

Rapport *Report*

Mesure du facteur de transmission spectral d'un lot de
5 filtres étalons réalisé dans le cadre de la
comparaison clef CCPR-K6-2012

*Measurement of spectral transmittance of five
standard filters within the framework of
CCPR-K6-2012 key comparison*

Round 2

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1. Description of the measurement facility :

The LNE-CNAM reference spectrophotometer for transmittance measurements is a self-built facility composed primarily of a source, a monochromator, a beam forming chamber with a filter holder and a detector chamber (Figure 1). According to the wavelength, a Xenon lamp or a QTH lamp is used. The image of the filament is formed at the entrance slit of the monochromator with two lenses. Between the lenses the beam is collimated and band filters are used to suppress higher orders. These filters are colored glass filters from the SFK filters collection from Schott. They are band pass filters with a half width at half the maximum ranging between 25 nm to 60 nm. To reduce the "in band" straylight, the aperture is adjusted to avoid having light outside the grating. The "out band" straylight was checked using long pass, sharp cut-off, coloured glass filters at various wavelengths.

The wavelength is controlled by a high resolution Jobin Yvon single grating monochromator. The focal distance of the spherical mirrors of the Czerny-Turner mount is 1500 mm and the numerical aperture is F/12. For the full spectral range 380 nm to 1000 nm, the grating is an engraved grating with 1200 groves per mm which, combined with the slit size, gives a band pass of 0.55 nm. The resolution obtained with the stepper motor is 0.0035 nm.

Two spherical mirrors are used to relay the light to the detector and avoid chromatics aberrations and back reflections. Between the mirrors, the light beam is collimated and goes through the filter to be measured. The beam spot on the filters is 20 mm diameter circle.

The filter chamber is temperature controlled at $23 \pm 0,5$ °C.

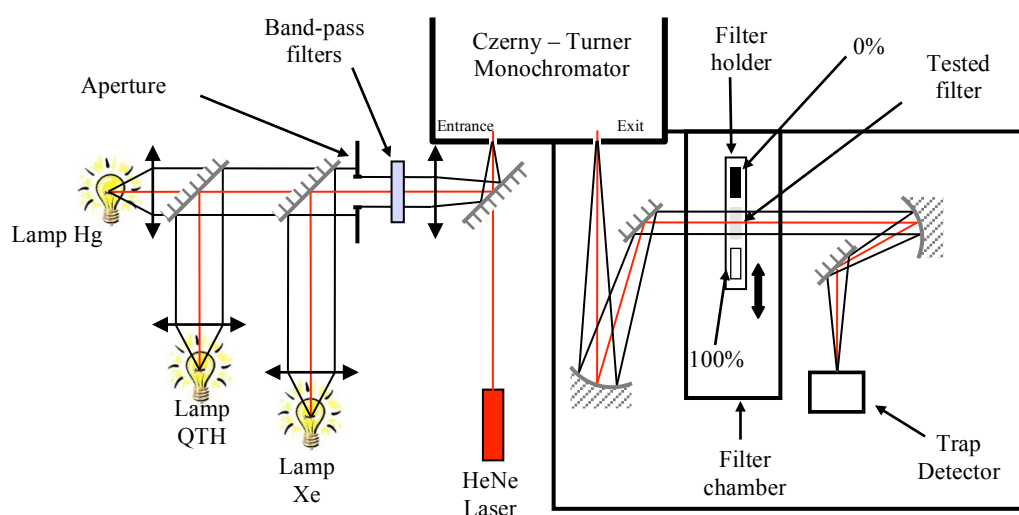


Figure 1 – Schematic drawing of the reference spectrometer.

2. Description of the measurement technique

The filter holder is mounted on a translation stage, to allow the measurement of the reference beam (100%) and the black (0%). The detector used is a self-build trap radiometer made with 3 large size silicon photodiodes (Hamamatsu 1337).

One cycle consists of sequence $\langle R_1 \rangle - \langle F_1 \rangle - \langle 0 \rangle - \langle F_2 \rangle - \langle R_2 \rangle$ were

$\langle R_i \rangle$ is a measurement of the reference beam

$\langle F_i \rangle$ is a measurement of the filter

$\langle 0 \rangle$ is a measurement of the black

The symmetry of the sequence allows to compensate a drift of the lamp radiation. For filters A, B and C, the reference beam is the 100%. For filters D and E we use a step down method with filter C as the reference beam.

An individual measurement is made of 4 or 5 cycles. For each measurement, we reported in table 3, 5, 7, 9 and 11 :

$\tau(\lambda)$, the average transmittance on the N cycles

$\sigma(\lambda)$ is standard deviation on the transmittance on the N cycles.
For each filter, and each wavelength, we made 3 measurements.

3. Description of the calibration conditions

The samples were not cleaned. Only dust stemming from the transportation box was blown off by clean and dry air.

During the measurement, the filter chamber is temperature controlled at $23 \pm 0,5$ °C. The relative humidity was monitored and laid below 60%.

In Table1, we reported the calibrations conditions

Table1 – Calibrations conditions

Wavelength (nm)	380	400	500	600	700	800	900	1000
Lamp type	Xe	Xe	QTH	QTH	QTH	QTH	QTH	QTH
Bandwith (nm)	0,55	0,55	0,55	0,55	0,55	0,55	0,55	0,55
Grating (tr/mm)	1200	1200	1200	1200	1200	1200	1200	1200
Cut of filter	SFK4	SFK5	SFK9	SFK13	SFK17	OO800	OO900	OO1000
Detector	P-99-S	P-99-S	P-99-S	P-99-S	P-99-S	P-99-S	P-99-S	P-99-S
Beam diameter (mm)	20	20	20	20	20	20	20	20

4. Uncertainties

Listed in table 4, 6, 8, 10 and 12 are the value for the reproducibility and estimates for the main sources of uncertainty for respectively the Filter A, B, C, D and E.

Wavelength :

The uncertainty in the wavelength setting is dependent on the wavelength and the bandwidth and is estimated in the following table

Table2 – Standard uncertainty on the wavelength calibration (k=1)

λ (nm)	380	400	500	600	700	800	900	1000
u_{λ} (nm)	0,020	0,014	0,011	0,010	0,009	0,010	0,012	0,014

The uncertainty component is calculated by deducting the slope of the transmittance of the filters from the measurement available.

Nonlinearity

The uncertainty for the nonlinearity correction is calculated from the uncertainty of the coefficients for the calculation of the correction factor.

Inter-reflections

The uncertainty due to the interreflections comes from the light reflected in the set-up and is estimated at $5 \cdot 10^{-5}$ of the transmittance value (rectangular distribution).

Obliquity effect

The uncertainty due to an obliquity of the incident beam is calculated with angle of 1° reduced by a refractive index of 1,5.

Straylight

The uncertainty due to the straylight is estimated at $5 \cdot 10^{-5}$ of the incident flux (rectangular distribution). The filters are assumed to be neutral in the spectral bandpath of the measurement and the effect is considered independent of the wavelength.

Polarisation

The uncertainty coming from the polarisation of light is calculated for an angle of 0,3° between the filter and the light beam. It is found to be negligible.

Temperature

The temperature in the filter chamber is controlled at 23°C ± 0,5°C.

A correction has been applied to the transmittance value in agreement with the recommendation of the pilot lab.

The correction is calculated using the relative temperature coefficients, κ , measured at MSL for filter set 19 from the first CCPR-K6 comparison. Knowing the transmittance τ_x at x °C, the corrected transmittance at 23 °C, τ_{23} , is given by

$$\tau_{23} = \tau_x + \kappa(23 - x)\tau_x$$

Temperature Coefficient, κ , at 23°C (Relative change in transmittance per degree Celsius)

Wavelength (nm)	Filter Type 2 NG 11, 2.5 mm	Filter Type 3 NG 5, 3.9 mm	Filter Type 4 NG 4, 3.9 mm	Filter Type 5 NG3, 3.1 mm
380	-1.14E-04	-5.23E-04	-1.09E-03	-1.58E-03
400	-1.67E-04	-9.00E-04	-2.05E-03	-3.16E-03
500	6.42E-05	3.72E-04	7.58E-04	1.12E-03
600	1.72E-04	1.02E-03	1.94E-03	2.84E-03
700	8.54E-05	4.00E-04	8.13E-04	1.21E-03
800	4.47E-05	1.72E-04	3.17E-04	4.36E-04
900	1.93E-05	6.93E-05	1.17E-04	1.50E-04
1000	-7.31E-05	-2.55E-04	-4.10E-04	-8.00E-04

No uncertainty component has been taken for that correction because it has been found negligible.

Beam size and position

The beam size is circular 20mm, adjusted at the middle of the filter. The effect of the position has not been tested. however it is accounted indirectly in the measurement reproducibility.

Fluctuation

The SFK filters used to suppress high order light have a strong spectral displacement with the temperature. A thermal stabilization of 10 mn is used to minimize this effect. The uncertainty component is calculated from the maximum deviation of the reference beam

$$u_{SFK} = \frac{\max\{R_{1,k} - R_{2,k}\}_{k=1,N}}{2\sqrt{N}(R_{1,k} + R_{2,k})}$$

where ,

$R_{1,k}$ and $R_{2,k}$ are respectively the measurement values of the reference before and after the measurement on the filter

k is the cycle

N is the total number of cycles

This component is not negligible and is reported in the tables.

Bandwidth

The bandwidth has been set at 0,55nm for the measurements. The bandwidth effects are estimated to be negligible for these spectrally neutral filters over most of the wavelength range. For $\lambda = 380$ nm, an additional component of 1.10^{-4} of the transmittance has been applied, due to the important spectral selectivity

5. Results

Listed in the tables below are the results for the calibration of filters A, B, C, D and E for the Round 2 of CCPR-K6-2012.

Filter A
Nominal transmittance 92%

Table 3 : Intermediate results for sample A

$\overline{\tau(\lambda)}$ $\sigma_{\tau(\lambda)}$ DoF	Date jj/mm/yy	λ nm	$\tau(\lambda)$	σ_{rel} %	N	T °C
0,9127 3,6E-04 9	26/11/13	380	0,9131	0,15%	5	22,9
	27/11/13	380	0,9125	0,07%	5	23,0
	29/11/13	380	0,9124	0,11%	5	23,0
0,9144 1,8E-04 7	26/11/13	400	0,9145	0,08%	5	22,9
	27/11/13	400	0,9144	0,15%	5	23,1
	29/11/13	400	0,9142	0,06%	5	23,0
0,9171 1,2E-04 10	26/11/13	500	0,9172	0,06%	5	22,9
	27/11/13	500	0,9169	0,11%	5	23,1
	29/11/13	500	0,9171	0,11%	5	23,0
0,9184 8,5E-05 9	26/11/13	600	0,9183	0,06%	5	22,9
	27/11/13	600	0,9183	0,12%	5	23,1
	29/11/13	600	0,9184	0,10%	5	23,0
0,9194 1,9E-05 5	26/11/13	700	0,9194	0,06%	4	23,0
	27/11/13	700	0,9195	0,02%	5	23,2
0,9203 4,4E-05 6	26/11/13	800	0,9204	0,08%	5	23,0
	27/11/13	800	0,9203	0,02%	5	23,2
	29/11/13	800	0,9203	0,04%	5	22,9
0,9205 1,4E-04 7	26/11/13	900	0,9204	0,11%	5	22,9
	27/11/13	900	0,9206	0,02%	5	23,2
	29/11/13	900	0,9206	0,06%	5	22,9
0,9209 6,1E-05 11	26/11/13	1000	0,9209	0,02%	5	22,9
	27/11/13	1000	0,9210	0,03%	5	23,2
	29/11/13	1000	0,9208	0,03%	4	22,9

Table 4 : Final results for sample A

λ	380	400	500	600	700	800	900	1000
$\overline{\tau(\lambda)}$	0,9127	0,9144	0,9171	0,9184	0,9194	0,9203	0,9205	0,9209
Reproducibility	2,1E-04	1,0E-04	6,9E-05	4,9E-05	1,3E-05	2,6E-05	8,2E-05	3,5E-05
Wavelength	1,7E-06	5,0E-07	2,3E-07	1,2E-07	9,3E-08	5,5E-08	3,3E-08	5,3E-08
Non Linearity	3,7E-05	3,6E-05	3,5E-05	3,4E-05	3,4E-05	3,4E-05	3,4E-05	3,3E-05
Inter-reflexion	2,6E-05	2,6E-05	2,6E-05	2,7E-05	2,7E-05	2,7E-05	2,7E-05	2,7E-05
Obliquity	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00
Straylight	5,3E-05	5,3E-05	5,3E-05	5,3E-05	5,3E-05	5,3E-05	5,3E-05	5,3E-05
SFK	3,3E-04	1,4E-04	7,6E-05	1,5E-04	5,6E-05	6,5E-05	6,0E-05	2,8E-05
Bandwidth	9,1E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00
Cascade	---	---	---	---	---	---	---	---
Total	5,0E-04	2,0E-04	2,0E-04	2,0E-04	1,0E-04	1,0E-04	2,0E-04	1,0E-04
DoF	9	7	10	9	5	6	7	11

Filter B
Nominal transmittance 56%

Table 5 : Intermediate results for sample B

$\overline{\tau(\lambda)}$ $\sigma_{\tau(\lambda)}$ DoF	Date jj/mm/yy	λ nm	$\tau(\lambda)$	σ_{rel} %	N	T °C
0,4094 1,7E-04 11	2/12/13	380	0,4095	0,13%	5	23,0
	3/12/13	380	0,4092	0,14%	5	23,0
	3/12/13	380	0,4096	0,10%	4	23,1
0,6075 2,2E-04 11	2/12/13	400	0,6077	0,11%	5	23,0
	3/12/13	400	0,6073	0,08%	5	23,0
	3/12/13	400	0,6076	0,10%	5	23,1
0,6216 2,8E-05 6	2/12/13	500	0,6216	0,18%	5	23,0
	3/12/13	500	0,6215	0,08%	5	23,3
	3/12/13	500	0,6216	0,04%	5	23,4
0,6095 4,9E-05 9	2/12/13	600	0,6094	0,05%	5	23,0
	3/12/13	600	0,6095	0,12%	4	23,4
	3/12/13	600	0,6095	0,09%	5	23,3
0,6372 7,8E-05 7	2/12/13	700	0,6372	0,07%	4	23,0
	3/12/13	700	0,6371	0,12%	4	23,4
	3/12/13	700	0,6373	0,03%	5	23,3
0,5767 2,7E-05 4	2/12/13	800	0,5767	0,01%	5	23,0
	3/12/13	800	0,5767	0,12%	5	23,4
	3/12/13	800	0,5767	0,02%	5	23,2
0,5017 3,4E-05 4	2/12/13	900	0,5017	0,01%	5	23,0
	3/12/13	900	0,5018	0,06%	5	23,4
	3/12/13	900	0,5017	0,01%	5	23,2
0,4533 4,2E-05 5	2/12/13	1000	0,4533	0,03%	5	23,0
	3/12/13	1000	0,4534	0,07%	4	23,4
	3/12/13	1000	0,4533	0,01%	5	23,2

Table 6 : Final results for sample B

λ	380	400	500	600	700	800	900	1000
$\overline{\tau(\lambda)}$	0,4094	0,6075	0,6216	0,6095	0,6372	0,5767	0,5017	0,4533
Reproducibility	9,7E-05	1,2E-04	1,6E-05	2,8E-05	4,5E-05	1,5E-05	1,9E-05	2,4E-05
Wavelength	2,0E-04	2,4E-05	1,1E-07	7,7E-07	1,5E-06	6,8E-06	7,2E-06	6,8E-06
Non Linearity	7,7E-05	1,1E-04	1,1E-04	1,1E-04	1,1E-04	1,1E-04	1,1E-04	7,9E-05
Inter-reflexion	1,2E-05	1,8E-05	1,8E-05	1,8E-05	1,8E-05	1,7E-05	1,4E-05	1,3E-05
Obliquity	8,2E-06	6,8E-06	6,7E-06	6,8E-06	6,5E-06	7,2E-06	7,8E-06	8,1E-06
Straylight	2,4E-05	3,5E-05	3,6E-05	3,5E-05	3,7E-05	3,3E-05	2,9E-05	2,6E-05
SFK	4,2E-04	8,4E-05	6,0E-05	9,3E-05	6,1E-05	3,5E-05	2,4E-05	2,4E-05
Bandwidth	4,1E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00
Cascade	---	---	---	---	---	---	---	---
Total	5,0E-04	2,0E-04	2,0E-04	2,0E-04	2,0E-04	2,0E-04	2,0E-04	1,0E-04
DoF	11	11	6	9	7	4	4	5

Filter C
Nominal transmittance 10%

Table 7 : Intermediate results for sample C

$\overline{\tau(\lambda)}$ $\sigma_{\tau(\lambda)}$ DoF	Date jj/mm/yy	λ nm	$\tau(\lambda)$	σ_{rel} %	N	T °C
0,02163 5,0E-06 11	4/12/13	380	0,02163	0,15%	5	23,2
	5/12/13	380	0,02163	0,11%	5	23,1
	5/12/13	380	0,02162	0,12%	4	23,3
0,09538 9,8E-06 12	4/12/13	400	0,09539	0,07%	5	23,3
	5/12/13	400	0,09539	0,09%	5	23,2
	5/12/13	400	0,09537	0,08%	4	23,2
0,09191 1,3E-05 9	4/12/13	500	0,09190	0,06%	5	23,3
	4/12/13	500	0,09192	0,08%	5	23,0
	5/12/13	500	0,09190	0,12%	5	23,2
0,07704 2,1E-05 7	4/12/13	600	0,07706	0,04%	5	23,2
	4/12/13	600	0,07705	0,06%	5	23,0
	5/12/13	600	0,07702	0,11%	5	23,3
0,16118 1,3E-05 9	4/12/13	700	0,16119	0,04%	5	23,1
	4/12/13	700	0,16119	0,06%	5	23,0
	5/12/13	700	0,16117	0,09%	5	23,3
0,14995 2,1E-05 10	4/12/13	800	0,14993	0,07%	5	23,1
	4/12/13	800	0,14993	0,04%	5	23,0
	5/12/13	800	0,14997	0,06%	5	23,3
0,10276 1,9E-05 9	4/12/13	900	0,10277	0,16%	5	23,0
	4/12/13	900	0,10277	0,05%	5	23,0
	5/12/13	900	0,10273	0,17%	5	23,3
0,07648 2,0E-06 5	4/12/13	1000	0,07648	0,04%	5	23,0
	4/12/13	1000	0,07648	0,02%	5	23,0
	5/12/13	1000	0,07648	0,12%	5	23,3

Table 8 : Final results for sample C

λ	380	400	500	600	700	800	900	1000
$\overline{\tau(\lambda)}$	0,02163	0,09538	0,09191	0,07704	0,16118	0,14995	0,10276	0,07648
Reproducibility	2,9E-06	5,7E-06	7,5E-06	1,2E-05	7,3E-06	1,2E-05	1,1E-05	1,1E-06
Wavelength	7,4E-05	8,0E-06	1,0E-06	3,4E-06	3,4E-06	2,9E-06	4,3E-06	3,7E-06
Non Linearity	2,1E-05	7,5E-05	7,2E-05	6,1E-05	1,2E-04	1,1E-04	8,0E-05	6,1E-05
Inter-reflexion	6,2E-07	2,8E-06	2,7E-06	2,2E-06	4,7E-06	4,3E-06	3,0E-06	2,2E-06
Obliquity	1,9E-06	5,1E-06	4,9E-06	4,5E-06	6,6E-06	6,4E-06	5,3E-06	4,4E-06
Straylight	1,2E-06	5,5E-06	5,3E-06	4,4E-06	9,3E-06	8,7E-06	5,9E-06	4,4E-06
SFK	1,2E-05	4,5E-05	6,5E-06	5,6E-06	9,9E-06	6,9E-06	9,7E-06	4,1E-06
Bandwidth	2,2E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00
Cascade	---	---	---	---	---	---	---	---
Total	8,0E-05	9,0E-05	8,0E-05	7,0E-05	1,3E-04	1,2E-04	9,0E-05	7,0E-05
DoF	11	12	9	7	9	10	9	5

Filter D
Nominal transmittance 1%

Table 9 : Intermediate results for sample D

$\overline{\tau(\lambda)}$ $\sigma_{\tau(\lambda)}$ DoF	Date jj/mm/yy	λ nm	$\tau(\lambda)$	σ_{rel} %	N	T °C
3,985E-04	10/12/13	380	3,987E-04	0,59%	5	22,9
7,0E-07	11/12/13	380	3,978E-04	0,64%	5	22,9
11	11/12/13	380	3,991E-04	0,79%	5	23,0
5,486E-03	10/12/13	400	5,484E-03	0,12%	5	23,0
1,5E-06	11/12/13	400	5,486E-03	0,10%	5	23,0
12	11/12/13	400	5,487E-03	0,13%	5	22,9
8,858E-03	10/12/13	500	8,853E-03	0,24%	5	23,0
6,9E-06	11/12/13	500	8,856E-03	0,37%	5	23,0
10	11/12/13	500	8,866E-03	0,26%	5	23,0
8,762E-03	10/12/13	600	8,765E-03	0,14%	5	22,9
1,9E-06	11/12/13	600	8,761E-03	0,14%	5	23,0
12	11/12/13	600	8,762E-03	0,14%	5	23,0
0,02752	10/12/13	700	0,02752	0,03%	5	23,0
8,5E-06	11/12/13	700	0,02751	0,02%	4	23,0
8	11/12/13	700	0,02753	0,06%	5	23,0
0,03337	10/12/13	800	0,03338	0,10%	5	23,1
8,8E-06	11/12/13	800	0,03338	0,14%	5	22,9
11	11/12/13	800	0,03336	0,15%	5	23,0
0,02343	10/12/13	900	0,02343	0,10%	5	22,9
2,7E-06	11/12/13	900	0,02343	0,03%	4	22,9
6	11/12/13	900	0,02343	0,03%	4	22,9
0,01739	10/12/13	1000	0,01739	0,07%	5	22,9
4,2E-06	11/12/13	1000	0,01739	0,07%	5	22,9
10	11/12/13	1000	0,01739	0,04%	5	22,9

Table 10 : Final results for sample D

λ	380	400	500	600	700	800	900	1000
$\overline{\tau(\lambda)}$	3,985E-04	5,486E-03	8,858E-03	8,762E-03	0,02752	0,03337	0,02343	0,01739
Reproducibility	4,0E-07	8,6E-07	4,0E-06	1,1E-06	4,9E-06	5,1E-06	1,5E-06	2,4E-06
Wavelength	5,1E-06	9,6E-07	1,9E-07	9,2E-07	1,2E-06	2,1E-07	9,4E-07	8,5E-07
Non Linearity	1,1E-06	5,0E-06	8,7E-06	8,6E-06	1,8E-05	2,2E-05	2,2E-05	1,7E-05
Inter-reflexion	1,2E-08	1,6E-07	2,6E-07	2,5E-07	7,9E-07	9,6E-07	6,8E-07	5,0E-07
Obliquity	7,0E-08	6,4E-07	9,4E-07	9,4E-07	2,2E-06	2,6E-06	2,0E-06	1,6E-06
Straylight	2,3E-08	3,2E-07	5,1E-07	5,1E-07	1,6E-06	1,9E-06	1,4E-06	1,0E-06
SFK	1,5E-07	8,1E-07	5,6E-07	1,0E-06	2,1E-06	2,0E-06	1,9E-06	1,3E-06
Bandwidth	4,0E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00
Cascade	1,4E-06	5,1E-06	7,1E-06	7,2E-06	2,1E-05	2,5E-05	1,9E-05	1,4E-05
Total	6,0E-06	8,0E-06	1,2E-05	1,2E-05	2,9E-05	3,5E-05	3,0E-05	2,3E-05
DoF	11	12	10	12	8	11	6	10

Filter E
Nominal transmittance 0,1%

Table 11 : Intermediate results for sample E

$\overline{\tau(\lambda)}$ $\sigma_{\tau(\lambda)}$ DoF	Date jj/mm/yy	λ nm	$\tau(\lambda)$	σ_{rel} %	N	T °C
1,153E-05	10/12/13	380	1,165E-05	17,60%	5	22,9
1,1E-07	11/12/13	380	1,150E-05	10,00%	5	22,9
8	11/12/13	380	1,144E-05	27,33%	5	23,0
3,101E-04	10/12/13	400	3,103E-04	0,83%	5	23,0
1,2E-07	11/12/13	400	3,100E-04	0,69%	5	23,0
9	11/12/13	400	3,101E-04	0,35%	5	22,9
8,670E-04	10/12/13	500	8,672E-04	0,15%	5	23,0
1,6E-07	11/12/13	500	8,669E-04	0,14%	5	23,0
11	11/12/13	500	8,671E-04	0,10%	5	23,0
9,285E-04	10/12/13	600	9,288E-04	1,09%	5	22,9
1,2E-06	11/12/13	600	9,294E-04	0,77%	5	23,0
10	11/12/13	600	9,271E-04	0,73%	5	23,0
4,767E-03	10/12/13	700	4,766E-03	0,20%	5	23,0
1,7E-06	11/12/13	700	4,765E-03	0,09%	5	23,0
9	11/12/13	700	4,769E-03	0,14%	5	23,0
9,204E-03	10/12/13	800	9,203E-03	0,33%	5	23,1
7,0E-06	11/12/13	800	9,198E-03	0,10%	5	22,9
7	11/12/13	800	9,212E-03	0,51%	4	23,0
8,014E-03	10/12/13	900	8,015E-03	0,09%	5	22,9
2,3E-06	11/12/13	900	8,016E-03	0,12%	5	22,9
10	11/12/13	900	8,012E-03	0,08%	5	22,9
6,757E-03	10/12/13	1000	6,760E-03	0,07%	5	22,9
3,5E-06	11/12/13	1000	6,759E-03	0,07%	5	22,9
6	11/12/13	1000	6,753E-03	0,20%	5	22,9

Table 12 : Final results for sample E

λ	380	400	500	600	700	800	900	1000
$\overline{\tau(\lambda)}$	1,15E-05	3,10E-04	8,67E-04	9,28E-04	4,767E-03	9,204E-03	8,014E-03	6,757E-03
Reproducibility	6,3E-08	6,9E-08	9,0E-08	6,8E-07	1,0E-06	4,1E-06	1,3E-06	2,0E-06
Wavelength	3,0E-07	9,8E-08	3,5E-08	1,9E-07	3,9E-07	1,6E-07	1,4E-07	1,8E-07
Non Linearity	3,7E-08	9,9E-07	1,6E-06	1,8E-06	4,3E-06	9,1E-06	7,9E-06	6,7E-06
Inter-reflexion	3,3E-10	9,0E-09	2,5E-08	2,7E-08	1,4E-07	2,7E-07	2,3E-07	2,0E-07
Obliquity	3,0E-09	5,7E-08	1,4E-07	1,5E-07	5,7E-07	9,7E-07	8,7E-07	7,6E-07
Straylight	6,7E-10	1,8E-08	5,0E-08	5,4E-08	2,8E-07	5,3E-07	4,6E-07	3,9E-07
SFK	4,4E-09	4,6E-08	5,4E-08	1,1E-07	3,5E-07	5,8E-07	6,2E-07	4,9E-07
Bandwidth	1,2E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00
Cascade	1,6E-07	4,1E-07	1,2E-06	1,2E-06	4,9E-06	9,4E-06	1,0E-05	8,6E-06
Total	4,0E-07	1,1E-06	2,1E-06	2,3E-06	6,7E-06	1,4E-05	1,3E-05	1,1E-05
DoF	8	9	11	10	9	7	10	6