Protocol of the intercomparison at the Laboratoire d'Optique Atmospherique University of Lille, Villeneuve D' Ascq (FRL), from August 31 to September 2, 2004 with the travelling standard spectroradiometer B5503 from ECUV within the project QASUME

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Operator: Josef Schreder

The purpose of the visit was the comparison of global solar irradiance measurements between the spectroradiometer operated by FRL and B5503 within the project QASUME. The measurement site is located at Villeneuve D'Ascq; Latitude 50.612 N, Longitude 3.141 E and altitude 70 m.a.s.l.
The horizon of the measurement site is free in all directions. The local environment is urban (close to large town) and with vegetation on the university campus.

B5503 arrived at Villeneuve D'Ascq in the afternoon of August 31, 2004. The spectroradiometer was installed on the roof of the institute at a distance of about 1 m from the FRL instrument. The spectroradiometer in use at Villeneuve D'Ascq is a Jobin-Yvon HD10 double monochromator equipped with a Teflon diffuser and a bundle fiber. The intercomparison between B5503 and the local spectroradiometer lasted slightly more than 2 days, from the afternoon of August 31 to the evening of September 2.

B5503 was calibrated twice during the intercomparison period using a portable calibration system. Two lamps were used to obtain an absolute spectral calibration traceable to the primary reference held at ECUV which is traceable to PTB: T57825 (100 W) and T61251 (250 W). The responsivity of the instrument based on these calibrations varied by less than 0.2% during the intercomparison. The internal temperature of B5503 was 27.1±0.3°C. The diffuser head was heated to a temperature of about 25±3°C.
The wavelength shifts relative to an extraterrestrial spectrum as retrieved from the SHICRivm analysis were between ± 50pm in the spectral range 310 to 400 nm (see appended graphs).

Protocol:
The measurement protocol was to measure one solar irradiance spectrum every 30 minutes from 290 to 400 nm, every 0.5 nm, and 3 seconds between each wavelength increment.

<u>August 31 (244):</u>
Arrival and setup of the instrument in the late afternoon. After the instrument stabilised, measurements were initiated at 16:30 UT. Weather conditions were broken clouds.

September 1 (245):

Synchronised measurements are available from 6:30 to 16:30 UT and from 17:30 to 18:00 UT. B5503 missed the 17:00 UT scan due to calibration. Weather conditions in the morning and afternoon is cloudless sky; from 10 to 14:30 UT mix of sun and clouds. Measurements from FRL were unsynchronised by about 10 seconds due to a problem with the time keeping of the controlling computer. The problem was fixed at the end of the day.

B5503 calibrated from 16:38 to 17:19 UT.

September 2 (246):

Synchronised measurements are available from 6:00 to 14:00 UT and from 15:00 to 17:00 UT. B5503 missed the 14:30 UT scan due to calibration. Weather conditions were stable with thin cirrus clouds (8 octa sky coverage after 8:00 UT).

B5503 calibrated from 14:06 to 14:50 UT.

Results:

55 synchronised scans are available from the measurement period. The measurements of FRL on September 1 are more noisy than on the following day due to a time keeping problem with the FRL instrument.

The wavelength shifts of the submitted solar spectra of the FRL spectroradiometer retrieved through the SHICRivm analysis varied by 0.05 nm over most of the wavelength range while between 330 and 350 nm the variability was up to 0.15 nm. A discrete change in wavelength shift occurs at 330 nm: At wavelengths shorter than 330 nm the average wavelength shift is about 0.06 nm; between 330 and 375 nm it is around -0.01 nm and between 380 and 390 nm the wavelength shift is 0.04 nm.

The intercomparison of the global irradiance measured by the two instruments can be summarized as follows:

- Global solar irradiances measured by FRL were between 10% lower to 7% higher than those measured by B5503 for wavelengths between 300 and 400 nm.
- The spectral ratios between FRL and B5503 are mostly constant with wavelength. However in the wavelength region 350 to 380 nm a decrease of about 8% occurs with a minimum at 372.5 nm.
- A diurnal variation of the ratios nearly independent of wavelength is observed on both days; On September 1 (245) the ratio at 320 nm increases by 5%, from 0.98 to 1.03 and on September 2 (246), the ratio at 320 nm increases by 4.5%, from 0.99 to 1.035.
- In the morning of both days a wavelength dependent decrease in the ratios of 2% at 395 nm, decreasing with shorter wavelengths (less than 1% at 310 nm) is observed. The SZA range is between 80° and 60° which could be a sign of a variability due to a difference in the directional response of the two instruments.

Conclusion:

On average, the global solar irradiance spectra measured by the FRL spectroradiometer are between 1% higher to 8% lower than those

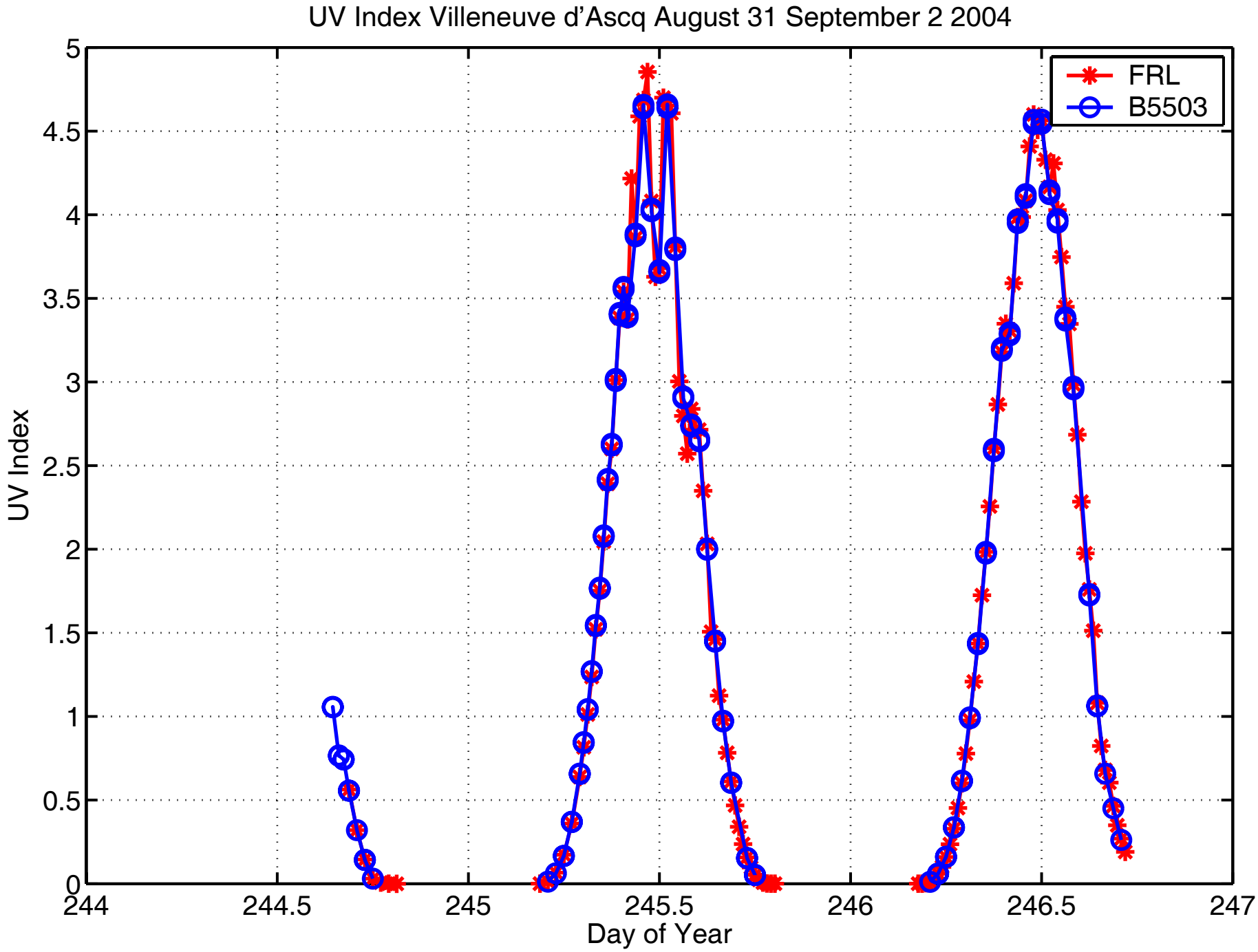
measured by B5503 between 300 and 400 nm. Between 350 and 380 nm the ratios show a dip of up to 8%. The variability between FRL and B5503 is of the order of 9% between 305 and 315 nm, and 8% between 315 and 400 nm.

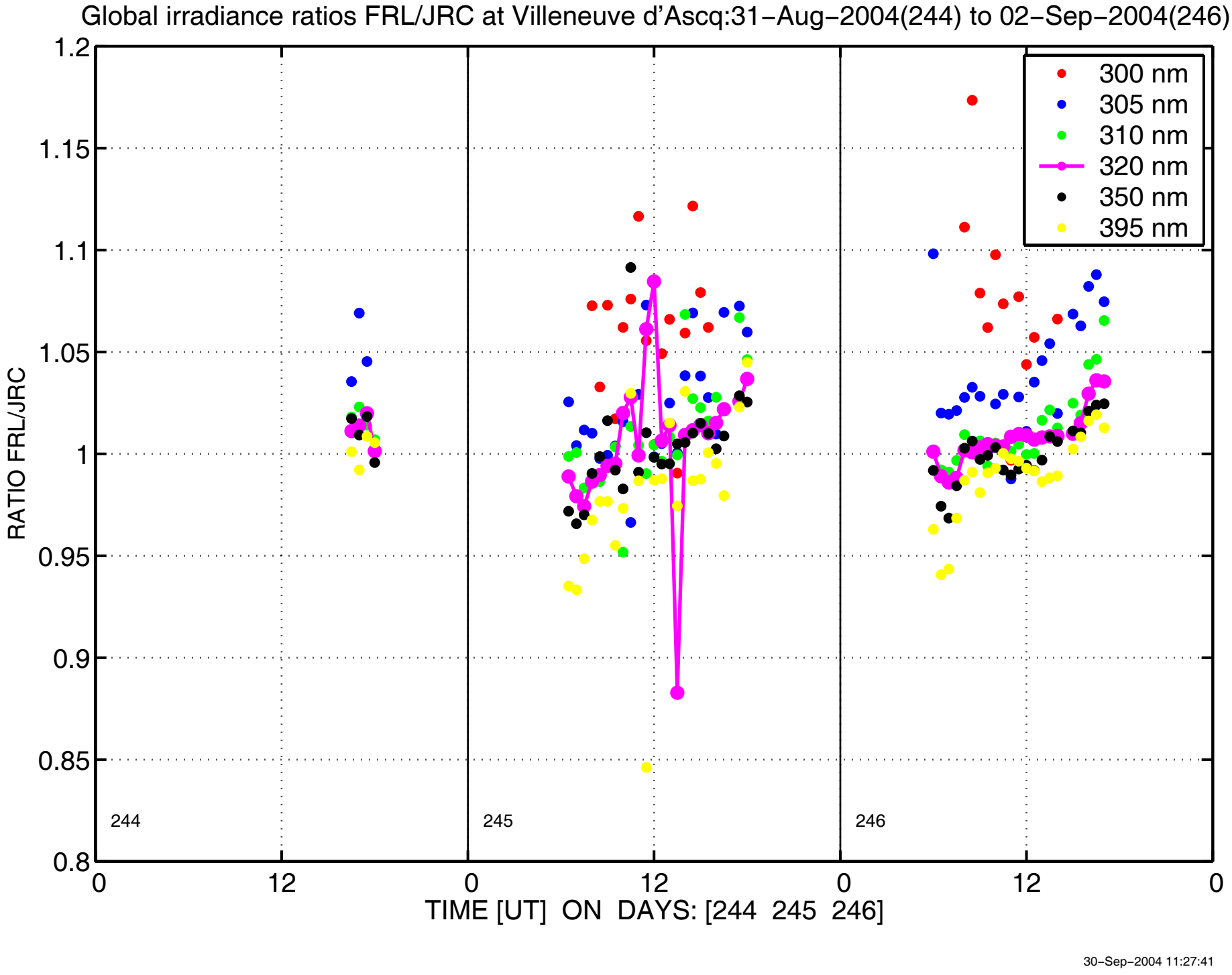
Comments from the local operator:

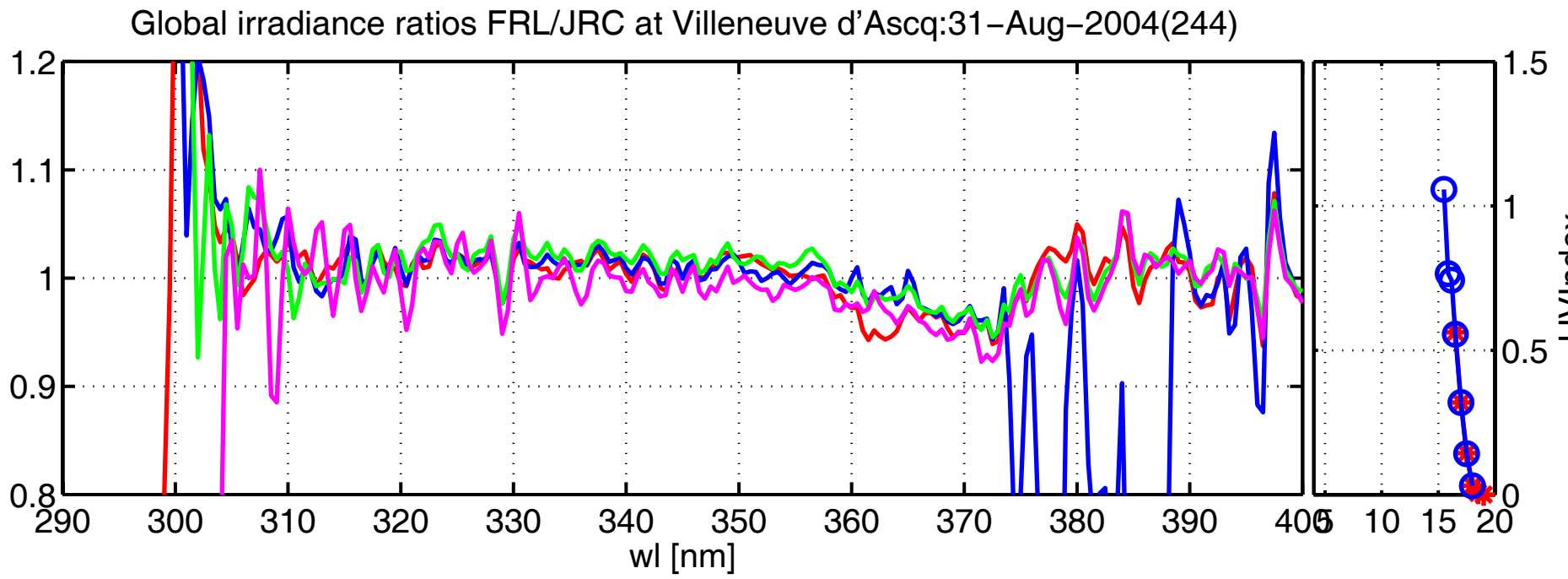
Measurement processing :

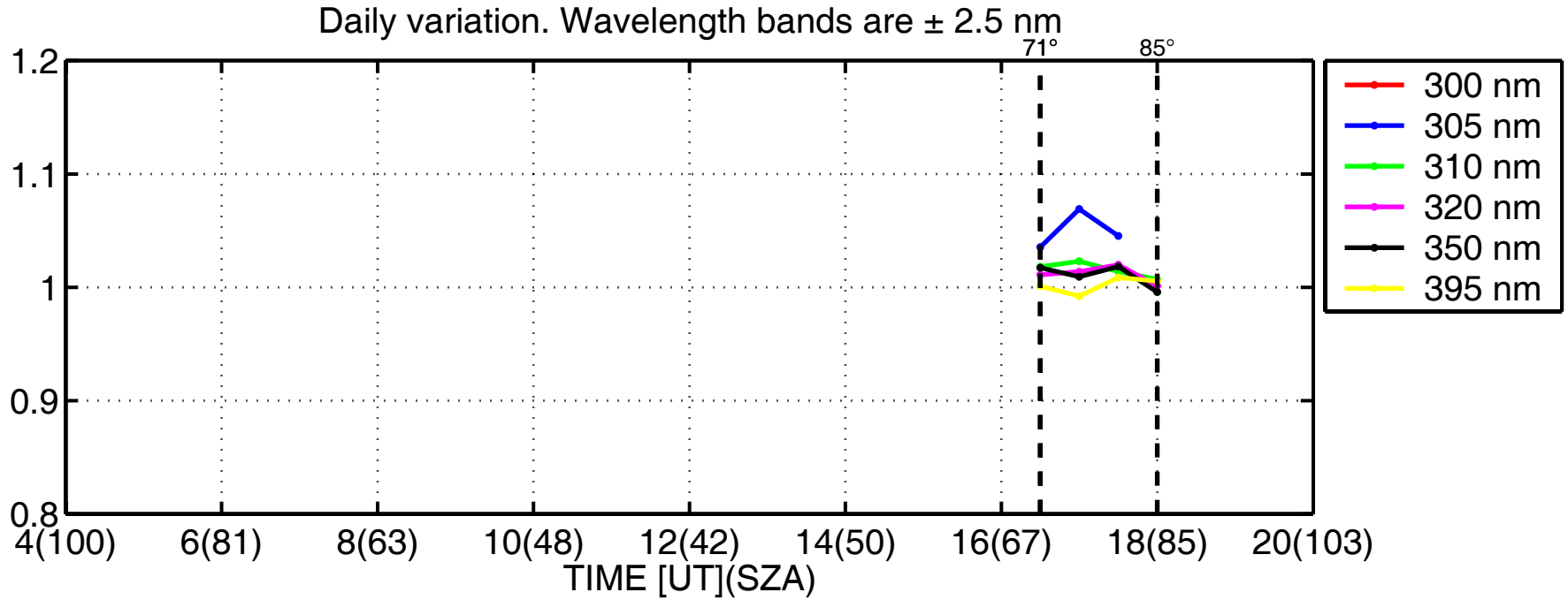
The instrument was calibrated about one week after the campaign, against two 1000 W Optronics lamps, and we made use of the new calibration curves (very close to the ones obtained 3 and 6 months before). During the processing of the outdoor measurements a cosine correction is applied and the wavelength shift is accounted for with a home-made program.

Analyses are currently conducted to explain the 360-380 nm dip in the global irradiance ratios.


UV Index Villeneuve d'Ascq August 31 September 2 2004
FRL
B5503
UV Index
Day of Year
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
244
244.5
245
245.5
246
246.5
247


Global irradiance ratios FRL/JRC at Villeneuve d'Ascq:31−Aug−2004(244) to 02−Sep−2004(246)
RATIO FRL/JRC
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
300 nm
305 nm
310 nm
320 nm
350 nm
395 nm
244
245
246
0
12
0
12
0
12
0
TIME [UT] ON DAYS: [244 245 246]
30−Sep−2004 11:27:41





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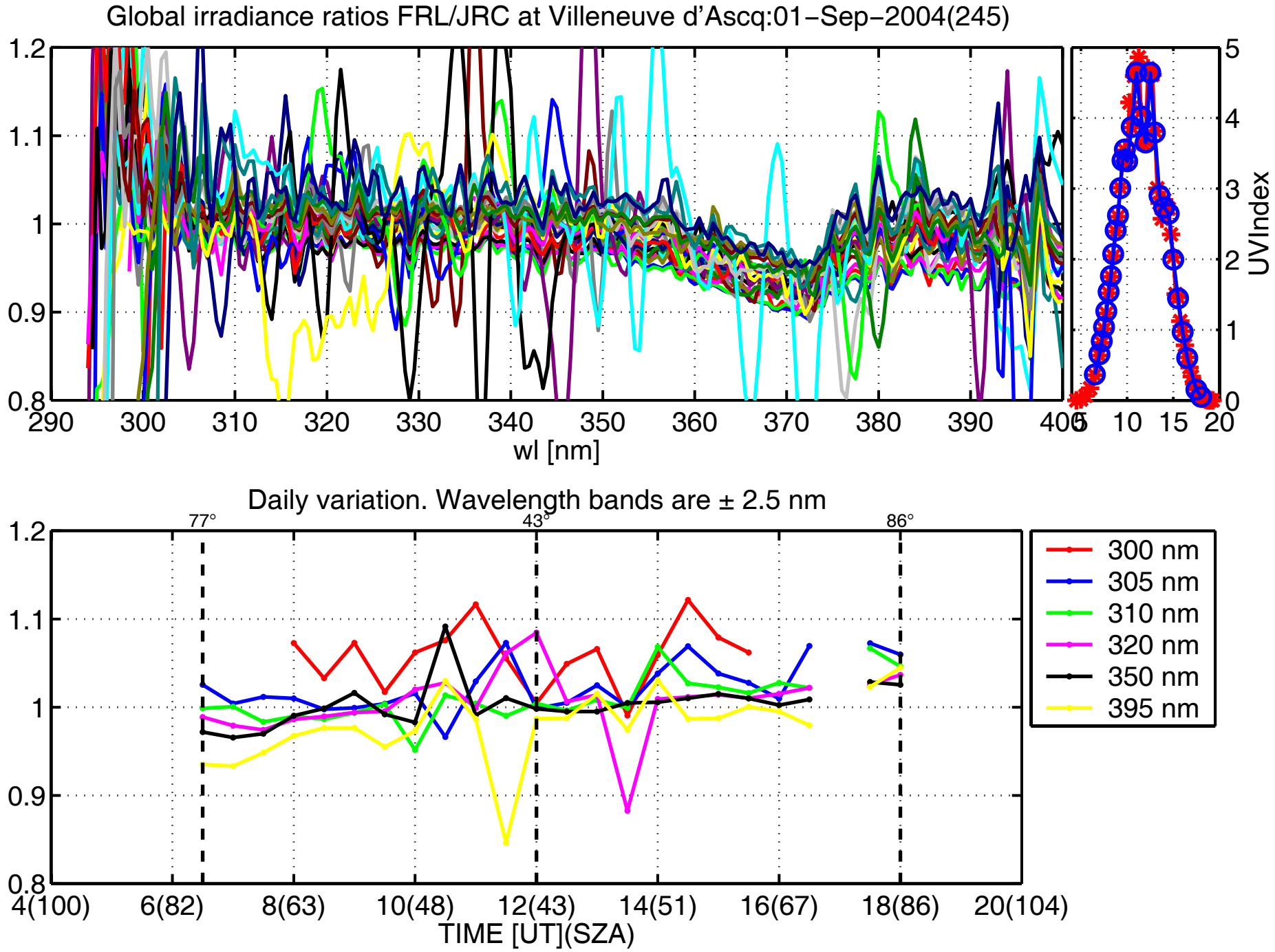
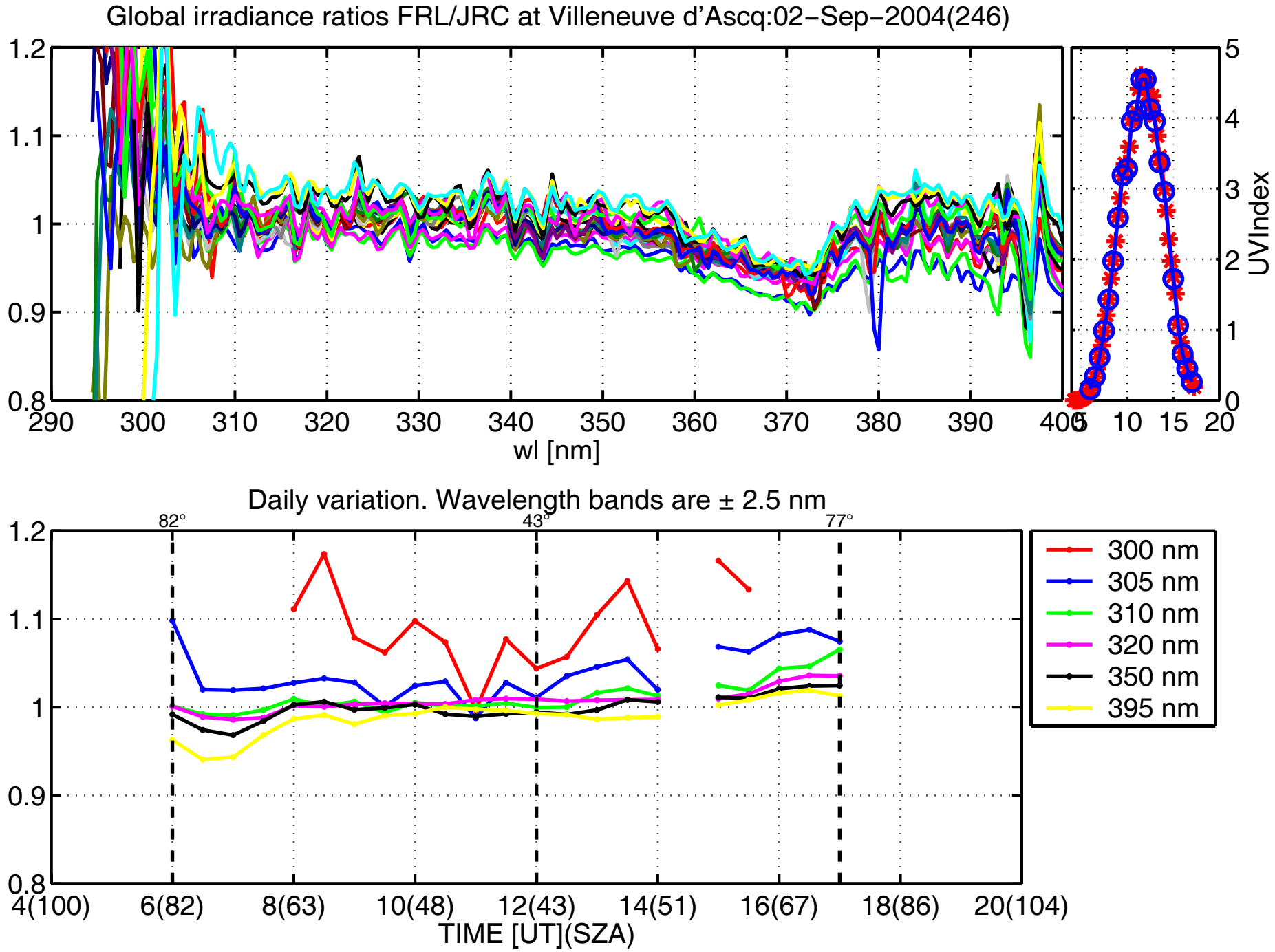
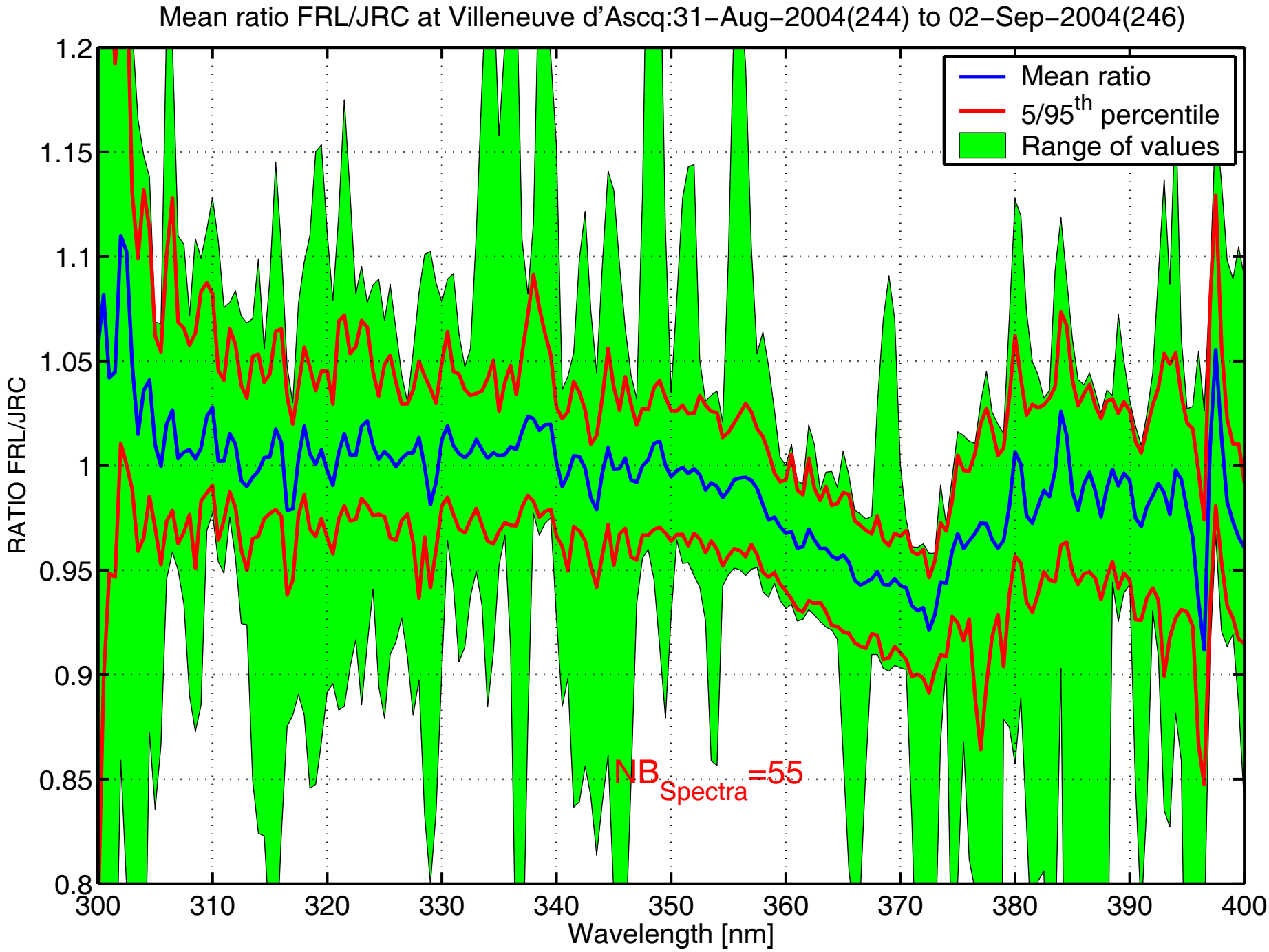
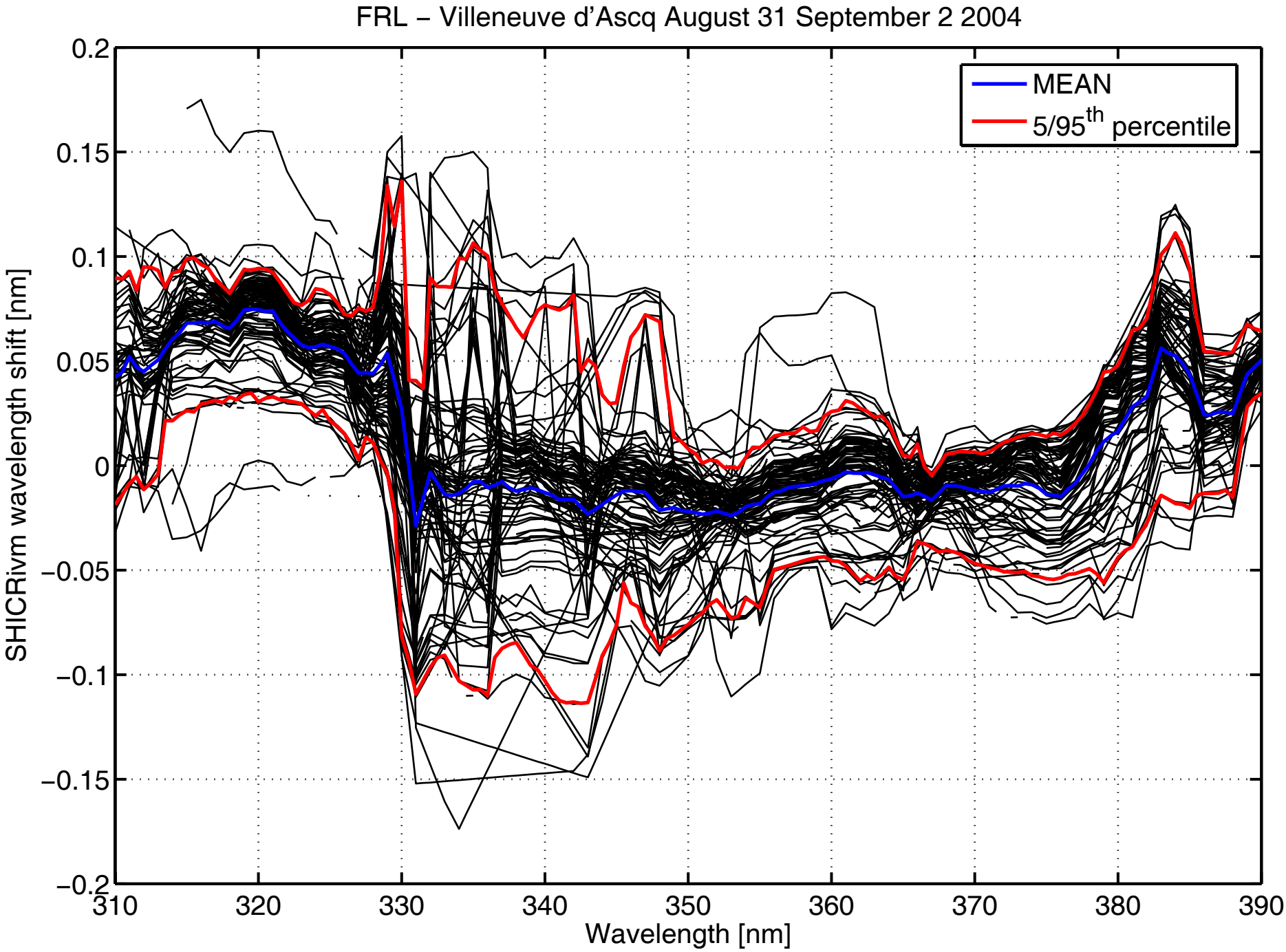
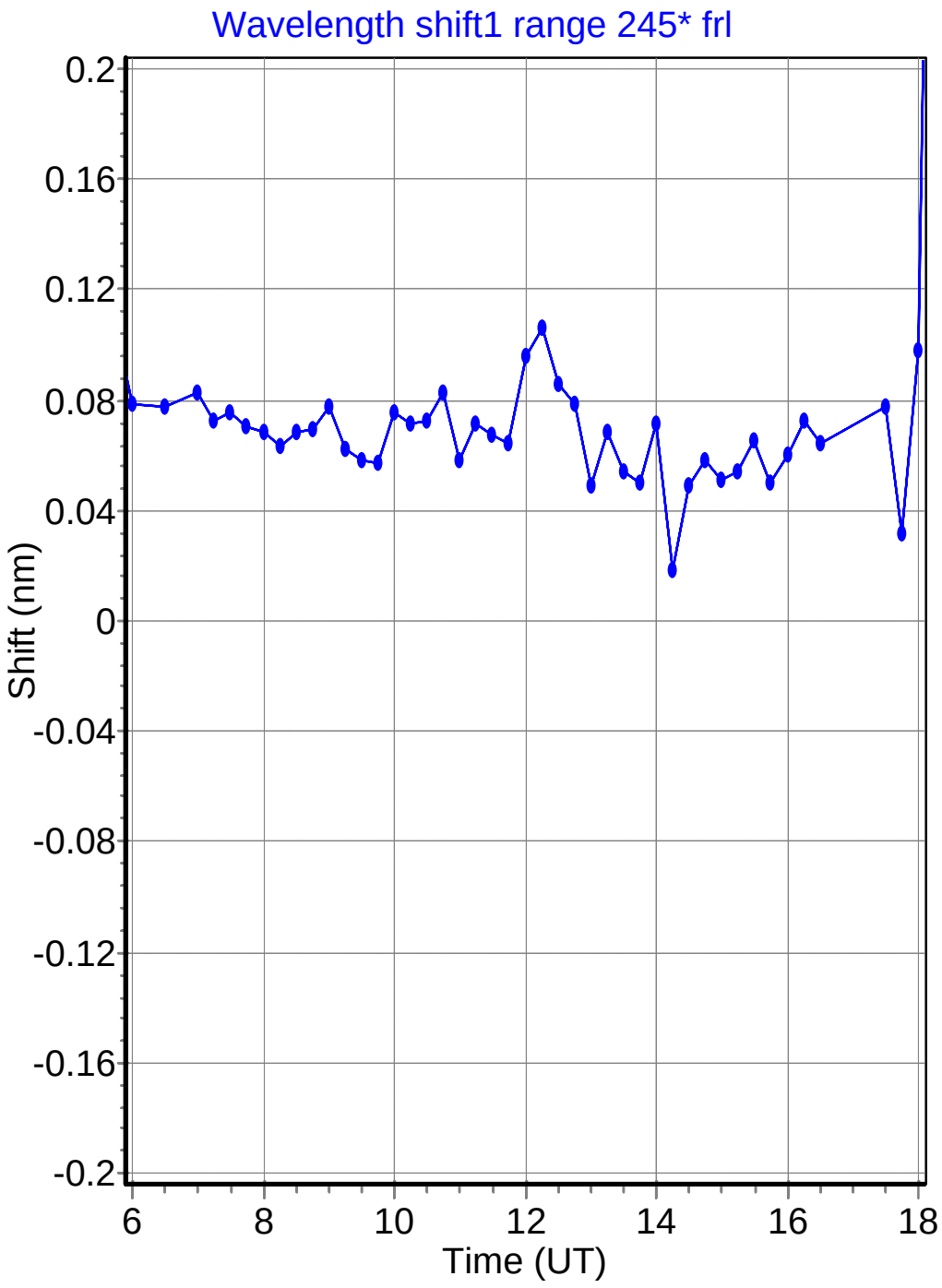
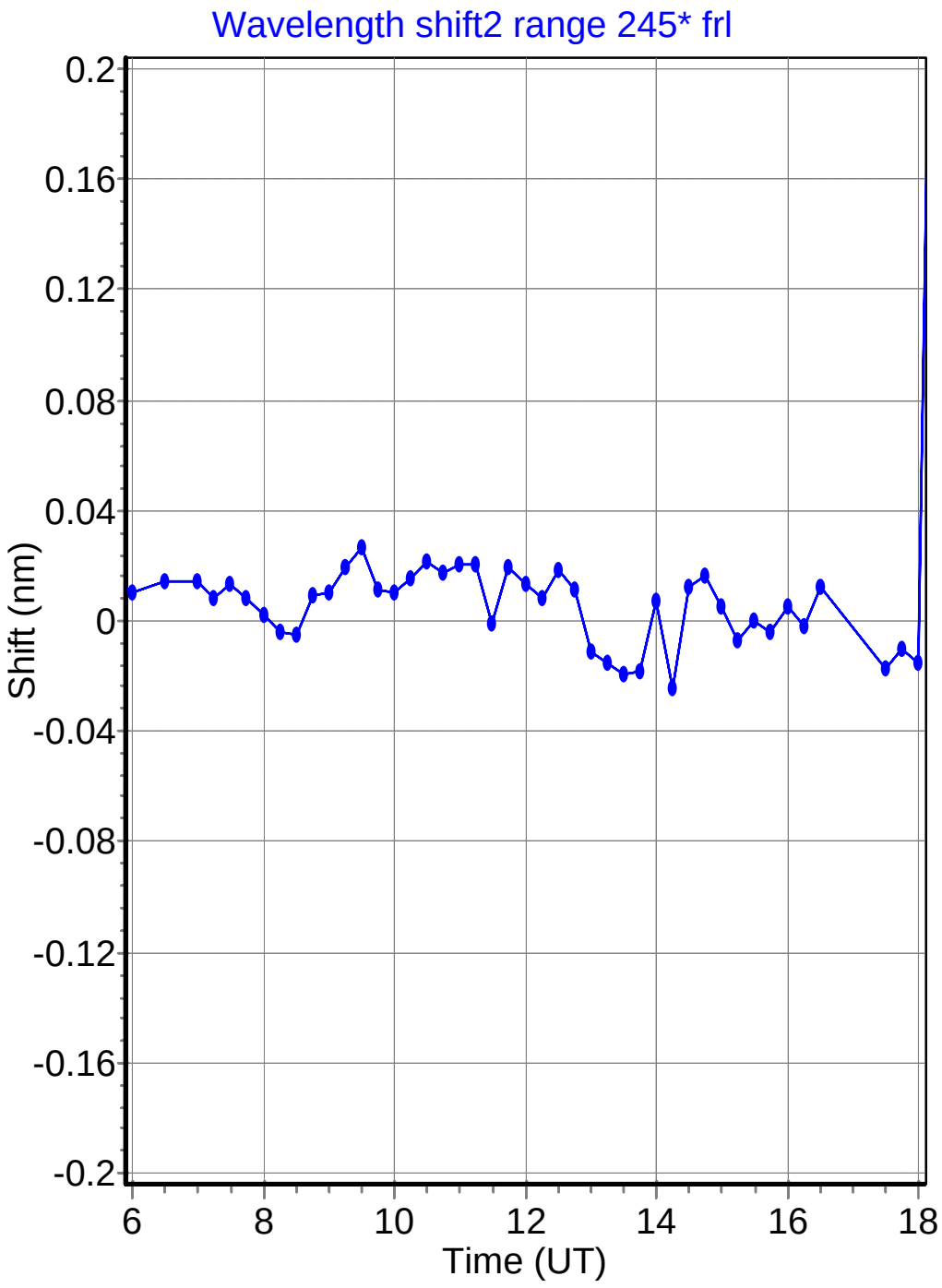

Global irradiance ratios FRL/JRC at Villeneuve d'Ascq:01−Sep−2004(245)
1.2
1.1
1
0.9
0.8
290
300
310
320
330
340
350
360
370
380
390
400
wl [nm]
5
4
3
2
1
0
UVIndex
5
10
15
20
Daily variation. Wavelength bands are ± 2.5 nm
77°
43°
86°
300 nm
305 nm
310 nm
320 nm
350 nm
395 nm
4(100)
6(82)
8(63)
10(48)
12(43)
14(51)
16(67)
18(86)
20(104)
TIME [UT](SZA)
30−Sep−2004 11:27:41

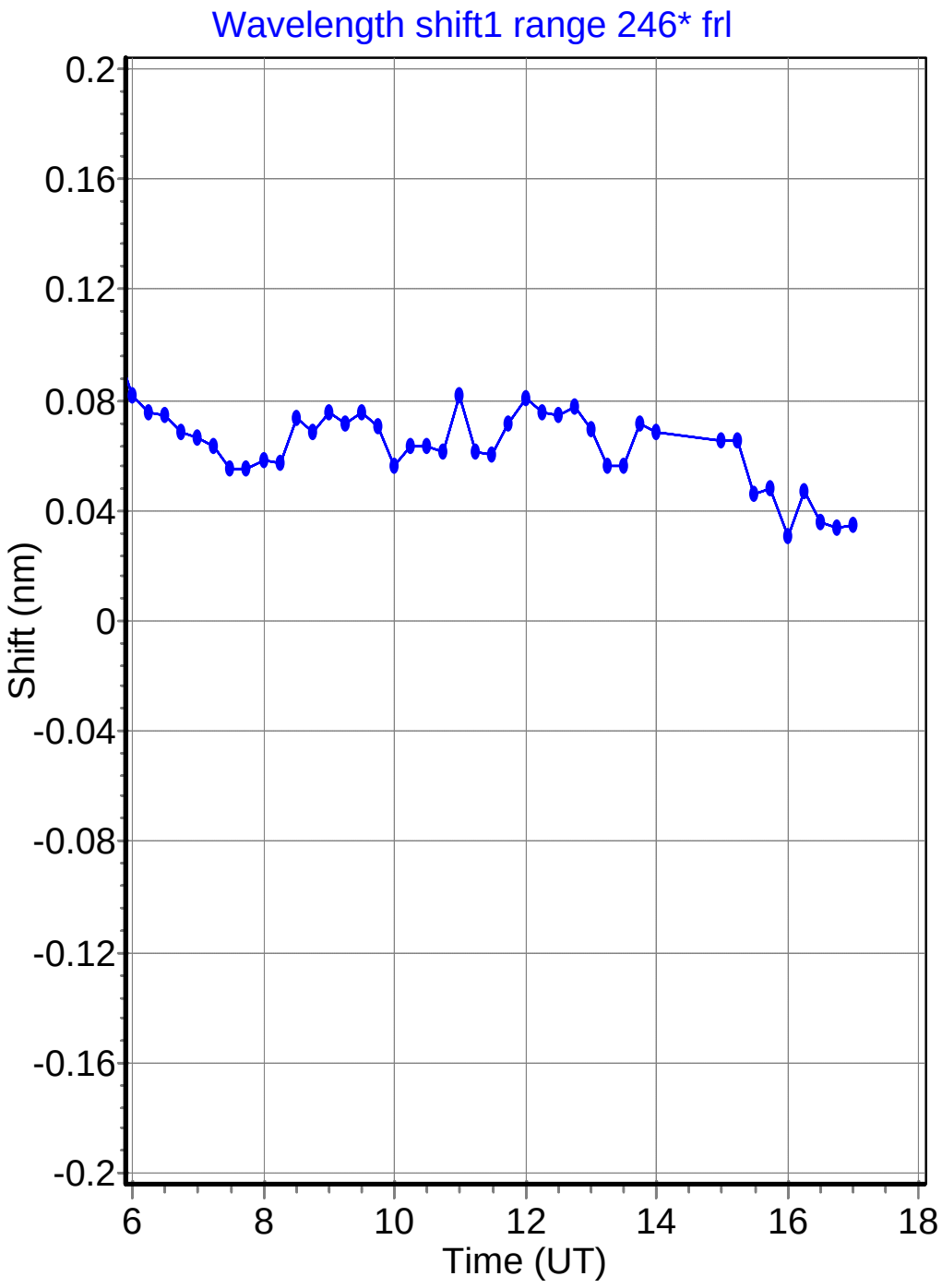

Global irradiance ratios FRL/JRC at Villeneuve d'Ascq:02−Sep−2004(246)
1.2
1.1
1
0.9
0.8
290
300
310
320
330
340
350
360
370
380
390
400
wl [nm]
5
4
3
2
1
0
UVIndex
5
10
15
20
Daily variation. Wavelength bands are ± 2.5 nm
82°
43°
77°
300 nm
305 nm
310 nm
320 nm
350 nm
395 nm
4(100)
6(82)
8(63)
10(48)
12(43)
14(51)
16(67)
18(86)
20(104)
TIME [UT](SZA)
30−Sep−2004 11:27:41

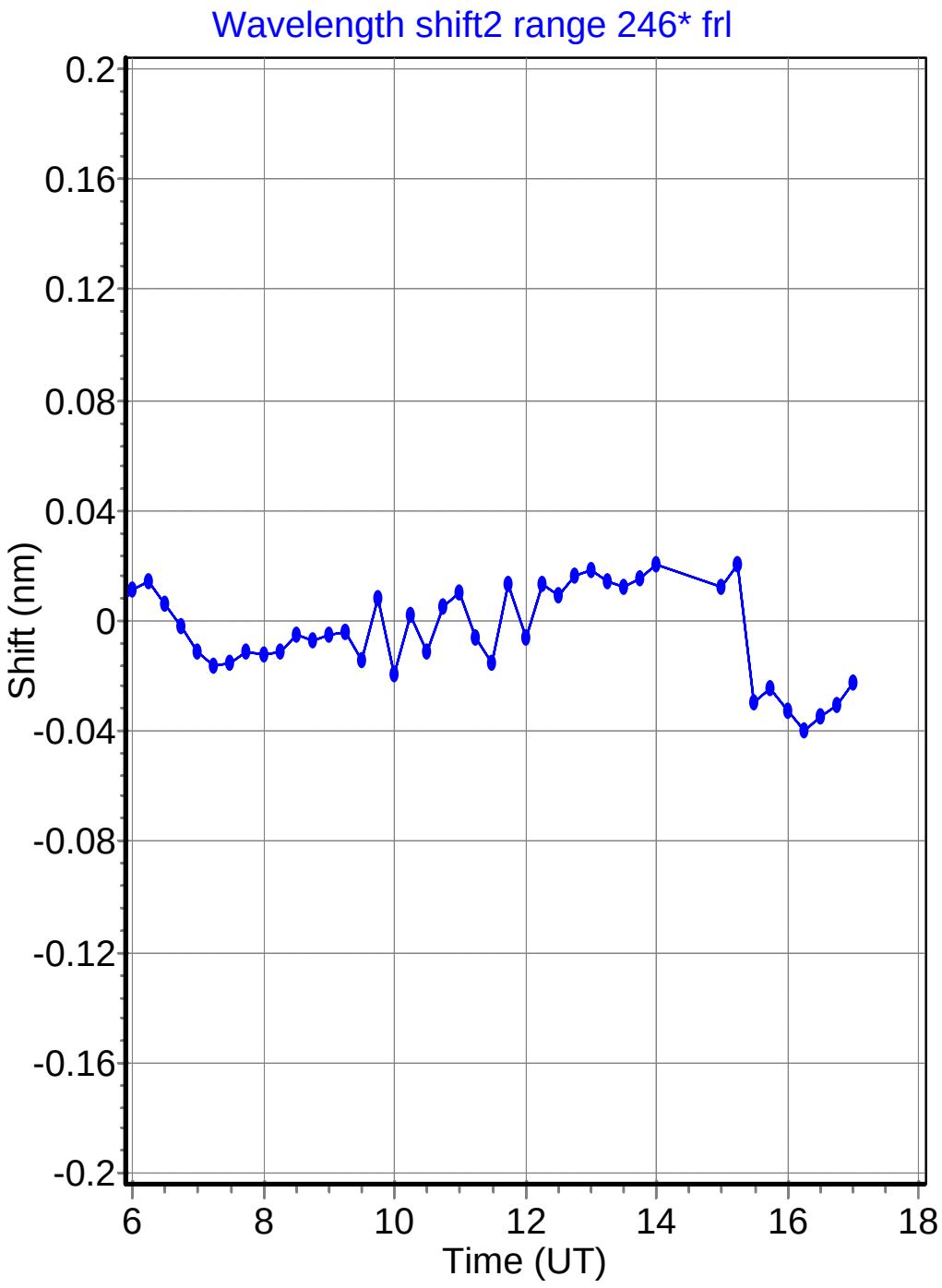

Mean ratio FRL/JRC at Villeneuve d'Ascq:31−Aug−2004(244) to 02−Sep−2004(246)
Mean ratio
5/95th percentile
Range of values
RATIO FRL/JRC
Wavelength [nm]
NBSpectra=55
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
300
310
320
330
340
350
360
370
380
390
400

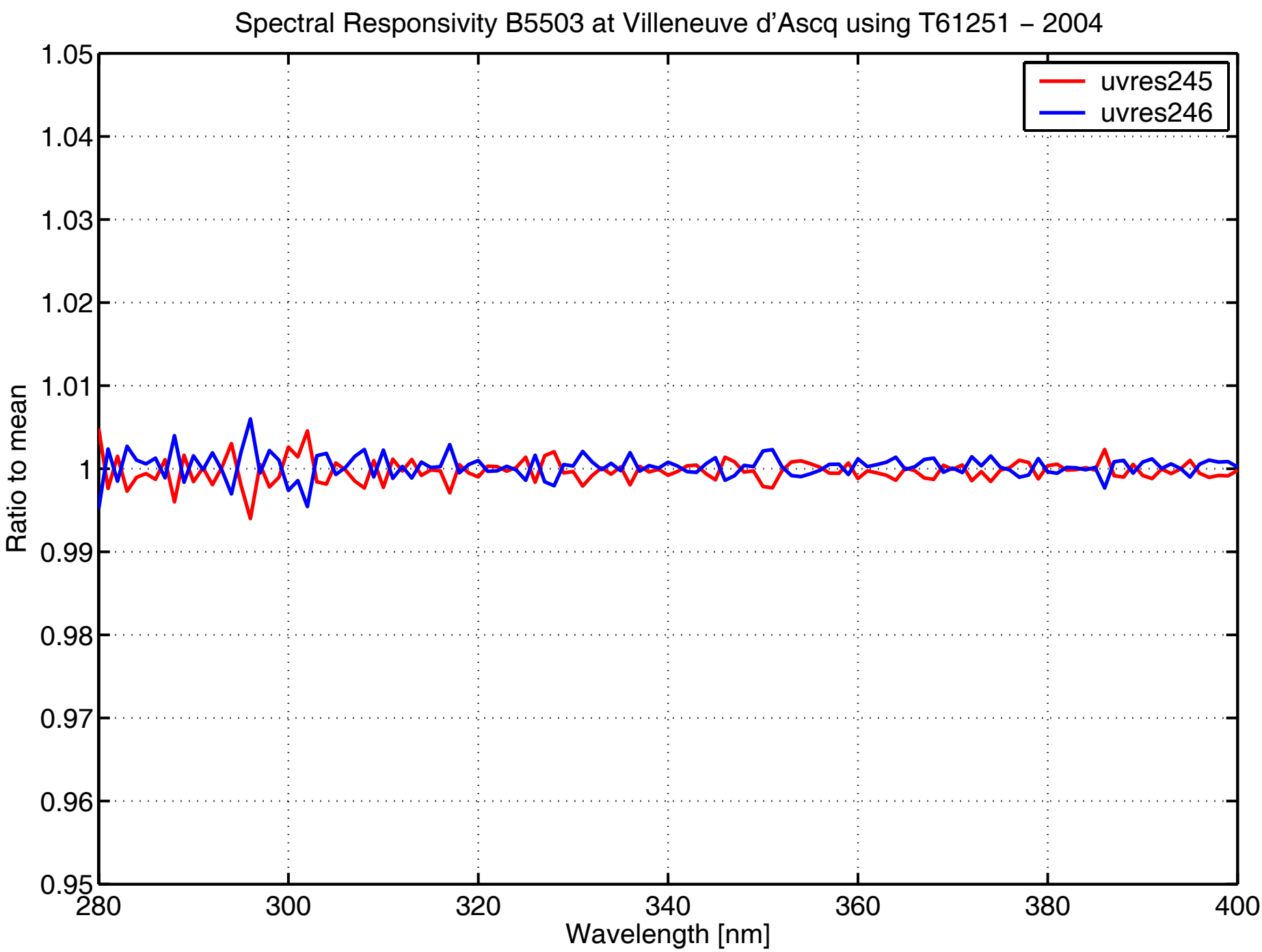

FRL – Villeneuve d'Ascq August 31 September 2 2004
MEAN
5/95th percentile
SHICRivm wavelength shift [nm]
Wavelength [nm]
0.2
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
−0.2
310
320
330
340
350
360
370
380
390


Wavelength shift1 range 245* frl
0.2
0.16
0.12
0.08
0.04
0
-0.04
-0.08
-0.12
-0.16
-0.2
Shift (nm)
6
8
10
12
14
16
18
Time (UT)


Wavelength shift2 range 245* frl
0.2
0.16
0.12
0.08
0.04
0
-0.04
-0.08
-0.12
-0.16
-0.2
Shift (nm)
6
8
10
12
14
16
18
Time (UT)


Wavelength shift1 range 246* frl
0.2
0.16
0.12
0.08
0.04
0
-0.04
-0.08
-0.12
-0.16
-0.2
Shift (nm)
6
8
10
12
14
16
18
Time (UT)


Wavelength shift2 range 246* frl
0.2
0.16
0.12
0.08
0.04
0
-0.04
-0.08
-0.12
-0.16
-0.2
Shift (nm)
6
8
10
12
14
16
18
Time (UT)


Spectral Responsivity B5503 at Villeneuve d'Ascq using T61251 – 2004
uvres245
uvres246
Ratio to mean
Wavelength [nm]
1.05
1.04
1.03
1.02
1.01
1
0.99
0.98
0.97
0.96
0.95
280
300
320
340
360
380
400