03	1,46E-03
440	1,56E-03	1,56E-03
465	2,48E-03	2,48E-03
500	2,01E-03	2,01E-03
546	1,46E-03	1,46E-03
590	1,91E-03	1,91E-03
635	1,56E-03	1,56E-03

Table 11 Type B uncertainties

	1 nm			2 nm		
λ(nm)	KA 102- 1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	1,20E-03	1,20E-03	1,20E-03	1,20E-03	1,20E-03	1,20E-03
465	1,20E-03	1,20E-03	1,20E-03	1,20E-03	1,20E-03	1,20E-03
546	1,20E-03	1,20E-03	1,20E-03	1,20E-03	1,20E-03	1,20E-03
590	1,20E-03	1,20E-03	1,20E-03	1,20E-03	1,20E-03	1,20E-03
635	1,20E-03	1,20E-03	1,20E-03	1,20E-03	1,20E-03	1,20E-03

	1 nm	2nm
λ(nm)	KA 102- 7	
250	1,50E-03	1,50E-03
280	1,50E-03	1,50E-03
340	1,50E-03	1,50E-03
360	1,50E-03	1,50E-03
400	1,20E-03	1,20E-03
440	1,20E-03	1,20E-03
465	1,20E-03	1,20E-03
500	1,20E-03	1,20E-03
546	1,20E-03	1,20E-03
590	1,20E-03	1,20E-03
635	1,20E-03	1,20E-03

4.4 SMU

Make and type of the spectrophotometer

Double beam UV-VIS spectrophotometer (the spectral transmittance primary standard equipment of SMU No. 027)

- Model: CARY 4E Varian
- No. of Series: EL 96063243

- Wavelength range: (175 to 900) nm
- Monochromator: double out-of plane Littrow monochromator
- Grating: 70x45 mm. 1200 limes/mm. blazed at 250 nm
  (blaze angle 8.5°, reciprocal dispersion 0.98 nm/mm)
- High-order rejection: filter (WG320. OG530.RG780)
- Beam splitting system: chopper (30 Hz)
- Detection system: high performance R928 PMT
- Sources: tungsten halogen visible source with quartz windows
  deuterium arc UV source
- Diameter of the illum. area: 5.1 mm
- Collimating optics: spherical mirrors
- Beam details: Polarisation: identical reference and sample beam (beams partially polarised only)

  Vertical F number 7.2

  Horizontal F number 9

  Maximum vertical angle of incidence on sample 7.61°

  Maximum horizontal angle of incidence on sample 3.22°

  Image sizes at centre of sample compartment:

  - full height slit (5 nm SBW) 13.35 mm x 5.1 mm wide

Description of the measuring technique

Method of measurement:

Simple reading transmittance measurement of filter (via point) at required wavelength (including base line correction) consists of 10 independent series of filter measurement for reproducibility and from 10 repetitive measurements for repeatability.

Measurement procedure:

Each filter was mounted in a sample holder after cleaning with ethanol (UV purity)with the identification number facing the incident beam and upright.

The transmittance of the filter was measured in 10 independent sequences. Each of 10 (k) independent sequences of filter measurements x_j(j = 1, … k) consisted of a volley of 10 (n) repeated cycles consecutive measurements for signal averaging time (SAT) 3 s (90 individual

readings) without repositioning of filter. Each separate sequence of measurements was performed after re-installation and repositioning of the filter after reset baseline 100 %T.
Measured values of spectral transmittance were corrected for reference (baseline 100 %T) and dark (0%T) error and for the deviancies of spectral transmittance scale from nominal values (represented by systematic error due to detector non linearity, obtained using the double-aperture method).

The spectral transmittance measured values of the filters are absolute % of spectral transmittance (%T). It is thought as % of spectral transmittance (%T) - in scale of measured range (0÷100) %T. To get an absolute value of spectral transmittance (T) they need to be divided by value 100 (1T=100%T).

Diagram of filters measurements:

T: = (Sample – dark)/(Reference – dark)

T_0: = T with blocking sample beam (dark)

T_{100}: = T with blank sample (air as reference)

1. Measurement:
   $T_{0,start}$, $T_{100,start}$, T, $T_{100,end}$, $T_{0,end}$ - there were measured in 10 (n) cycles individually for each sequence to check the drift.

2. Apparent spectral transmittance (T_j')for an individual separate sequence(j = 1, … k, where k = 10) of filter measurements:
   $T_j' = [(T_{j,av}-T_{j,0,av})/((T_{j,100,av}-T_{j,0,av})]x100.$

   where:

   $T_{j,av}$ = average of 10 cycles measurements of spectral transmittance of the filter;

   $T_{j,0,av}$ = $(T_{j,0,start,av}+T_{j,0,end,av})/2$, where $T_{j,0,start,av}$ and $T_{j,0,end,av}$is the average of 10 cycles measurements of spectral transmittance with blocking sample beam (dark) at the start and at the end;

   $T_{j,100,av}$ = $(T_{j,100,start,av}+T_{j,100,end,av})/2$, where $T_{j,100,start,av}$ and $T_{j,100,end,av}$is the average of 10 cycles measurements of spectral transmittance with blank sample (air as reference)at the start and at the end.

3. Measurement result (T_j")for an individual separate sequence(j = 1, … 10) of filter measurements:
   $T_j" = T_j' + \Delta T_j$,

   where:

   ΔT_j = the correction for corresponding nonlinearity of detectors.

4. Final measurement result (T") for 10 (k) separate sequences of filter measurements (j = 1, … k, where k = 10):
   $T" = [\sum_{j=1,10}(T_j")]/10.$

5. Number of runs:

10x10 measurements at each wavelength were made (10 separate sequences and each of 10 separate sequences consist of 10 repeated cycles of consecutive measurements for integration time 3 s (90 individual readings).

Method of characterisation of the spectrophotometer

Wavelength accuracy $\Delta\lambda$: 0.10 nm

(Hg/Ar/Ne emission lines)

Photometric accuracy ΔA: 0.00050 at absorbance level 1.2

(double aperture) 0.00012 at absorbance level 0.3

Photometric accuracy ΔT (absolute): 0.014 % at spectral transmittance level (absolute) 50 %

(double aperture) 0.0045 % at spectral transmittance level (absolute) 3.125 %

Stray light or stray light ratio: 0.0065 % of spectral transmittance *T* (absolute) or 0.000065 % at 260 nm

(NIST SRM 2033, 10 g/L KI)

Instrument uncertainty (u_c):

Wavelength λ: (0.0034÷0.015) nm

Spectral transmittance *T* (absolute): (0.0011÷0.0033) %

Absorbance *A*: (0.000029÷0.00015)

Operating conditions

Spectral bandwidth: 1 nm and 2 nm

Integration time (SAT- signal averaging time):3 s (90 individual readings)

Description of calibration laboratory conditions and specifications

Ambient temperature: (21,9 to 24,6)°C

Relative humidity: (26 to 42) %

Cleaning of filters: The filters were cleaned with ethanol (UV purity) before measurements and between the measurements were wrapped into a special paper for optical glass instead of the original contaminated fabric, which was a significant source of filter contamination and resulting non-reproducible spectral transmittance values (especially for filter KA102-7). Due to this contamination were observed differences (variation span) in spectral transmittance (absolute) values for individual filters as follows:

for filter KA102-10.03 %

for filter KA102-3 0.31 %

for filter KA102-4 0.31 %

for filter KA102-7 1.17

and after cleaning with ethanol there were observed insignificant differences only:

for filter KA102-1 0.011 %

for filter KA102-3 0.068 %

for filter KA102-4 0.035 %

for filter KA102-7 0.084 %

In case of accidental pollution during measurements all filters were cleaned with a special paper for optical glass or with brush for optics.

Orientation of filters: Each filter was mounted in a sample holder of instrument, with the identification number (front) facing the incident beam and upright.

Uncertainties

The uncertainties are absolute uncertainties

Table 12 Type A uncertainties

		1 nm			2 nm	
λ(nm)	KA 102 -1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	1,01E-03	8,04E-03	4,36E-03	6,30E-04	3,70E-03	3,10E-03
465	9,05E-04	6,00E-03	3,73E-03	7,01E-04	3,51E-03	3,12E-03
546	9,99E-04	4,15E-03	3,55E-03	6,61E-04	3,16E-03	3,40E-03
590	1,02E-03	3,30E-03	3,35E-03	6,75E-04	3,12E-03	2,61E-03
635	1,04E-03	2,69E-03	3,42E-03	6,41E-04	2,87E-03	3,26E-03

	1 nm	2nm
λ(nm)	KA 102- 7	
250	2,91E-03	9,01E-03
280	3,74E-03	8,05E-03
340	2,81E-03	7,17E-03
360	3,20E-03	5,36E-03
400	1,03E-02	7,22E-03
440	8,86E-03	7,79E-03
465	8,80E-03	8,83E-03
500	8,93E-03	8,71E-03
546	8,20E-03	8,56E-03
590	8,36E-03	6,89E-03
635	8,36E-03	7,20E-03

Table 13 Type B uncertainties

		1 nm			2 nm	
λ(nm)**)**	KA 102- 1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	2,55E-03	3,24E-03	3,53E-03	2,46E-03	3,10E-03	3,60E-03
465	2,22E-03	5,79E-03	3,35E-03	2,23E-03	5,77E-03	3,59E-03
546	2,13E-03	3,20E-03	3,56E-03	1,91E-03	3,69E-03	3,88E-03
590	1,77E-03	3,00E-03	3,39E-03	2,14E-03	3,18E-03	3,56E-03
635	2,79E-03	2,93E-03	3,46E-03	2,75E-03	3,13E-03	3,67E-03

	1 nm	2nm
λ(nm)	KA 102- 7	
250	3,32E-03	3,32E-03
280	3,36E-03	3,36E-03
340	5,45E-03	5,45E-03
360	3,31E-03	3,31E-03
400	4,79E-03	4,78E-03
440	3,64E-03	3,65E-03
465	4,31E-03	4,31E-03
500	3,66E-03	3,66E-03
546	4,00E-03	4,01E-03
590	3,69E-03	3,69E-03
635	4,96E-03	4,96E-03

4.5 NSC “IM” National Scientific Centre “Institute of Metrology” Ukraine

Make and Type of the spectrophotometer

National primary measurement standard of the units of spectral transmittance, spectral and diffuse reflectance in the (0,25 to 25) μm wavelength range

Identification: DETU 11-09-08

Description of the measuring technique

Additional Stray Light Rejection	Less than 0.01%
Source Drift Monitoring	Less than 0.1% per hour
Source	Tungsten halogen lamp with monochromator
Detector	Photodiode Hamamatsu
Beam Size	4 mm x 20 mm
Beam Collimation	Parallel beam
Measurement Sequence[(b)]	Ten measurements without filter orientation changes

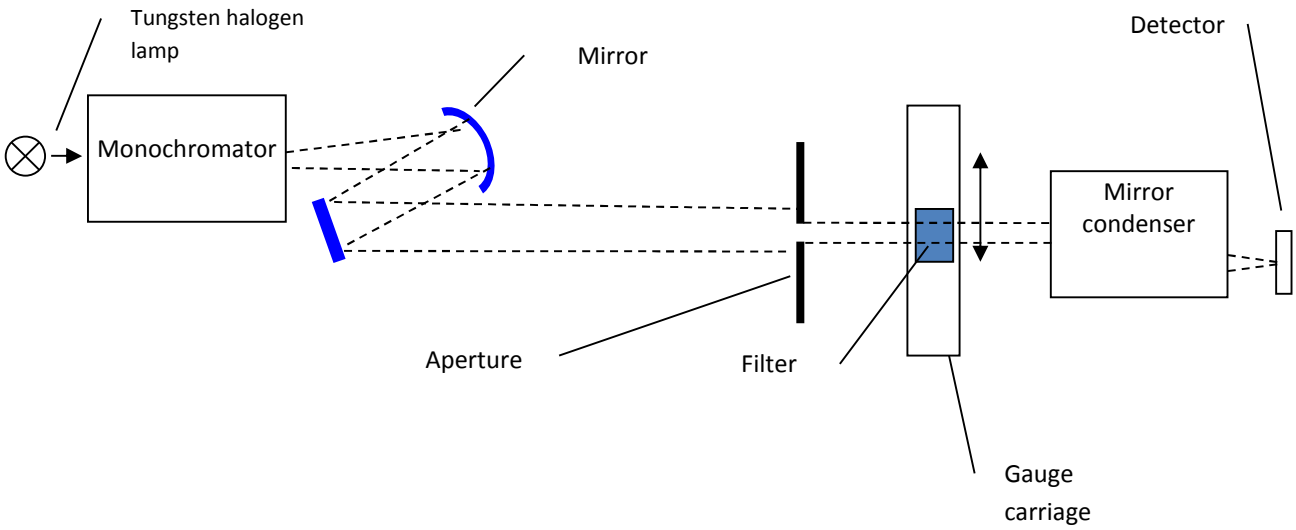


Figure 6- Diagram of measuring technique

Method of characterization of the spectrophotometer:

- Accuracy of determination of radiation wavelength
- finiteness of the width of the monochromator gaps
- nonlinearity of photoreception system
- the influence of scattered radiation
- signal displacement in time
- the interaction of radiation flow with sample under investigation

Description of calibration laboratory conditions and specifications

Ambient temperature: 20,0 °C

Relative humidity: 56 %

Uncertainties

The uncertainties are absolute uncertainties

Table 17 Type A uncertainties

	1 nm			2 nm		
λ(nm)	KA 102- 1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	1,48E-05	4,60E-05	6,33E-05	5,22E-05	6,16E-05	6,07E-05
465	1,78E-05	2,34E-05	4,59E-05	2,44E-05	2,99E-05	4,39E-05
546	9,37E-06	4,54E-05	6,63E-05	5,71E-06	2,31E-05	3,09E-05
590	2,03E-05	3,99E-05	5,30E-05	1,29E-05	4,31E-05	4,59E-05
635	3,49E-06	3,34E-05	2,90E-05	3,58E-06	2,11E-05	3,51E-05

	1 nm	2nm
λ(nm)	KA 102- 7	
250	2,37E-04	4,05E-04
280	4,15E-04	4,05E-04
340	2,17E-04	4,05E-04
360	2,88E-04	4,05E-04
400	8,58E-05	3,86E-04
440	6,33E-05	3,86E-04
465	7,28E-05	3,86E-04
500	4,54E-05	3,86E-04
546	3,17E-05	3,86E-04
590	8,23E-05	3,86E-04
635	9,72E-05	3,86E-04

Table 18 Type B uncertainties

	1 nm			2 nm		
λ(nm)	KA 102 -1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	3,86E-04	3,86E-04	3,86E-04	3,86E-04	3,86E-04	3,86E-04
465	3,86E-04	3,86E-04	3,86E-04	3,86E-04	3,86E-04	3,86E-04
546	3,86E-04	3,86E-04	3,86E-04	3,86E-04	3,86E-04	3,86E-04
590	3,86E-04	3,86E-04	3,86E-04	3,86E-04	3,86E-04	3,86E-04
635	3,86E-04	3,86E-04	3,86E-04	3,86E-04	3,86E-04	3,86E-04

	1 nm	2nm
λ(nm)	KA 102- 7	
250	4,05E-04	5,40E-04
280	4,05E-04	5,53E-04
340	4,05E-04	4,25E-04
360	4,05E-04	5,34E-04
400	3,86E-04	4,01E-04
440	3,86E-04	3,91E-04
465	3,86E-04	4,00E-04
500	3,86E-04	3,88E-04
546	3,86E-04	3,88E-04
590	3,86E-04	3,88E-04
635	3,86E-04	3,93E-04

5. Results

The method that was used was that of the stocking pondered in the cut-off (it cuts). The court value, is the stocking of the uncertainty of the participant laboratories that are in the medium one.

The absolute values and the calculation method were used in the CCPR -K6 Report on the CCPR Key Comparison K6 Spectral to regulate transmittance."

5.1. Notations

N Number of participant NMIs, not counting the pilot laboratory (Tab.1, we have *N* = 5).

$^2_{X,i}$ Spectral transmittance of the filter.

$u(^2_{X,i})$ Total absolute uncertainty (*k*=1) of $^2_{X,i}$ reported by the NMI.

$^{2\,P}_{X,i,r}$ Spectral transmittance of the filter measured by the Pilot. *r* is the round. *r* = 1 to 2, where *r*=1 is the measurement before dispatching and *r* = 2 is the measurement after dispatching.

$u(^{2\,P}_{X,i,r})$ Total absolute uncertainty (*k*=1) of $^{2\,P}_{X,i,r}$ reported by the Pilot.

$u(^{2\,PR}_{X,i,r})$ Reproducibility (type A) of Pilot measurements for $^{2\,P}_{X,i,r}$.

Pilot Measurements:

The pilot measurements of all the filters involved in the comparisons for *r* = 1 and 2 are reported in Annex A

Annex A.1 Pilot lab transmission measurements $^{2\,P}_{x,i,r}$ for r = 1

Annex A.2, Pilot laboratory transmittance measurements $^{2\,P}_{x,i,r}$ for r=2

The adopted value for the pilot lab transmission measurements is the average of round 1 and round 2.

$$^{2\,P}_{X,j} = \frac{1}{2}\left(^{2\,P}_{X,i,1} + ^{2\,P}_{X,i,2} \right)$$

All the values are in following annexes:

Annex A.3 Pilot lab adopted transmission $^{2\,P}_{x,i,r}$

Annex A.4, Pilot laboratory total uncertainty on adopted transmittance $u\left(^{2\,P}_{X,i}\right)$

Annex A.5 and A.6 Pilot lab “type A” uncertainty on adopted transmission $u(^{2\,PR}_{X,i,r})$

NMI Measurements

The participant laboratories measurements are reported in:

Annex A.7 and Annex A.8 NMI absolute transmission measurements $^2_{x_i}$

Annex A.9 and Annex A.10 NMI total absolute uncertainties on transmission $u\left(^2_{x_i}\right)$

6. Additional uncertainties

The additional uncertainties arise from artifacts due to transportation or different measurement conditions between Pilot and participants that affect comparison results. No problem was identified during the procedure that could suggest incorporating an additional uncertainty.

As it was showed in 3.5, the stability of the filters during the comparison can be accessed by the difference between transmittance measurements before and after the dispatching. We plotted

this difference for all the filters (see Figure 2 to Figure 5). It appears that the drift is quite smooth and reasonably taken into account by the mean value of the measurement “before” and “after” at the pilot laboratory.

The same as in the CCPR Key Comparison K6 Spectral regular transmittance the uncertainty “*u*”, associated to possible drift of the filter *X,i* is estimated to be within the difference “before” – “after” with a rectangular probability distribution.

$$u_{driftX,j} = \frac{1}{2\sqrt{3}} \left| \rho^{P}_{X,i,1} - \rho^{P}_{X,i,2} \right|$$

The uncertainties associated are in Annex A.11 and Annex A.12, where:

Determination of the cut-off

$$u_{cut-off} = average \left\{ u\left(\rho_{X,,i}\right) \right\} \text{ for } u\left(\rho_{X,,i}\right) \le median \left\{ u\left(\rho_{X,,i}\right) \right\}; i = 0 \text{ to } N$$

The cut-off value is when the uncertainty $u(\rho_{X,i})$ of the NMI is under the cut-off value, it is adjusted by the cut-off. After this operation, the uncertainties of the NMI become $u_{adj}(\rho_{X,i})$

In Annex A.13 is reported the $u_{adj}\left(\rho_{X,i}\right)$

Determination of the weight

For each NMI *i* for each filter *X*, the difference between NMI measurement and the Pilot lab measurement (as the average of the two rounds) is given by:

$$\Delta_{X,i} = \rho_{X,i} - \rho^{P}_{X,i}$$

and its uncertainty, for *i* =1to *N* by

$u(\Delta_{X,i}) = \sqrt{u^2(\rho_{X,i}) + u^2(\rho^{PR}_{X,i}) + u^2_{driftX,i}}$ without cut-off adjustment

$u_{adj}\left(\Delta_{X,i}\right) = \sqrt{u^2_{adj}\left(\rho_{X,i}\right) + u^2\left(\rho^{PR}_{X,i}\right) + u^2_{driftX,i}}$ with cut-off adjustment

For the pilot lab (*i* =0), we have

$\Delta_{x,0} = 0$

$u(\Delta_{x,0}) = \sqrt{u^2(\rho^{P}_{X,0}) + u^2_{driftX,0}}$ without cut-off

$u_{adj}(\Delta_{x,0}) = \sqrt{u^2_{adj}(\rho^{P}_{X,0}) + u^2_{driftX,0}}$ with cut-off

$\Delta_{x,i}$, $u(\Delta_{x,i})$, $u_{adj}\left(\Delta_{X,i}\right)$ are reported respectively in Annex A.13 to Annex A.19

The weights *w* for the NMI *i* is determined by:

$$w_i = \frac{u_{adj}^{J2}(\Delta_i)}{\sum_{i=0}^{N} u_{adj}^{J2}(\Delta_i)}$$

Results are reported in Annex A.21 and Annex A.22

6.1 Comparison Reference Value (CRV)

The CRV is given by

$$\Delta_{CRV} = \sum_{i=0}^{N} w_i \Delta_i$$

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

$$u(\Delta_{CRV}) = \frac{\sqrt{\sum_{i=0}^{N} \frac{u^2(\Delta_i)}{u_{adj}^4(\Delta_i)}}}{\sum_{i=0}^{N} u_{adj}^{-2}(\Delta_i)}$$

The results are reported in the following tables

Table 19 Δ_{CRV} for the four filters:

1 nm

λ (nm)	KA102- 1	KA102- 3	KA102- 4
440	2,50E-04	1,63E-03	-2,47E-03
465	2,04E-04	1,35E-03	-2,39E-03
546	2,35E-04	9,14E-04	-4,26E-04
590	7,60E-04	4,01E-04	5,45E-04
635	1,39E-04	2,18E-04	8,38E-04

λ (nm)	KA102- 7
250	-1,18E-03
280	1,74E-04
340	-1,20E-03
360	-4,09E-04
400	-4,78E-04
440	5,26E-04
465	6,43E-04
500	1,57E-03
546	-4,68E-04
590	-7,76E-04
635	-8,57E-04

2 nm

λ (nm)	KA102- 1	KA102- 3	KA102- 4
440	-7,81E-05	-1,37E-04	-2,29E-03
465	-6,23E-05	3,25E-04	-1,38E-03
546	-5,79E-05	2,12E-04	2,71E-04
590	-6,22E-05	8,59E-05	1,10E-03
635	-8,96E-07	4,47E-05	1,36E-03

λ (nm)	KA102- 7
250	-1,18E-03
280	-9,65E-04
340	-1,12E-03
360	-1,29E-03
400	-5,71E-04
440	5,96E-04
465	2,44E-04
500	-4,78E-04
546	-1,55E-03
590	-1,15E-03
635	-1,10E-03

Table 19 $u(\Delta_{KCRV})$ for the four filters

1 nm

2 nm

λ (nm)	KA102- 1	KA102- 3	KA102- 4
440	1,02E-04	3,98E-04	5,55E-04
465	1,03E-04	3,84E-04	5,38E-04
546	1,03E-04	2,99E-04	2,84E-04
590	1,04E-04	2,47E-04	4,28E-04
635	1,05E-04	2,43E-04	4,68E-04

λ (nm)	KA102- 1	KA102- 3	KA102- 4
440	1,06E-04	2,12E-04	3,90E-04
465	1,08E-04	2,13E-04	3,63E-04
546	1,08E-04	2,13E-04	3,57E-04
590	1,08E-04	2,14E-04	5,81E-04
635	1,99E-04	3,76E-04	6,20E-04

λ (nm)	KA102- 7
250	3,04E-04
280	4,72E-04
340	2,37E-04
360	3,72E-04
400	5,48E-04
440	5,47E-04
465	5,27E-04
500	2,31E-04
546	2,30E-04
590	2,28E-04
635	2,46E-04

λ (nm)	KA102- 7
250	5,75E-04
280	5,32E-04
340	4,16E-04
360	3,92E-04
400	6,14E-04
440	6,13E-04
465	6,05E-04
500	4,49E-04
546	2,50E-04
590	2,43E-04
635	2,61E-04

Uncertainties are absolute uncertainties

6.2 Degrees of equivalence (DoE)

Knowing the Δ_{CRV}, the unilateral DoE of NMI *i* is given by:

$$D_i = \Delta_i - \Delta_{CRV}$$

$$U_i = k\sqrt{u^2(\Delta_i) + u^2(\Delta_{CRV}) - 2\frac{\frac{u^2(\Delta_i)}{u_{adj}^2(\Delta_i)}}{\sum_{j=0}^{N} u_{adj}^{-2}(\Delta_j)}} \;;k = 2$$

Results are reported in Annex A.23, Annex A.24, Annex A.25 and Annex A.26.

A graphical representation of the unilateral degrees of equivalence with k=2 is proposed in the followings pages.

6.3 Consistency check

Calculate the Chi-square value χ^2_{obs} for consistency check $i Z 0$ represents the pilot laboratory.

N=5

$$\chi^2_{obs} = \sum_{i=0}^{N} \frac{\{\Delta_i - \Delta_{KCRV}\}}{u^2_{adj}(\Delta_i)}$$

$\chi^2_{0,05}$ *for* $\neg Z N J 1$

$\chi^2_{0,05}(4) = 9{,}488$ Value from the table below $\chi^2_{0,05}$

If $\chi^2_{obs} \leq \chi^2_{0,05}$ Consistency is satisfied.

If $\chi^2_{obs} > \chi^2_{0,05}$ Consistency fails

The results are reported in the following tables

Table 20 Chi-square value χ^2_{obs}

1 nm

λ (nm)	KA102- 1	KA102- 3	KA102- 4
440	1,89	6,46	8,51
465	1,63	4,16	6,89
546	1,94	2,40	4,55
590	2,84	1,47	2,06
635	3,90	2,01	1,79

λ (nm)	KA102- 7
250	8,25
280	5,76
340	8,52
360	5,43
400	3,35
440	3,40
465	3,48
500	8,32
546	2,65
590	3,41
635	3,69

2 nm

λ (nm)	KA102- 1	KA102- 3	KA102- 4
440	2,63	4,23	6,73
465	1,48	8,40	8,75
546	1,71	6,81	8,57
590	1,12	7,21	3,60
635	2,23	6,70	3,28

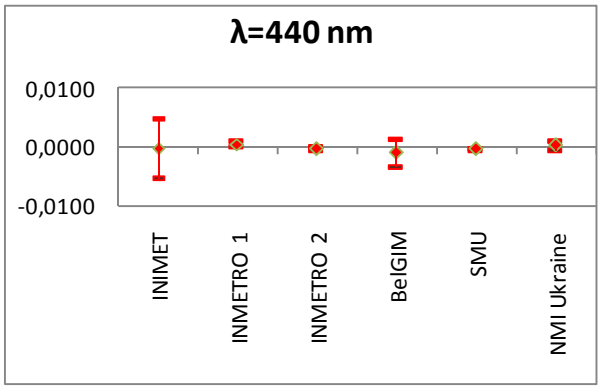
λ (nm)	KA102- 7
250	8,32
280	3,01
340	2,12
360	3,89
400	2,70
440	3,65
465	2,44
500	2,86
546	3,43
590	3,50
635	1,88

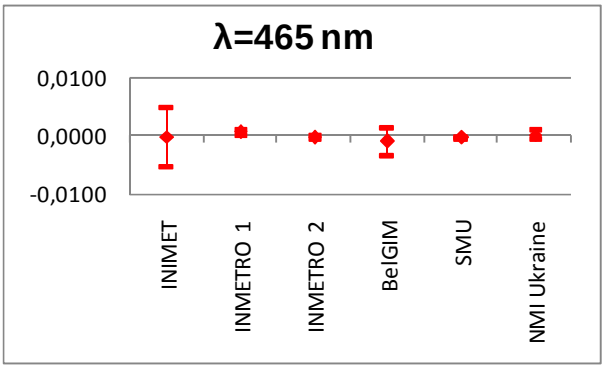
$\chi^2_{obs} \leq \chi^2_{0,05}$ Consistency is satisfied

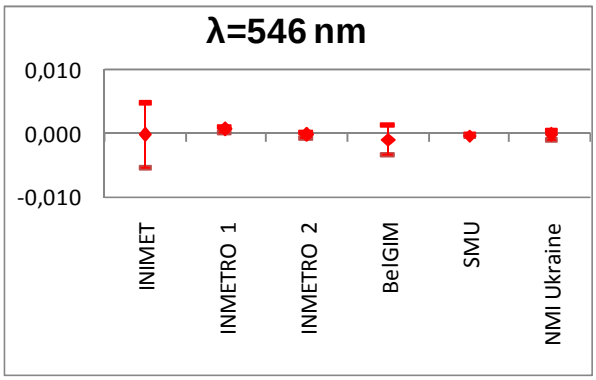
6.4 Unilateral DoE of COOMET.PR-S5 Participants
Filter KA 102-1 1 nm

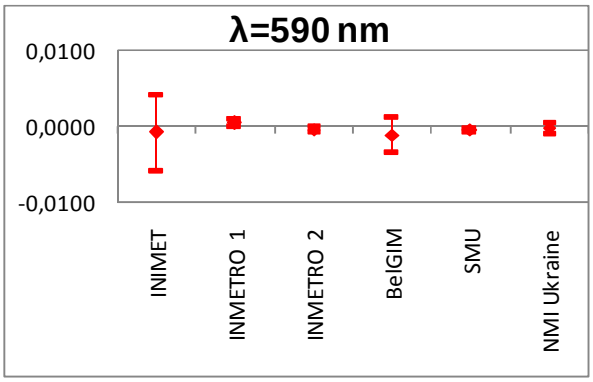
Values reported here are absolute
Uncertainties are calculated with k=2

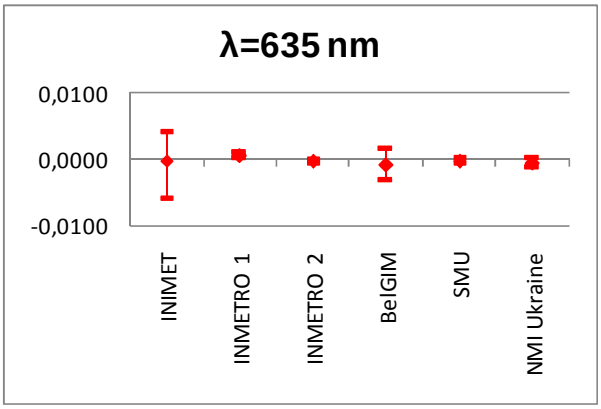
*Nominal transmittance value : 0,050











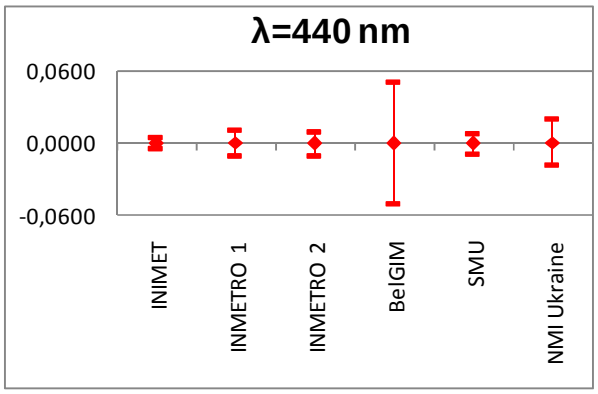
6.5 Unilateral DoE of COOMET.PR-S5 Participants

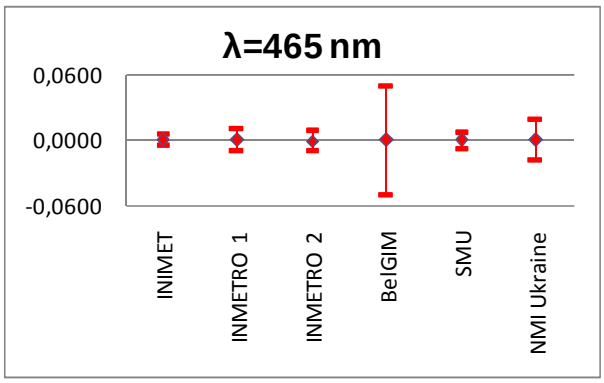
Filter KA 102-1 2 nm

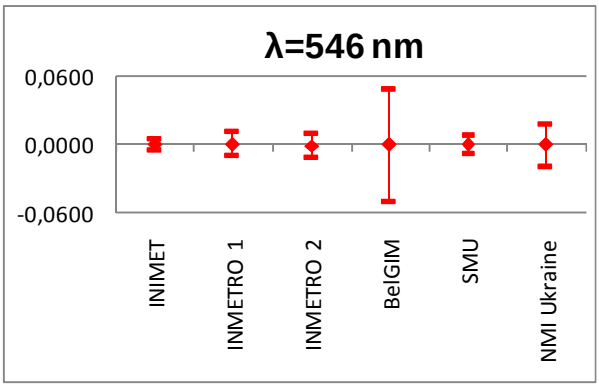
Values reported here are absolute

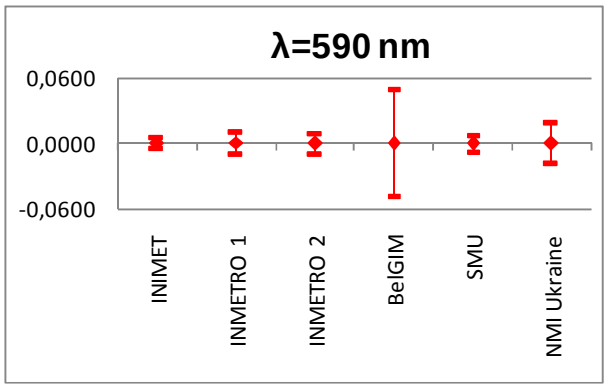
Uncertainties are calculated with k=2

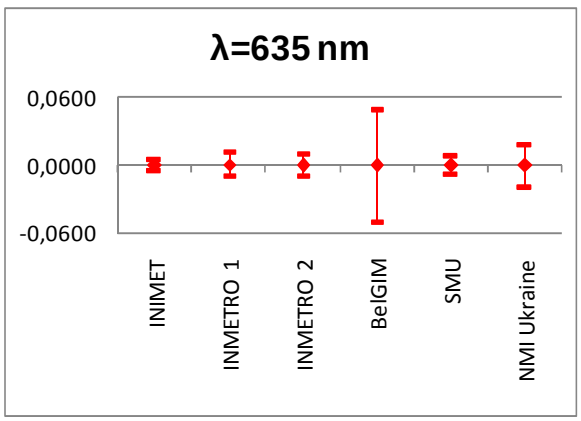
*Nominal transmittance value : 0,050







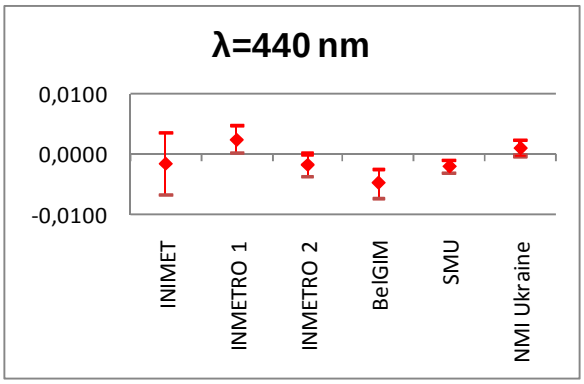


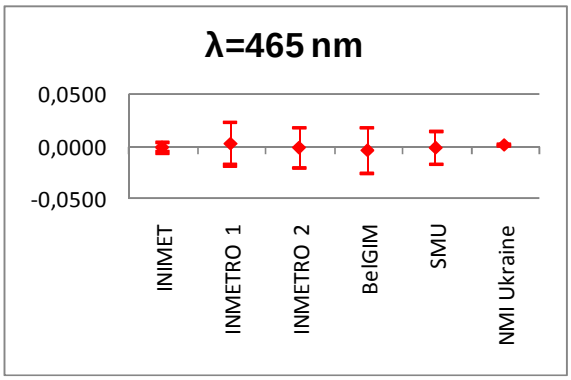


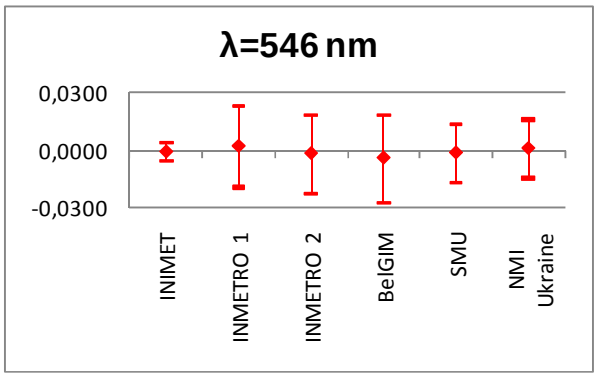
6.6 Unilateral DoE of COOMET.PR-S5 Participants
Filter KA 102-3 1 nm

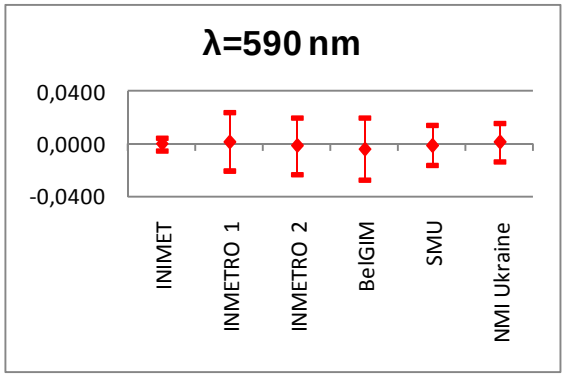
Values reported here are absolute
Uncertainties are calculated with k=2

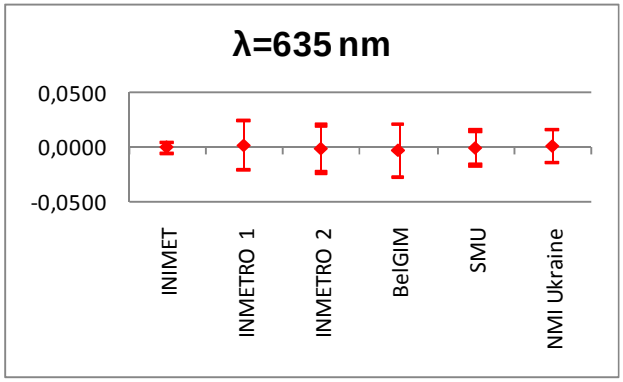
*Nominal transmittance value :0,300









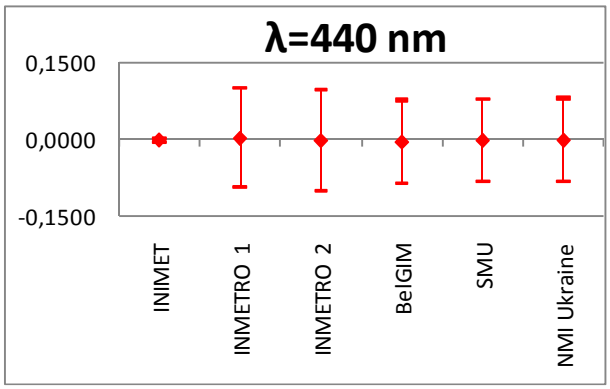


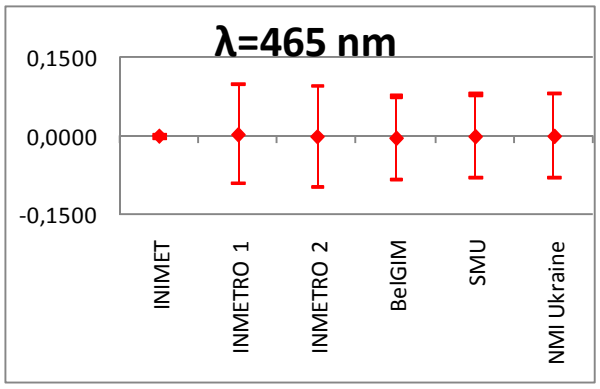
6.7 Unilateral DoE of COOMET.PR-S5 Participants

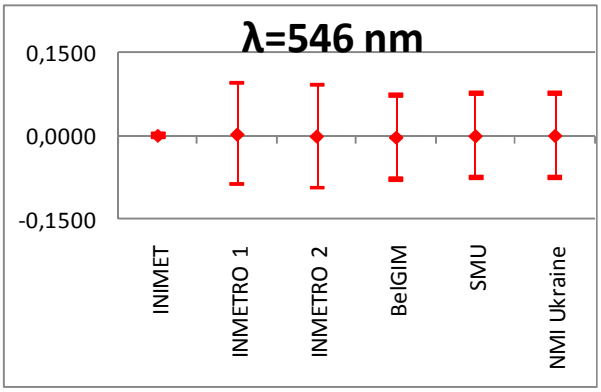
Filter KA 102-3 2 nm

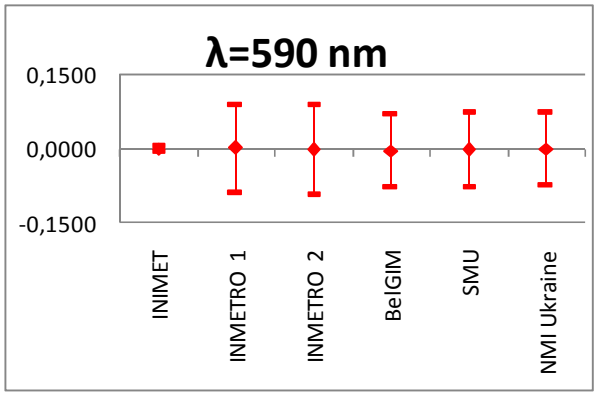
Values reported here are absolute
Uncertainties are calculated with k=2

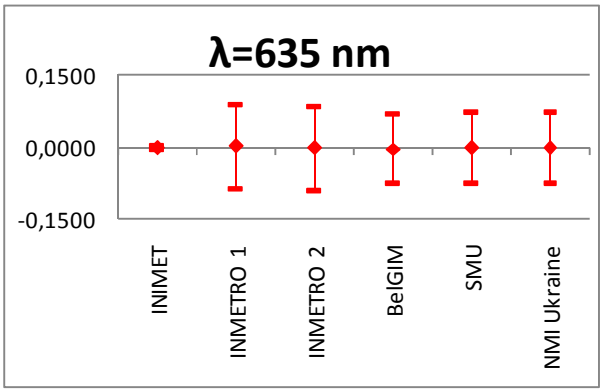
*Nominal transmittance value : 0,300







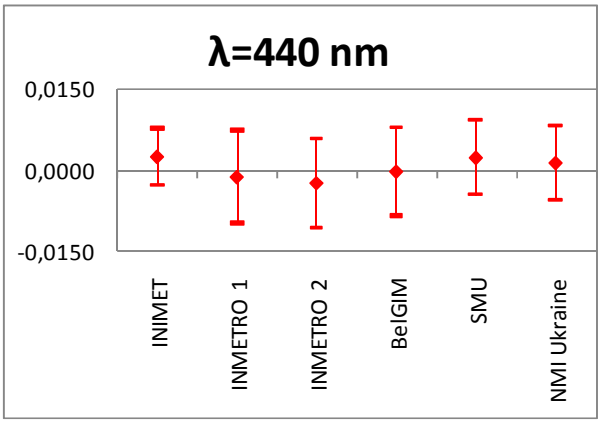


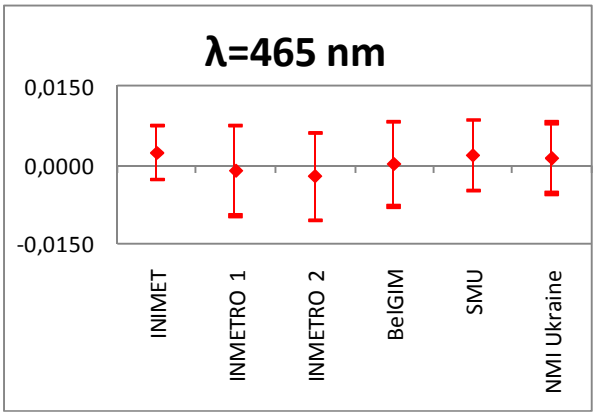


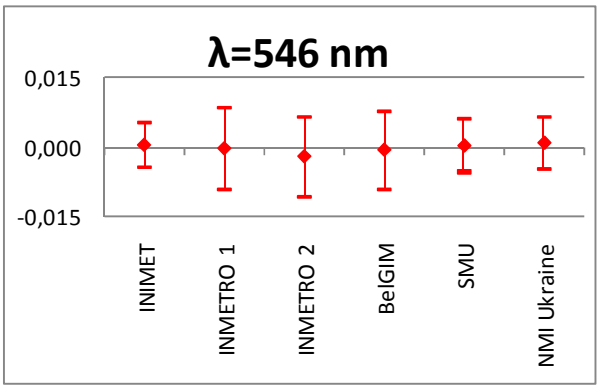
6.8 Unilateral DoE of COOMET.PR-S5 Participants
Filter KA 102-4 1 nm

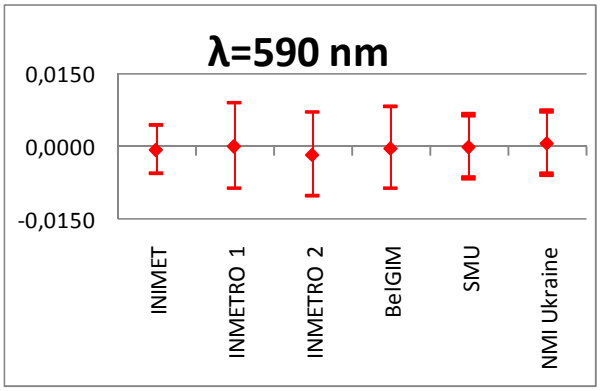
Values reported here are absolute
Uncertainties are calculated with k=2

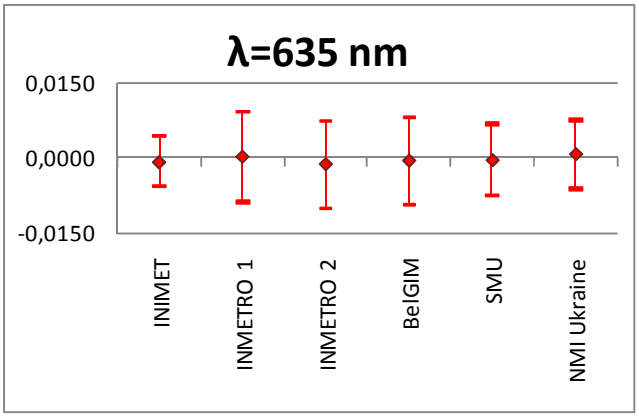
*Nominal transmittance value : 0,500







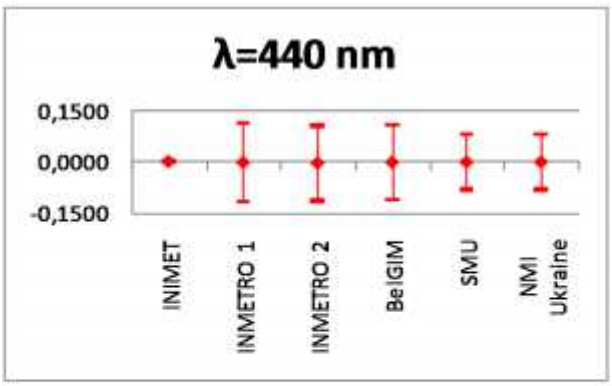


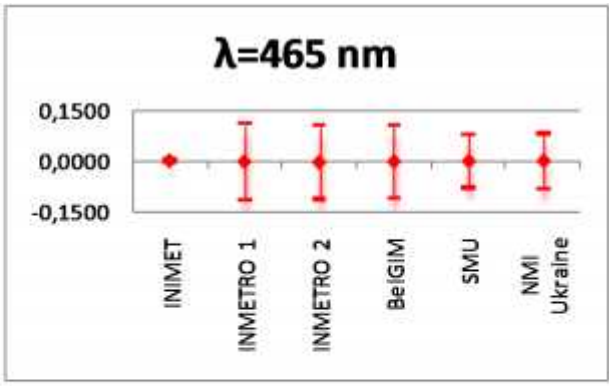


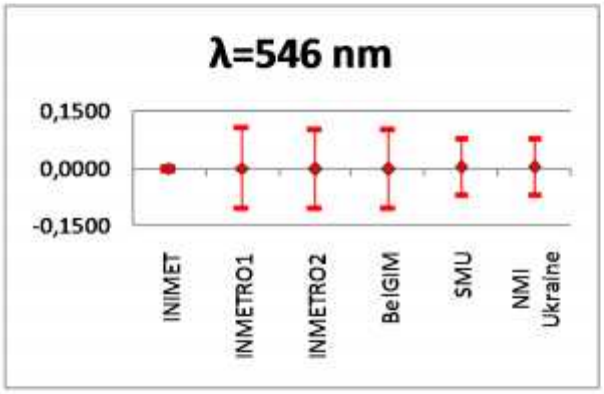
6.9 Unilateral DoE of COOMET.PR-S5 Participants
Filter KA 102-4 2 nm

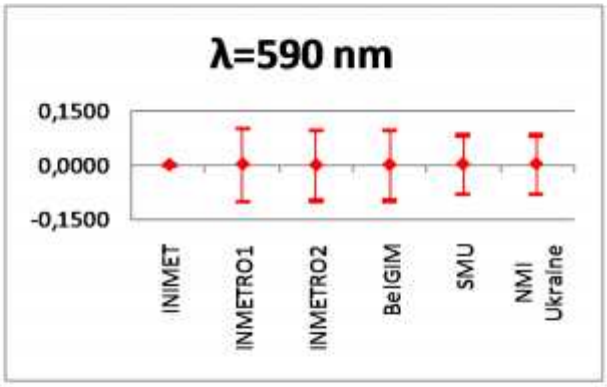
Values reported here are absolute
Uncertainties are calculated with k=2

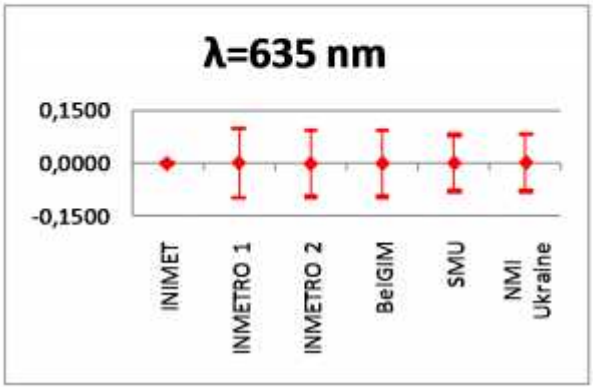
*Nominal transmittance value : 0,500









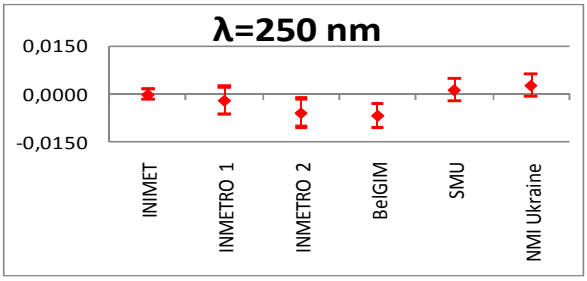


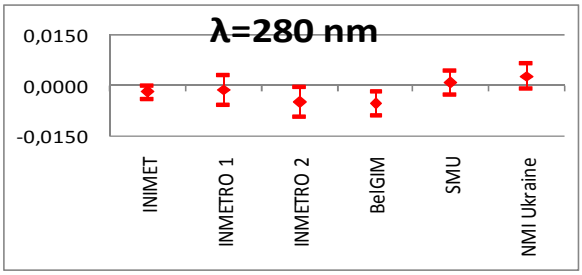
7.0 Unilateral DoE of COOMET.PR-S5 Participants

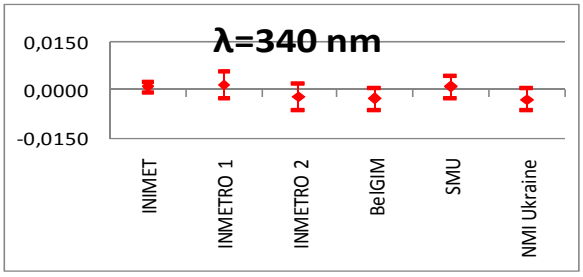
Filter KA 102-7 1 nm

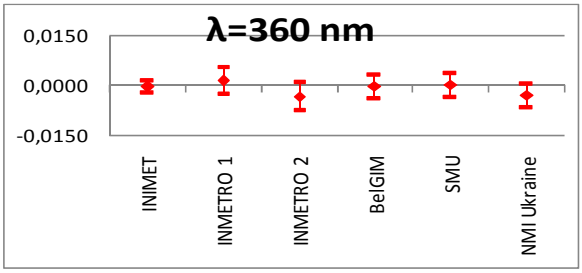
Values reported here are absolute *Nominal transmittance value:0,930

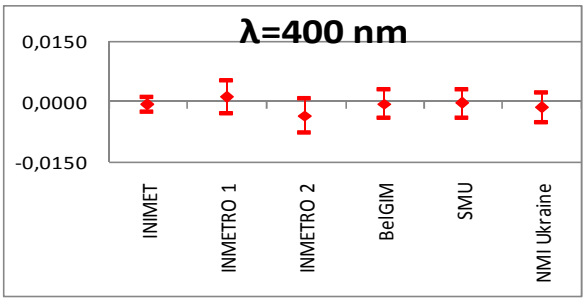
Uncertainties are calculated with k=2

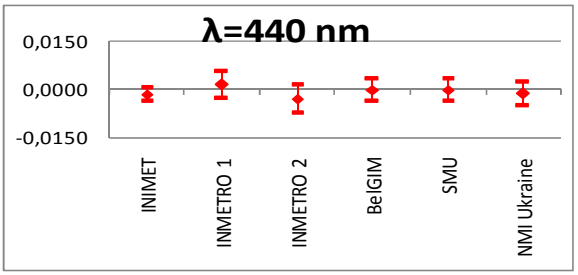


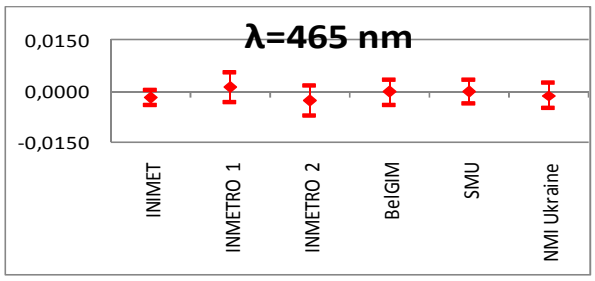


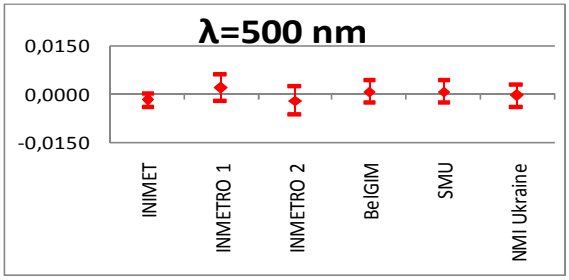


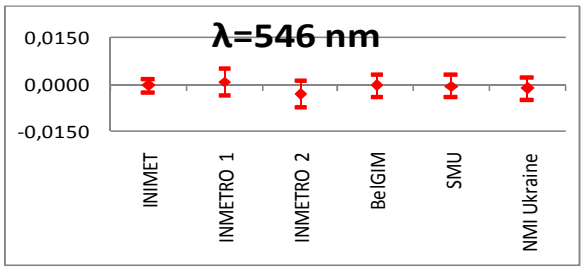


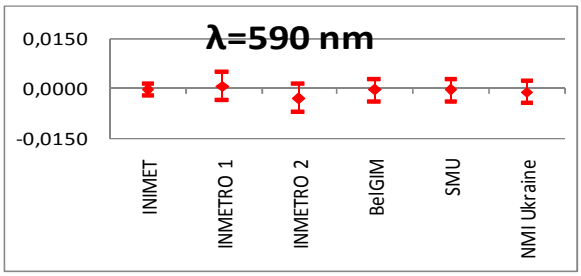


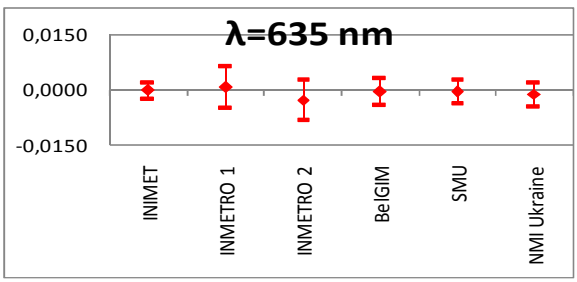










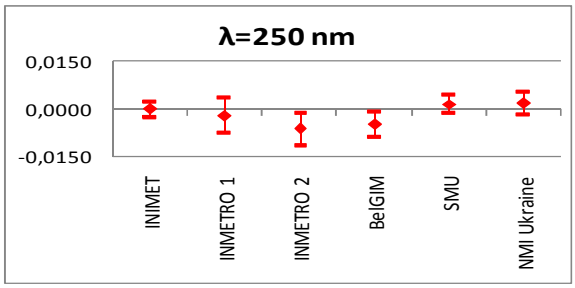


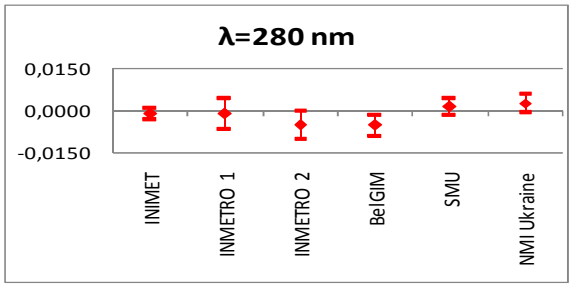
7.1 Unilateral DoE of COOMET.PR-S5 Participants

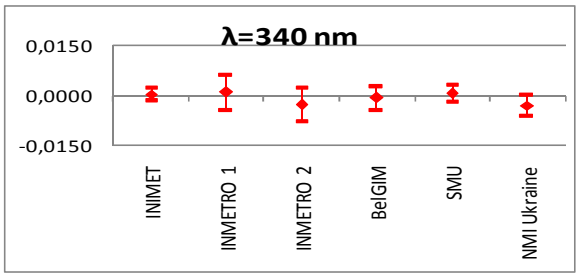
Filter KA 102-7 2 nm

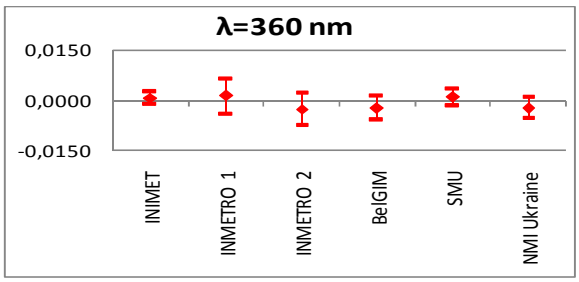
Values reported here are absolute *Nominal transmittance value :0,930

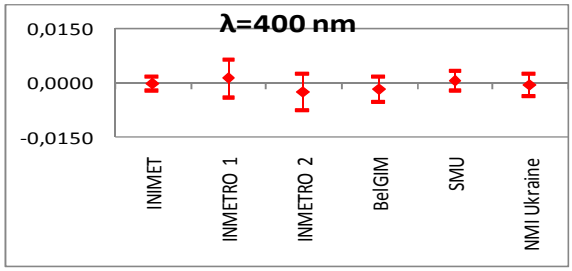
Uncertainties are calculated with k=2

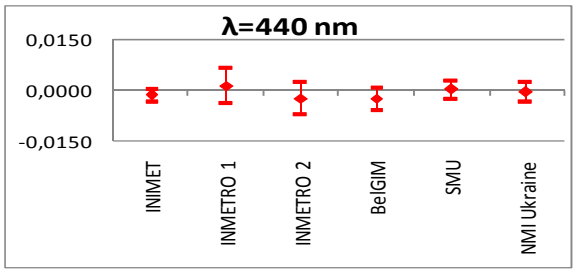


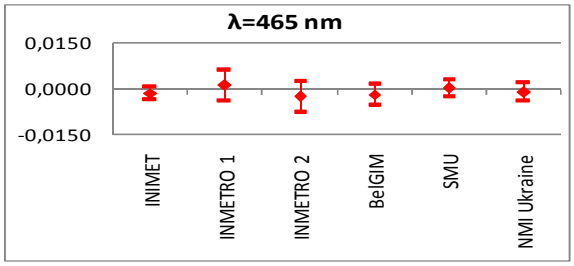


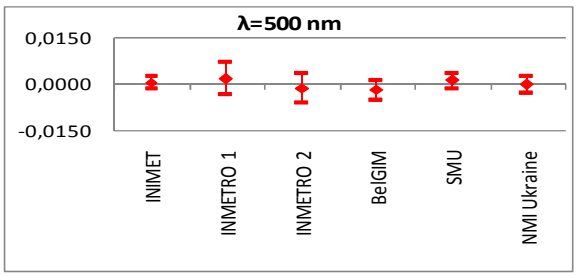


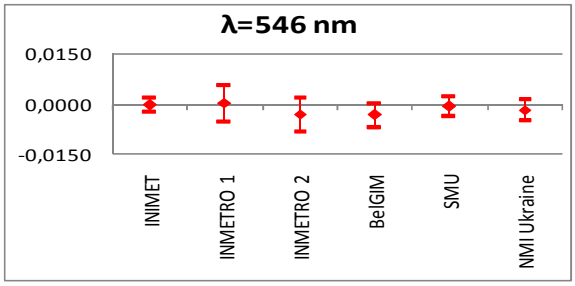


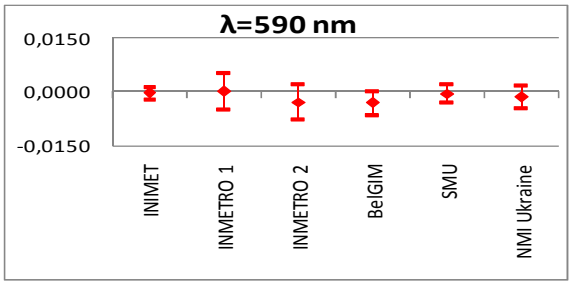


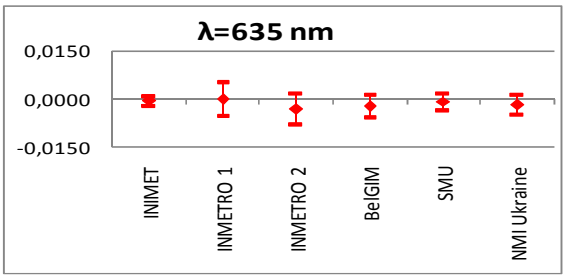












8. REFERENCES

[1] Obein G.; Bastie J. Report on the CCPR Key Comparison K6 Spectral regular transmittance. LNE-INM. Sept 2008

[2] *CCPR-G7*Guidelines for RMO PR Supplementary Comparisons. 14 December 2018

[3] *CCPR-G2* Guidelines for CCPR Key Comparison Report Preparation. Rev-4. January 8. 2019

ANNEX A

Annex A.1

Pilot laboratory transmittance measurements ${}^{2}P_{x,i,r}$ for r=1

1nm

λ (nm)	KA102-1	KA102-3	KA102-4
440	4,73E-02	3,18E-01	4,97E-01
465	4,78E-02	3,16E-01	4,94E-01
546	4,89E-02	3,10E-01	4,81E-01
590	4,85E-02	3,06E-01	4,73E-01
635	4,88E-02	3,03E-01	4,67E-01

λ(nm)	KA102-7
250	9,10E-01
280	9,15E-01
340	9,24E-01
360	9,25E-01
400	9,29E-01
440	9,29E-01
465	9,30E-01
500	9,28E-01
546	9,31E-01
590	9,32E-01
635	9,32E-01

2 nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	4,76E-02	3,18E-01	4,95E-01
465	4,81E-02	3,16E-01	4,92E-01
546	4,92E-02	3,10E-01	4,79E-01
590	4,93E-02	3,06E-01	4,72E-01
635	4,89E-02	3,02E-01	4,66E-01

λ(nm)	KA102-7
250	9,09E-01
280	9,15E-01
340	9,23E-01
360	9,25E-01
400	9,29E-01
440	9,29E-01
465	9,30E-01
500	9,29E-01
546	9,31E-01
590	9,32E-01
635	9,32E-01

Annex A.2

Pilot laboratory transmittance measurements ${}^{2}P_{x,i,r}$ for r=2

1 nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	4,73E-02	3,16E-01	4,94E-01
465	4,78E-02	3,14E-01	4,91E-01
546	4,89E-02	3,09E-01	4,81E-01
590	4,85E-02	3,06E-01	4,76E-01
635	4,88E-02	3,03E-01	4,70E-01

λ(nm)	KA102-7
250	9,11E-01
280	9,17E-01
340	9,24E-01
360	9,26E-01
400	9,26E-01
440	9,26E-01
465	9,27E-01
500	9,28E-01
546	9,31E-01
590	9,32E-01
635	9,32E-01

2 nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	4,76E-02	3,18E-01	4,94E-01
465	4,81E-02	3,16E-01	4,90E-01
546	4,92E-02	3,10E-01	4,81E-01
590	4,93E-02	3,06E-01	4,75E-01
635	4,89E-02	3,02E-01	4,69E-01

λ(nm)	KA102-7
250	9,12E-01
280	9,18E-01
340	9,25E-01
360	9,27E-01
400	9,26E-01
440	9,26E-01
465	9,26E-01
500	9,31E-01
546	9,31E-01
590	9,32E-01
635	9,32E-01

Annex A.3

Pilot lab adopted transmission $^{2}P_{x,i,r}$ (average round 1 and 2)

1 nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	4.73E-02	3.17E-01	4.95E-01
465	4.78E-02	3.15E-01	4.92E-01
546	4.89E-02	3.09E-01	4.81E-01
590	4.85E-02	3.06E-01	4.74E-01
635	4.88E-02	3.03E-01	4.68E-01

2 nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	4.76E-02	3.18E-01	4.94E-01
465	4.81E-02	3.16E-01	4.91E-01
546	4.92E-02	3.10E-01	4.80E-01
590	4.93E-02	3.06E-01	4.73E-01
635	4.89E-02	3.02E-01	4.67E-01

λ(nm)	KA102-7
250	9.11E-01
280	9.16E-01
340	9.24E-01
360	9.25E-01
400	9.28E-01
440	9.28E-01
465	9.28E-01
500	9.28E-01
546	9.31E-01
590	9.32E-01
635	9.32E-01

λ(nm)	KA102-7
250	9.11E-01
280	9.17E-01
340	9.24E-01
360	9.26E-01
400	9.28E-01
440	9.28E-01
465	9.28E-01
500	9.30E-01
546	9.31E-01
590	9.32E-01
635	9.32E-01

Annex A.4

Pilot laboratory total uncertainty on adopted transmittance $u\left(^{2}{}_{X,i}^{P}\right)$

1 nm

λ nm	KA102-1	KA102-3	KA102-4
440	2,53E-03	2,533E-03	2,55E-03
465	2,53E-03	2,533E-03	2,54E-03
546	2,53E-03	2,534E-03	2,53E-03
590	2,53E-03	2,534E-03	2,54E-03
635	2,53E-03	2,533E-03	2,53E-03

2 nm

λ nm	KA102-1	KA102-3	KA102-4
440	2,53E-03	2,53E-03	2,55E-03
465	2,53E-03	2,53E-03	2,54E-03
546	2,53E-03	2,53E-03	2,53E-03
590	2,53E-03	2,53E-03	2,54E-03
635	2,53E-03	2,53E-03	2,53E-03

λ nm	KA102-7
250	2,53E-03
280	2,53E-03
340	2,53E-03
360	2,53E-03
400	2,53E-03
440	2,53E-03
465	2,53E-03
500	2,54E-03
546	2,54E-03
590	2,54E-03
635	2,54E-03

λ nm	KA102-7
250	2,53E-03
280	2,53E-03
340	2,53E-03
360	2,53E-03
400	2,53E-03
440	2,53E-03
465	2,53E-03
500	2,54E-03
546	2,54E-03
590	2,54E-03
635	2,54E-03

Annex A.5

Pilot laboratory “type A” uncertainty on adopted transmittance $u(^{2}{}_{X,i,r}^{PR})$

KA102- 1 1 nm

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	9,36E-18	4,83E-05	4,80E-05	1,01E-03	1,00E-04
465	5,27E-05	4,83E-05	4,80E-05	9,05E-04	1,00E-04
546	5,27E-05	0,00E+00	4,80E-05	9,99E-04	1,00E-04
590	9,36E-18	4,83E-05	4,80E-05	1,02E-03	1,00E-04
635	5,27E-05	5,27E-05	4,80E-05	1,04E-03	1,00E-04

KA102- 3

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	7,89E-05	1,16E-04	1,60E-05	8,04E-03	1,00E-04
465	7,89E-05	1,14E-04	1,60E-05	6,00E-03	1,00E-04
546	7,89E-05	6,75E-05	1,60E-05	4,15E-03	1,00E-04
590	8,23E-05	5,16E-05	1,60E-05	3,30E-03	1,00E-04
635	9,19E-05	6,75E-05	1,60E-05	2,69E-03	1,00E-04

KA102- 4

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	8,43E-05	4,83E-05	1,50E-05	4,36E-03	1,00E-04
465	8,23E-05	8,43E-05	1,50E-05	3,73E-03	1,00E-04
546	4,22E-05	4,71E-05	1,50E-05	3,55E-03	1,00E-04
590	5,68E-05	4,83E-05	1,50E-05	3,35E-03	1,00E-04
635	7,38E-05	0,00E+00	1,50E-05	3,42E-03	1,00E-04

KA102- 7

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
250	2,23E-04	1,03E-04	2,60E-05	2,91E-03	1,00E-04
280	1,89E-04	7,89E-05	2,60E-05	3,74E-03	1,00E-04
340	3,06E-04	1,56E-04	2,60E-05	2,81E-03	1,00E-04
360	2,31E-04	5,16E-05	2,60E-05	3,20E-03	1,00E-04
400	3,27E-04	5,16E-05	2,60E-05	1,03E-02	4,20E-04
440	2,12E-04	8,50E-05	2,60E-05	8,86E-03	4,20E-04
465	1,57E-04	5,68E-05	2,60E-05	8,80E-03	4,20E-04
500	1,18E-04	6,32E-05	2,60E-05	8,93E-03	4,20E-04
546	1,29E-04	5,16E-05	2,60E-05	8,20E-03	4,20E-04
590	1,40E-04	6,32E-05	2,60E-05	8,36E-03	4,20E-04
635	1,77E-04	6,32E-05	2,60E-05	8,36E-03	4,20E-04

Annex A.6

Pilot laboratory “type A” uncertainty on adopted transmittance $u(^{2}{}_{X,j,r}^{PR})$

KA102- 1 2 nm

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	9,36E-18	4,83E-05	4,80E-03	6,30E-04	1,00E-04
465	5,27E-05	4,83E-05	4,80E-03	7,01E-04	1,00E-04
546	5,27E-05	0,00E+00	4,80E-03	6,61E-04	1,00E-04
590	9,3 6E-18	4,83E-05	4,80E-03	6,75E-04	1,00E-04
635	5,27E-05	5,27E-05	4,80E-03	6,41E-04	1,00E-04

KA102- 3

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	7,89E-05	1,16E-04	1,60E-05	3,70E-03	1,00E-04
465	7,89E-05	1,14E-04	1,60E-05	3,51E-03	1,00E-04
546	7,89E-05	6,75E-05	1,60E-05	3,16E-03	1,00E-04
590	8,23E-05	5,16E-05	1,60E-05	3,12E-03	1,00E-04
635	9,19E-05	6,75E-05	1,60E-05	2,87E-03	1,00E-04

KA102- 4

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	8,43E-05	4,83E-05	1,50E-05	3,10E-03	1,00E-04
465	8,23E-05	8,43E-05	1,50E-05	3,12E-03	1,00E-04
546	4,22E-05	4,71E-05	1,50E-05	3,40E-03	1,00E-04
590	5,68E-05	4,83E-05	1,50E-05	2,61E-03	1,00E-04
635	7,38E-05	0,00E+00	1,50E-05	3,26E-03	1,00E-04

KA102- 7

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
250	2,23E-04	1,03E-04	2,60E-05	9,01E-03	1,00E-04
280	1,89E-04	7,89E-05	2,60E-05	8,05E-03	1,00E-04
340	3,06E-04	1,56E-04	2,60E-05	7,17E-03	1,00E-04
360	2,31E-04	5,16E-05	2,60E-05	5,36E-03	1,00E-04
400	3,27E-04	5,16E-05	2,60E-05	7,22E-03	4,20E-04
440	2,12E-04	8,50E-05	2,60E-05	7,79E-03	4,20E-04
465	1,57E-04	5,68E-05	2,60E-05	8,83E-03	4,20E-04
500	1,18E-04	6,32E-05	2,60E-05	8,71E-03	4,20E-04
546	1,29E-04	5,16E-05	2,60E-05	8,56E-03	4,20E-04
590	1,40E-04	6,32E-05	2,60E-05	6,89E-03	4,20E-04
635	1,77E-04	6,32E-05	2,60E-05	7,20E-03	4,20E-04

Annex A.7

NMI absolute transmission measurements [2] x_i

KA102- 1 1 nm

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	4,80E-02	4,72E-02	4,66E-02	4,72E-02	4,77E-02
465	4,86E-02	4,77E-02	4,71E-02	4,77E-02	4,80E-02
546	4,97E-02	4,88E-02	4,81E-02	4,88E-02	4,89E-02
590	4,98E-02	4,89E-02	4,82E-02	4,89E-02	4,91E-02
635	4,95E-02	4,86E-02	4,81E-02	4,87E-02	4,84E-02

KA102- 3

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	3,21E-01	3,17E-01	3,14E-01	3,17E-01	3,20E-01
465	3,19E-01	3,15E-01	3,12E-01	3,15E-01	3,17E-01
546	3,12E-01	3,08E-01	3,06E-01	3,09E-01	3,11E-01
590	3,08E-01	3,05E-01	3,03E-01	3,05E-01	3,07E-01
635	3,04E-01	3,01E-01	2,99E-01	3,02E-01	3,04E-01

KA102- 4

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	4,92E-01	4,91E-01	4,93E-01	4,95E-01	4,94E-01
465	4,89E-01	4,88E-01	4,90E-01	4,92E-01	4,91E-01
546	4,80E-01	4,79E-01	4,80E-01	4,81E-01	4,81E-01
590	4,75E-01	4,74E-01	4,75E-01	4,75E-01	4,76E-01
635	4,70E-01	4,68E-01	4,69E-01	4,69E-01	4,70E-01

KA102- 7

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	9,09E-01	9,05E-01	9,04E-01	9,12E-01	9,14E-01
280	9,17E-01	9,13E-01	9,13E-01	9,19E-01	9,21E-01
340	9,25E-01	9,21E-01	9,21E-01	9,24E-01	9,20E-01
360	9,27E-01	9,23E-01	9,26E-01	9,26E-01	9,23E-01
400	9,30E-01	9,25E-01	9,28E-01	9,28E-01	9,27E-01
440	9,31E-01	9,27E-01	9,29E-01	9,29E-01	9,28E-01
465	9,31E-01	9,27E-01	9,30E-01	9,30E-01	9,29E-01
500	9,32E-01	9,28E-01	9,30E-01	9,30E-01	9,29E-01
546	9,33E-01	9,29E-01	9,31E-01	9,31E-01	9,30E-01
590	9,33E-01	9,29E-01	9,32E-01	9,32E-01	9,31E-01
635	9,33E-01	9,30E-01	9,32E-01	9,32E-01	9,31E-01

Annex A.8

NMI absolute transmission measurements [2] x_i

KA102- 1 2 nm

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	4,80E-02	4,70E-02	4,76E-02	4,73E-02	4,79E-02
465	4,85E-02	4,76E-02	4,80E-02	4,78E-02	4,81E-02
546	4,97E-02	4,86E-02	4,91E-02	4,89E-02	4,91E-02
590	4,98E-02	4,86E-02	4,92E-02	4,90E-02	4,91E-02
635	4,95E-02	4,84E-02	4,86E-02	4,88E-02	4,83E-02

KA102- 3

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	3,21E-01	3,17E-01	3,14E-01	3,18E-01	3,19E-01
465	3,19E-01	3,15E-01	3,13E-01	3,15E-01	3,16E-01
546	3,12E-01	3,08E-01	3,06E-01	3,09E-01	3,10E-01
590	3,08E-01	3,04E-01	3,03E-01	3,06E-01	3,06E-01
635	3,04E-01	3,00E-01	3,00E-01	3,02E-01	3,02E-01

KA102- 4

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	4,92E-01	4,90E-01	4,92E-01	4,96E-01	4,95E-01
465	4,89E-01	4,87E-01	4,89E-01	4,92E-01	4,91E-01
546	4,80E-01	4,78E-01	4,78E-01	4,81E-01	4,82E-01
590	4,75E-01	4,73E-01	4,73E-01	4,75E-01	4,76E-01
635	4,69E-01	4,67E-01	4,68E-01	4,69E-01	4,70E-01

KA102- 7

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	9,09E-01	9,05E-01	9,06E-01	9,13E-01	9,13E-01
280	9,17E-01	9,13E-01	9,12E-01	9,19E-01	9,20E-01
340	9,25E-01	9,21E-01	9,23E-01	9,24E-01	9,21E-01
360	9,27E-01	9,23E-01	9,23E-01	9,26E-01	9,23E-01
400	9,29E-01	9,25E-01	9,26E-01	9,28E-01	9,27E-01
440	9,30E-01	9,27E-01	9,27E-01	9,29E-01	9,29E-01
465	9,31E-01	9,27E-01	9,28E-01	9,30E-01	9,28E-01
500	9,31E-01	9,28E-01	9,28E-01	9,30E-01	9,29E-01
546	9,32E-01	9,29E-01	9,28E-01	9,31E-01	9,30E-01
590	9,32E-01	9,29E-01	9,29E-01	9,32E-01	9,31E-01
635	9,33E-01	9,30E-01	9,31E-01	9,32E-01	9,31E-01

Annex A.9

NMI total absolute uncertainties on transmission measurements $u^2(x_i)$

KA102- 1 1 nm

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,47E-04	2,17E-04	1,20E-03	2,74E-05	3,86E-04
465	2,55E-04	2,19E-04	1,20E-03	2,39E-05	3,86E-04
546	2,59E-04	2,18E-04	1,20E-03	2,35E-05	3,86E-04
590	2,54E-04	2,23E-04	1,20E-03	2,04E-05	3,87E-04
635	2,58E-04	2,23E-04	1,20E-03	2,97E-05	3,86E-04

KA102- 3

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	1,07E-03	9,25E-04	1,20E-03	8,67E-05	3,89E-04
465	1,06E-03	9,20E-04	1,20E-03	8,34E-05	3,87E-04
546	1,04E-03	9,02E-04	1,20E-03	5,24E-05	3,89E-04
590	1,04E-03	8,93E-04	1,20E-03	4,46E-05	3,88E-04
635	1,03E-03	8,87E-04	1,20E-03	3,98E-05	3,87E-04

KA102- 4

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	1,43E-03	1,24E-03	1,20E-03	5,61E-05	3,91E-04
465	1,42E-03	1,24E-03	1,20E-03	5,01E-05	3,89E-04
546	1,40E-03	1,22E-03	1,20E-03	5,03E-05	3,92E-04
590	1,40E-03	1,21E-03	1,20E-03	4,77E-05	3,90E-04
635	1,38E-03	1,20E-03	1,20E-03	4,86E-05	3,87E-04

KA102- 7

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	2,11E-03	1,83E-03	1,50E-03	4,42E-05	4,69E-04
280	2,12E-03	1,83E-03	1,50E-03	5,03E-05	5,80E-04
340	2,14E-03	1,85E-03	1,50E-03	6,13E-05	4,60E-04
360	2,14E-03	1,84E-03	1,50E-03	4,60E-05	4,97E-04
400	2,15E-03	1,85E-03	1,20E-03	1,14E-04	3,95E-04
440	2,14E-03	1,85E-03	1,20E-03	9,58E-05	3,91E-04
465	2,13E-03	1,85E-03	1,20E-03	9,80E-05	3,93E-04
500	2,13E-03	1,85E-01	1,20E-03	9,65E-05	3,89E-04
546	2,13E-03	1,85E-03	1,20E-03	9,12E-05	3,87E-04
590	2,13E-03	1,85E-03	1,20E-03	9,14E-05	3,95E-04
635	2,14E-03	1,85E-03	1,20E-03	9,72E-05	3,98E-04

Annex A.10

NMI total absolute uncertainties on transmission measurements $u^2(x_i)$

KA102- 1 2 nm

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,47E-04	2,17E-04	1,20E-03	2,54E-05	3,90E-04
465	2,55E-04	2,19E-04	1,20E-03	2,34E-05	3,87E-04
546	2,59E-04	2,18E-04	1,20E-03	2,02E-05	3,86E-04
590	2,54E-04	2,23E-04	1,20E-03	2,24E-05	3,86E-04
635	2,58E-04	2,23E-04	1,20E-03	2,82E-05	3,86E-04

KA102- 3

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	1,07E-03	9,25E-04	1,20E-03	4,82E-05	3,91E-04
465	1,06E-03	9,20E-04	1,20E-03	6,76E-05	3,87E-04
546	1,04E-03	9,02E-04	1,20E-03	4,86E-05	3,87E-04
590	1,04E-03	8,93E-04	1,20E-03	4,45E-05	3,88E-04
635	1,03E-03	8,87E-04	1,20E-03	4,24E-05	3,87E-04

KA102- 4

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	1,43E-03	1,24E-03	1,20E-03	4,75E-05	3,91E-04
465	1,42E-03	1,24E-03	1,20E-03	4,76E-05	3,88E-04
546	1,40E-03	1,22E-03	1,20E-03	5,16E-05	3,87E-04
590	1,40E-03	1,21E-03	1,20E-03	4,42E-05	3,89E-04
635	1,38E-03	1,20E-03	1,20E-03	4,91E-05	3,88E-04

KA102- 7

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	2,11E-03	1,83E-03	1,50E-03	9,60E-05	5,40E-04
280	2,12E-03	1,83E-03	1,50E-03	8,72E-05	5,53E-04
340	2,14E-03	1,85E-03	1,50E-03	9,01E-05	4,25E-04
360	2,14E-03	1,84E-03	1,50E-03	6,30E-05	5,34E-04
400	2,15E-03	1,85E-03	1,20E-03	8,66E-05	4,01E-04
440	2,14E-03	1,85E-03	1,20E-03	8,60E-05	3,91E-04
465	2,13E-03	1,85E-03	1,20E-03	9,83E-05	4,00E-04
500	2,13E-03	1,85E-01	1,20E-03	9,45E-05	3,88E-04
546	2,13E-03	1,85E-03	1,20E-03	9,45E-05	3,88E-04
590	2,13E-03	1,85E-03	1,20E-03	7,81E-05	3,88E-04
635	2,14E-03	1,85E-03	1,20E-03	8,74E-05	3,93E-04

Annex A.11

$\left(2^{P}_{x,i,1} - 2^{P}_{x,i,2}\right)$

1nm

λ (nm)	KA102-1	KA102-3	KA102-4
440	0,00E+00	2,04E-03	3,14E-03
465	0,00E+00	1,92E-03	3,01E-03
546	0,00E+00	1,04E-03	8,34E-05
590	0,00E+00	0,00E+00	-2,07E-03
635	0,00E+00	0,00E+00	-2,48E-03

2nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	0,00E+00	0,00E+00	1,47E-03
465	0,00E+00	0,00E+00	1,22E-03
546	0,00E+00	0,00E+00	-1,35E-03
590	0,00E+00	0,00E+00	-3,51E-03
635	0,00E+00	0,00E+00	-3,77E-03

λ(nm)	KA102-7
250	-1,00E-03
280	-2,15E-03
340	5,81E-05
360	-1,49E-03
400	3,02E-03
440	3,02E-03
465	2,86E-03
500	-4,53E-05
546	0,00E+00
590	0,00E+00
635	0,00E+00

λ(nm)	KA102-7
250	-3,01E-03
280	-2,61E-03
340	-1,84E-03
360	-1,45E-03
400	3,55E-03
440	3,55E-03
465	3,47E-03
500	-2,09E-03
546	0,00E+00
590	0,00E+00
635	0,00E+00

Annex A.12

$u_{drift,x,i}$

1nm

λ (nm)	KA102-1	KA102-3	KA102-4
440	0,00E+00	5,89E-04	9,07E-04
465	0,00E+00	5,53E-04	8,70E-04
546	0,00E+00	3,01E-04	2,41E-05
590	0,00E+00	0,00E+00	5,98E-04
635	0,00E+00	0,00E+00	7,16E-04

2nm

λ(nm)	KA102-1	KA102-3	KA102-4
440	0,00E+00	0,00E+00	4,25E-04
465	0,00E+00	0,00E+00	3,53E-04
546	0,00E+00	0,00E+00	3,90E-04
590	0,00E+00	0,00E+00	1,01E-03
635	0,00E+00	0,00E+00	1,09E-03

λ(nm)	KA102-7
250	2,89E-04
280	6,21E-04
340	1,68E-05
360	4,31E-04
400	8,72E-04
440	8,72E-04
465	8,25E-04
500	1,31E-05
546	0,00E+00
590	0,00E+00
635	0,00E+00

λ(nm)	KA102-7
250	8,70E-04
280	7,54E-04
340	5,32E-04
360	4,18E-04
400	1,02E-03
440	1,02E-03
465	1,00E-03
500	6,05E-04
546	0,00E+00
590	0,00E+00
635	0,00E+00

Annex A.13

$u_{adj}\left(^{2}{}_{X,i}\right)$

KA102- 1 1 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,53E-03	2,47E-04	2,19E-04	1,20E-03	2,19E-04	3,86E-04
465	2,53E-03	2,55E-04	2,21E-04	1,20E-03	2,21E-04	3,86E-04
546	2,53E-03	2,59E-04	2,22E-04	1,20E-03	2,22E-04	3,86E-04
590	2,53E-03	2,54E-04	2,21E-04	1,20E-03	2,21E-04	3,87E-04
635	2,53E-03	2,58E-04	2,24E-04	1,20E-03	2,24E-04	3,86E-04

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,53E-03	1,07E-03	9,25E-04	1,18E-03	6,17E-04	6,17E-04
465	2,53E-03	1,06E-03	9,20E-04	1,18E-03	6,13E-04	6,13E-04
546	2,53E-03	1,04E-03	9,02E-04	1,18E-03	5,97E-04	5,97E-04
590	2,53E-03	1,04E-03	8,93E-04	1,18E-03	5,90E-04	5,90E-04
635	2,53E-03	1,03E-03	8,87E-04	1,18E-03	5,85E-04	5,85E-04

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,55E-03	1,43E-03	1,24E-03	1,20E-03	7,22E-04	7,22E-04
465	2,54E-03	1,42E-03	1,24E-03	1,20E-03	7,19E-04	7,19E-04
546	2,53E-03	1,40E-03	1,22E-03	1,20E-03	7,16E-04	7,16E-04
590	2,54E-03	1,40E-03	1,21E-03	1,20E-03	7,12E-04	7,12E-04
635	2,53E-03	1,38E-03	1,20E-03	1,20E-03	7,09E-04	7,09E-04

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	2,53E-03	2,11E-03	1,83E-03	1,50E-03	7,55E-04	7,55E-04
280	2,53E-03	2,12E-03	1,83E-03	1,50E-03	7,83E-04	7,83E-04
340	2,53E-03	2,14E-03	1,85E-03	1,50E-03	7,55E-04	7,55E-04
360	2,53E-03	2,14E-03	1,84E-03	1,50E-03	7,61E-04	7,61E-04
400	2,53E-03	2,15E-03	1,85E-03	1,20E-03	6,02E-04	6,02E-04
440	2,53E-03	2,14E-03	1,85E-03	1,20E-03	5,97E-04	5,97E-04
465	2,53E-03	2,13E-03	1,85E-03	1,20E-03	5,98E-04	5,98E-04
500	2,54E-03	2,13E-03	1,85E-01	1,20E-03	4,21E-04	4,21E-04
546	2,54E-03	2,13E-03	1,85E-03	1,20E-03	5,95E-04	5,95E-04
590	2,54E-03	2,13E-03	1,85E-03	1,20E-03	5,97E-04	5,97E-04
635	2,54E-03	2,14E-03	1,85E-03	1,20E-03	5,99E-04	5,99E-04

Annex A.14

$u_{adj}\left(^{2}{}_{X,i}\right)$

KA102- 1 2 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,53E-03	2,20E-04	2,20E-04	1,20E-03	2,20E-04	3,90E-04
465	2,53E-03	2,21E-04	2,21E-04	1,20E-03	2,21E-04	4,00E-04
546	2,53E-03	2,21E-04	2,21E-04	1,20E-03	2,21E-04	4,00E-04
590	2,53E-03	2,22E-04	2,22E-04	1,20E-03	2,22E-04	4,00E-04
635	2,53E-03	2,24E-04	2,24E-04	1,20E-03	2,24E-04	4,00E-04

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,53E-03	9,25E-04	9,25E-04	1,20E-03	4,55E-04	4,55E-04
465	2,53E-03	9,20E-04	9,20E-04	1,20E-03	4,58E-04	4,58E-04
546	2,53E-03	9,02E-04	9,02E-04	1,20E-03	4,46E-04	4,46E-04
590	2,53E-03	8,93E-04	8,93E-04	1,20E-03	4,42E-04	4,42E-04
635	2,53E-03	8,87E-04	8,87E-04	1,20E-03	4,39E-04	4,39E-04

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,55E-03	1,43E-03	1,24E-03	1,20E-03	7,20E-04	7,20E-04
465	2,54E-03	1,42E-03	1,24E-03	1,20E-03	7,19E-04	7,19E-04
546	2,53E-03	1,40E-03	1,22E-03	1,20E-03	7,15E-04	7,15E-04
590	2,54E-03	1,40E-03	1,21E-03	1,20E-03	7,11E-04	7,11E-04
635	2,53E-03	1,38E-03	1,20E-03	1,20E-03	7,10E-04	7,10E-04

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	2,53E-03	2,11E-03	1,83E-03	1,50E-03	7,12E-04	7,12E-04
280	2,53E-03	2,12E-03	1,83E-03	1,50E-03	7,13E-04	7,13E-04
340	2,53E-03	2,14E-03	1,85E-03	1,50E-03	6,72E-04	6,72E-04
360	2,53E-03	2,14E-03	1,84E-03	1,50E-03	6,99E-04	6,99E-04
400	2,53E-03	2,15E-03	1,85E-03	1,20E-03	5,63E-04	5,63E-04
440	2,53E-03	2,14E-03	1,85E-03	1,20E-03	5,59E-04	5,59E-04
465	2,53E-03	2,13E-03	1,85E-03	1,20E-03	5,66E-04	5,66E-04
500	2,54E-03	2,13E-03	1,85E-01	1,20E-03	5,61E-04	5,61E-04
546	2,54E-03	2,13E-03	1,85E-03	1,20E-03	5,61E-04	5,61E-04
590	2,54E-03	2,13E-03	1,85E-03	1,20E-03	5,55E-04	5,55E-04
635	2,54E-03	2,14E-03	1,85E-03	1,20E-03	5,60E-04	5,60E-04

Annex A.15

$\Delta_{x,i}$

KA102- 1 1 nm

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"	INIMET
440	6,71E-04	-1,29E-04	-7,39E-04	-1,29E-04	4,16E-04	0,00E+00
465	7,51E-04	-1,49E-04	-7,59E-04	-1,20E-04	1,29E-04	0,00E+00
546	8,28E-04	-7,24E-05	-7,72E-04	-1,08E-04	1,15E-05	0,00E+00
590	1,31E-03	4,12E-04	-2,98E-04	4,04E-04	6,26E-04	0,00E+00
635	7,50E-04	-1,50E-04	-6,60E-04	-7,50E-05	-3,45E-04	0,00E+00

KA102- 3

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"	INIMET
440	4,01E-03	-1,93E-04	-3,20E-03	-4,50E-04	2,62E-03	0,00E+00
465	3,60E-03	-2,96E-04	-2,91E-03	-3,49E-04	2,30E-03	0,00E+00
546	2,93E-03	-8,66E-04	-3,28E-03	-5,05E-04	1,75E-03	0,00E+00
590	2,06E-03	-1,44E-03	-3,55E-03	-8,85E-04	1,21E-03	0,00E+00
635	1,62E-03	-1,38E-03	-3,19E-03	-8,08E-04	1,05E-03	0,00E+00

KA102- 4

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"	INIMET
440	-3,68E-03	-4,78E-03	-2,69E-03	-1,80E-04	-1,13E-03	0,00E+00
465	-3,48E-03	-4,58E-03	-2,17E-03	-4,56E-04	-1,35E-03	0,00E+00
546	-7,32E-04	-2,43E-03	-1,02E-03	-1,53E-04	4,45E-04	0,00E+00
590	7,15E-04	-9,85E-04	3,05E-04	5,76E-04	1,33E-03	0,00E+00
635	1,13E-03	-3,74E-04	3,36E-04	4,34E-04	1,64E-03	0,00E+00

KA102- 7

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"	INIMET
250	-1,81E-03	-5,61E-03	-6,40E-03	1,44E-03	2,81E-03	0,00E+00
280	6,89E-04	-3,11E-03	-3,38E-03	2,76E-03	4,73E-03	0,00E+00
340	8,00E-04	-2,90E-03	-3,72E-03	6,24E-05	-3,83E-03	0,00E+00
360	1,76E-03	-2,94E-03	1,85E-04	6,52E-04	-2,49E-03	0,00E+00
400	1,98E-03	-2,72E-03	2,01E-04	3,76E-04	-6,37E-04	0,00E+00
440	3,08E-03	-1,32E-03	1,45E-03	1,46E-03	3,33E-04	0,00E+00
465	3,01E-03	-1,09E-03	1,58E-03	1,68E-03	5,78E-04	0,00E+00
500	3,90E-03	-9,92E-05	2,67E-03	2,67E-03	1,40E-03	0,00E+00
546	1,20E-03	-2,80E-03	-4,00E-05	-2,79E-04	-1,08E-03	0,00E+00
590	1,00E-03	-2,70E-03	-2,20E-04	-2,56E-04	-7,99E-04	0,00E+00
635	9,00E-04	-2,50E-03	-2,30E-04	-2,16E-04	-9,31E-04	0,00E+00

Annex A.16

$\Delta_{x,i}$

KA102- 1 2 nm

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"	INIMET
440	3,66E-04	-6,34E-04	-7,38E-05	-3,28E-04	2,98E-04	0,00E+00
465	3,90E-04	-5,10E-04	-9,01E-05	-2,80E-04	4,88E-06	0,00E+00
546	5,21E-04	-5,79E-04	-8,89E-05	-3,18E-04	-5,98E-05	0,00E+00
590	5,42E-04	-6,58E-04	-6,76E-05	-2,64E-04	-1,21E-04	0,00E+00
635	6,35E-04	-4,65E-04	-2,85E-04	-8,11E-05	-5,20E-04	0,00E+00

KA102- 3

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"	INIMET
440	2,97E-03	-1,23E-03	-3,97E-03	-8,37E-04	6,39E-04	0,00E+00
465	2,55E-03	-1,15E-03	-3,57E-03	-7,72E-04	3,32E-04	0,00E+00
546	2,29E-03	-1,31E-03	-3,49E-03	-6,32E-04	2,80E-04	0,00E+00
590	2,10E-03	-1,80E-03	-2,98E-03	-4,89E-04	2,76E-04	0,00E+00
635	1,80E-03	-2,00E-03	-2,59E-03	-3,36E-04	1,89E-04	0,00E+00

KA102- 4

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"	INIMET
440	-2,69E-03	-4,89E-03	-2,36E-03	1,20E-03	1,93E-04	0,00E+00
465	-2,36E-03	-4,16E-03	-2,17E-03	9,01E-04	6,47E-05	0,00E+00
546	1,21E-04	-1,98E-03	-1,47E-03	9,23E-04	1,70E-03	0,00E+00
590	1,59E-03	-8,05E-04	6,45E-05	1,73E-03	2,48E-03	0,00E+00
635	1,87E-03	-4,31E-04	3,69E-04	1,43E-03	2,88E-03	0,00E+00

KA102- 7

λ (nm)	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"	INIMET
250	-1,81E-03	-5,61E-03	-6,40E-03	1,44E-03	2,81E-03	0,00E+00
280	6,89E-04	-3,11E-03	-3,38E-03	2,76E-03	4,73E-03	0,00E+00
340	8,00E-04	-2,90E-03	-3,72E-03	6,24E-05	-3,83E-03	0,00E+00
360	1,76E-03	-2,94E-03	1,85E-04	6,52E-04	-2,49E-03	0,00E+00
400	1,98E-03	-2,72E-03	2,01E-04	3,76E-04	-6,37E-04	0,00E+00
440	3,08E-03	-1,32E-03	1,45E-03	1,46E-03	3,33E-04	0,00E+00
465	3,01E-03	-1,09E-03	1,58E-03	1,68E-03	5,78E-04	0,00E+00
500	3,90E-03	-9,92E-05	2,67E-03	2,67E-03	1,40E-03	0,00E+00
546	1,20E-03	-2,80E-03	-4,00E-05	-2,79E-04	-1,08E-03	0,00E+00
590	1,00E-03	-2,70E-03	-2,20E-04	-2,56E-04	-7,99E-04	0,00E+00
635	9,00E-04	-2,50E-03	-2,30E-04	-2,16E-04	-9,31E-04	0,00E+00

Annex A.17

$u(\Delta_{x,i})$

KA102- 1 1 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,53E-03	2,47E-04	2,17E-04	1,20E-03	2,77E-05	3,86E-04
465	2,53E-03	2,55E-04	2,19E-04	1,20E-03	2,47E-05	3,86E-04
546	2,53E-03	2,59E-04	2,18E-04	1,20E-03	2,42E-05	3,86E-04
590	2,53E-03	2,54E-04	2,23E-04	1,20E-03	2,04E-05	3,87E-04
635	2,53E-03	2,58E-04	2,23E-04	1,20E-03	2,99E-05	3,86E-04

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,60E-03	1,22E-03	1,10E-03	1,34E-03	6,04E-04	7,13E-04
465	2,59E-03	1,20E-03	1,08E-03	1,32E-03	5,68E-04	6,82E-04
546	2,55E-03	1,09E-03	9,58E-04	1,24E-03	3,27E-04	5,05E-04
590	2,53E-03	1,04E-03	9,02E-04	1,21E-03	1,30E-04	4,07E-04
635	2,53E-03	1,03E-03	8,94E-04	1,20E-03	1,15E-04	4,02E-04

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,70E-03	1,71E-03	1,56E-03	1,53E-03	9,48E-04	1,02E-03
465	2,69E-03	1,69E-03	1,53E-03	1,50E-03	9,05E-04	9,83E-04
546	2,53E-03	1,41E-03	1,23E-03	1,21E-03	1,47E-04	4,15E-04
590	2,61E-03	1,53E-03	1,36E-03	1,35E-03	6,18E-04	7,29E-04
635	2,63E-03	1,56E-03	1,40E-03	1,40E-03	7,26E-04	8,21E-04

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	2,55E-03	1,85E-03	1,53E-03	2,97E-04	2,13E-03	5,54E-04
280	2,61E-03	1,94E-03	1,63E-03	6,34E-04	2,21E-03	8,58E-04
340	2,53E-03	1,85E-03	1,50E-03	7,54E-05	2,14E-03	4,62E-04
360	2,57E-03	1,90E-03	1,56E-03	4,41E-04	2,18E-03	6,63E-04
400	2,68E-03	2,05E-03	1,49E-03	8,87E-04	2,32E-03	9,65E-04
440	2,68E-03	2,05E-03	1,49E-03	8,85E-04	2,31E-03	9,63E-04
465	2,67E-03	2,03E-03	1,46E-03	8,41E-04	2,29E-03	9,23E-04
500	2,54E-03	1,85E-01	1,21E-03	1,94E-04	2,14E-03	4,24E-04
546	2,54E-03	1,86E-03	1,21E-03	1,96E-04	2,14E-03	4,24E-04
590	2,54E-03	1,86E-03	1,21E-03	1,80E-04	2,14E-03	4,24E-04
635	2,54E-03	1,86E-03	1,22E-03	2,29E-04	2,15E-03	4,49E-04

Annex A.18

$u(\Delta_{x,i})$

KA102- 1 2 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,53E-03	2,47E-04	2,17E-04	1,20E-03	2,57E-05	3,90E-04
465	2,53E-03	2,55E-04	2,19E-04	1,20E-03	2,42E-05	3,87E-04
546	2,53E-03	2,59E-04	2,18E-04	1,20E-03	2,10E-05	3,86E-04
590	2,53E-03	2,54E-04	2,23E-04	1,20E-03	2,24E-05	3,86E-04
635	2,53E-03	2,58E-04	2,23E-04	1,20E-03	2,83E-05	3,86E-04

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,53E-03	1,07E-03	9,30E-04	1,20E-03	1,09E-04	4,03E-04
465	2,53E-03	1,07E-03	9,25E-04	1,20E-03	1,20E-04	4,00E-04
546	2,53E-03	1,05E-03	9,09E-04	1,21E-03	1,28E-04	4,04E-04
590	2,53E-03	1,04E-03	9,02E-04	1,21E-03	1,30E-04	4,07E-04
635	2,53E-03	1,03E-03	8,94E-04	1,20E-03	1,16E-04	4,01E-04

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,58E-03	1,52E-03	1,34E-03	1,30E-03	5,07E-04	6,38E-04
465	2,57E-03	1,49E-03	1,31E-03	1,27E-03	4,30E-04	5,78E-04
546	2,56E-03	1,46E-03	1,29E-03	1,27E-03	4,16E-04	5,66E-04
590	2,73E-03	1,73E-03	1,59E-03	1,58E-03	1,03E-03	1,10E-03
635	2,76E-03	1,76E-03	1,62E-03	1,62E-03	1,09E-03	1,16E-03

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	2,68E-03	2,28E-03	2,02E-03	1,73E-03	8,77E-04	1,03E-03
280	2,64E-03	2,25E-03	1,99E-03	1,68E-03	7,68E-04	9,42E-04
340	2,59E-03	2,21E-03	1,92E-03	1,59E-03	5,41E-04	6,82E-04
360	2,57E-03	2,18E-03	1,89E-03	1,56E-03	4,31E-04	6,83E-04
400	2,73E-03	2,39E-03	2,12E-03	1,58E-03	1,03E-03	1,11E-03
440	2,73E-03	2,37E-03	2,12E-03	1,58E-03	1,03E-03	1,10E-03
465	2,73E-03	2,36E-03	2,11E-03	1,57E-03	1,01E-03	1,09E-03
500	2,61E-03	2,22E-03	1,85E-01	1,35E-03	6,35E-04	7,38E-04
546	2,54E-03	2,14E-03	1,86E-03	1,21E-03	1,97E-04	4,24E-04
590	2,54E-03	2,14E-03	1,86E-03	1,21E-03	1,74E-04	4,18E-04
635	2,54E-03	2,15E-03	1,86E-03	1,22E-03	2,25E-04	4,44E-04

Annex A.19

$u_{adj}\left(\Delta_{X,i}\right)$

KA102- 1 1 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	2,53E-03	2,47E-04	2,25E-04	4,91E-03	1,03E-03	3,99E-04
465	2,53E-03	2,60E-04	2,26E-04	1,75E-03	9,32E-04	3,99E-04
546	2,53E-03	2,65E-04	2,22E-04	1,53E-03	1,02E-03	3,99E-04
590	2,53E-03	2,54E-04	2,26E-04	1,53E-03	1,04E-03	3,99E-04
635	2,53E-03	2,64E-04	2,30E-04	3,33E-03	1,06E-03	3,99E-04

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	2,60E-03	1,22E-03	1,10E-03	2,04E-03	8,09E-03	8,59E-04
465	2,59E-03	1,20E-03	1,08E-03	1,82E-03	6,06E-03	8,31E-04
546	2,55E-03	1,09E-03	9,53E-04	1,76E-03	4,20E-03	6,76E-04
590	2,53E-03	1,04E-03	8,95E-04	1,73E-03	3,35E-03	5,99E-04
635	2,53E-03	1,03E-03	8,90E-04	1,52E-03	2,75E-03	5,94E-04

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	2,70E-03	1,69E-03	1,54E-03	2,10E-03	4,51E-03	1,16E-03
465	2,69E-03	1,67E-03	1,52E-03	1,76E-03	3,90E-03	1,13E-03
546	2,53E-03	1,41E-03	1,22E-03	1,53E-03	3,62E-03	7,23E-04
590	2,61E-03	1,52E-03	1,35E-03	1,98E-03	3,48E-03	9,35E-04
635	2,63E-03	1,56E-03	1,40E-03	1,99E-03	3,57E-03	1,01E-03

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
250	2,55E-03	2,14E-03	1,85E-03	3,05E-03	2,97E-03	5,89E-04
280	2,61E-03	2,21E-03	1,94E-03	3,10E-03	3,83E-03	8,24E-04
340	2,53E-03	2,16E-03	1,86E-03	2,90E-03	2,86E-03	5,15E-04
360	2,57E-03	2,19E-03	1,89E-03	2,01E-03	3,27E-03	6,75E-04
400	2,68E-03	2,34E-03	2,04E-03	2,08E-03	1,03E-02	1,06E-03
440	2,68E-03	2,32E-03	2,05E-03	2,15E-03	8,91E-03	1,06E-03
465	2,67E-03	2,29E-03	2,03E-03	2,88E-03	8,85E-03	1,02E-03
500	2,54E-03	2,14E-03	1,85E-01	2,34E-03	8,94E-03	5,95E-04
546	2,54E-03	1,30E-02	1,85E-03	1,89E-03	8,21E-03	5,94E-04
590	2,54E-03	2,14E-03	1,85E-03	2,26E-03	8,37E-03	5,95E-04
635	2,54E-03	2,15E-03	1,85E-03	1,97E-03	8,37E-03	5,97E-04

Annex A.20

$u_{adj}\left(\Delta_{X,i}\right)$

KA102- 1 2 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,53E-03	2,20E-04	2,25E-04	4,91E-03	6,67E-04	4,02E-04
465	2,53E-03	2,27E-04	2,26E-04	1,75E-03	7,35E-04	4,12E-04
546	2,53E-03	2,27E-04	2,21E-04	1,53E-03	6,97E-04	4,12E-04
590	2,53E-03	2,22E-04	2,27E-04	1,53E-03	7,10E-04	4,12E-04
635	2,53E-03	2,30E-04	2,30E-04	3,33E-03	6,79E-04	4,12E-04

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,53E-03	1,07E-03	9,32E-04	1,97E-03	3,73E-03	4,66E-04
465	2,53E-03	1,06E-03	9,27E-04	1,75E-03	3,54E-03	4,69E-04
546	2,53E-03	1,05E-03	9,04E-04	1,75E-03	3,19E-03	4,57E-04
590	2,53E-03	1,04E-03	8,95E-04	1,75E-03	3,15E-03	4,53E-04
635	2,53E-03	1,03E-03	8,90E-04	1,53E-03	2,90E-03	4,50E-04

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,58E-03	1,49E-03	1,31E-03	1,94E-03	3,21E-03	8,42E-04
465	2,57E-03	1,47E-03	1,29E-03	1,57E-03	3,22E-03	8,07E-04
546	2,56E-03	1,46E-03	1,28E-03	1,58E-03	3,50E-03	8,20E-04
590	2,73E-03	1,73E-03	1,58E-03	2,14E-03	2,89E-03	1,24E-03
635	2,76E-03	1,76E-03	1,62E-03	2,15E-03	3,51E-03	1,30E-03

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	2,68E-03	2,29E-03	2,03E-03	3,16E-03	9,08E-03	1,13E-03
280	2,64E-03	2,26E-03	1,98E-03	3,13E-03	8,12E-03	1,04E-03
340	2,59E-03	2,23E-03	1,93E-03	2,95E-03	7,22E-03	8,62E-04
360	2,57E-03	2,19E-03	1,89E-03	2,01E-03	5,42E-03	8,21E-04
400	2,73E-03	2,40E-03	2,11E-03	2,15E-03	7,31E-03	1,24E-03
440	2,73E-03	2,38E-03	2,12E-03	2,22E-03	7,88E-03	1,24E-03
465	2,73E-03	2,36E-03	2,10E-03	2,93E-03	8,90E-03	1,22E-03
500	2,61E-03	2,22E-03	1,85E-01	2,42E-03	8,75E-03	9,25E-04
546	2,54E-03	1,30E-02	1,85E-03	1,89E-03	8,58E-03	7,01E-04
590	2,54E-03	2,14E-03	1,85E-03	2,26E-03	6,91E-03	6,96E-04
635	2,54E-03	2,15E-03	1,85E-03	1,97E-03	7,22E-03	7,00E-04

Annex B.21

w_i

KA102- 1 1 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	3,58E-03	3,76E-01	4,54E-01	9,51E-04	2,14E-02	1,44E-01
465	3,69E-03	3,50E-01	4,62E-01	7,75E-03	2,73E-02	1,49E-01
546	3,68E-03	3,36E-01	4,79E-01	1,00E-02	2,25E-02	1,48E-01
590	3,65E-03	3,62E-01	4,56E-01	9,96E-03	2,15E-02	1,47E-01
635	3,84E-03	3,54E-01	4,63E-01	2,22E-03	2,17E-02	1,55E-01

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	4,55E-02	2,06E-01	2,53E-01	7,38E-02	4,71E-03	4,17E-01
465	4,27E-02	2,00E-01	2,47E-01	8,69E-02	7,83E-03	4,16E-01
546	3,29E-02	1,80E-01	2,36E-01	6,93E-02	1,21E-02	4,69E-01
590	2,81E-02	1,67E-01	2,25E-01	6,01E-02	1,61E-02	5,03E-01
635	2,70E-02	1,63E-01	2,19E-01	7,56E-02	2,29E-02	4,92E-01

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	7,12E-02	1,81E-01	2,20E-01	1,18E-01	2,55E-02	3,84E-01
465	6,60E-02	1,71E-01	2,07E-01	1,53E-01	3,14E-02	3,71E-01
546	4,15E-02	1,35E-01	1,79E-01	1,14E-01	2,03E-02	5,11E-01
590	5,65E-02	1,66E-01	2,10E-01	9,76E-02	3,17E-02	4,38E-01
635	6,09E-02	1,73E-01	2,16E-01	1,06E-01	3,32E-02	4,11E-01

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	4,09E-02	5,79E-02	7,74E-02	2,85E-02	3,01E-02	7,65E-01
280	6,50E-02	9,02E-02	1,18E-01	4,60E-02	3,02E-02	6,51E-01
340	3,34E-02	4,58E-02	6,22E-02	2,55E-02	2,63E-02	8,07E-01
360	4,78E-02	6,57E-02	8,79E-02	7,79E-02	2,95E-02	6,91E-01
400	8,22E-02	1,07E-01	1,41E-01	1,36E-01	5,51E-03	5,27E-01
440	8,24E-02	1,10E-01	1,41E-01	1,28E-01	7,45E-03	5,31E-01
465	8,41E-02	1,14E-01	1,46E-01	7,22E-02	7,63E-03	5,77E-01
500	4,58E-02	6,46E-02	8,60E-06	5,38E-02	3,69E-03	8,32E-01
546	4,33E-02	1,64E-03	8,13E-02	7,81E-02	4,14E-03	7,91E-01
590	4,20E-02	5,90E-02	7,87E-02	5,31E-02	3,86E-03	7,63E-01
635	4,14E-02	5,80E-02	7,77E-02	6,89E-02	3,81E-03	7,50E-01

Annex A.22

w_i

KA102- 1 2 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	3,18E-03	4,22E-01	4,02E-01	8,45E-04	4,58E-02	1,26E-01
465	3,31E-03	4,11E-01	4,15E-01	6,95E-03	3,93E-02	1,25E-01
546	3,22E-03	4,01E-01	4,23E-01	8,79E-03	4,25E-02	1,21E-01
590	3,23E-03	4,22E-01	4,03E-01	8,82E-03	4,10E-02	1,22E-01
635	3,39E-03	4,10E-01	4,10E-01	1,95E-03	4,71E-02	1,28E-01

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,19E-02	1,23E-01	1,61E-01	3,62E-02	1,01E-02	6,48E-01
465	2,18E-02	1,24E-01	1,63E-01	4,58E-02	1,12E-02	6,35E-01
546	2,07E-02	1,21E-01	1,63E-01	4,36E-02	1,31E-02	6,38E-01
590	2,04E-02	1,21E-01	1,64E-01	4,30E-02	1,32E-02	6,38E-01
635	1,99E-02	1,20E-01	1,61E-01	5,43E-02	1,51E-02	6,30E-01

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	5,08E-02	1,52E-01	1,96E-01	9,03E-02	3,29E-02	4,78E-01
465	4,66E-02	1,43E-01	1,85E-01	1,24E-01	2,96E-02	4,72E-01
546	4,75E-02	1,47E-01	1,90E-01	1,25E-01	2,56E-02	4,65E-01
590	7,23E-02	1,81E-01	2,16E-01	1,17E-01	6,46E-02	3,49E-01
635	7,64E-02	1,87E-01	2,21E-01	1,25E-01	4,72E-02	3,43E-01

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	9,49E-02	1,29E-01	1,66E-01	6,81E-02	8,25E-03	5,34E-01
280	8,78E-02	1,21E-01	1,56E-01	6,27E-02	9,31E-03	5,64E-01
340	7,12E-02	9,60E-02	1,28E-01	5,49E-02	9,14E-03	6,41E-01
360	6,31E-02	8,68E-02	1,16E-01	1,03E-01	1,41E-02	6,17E-01
400	9,46E-02	1,22E-01	1,58E-01	1,53E-01	1,32E-02	4,59E-01
440	9,54E-02	1,26E-01	1,59E-01	1,45E-01	1,15E-02	4,64E-01
465	1,01E-01	1,34E-01	1,69E-01	8,71E-02	9,44E-03	4,99E-01
500	8,64E-02	1,19E-01	1,72E-05	1,01E-01	7,68E-03	6,86E-01
546	5,58E-02	2,11E-03	1,05E-01	1,01E-01	4,88E-03	7,32E-01
590	5,28E-02	7,42E-02	9,89E-02	6,67E-02	7,11E-03	7,00E-01
635	5,20E-02	7,29E-02	9,76E-02	8,66E-02	6,43E-03	6,84E-01

Annex A.23
Unilateral Degrees of Equivalence of participating NMI

D_i

KA102- 1 1 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	-2,50E-04	4,21E-04	-3,79E-04	-9,89E-04	-3,79E-04	1,65E-04
465	-2,04E-04	5,47E-04	-3,53E-04	-9,63E-04	-3,24E-04	-7,51E-05
546	-2,35E-04	5,92E-04	-3,08E-04	-1,01E-03	-3,43E-04	-2,24E-04
590	-7,60E-04	5,52E-04	-3,48E-04	-1,06E-03	-3,56E-04	-1,35E-04
635	-1,39E-04	6,10E-04	-2,90E-04	-8,00E-04	-2,14E-04	-4,84E-04

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	-1,63E-03	2,38E-03	-1,82E-03	-4,83E-03	-2,08E-03	9,86E-04
465	-1,35E-03	2,25E-03	-1,65E-03	-4,26E-03	-1,70E-03	9,51E-04
546	-9,14E-04	2,02E-03	-1,78E-03	-4,19E-03	-1,42E-03	8,38E-04
590	-4,01E-04	1,66E-03	-1,84E-03	-3,95E-03	-1,29E-03	8,06E-04
635	-2,18E-04	1,40E-03	-1,60E-03	-3,41E-03	-1,03E-03	8,30E-04

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,47E-03	-1,21E-03	-2,31E-03	-2,15E-04	2,29E-03	1,34E-03
465	2,39E-03	-1,09E-03	-2,19E-03	2,24E-04	1,94E-03	1,04E-03
546	4,26E-04	-3,06E-04	-2,01E-03	-5,96E-04	2,73E-04	8,71E-04
590	-5,45E-04	1,70E-04	-1,53E-03	-2,40E-04	3,10E-05	7,89E-04
635	-8,38E-04	2,88E-04	-1,21E-03	-5,02E-04	-4,04E-04	8,01E-04

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	1,18E-03	-6,34E-04	-4,43E-03	3,66E-04	1,37E-03	3,66E-04
280	-1,74E-04	5,15E-04	-3,28E-03	-2,28E-03	-2,85E-04	7,15E-04
340	1,20E-03	2,00E-03	-1,70E-03	8,99E-04	1,26E-03	-1,01E-04
360	4,09E-04	2,17E-03	-2,53E-03	5,94E-04	1,06E-03	-2,61E-05
400	4,78E-04	2,46E-03	-2,24E-03	6,79E-04	8,55E-04	-1,59E-04
440	-5,26E-04	2,55E-03	-1,85E-03	9,25E-04	9,30E-04	-1,93E-04
465	-6,43E-04	2,37E-03	-1,73E-03	9,35E-04	1,03E-03	-6,51E-05
500	-1,57E-03	2,33E-03	-1,67E-03	1,10E-03	1,09E-03	-1,70E-04
546	4,68E-04	1,67E-03	-2,33E-03	4,28E-04	1,89E-04	1,68E-04
590	7,76E-04	1,78E-03	-1,92E-03	5,56E-04	5,20E-04	-2,30E-05
635	8,57E-04	1,76E-03	-1,64E-03	6,27E-04	6,41E-04	-7,38E-05

Annex A.24
Unilateral Degrees of Equivalence of participating NMI

D_i

KA102- 1 2 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	7,81E-05	4,44E-04	-5,56E-04	4,32E-06	-2,50E-04	3,76E-04
465	6,23E-05	4,52E-04	-4,48E-04	-2,79E-05	-2,18E-04	6,72E-05
546	5,79E-05	5,79E-04	-5,21E-04	-3,10E-05	-2,60E-04	-1,86E-06
590	6,22E-05	6,05E-04	-5,95E-04	-5,45E-06	-2,02E-04	-5,84E-05
635	8,96E-07	6,36E-04	-4,64E-04	-2,84E-04	-8,02E-05	-5,19E-04

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	1,37E-04	3,11E-03	-1,09E-03	-2,93E-04	-7,00E-04	-2,93E-04
465	-3,25E-04	2,23E-03	-1,47E-03	-4,72E-04	-1,10E-03	7,68E-06
546	-2,12E-04	2,07E-03	-1,53E-03	-7,26E-04	-8,43E-04	6,86E-05
590	-8,59E-05	2,01E-03	-1,89E-03	-1,09E-03	-5,75E-04	1,90E-04
635	-4,47E-05	1,75E-03	-2,05E-03	6,52E-04	-3,81E-04	1,44E-04

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	2,29E-03	-3,98E-04	-2,60E-03	-6,78E-05	9,02E-04	9,02E-04
465	1,38E-03	-9,86E-04	-2,79E-03	-7,96E-04	3,14E-04	1,44E-03
546	-2,71E-04	-1,50E-04	-2,25E-03	-1,74E-03	6,51E-04	1,43E-03
590	-1,10E-03	4,93E-04	-1,91E-03	-1,04E-03	6,29E-04	1,38E-03
635	-1,36E-03	5,13E-04	-1,79E-03	-9,87E-04	7,35E-05	1,53E-03

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	1,18E-03	-7,98E-04	-4,90E-03	1,30E-03	2,30E-03	1,30E-03
280	9,65E-04	9,88E-04	-3,01E-03	3,88E-04	2,39E-03	3,88E-04
340	1,12E-03	1,68E-03	-1,92E-03	5,17E-05	1,43E-03	-1,83E-05
360	1,29E-03	1,94E-03	-2,06E-03	-1,74E-03	1,44E-03	2,40E-04
400	5,71E-04	2,12E-03	-1,68E-03	-9,47E-04	1,27E-03	1,74E-04
440	-5,96E-04	2,26E-03	-1,54E-03	-1,50E-03	1,12E-03	4,82E-04
465	-2,44E-04	2,26E-03	-1,44E-03	-8,11E-04	1,32E-03	4,69E-05
500	4,78E-04	1,78E-03	-1,22E-03	-1,69E-03	1,09E-03	-1,34E-04
546	1,55E-03	2,25E-03	-1,15E-03	-1,35E-03	1,35E-03	2,18E-04
590	1,15E-03	1,65E-03	-1,35E-03	-1,62E-03	9,42E-04	7,20E-05
635	1,10E-03	1,50E-03	-1,50E-03	-4,61E-04	9,31E-04	2,02E-05

Annex A.25
U (DoE) ; *k*=2

KA102- 1 1 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	5,05E-03	4,04E-04	3,33E-04	2,38E-03	2,07E-04	7,19E-04
465	5,05E-03	4,20E-04	3,35E-04	2,38E-03	2,09E-04	7,18E-04
546	5,05E-03	4,30E-04	3,32E-04	2,38E-03	2,09E-04	7,16E-04
590	5,05E-03	4,20E-04	3,39E-04	2,38E-03	2,10E-04	7,18E-04
635	5,05E-03	4,28E-04	3,41E-04	2,38E-03	2,13E-04	7,15E-04

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	5,11E-03	2,23E-03	1,96E-03	2,48E-03	1,13E-03	1,24E-03
465	4,82E-03	2,01E-02	1,96E-02	2,14E-02	1,60E-02	1,58E-02
546	5,03E-03	2,14E-02	2,08E-02	2,28E-02	1,55E-02	1,53E-02
590	5,17E-03	2,21E-02	2,15E-02	2,35E-02	1,51E-02	1,50E-02
635	5,29E-03	2,27E-02	2,19E-02	2,40E-02	1,54E-02	1,52E-02

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
440	5,24E-03	8,51E-03	8,24E-03	8,11E-03	6,78E-03	6,80E-03
465	5,22E-03	8,53E-03	8,27E-03	8,13E-03	6,74E-03	6,76E-03
546	4,96E-03	8,92E-03	8,67E-03	8,58E-03	5,79E-03	5,78E-03
590	5,08E-03	8,89E-03	8,62E-03	8,56E-03	6,59E-03	6,58E-03
635	5,13E-03	8,96E-03	8,68E-03	8,65E-03	6,88E-03	6,85E-03

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC “Institute of Metrology”
250	5,02E-03	4,28E-03	4,24E-03	4,15E-03	1,83E-03	1,83E-03
280	5,11E-03	4,33E-03	4,27E-03	4,14E-03	2,44E-03	2,43E-03
340	5,00E-03	4,15E-03	4,13E-03	4,06E-03	1,57E-03	1,57E-03
360	5,05E-03	4,21E-03	4,17E-03	4,05E-03	2,03E-03	2,04E-03
400	5,23E-03	4,16E-03	4,10E-03	3,77E-03	2,68E-03	2,69E-03
440	5,23E-03	4,26E-03	4,19E-03	3,86E-03	2,74E-03	2,74E-03
465	5,21E-03	4,29E-03	4,23E-03	3,89E-03	2,69E-03	2,69E-03
500	5,02E-03	4,50E-03	4,60E-03	4,30E-03	1,50E-03	1,50E-03
546	5,02E-03	4,48E-03	4,46E-03	4,29E-03	1,65E-03	1,65E-03
590	5,02E-03	4,35E-03	4,33E-03	4,16E-03	1,59E-03	1,59E-03
635	5,03E-03	5,86E-03	5,39E-03	4,33E-03	1,46E-03	1,49E-03

Annex A.26
U (DoE); *k*=2

KA102- 1 2 nm

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	5,06E-03	1,06E-02	1,02E-02	5,07E-02	8,37E-03	1,87E-02
465	5,06E-03	1,06E-02	1,01E-02	5,02E-02	8,25E-03	1,87E-02
546	5,06E-03	1,04E-02	9,84E-03	4,91E-02	8,05E-03	1,83E-02
590	5,06E-03	1,03E-02	9,91E-03	4,90E-02	8,04E-03	1,82E-02
635	5,06E-03	1,05E-02	9,98E-03	4,96E-02	8,11E-03	1,84E-02

KA102- 3

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	5,02E-03	9,55E-02	9,28E-02	9,72E-02	5,01E-02	5,02E-02
465	4,89E-03	9,41E-02	9,14E-02	9,59E-02	4,99E-02	5,00E-02
546	5,10E-03	9,04E-02	8,77E-02	9,23E-02	4,77E-02	4,77E-02
590	5,22E-03	8,84E-02	8,57E-02	9,04E-02	4,67E-02	4,67E-02
635	5,35E-03	8,65E-02	8,39E-02	8,85E-02	4,54E-02	4,54E-02

KA102- 4

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
440	5,04E-03	1,12E-01	1,08E-01	1,07E-01	7,95E-02	7,95E-02
465	5,02E-03	1,11E-01	1,07E-01	1,06E-01	7,71E-02	7,71E-02
546	5,01E-03	1,07E-01	1,03E-01	1,02E-01	7,38E-02	7,38E-02
590	5,30E-03	9,99E-02	9,64E-02	9,62E-02	8,18E-02	8,18E-02
635	5,34E-03	9,70E-02	9,37E-02	9,37E-02	8,07E-02	8,07E-02

KA102- 7

λ (nm)	INIMET	INMETRO 1	INMETRO 2	BelGIM	SMU	NSC "Institute of Metrology"
250	5,17E-03	5,41E-03	4,86E-03	4,21E-03	2,35E-03	2,74E-03
280	5,12E-03	5,34E-03	4,79E-03	4,13E-03	2,17E-03	2,59E-03
340	5,03E-03	5,30E-03	4,73E-03	4,04E-03	1,80E-03	2,04E-03
360	5,00E-03	5,24E-03	4,68E-03	4,00E-03	1,71E-03	2,07E-03
400	5,29E-03	5,25E-03	4,68E-03	3,47E-03	2,26E-03	2,50E-03
440	5,29E-03	5,14E-03	4,59E-03	3,38E-03	2,17E-03	2,41E-03
465	5,28E-03	5,21E-03	4,67E-03	3,46E-03	2,23E-03	2,47E-03
500	5,08E-03	5,28E-03	5,11E-03	3,50E-03	1,76E-03	1,94E-03
546	4,99E-03	5,43E-03	4,92E-03	3,73E-03	1,47E-03	1,64E-03
590	4,99E-03	5,28E-03	4,75E-03	3,53E-03	1,33E-03	1,51E-03
635	4,99E-03	5,27E-03	4,74E-03	3,51E-03	1,37E-03	1,55E-03

ANNEX B

Annex B.1
GP "Ukrmeterteststandard"Ukraine

Make and type of the spectrophotometer

The double beam spectrophotometer was used for this comparison. The optical unit includes: Pre-aligned tungsten-halogen lamp and deuterium lamp (lifetime counter) with automatic source change and a source doubling mirror for improved UV/Vis/NIR energy; Reflecting optical system (SiO2 coated) with holographic grating monochromator with 1440 lines/mm UV/Vis blazed at 240 nm and 360 lines/mm NIR blazed at 1100 nm, Littrow mounting, sample thickness compensated detector optics; Chopper (46+ Hz, Cycle: Dark/Sample/Dark/Reference, Chopper Segment Signal Correction); Photomultiplier R6872 for high energy in the entire UV/Vis wavelength range.

Method of characterization of the spectrophotometer

For compensation of the effect of polarization on the mirror coating of the filter was used depolariser. For correction systematic error was applied a technique called double aperture correction. Before measuring the filters were cleaned according to the standard procedure adopted in the laboratory. Filters were mounted in the sample holder. The transmittance was measured relative to air.

Description of measuring technique

The spectrophotometer is contained in a light-tight room. The temperature inside the room remained at (20 ± 1) °C, the relative humidity varied between 40 % and 62 %.

Uncertainties

The uncertainties are absolute uncertainties

Table 14 Type A uncertainties

	1 nm			2 nm		
λ(nm)	KA 102- 1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	1,09E-06	6,20E-06	1,15E-05	1,81E-06	6,72E-06	1,09E-05
465	2,09E-06	4,28E-06	6,33E-06	1,64E-06	6,86E-06	1,05E-05
546	1,78E-06	5,44E-06	3,93E-06	1,44E-06	6,63E-06	8,53E-06
590	1,44E-06	1,26E-05	7,56E-06	1,34E-06	6,09E-06	8,43E-06
635	1,80E-06	5,24E-06	1,10E-05	1,72E-06	7,95E-06	2,61E-05

	1 nm	2nm
λ(nm)	KA 102- 7	
250	1,10E-04	2,03E-05
280	2,71E-05	2,57E-05
340	2,43E-05	2,60E-05
360	2,01E-05	3,04E-05
400	1,94E-05	1,34E-05
440	1,93E-05	1,19E-05
465	1,64E-05	9,95E-06
500	--	--
546	9,59E-06	6,50E-06
590	1,33E-05	1,64E-05
635	2,15E-05	1,65E-05

Table 16 Type B uncertainties

	1 nm			2 nm		
λ(nm)	KA 102- 1	KA 102- 3	KA 102- 4	KA 102- 1	KA 102- 3	KA 102- 4
440	6,00E-04	1,80E-03	1,80E-03	5,10E-04	1,70E-03	1,80E-03
465	6,00E-04	1,80E-03	1,80E-03	5,10E-04	1,70E-03	1,80E-03
546	6,00E-04	1,80E-03	1,80E-03	5,10E-04	1,70E-03	1,80E-03
590	6,00E-04	1,80E-03	1,80E-03	5,10E-04	1,70E-03	1,80E-03
635	6,00E-04	1,80E-03	1,80E-03	5,10E-04	1,70E-03	1,80E-03

	1 nm	2nm
λ(nm)	KA 102- 7	
250	1,00E-03	1,00E-03
280	1,00E-03	1,00E-03
340	1,00E-03	1,00E-03
360	1,00E-03	1,00E-03
400	7,00E-04	1,10E-03
440	7,00E-04	1,10E-03
465	7,00E-04	1,10E-03
500	--	--
546	7,00E-04	1,10E-03
590	7,00E-04	1,10E-03
635	7,00E-04	1,10E-03

Note: The laboratory didn’t carry out measurements to 500 nm

Measurement results

1 nm

λ (nm)	KA102- 1	KA102- 3	KA102- 4
440	4,78E-02	3,21E-01	4,98E-01
465	4,83E-02	3,19E-01	4,95E-01
546	4,94E-02	3,12E-01	4,85E-01
590	4,96E-02	3,09E-01	4,79E-01
635	4,93E-02	3,05E-01	4,73E-01

λ (nm)	KA102- 7
250	9,16E-01
280	9,22E-01
340	9,27E-01
360	9,29E-01
400	9,31E-01
440	9,33E-01
465	9,33E-01
500	------
546	9,34E-01
590	9,35E-01
635	9,35E-01

2 nm

λ (nm)	KA102- 1	KA102- 3	KA102- 4
440	4,80E-02	3,21E-01	4,99E-01
465	4,86E-02	3,19E-01	4,95E-01
546	4,97E-02	3,12E-01	4,85E-01
590	4,98E-02	3,09E-01	4,79E-01
635	4,96E-02	3,05E-01	4,73E-01

λ (nm)	KA102- 7
250	9,15E-01
280	9,21E-01
340	9,26E-01
360	9,28E-01
400	9,30E-01
440	9,32E-01
465	9,33E-01
500	
546	9,34E-01
590	9,35E-01
635	9,35E-01

Note: The laboratory didn’t carry out measurements to 500 nm