

Protocol of the intercomparison at the University of Lille, Villeneuve d'Ascq, France from May 30 to 3 June 2022 with the travelling reference spectroradiometer QASUME from PMOD/WRC

Report prepared by Gregor Hülsen

Operator: Gregor Hülsen, Christian Thomann

The purpose of the visit was the comparison of global solar irradiance measurements between two Bentham DM300 spectroradiometer operated at Villeneuve d'Ascq by the Univ. of Lille and the travel reference spectroradiometer QASUME. The measurement site is located at the University of Lille; Latitude 50.612 N, Longitude 3.141 E and altitude 70 m.a.s.l.

The horizon of the measurement site is free down to at least 85° solar zenith angle (SZA). Measurements between 4:00 UT and 19:30 UT have been analysed.

QASUME was installed in the afternoon of May 30, 2022. The spectroradiometer was installed within 50 cm of the entrance optic of the local spectroradiometers. The intercomparison between QASUME and the local spectroradiometer lasted four days, from morning of May 31 to afternoon of June 03.

QASUME was calibrated several times during the intercomparison period using a portable calibration system. Three lamps (T68522, T68523 and T16573) were used to obtain an absolute spectral irradiance calibration traceable to the primary reference held at PMOD/WRC, which is traceable to PTB. The daily mean responsivity of the instrument based on these calibrations varied by less than 1 % during the intercomparison period. The internal temperature of QASUME was 27.21 ± 0.45 °C and the diffuser head was heated to a temperature of 28.72 ± 0.36 °C. The wavelength shifts relative to an extraterrestrial spectrum as retrieved from the matSHIC analysis were between ± 50 pm in the spectral range 290 to 500 nm.

Protocol:

The measurement protocol was to measure one solar irradiance spectrum every 30 minutes from 280 to 450 nm, every 0.5 nm, and 3.0 seconds between each wavelength increment. QASUME recorded the spectra in 30 min intervals with 0.25 nm increments.

DOY	Date	Day	Weather	Comments (times in UT)
150	30. May	Monday	Mostly overcast sky.	Installed at 14:00 ARF Labor measurements of VDA2
151	31. May	Tuesday	Mix of sun and clouds, few rain drops around 10 UT, Clear sky after 15 UT.	07:50 Calibration (T68522) 08:11 Calibration (T16573)
152	01. June	Wednesday	Cirrus and cumulus all the day, with clear sky from 17:30 and in the morning until 7:30	07:53 Calibration (T68522) 14:00 Installation of the ARF system 20:55 ARF roof measurements of VDA2 and VDA1
153	02. June	Thursday	Mostly clear sky with some cirrus clouds.	08:53 Calibration (T68522) 09:13 Calibration (T68523) 15:30 Slit function measurements
154	03. June	Friday	Cirrus clouds haze a lot the sky, that is denser from 10:30	11:55 Calibration (T68522) 13:00: F540 irradiance calibration 14:00 End of campaign

Results:

In total 99/104 synchronised simultaneous spectra from QASUME and the local spectroradiometers are available from the measurement period. Measurements between 4:00 UT and 19:30 UT have been analysed (SZA smaller than 88°).

Remarks:

1. The dataset used for the comparison is based on a revised analysis from the local operators (see below).
2. A diurnal variation of 8% (VDA1) and 5% (VDA2) was observed especially on DOY 153, during a period of clear skies without clouds in front of the sun. This reason for the diurnal variation is unknown. For VDA1 it look more like a azimuth error, but the tilt mounting of the entrance optics in the roof of the shelter was checked and looks fine within the uncertainty of the measurement. The variability also doesn't indicate a large cosine error. The diurnal variability is smaller but still visible during the overcast sky periods. For VDA2 the diurnal variability is symmetric around local noon.
3. The measurements between both local spectroradiometer and QASUME agreed to within $\pm 3\%$, with a minor spectral dependence.

Auxiliary measurements:

1. The slit functions of VDA1 and VDA2 were measured using a Crysta Laser (372 nm).
2. The angular responsivity of VDA1 was measured outdoors at 360 nm and 410 nm. During the last scan the BenWin software malfunctioned. The analysis of the two measurements disagrees.
3. The angular responsivity of VDA2 was measured first indoors at 310, 360 and 410 nm. Later the measurement was repeated outdoors at 360 nm and 410 nm. All measurements agree within an uncertainty of 5%.

Local Operators: Frederique Auriol, Fanny Minvielle, Maxime Catalfamo, Romain De Filippi, Nicolas Henriot, Eric Bourrienne and Colette Brogniez.

Comments from the operator:

QASUME 2022 – VDA

Comments from operators :

The UV spectroradiometer VDA1 is operational since 2009. The UV spectroradiometer VDA2 is a new device. It has been acquired in October 2021. Both are Bentham DTMC300 regulated in temperature.

1. The dataset used for comparison was revised for the following reason.
 First of all, for the two set we provided, we have taken into account the new measurements of slit function and also of the angular responsivity (arf) of both spectroradiometers measured by the PMOD/WRC during the campaign. We call them QASUME configurations.
 Spectroradiometers were calibrated on the roof with a portable system, a CL6 (150W) almost every day: for VDA2 on 30 May, 31 May, 2 June, 3 June and for VDA1 on 30 May, 1 June, 3 June 2022. This enables processing measures of each day with the corresponding calibration. Absolute calibration of the CL6 was performed in the dark room with four 1000 W lamps (F1413, F700, F706 and F1653, traceable to NIST). We observed that the CL6 roof-calibration of 3 June was very different from the other days. So, we used the CL6 calibration of the previous day in replacement. Thus, the set 1 relied on CL6 roof-calibrations.
 The difference between the 3 June CL6 calibrations and the others led us to suspect a problem with the CL6. So, we reprocessed measures using only the 1000 W lamps calibrations. So, the Set 2 (revised one), that replaces the first one, relies on 1000 W lamps calibrations.

2. “A diurnal variation of 8% (VDA1) and 5% (VDA2) was observed especially on DOY 153 during a period of clear skies without clouds in front of the sun.”
 Actually, on 2 June, the sky was not clear but with some scattered clouds, and with small cloud in front of the sun. Indeed, with the sky imager located close to the instruments, we can see cirrus cloud have appeared from 9h54 to 10h27 with especially at this time, cirrocumulus in front of the sun.

We are trying to understand the different reasons of this diurnal variation.

3. During VDA2 calibrations, small oscillations appear on the signal above ≈ 360 nm. Such oscillations are absent in VDA1 calibrations. As suggested by the QASUME operator (Gregor Hülsen), we replaced the intermediate slit by a larger one (1.48mm instead of 1 mm). We observe that the small oscillations have disappeared (see Figure 1).
 The new slit function will be measured in the future.

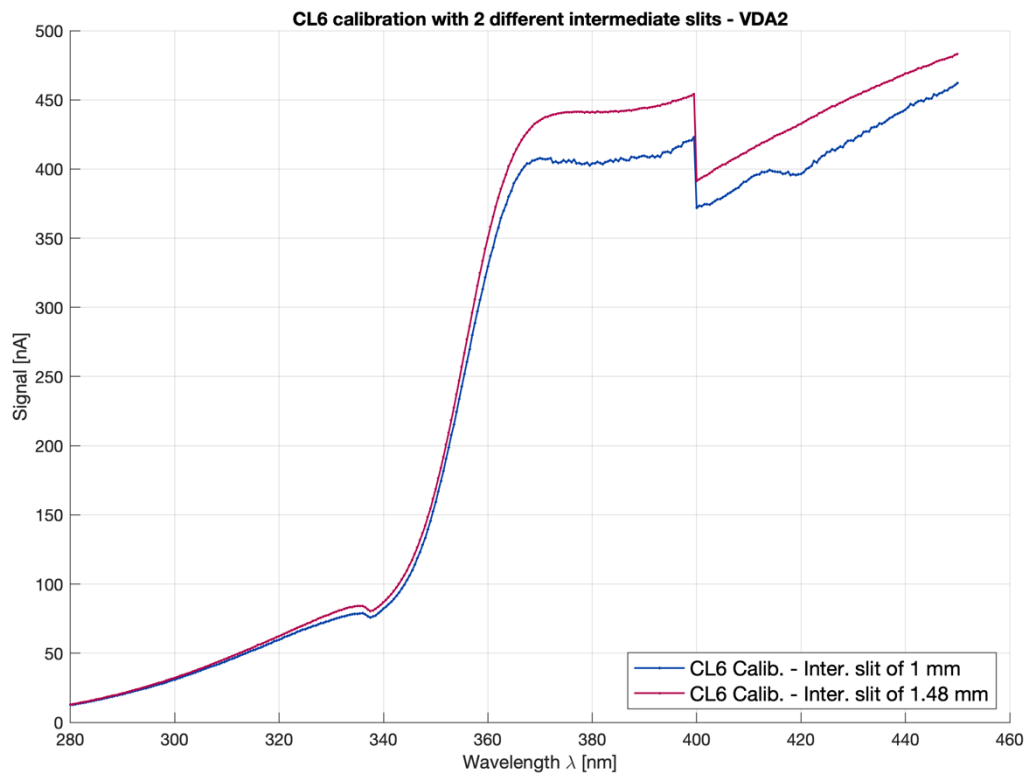
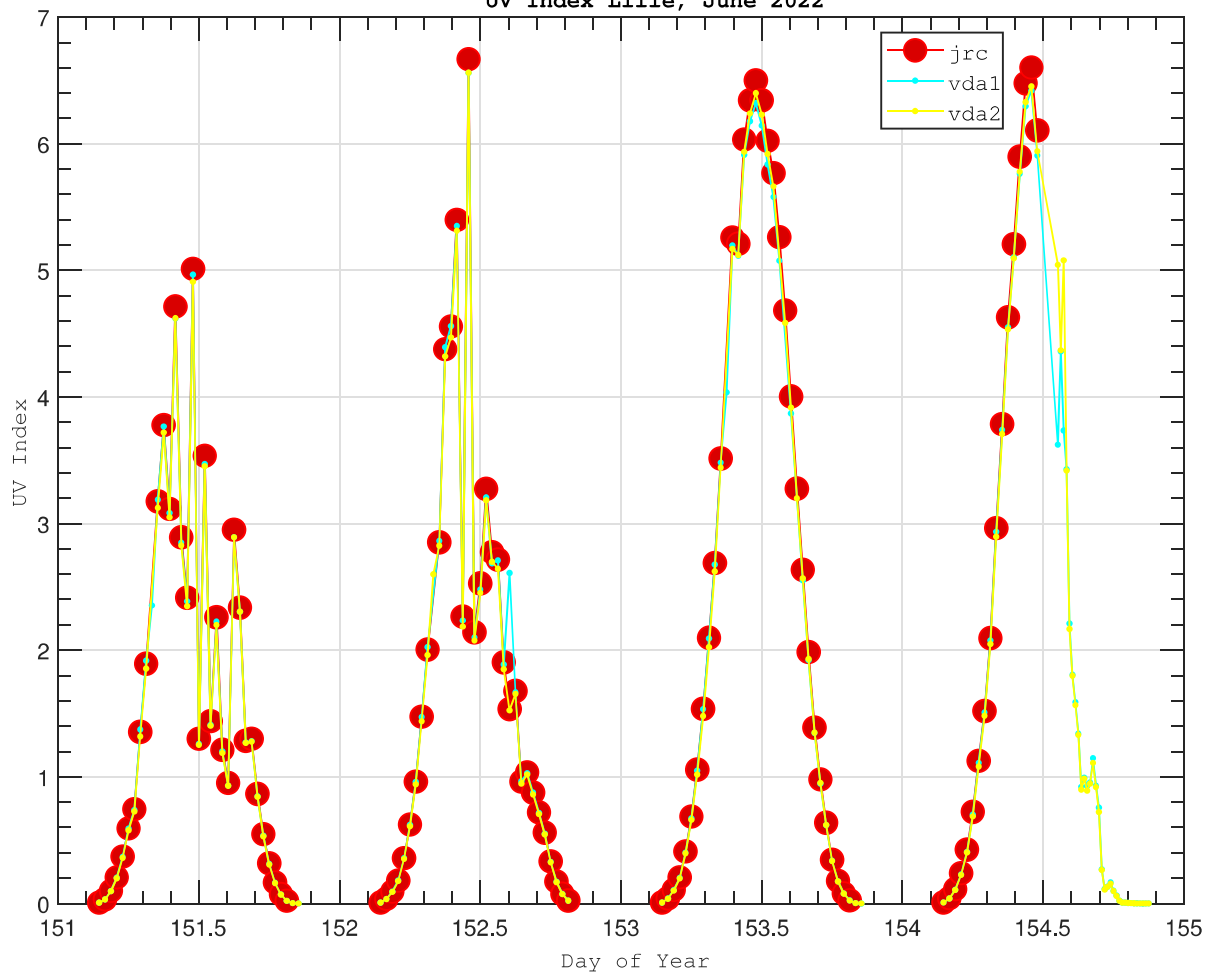
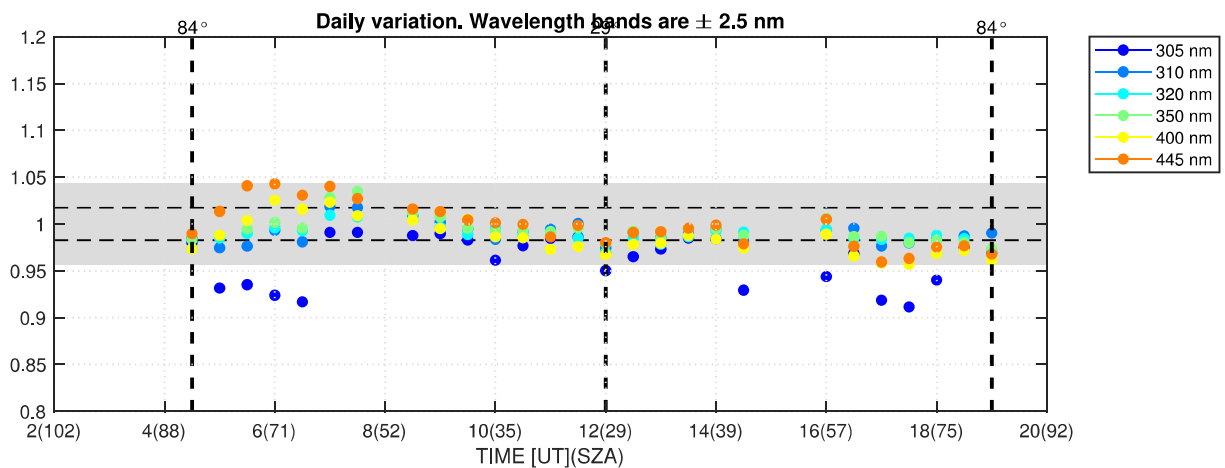
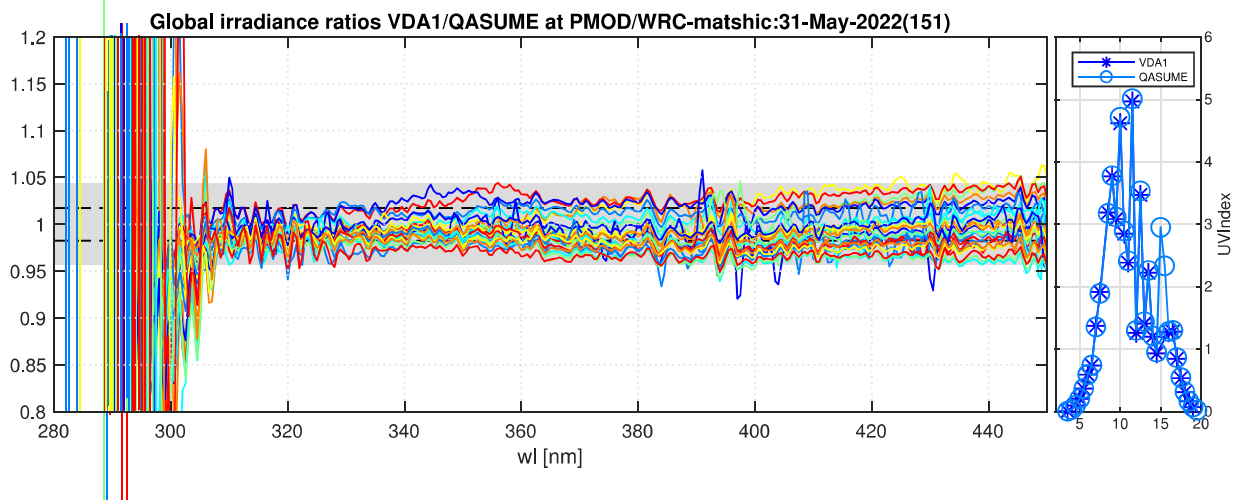
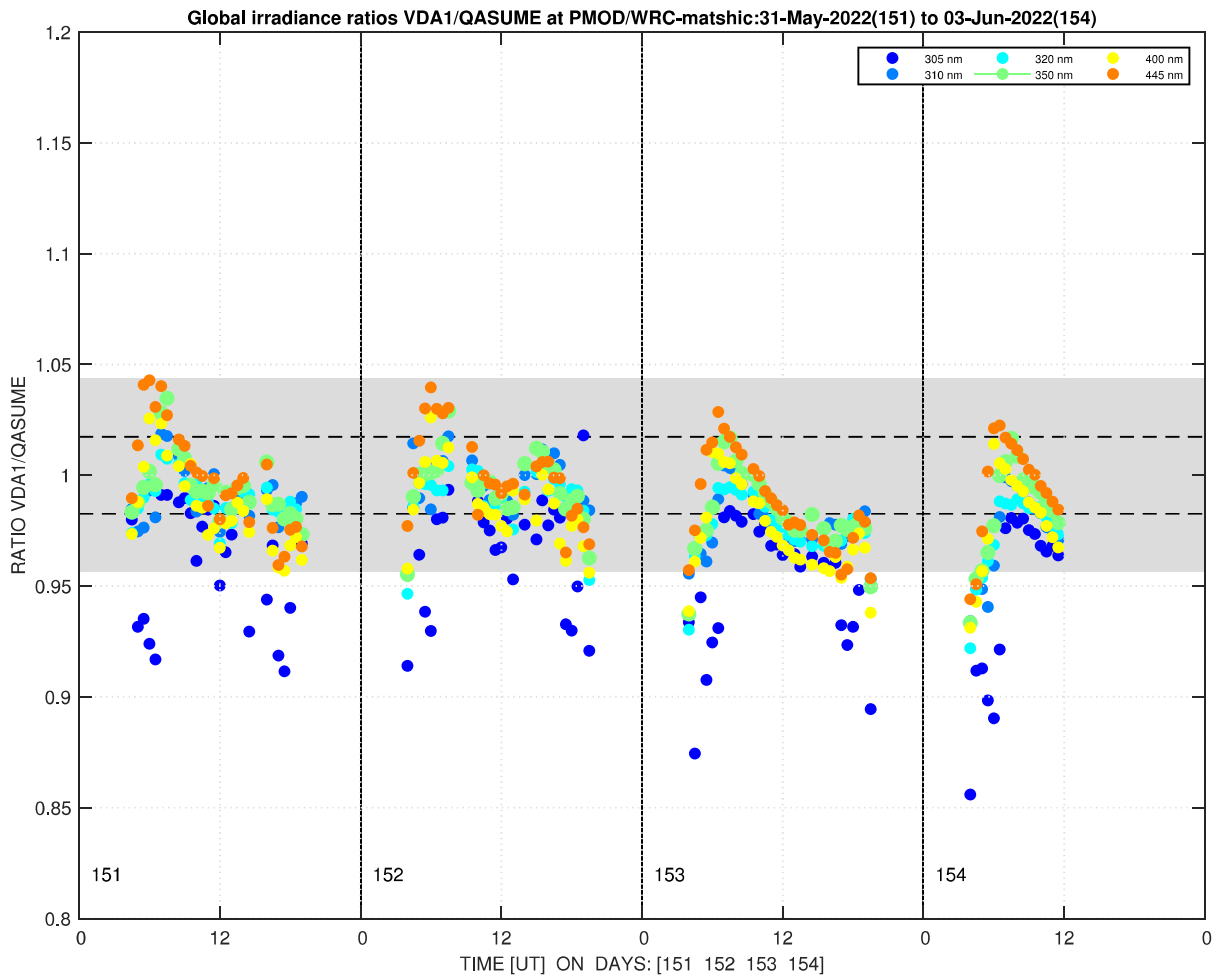
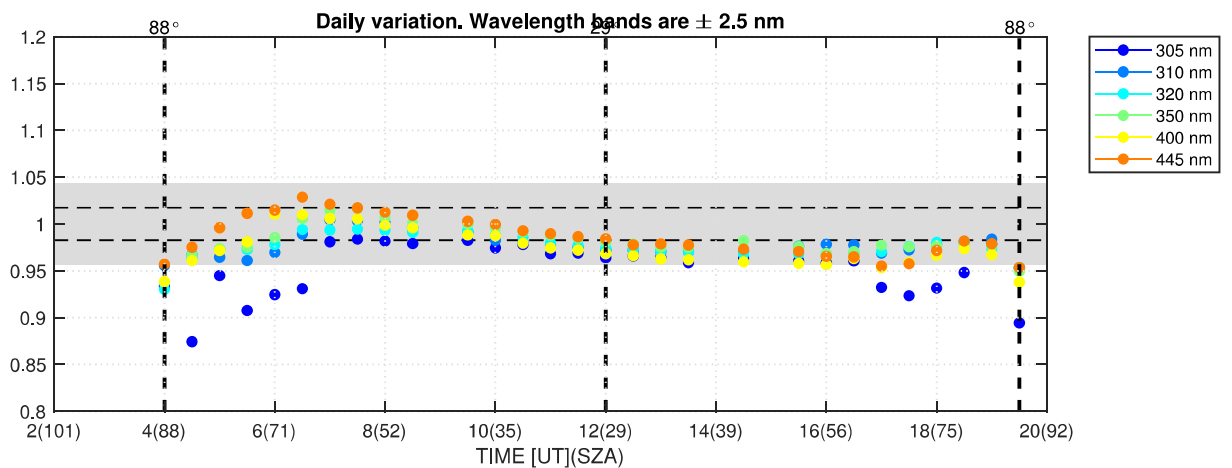
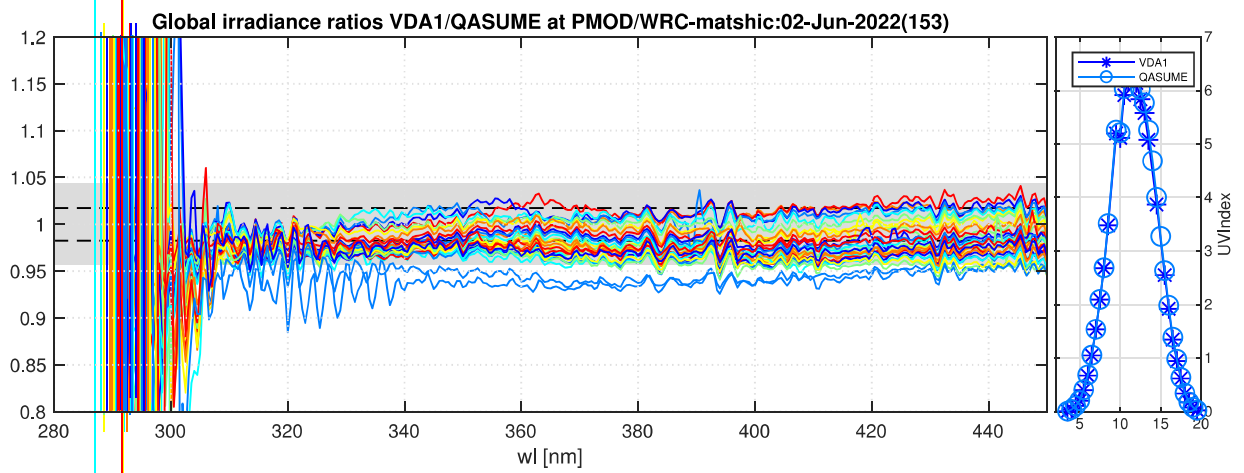
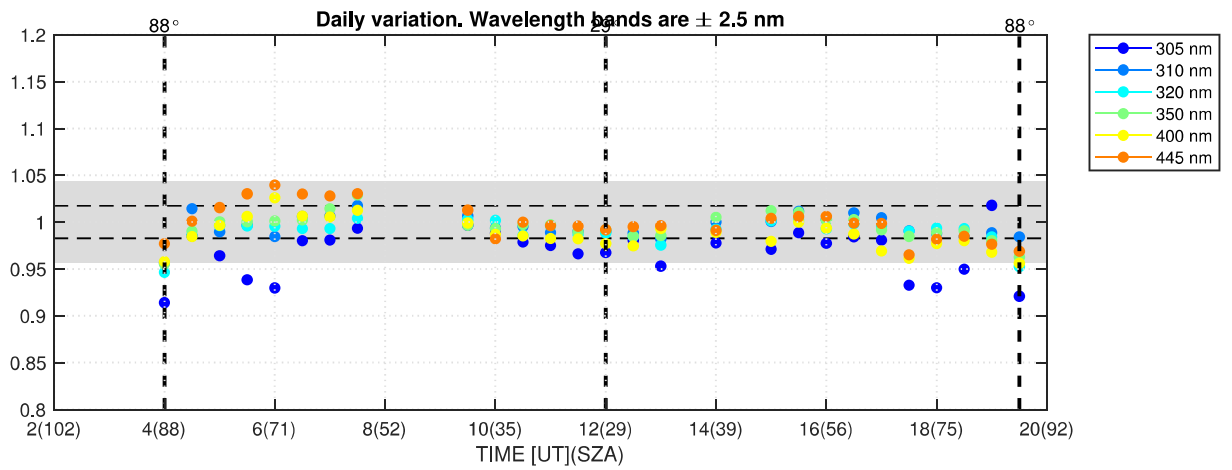
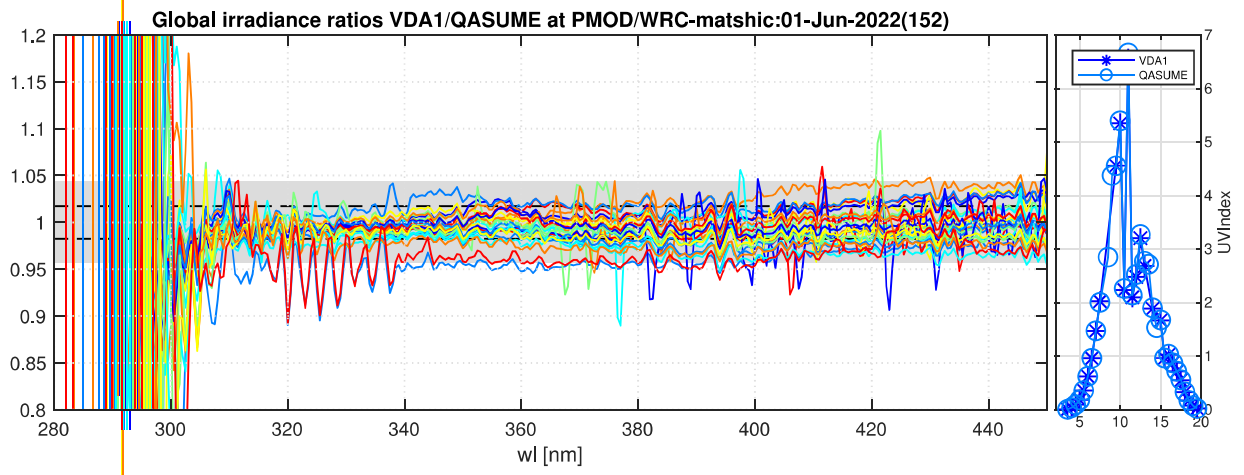


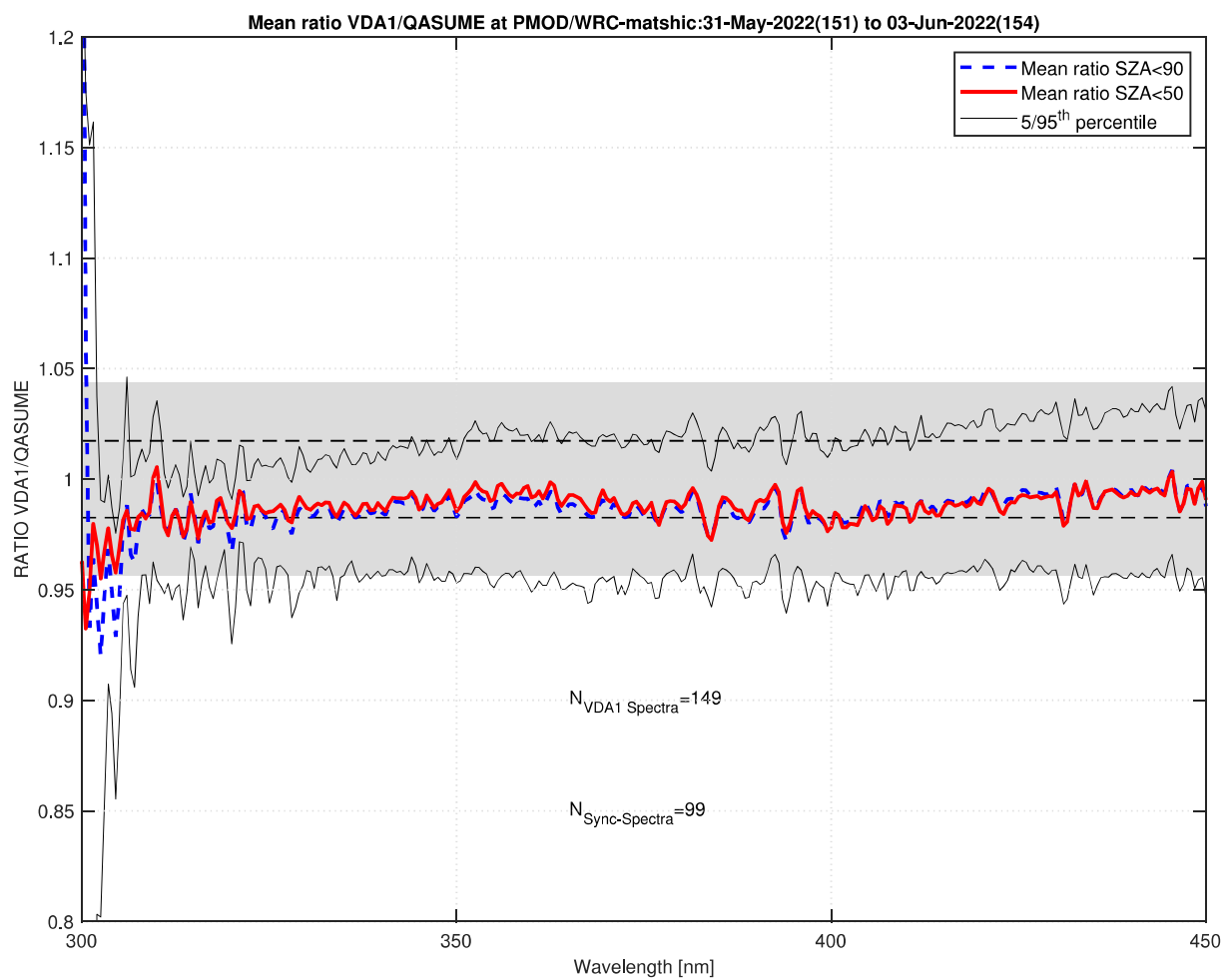
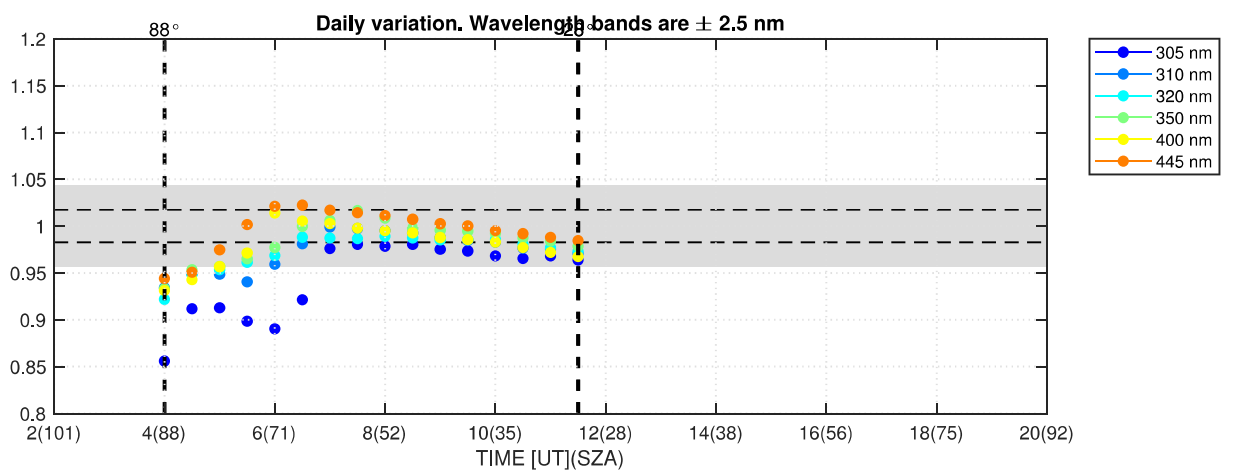
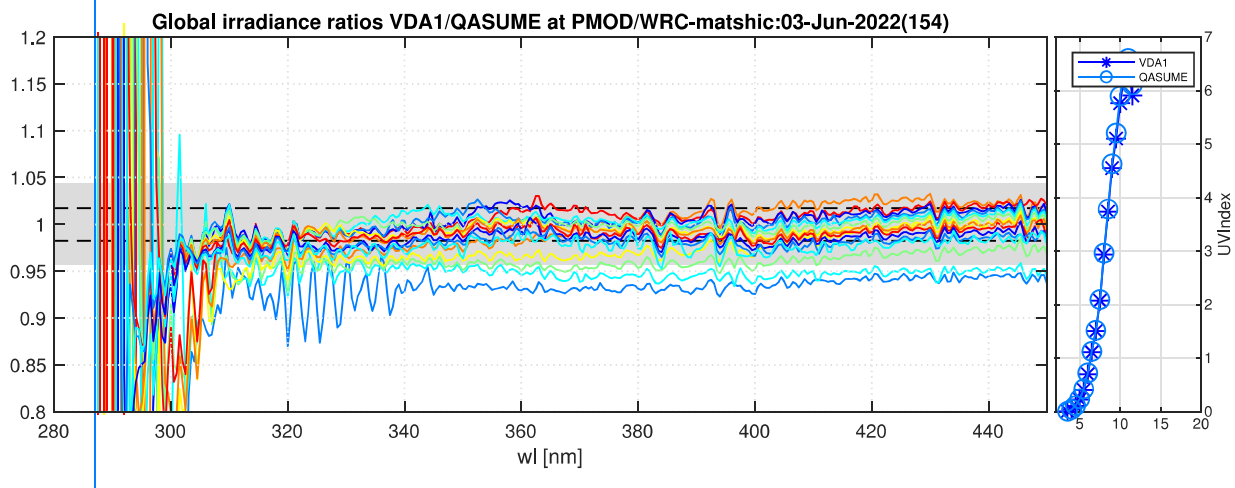
Figure 1 : CL6 calibrations performed with 2 different slits

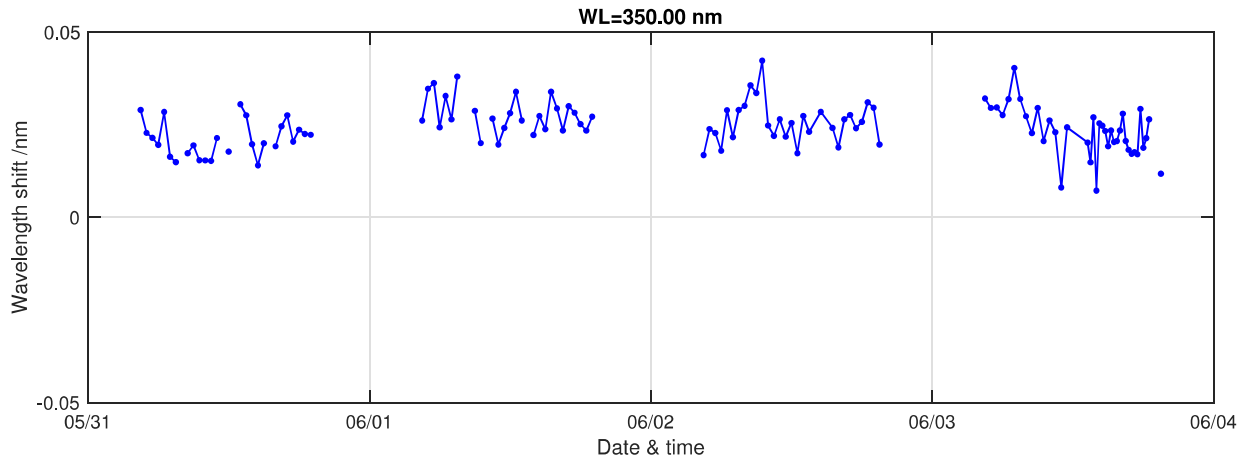
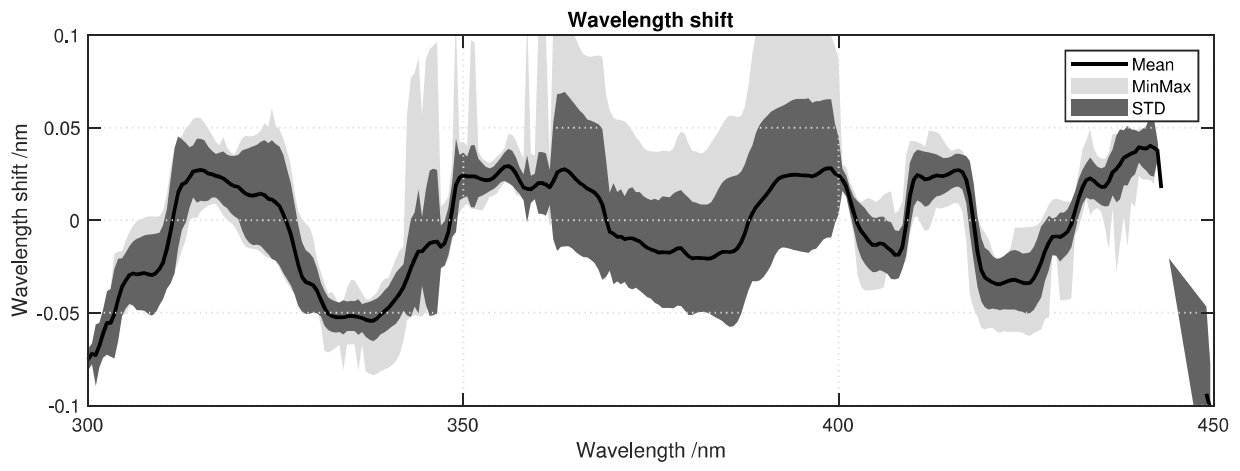
UV Index Lille, June 2022

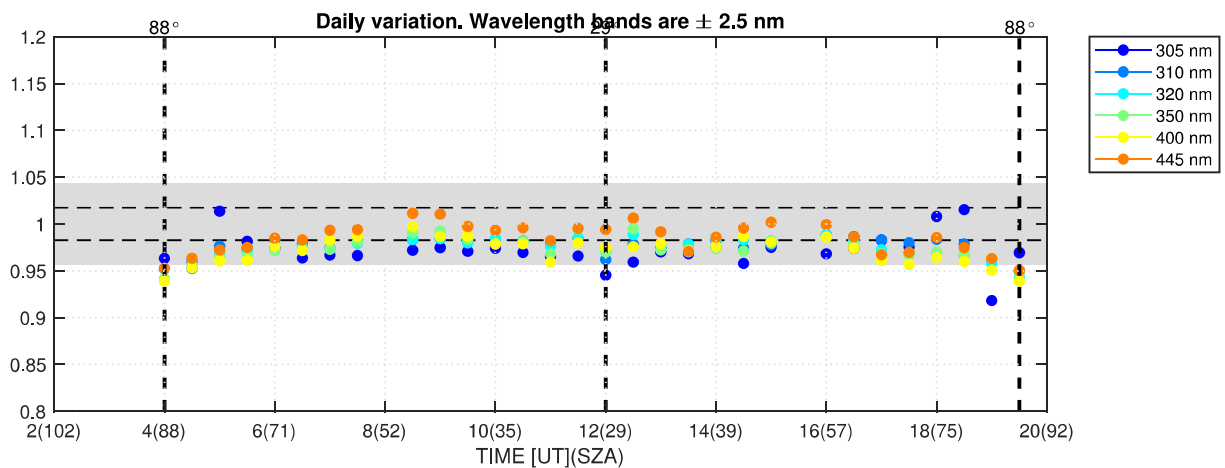
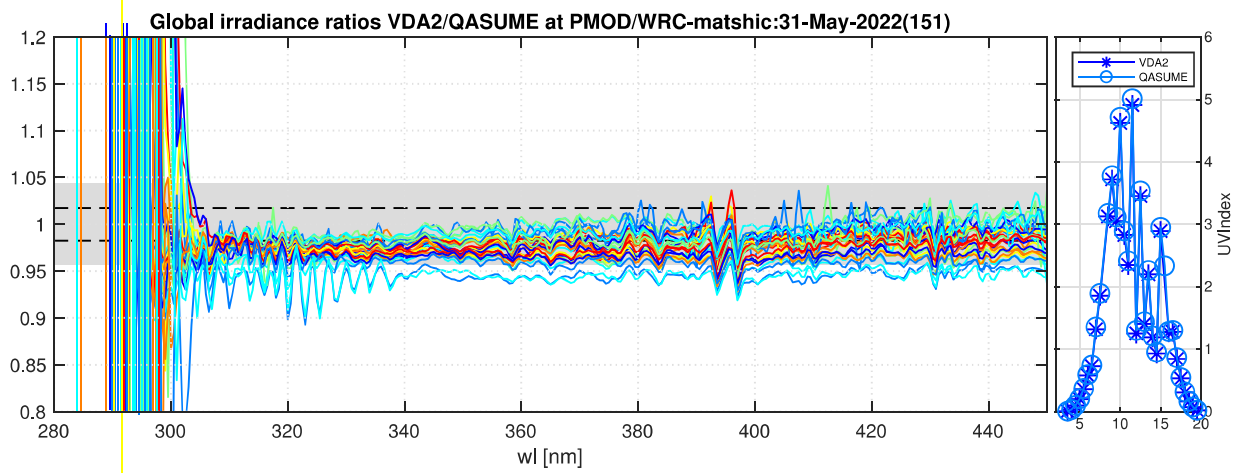
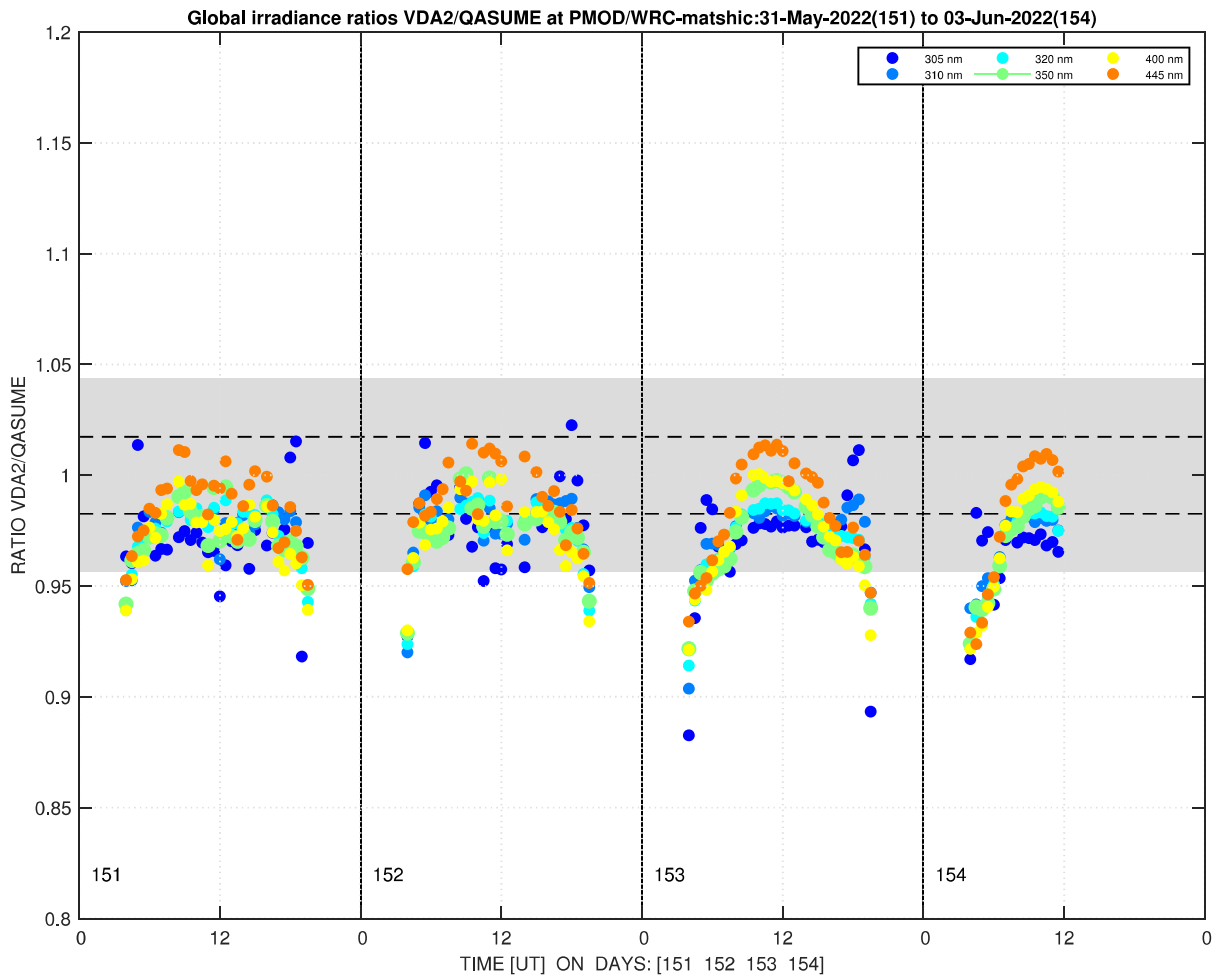


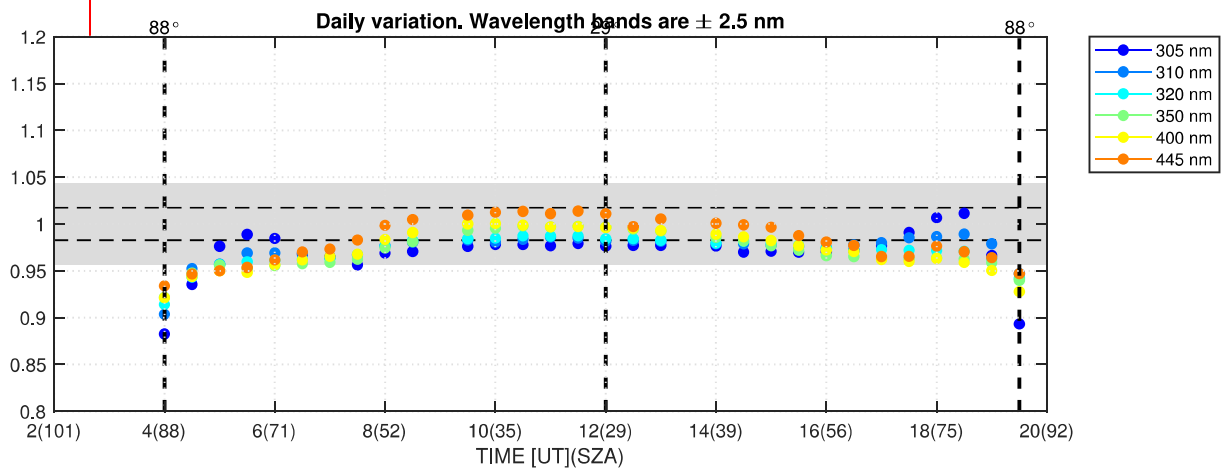
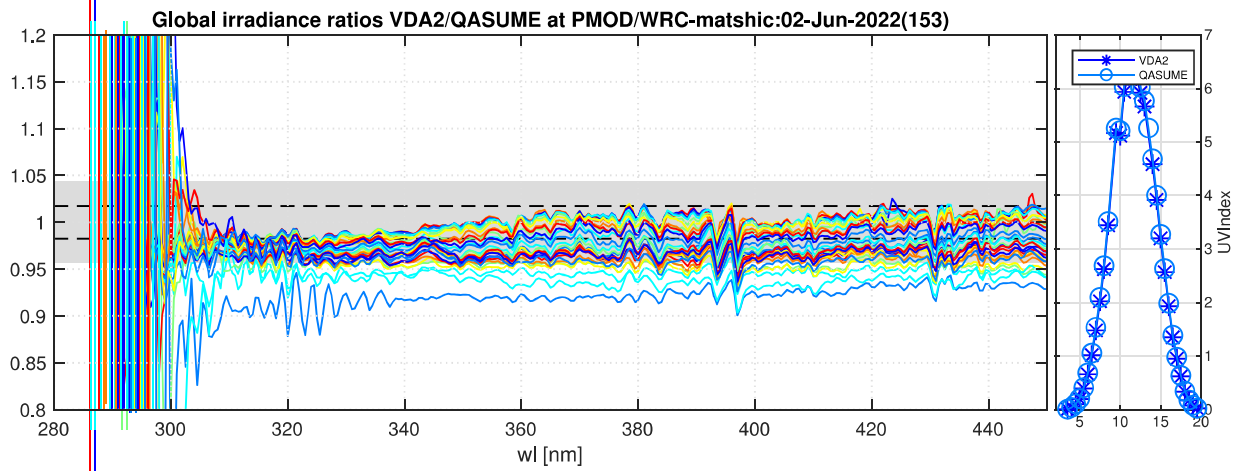
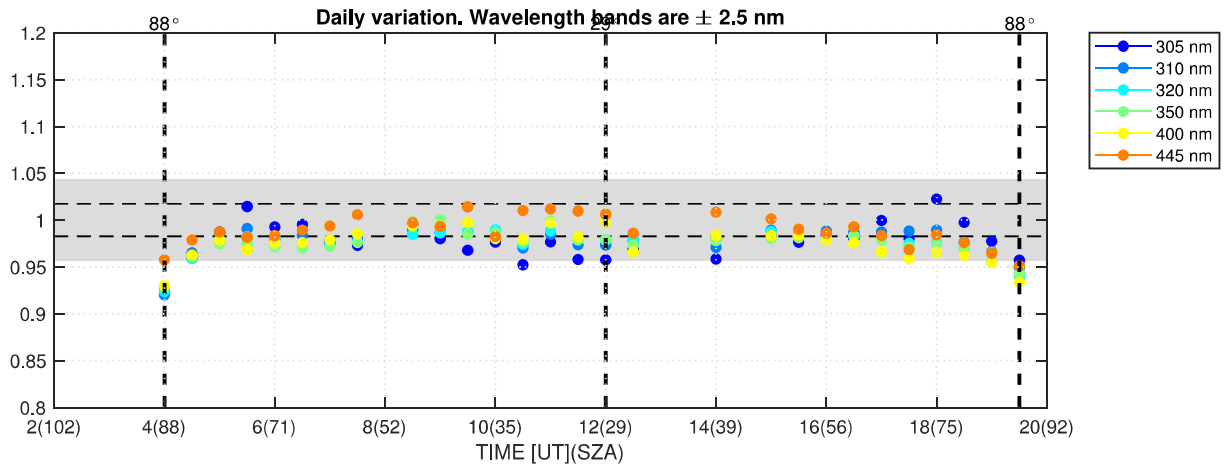
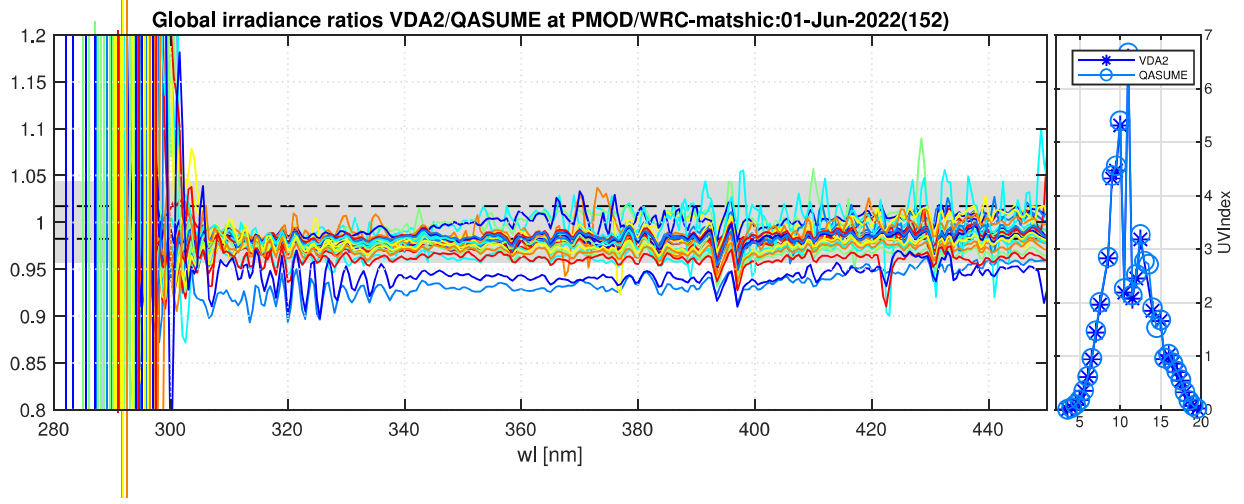


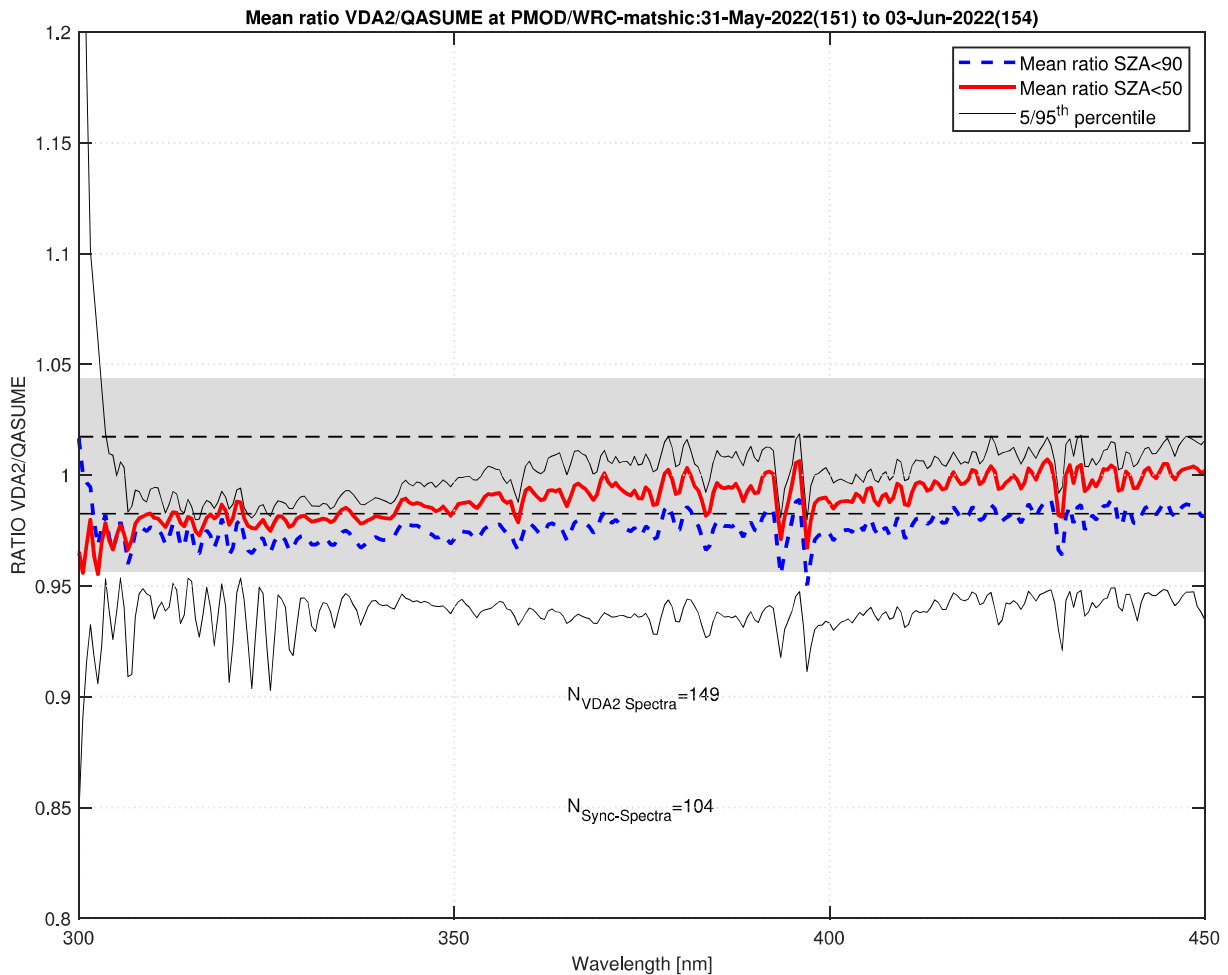
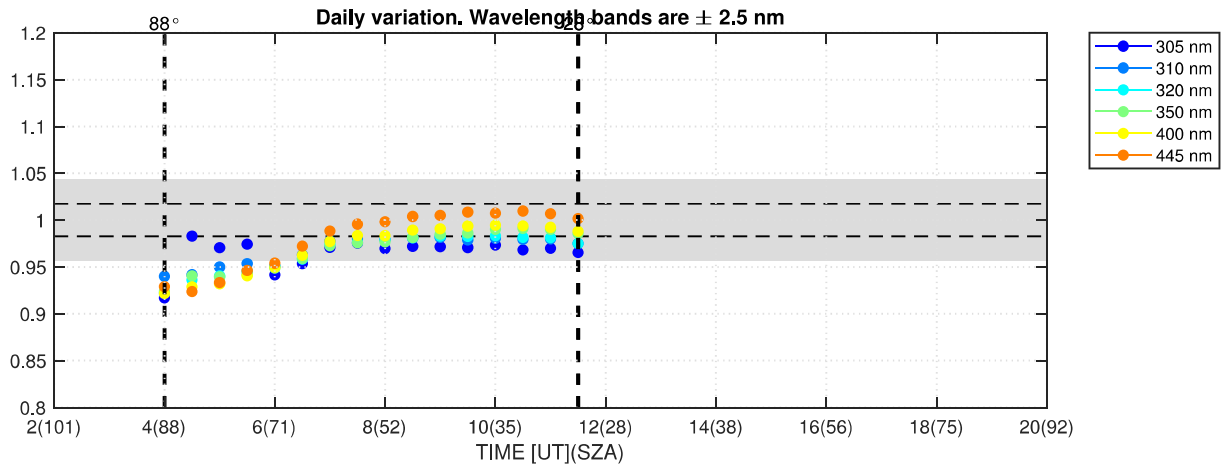
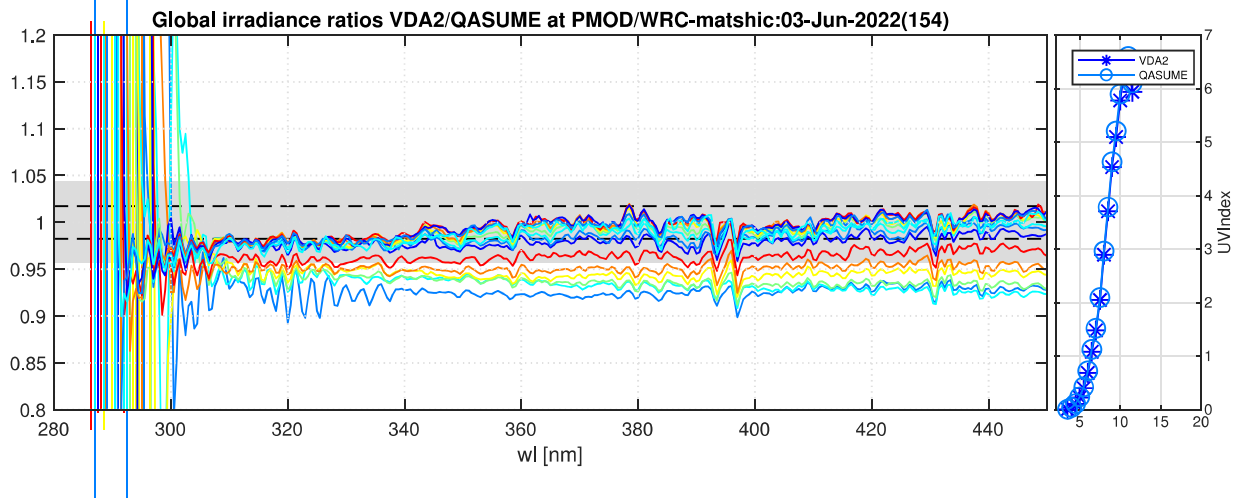


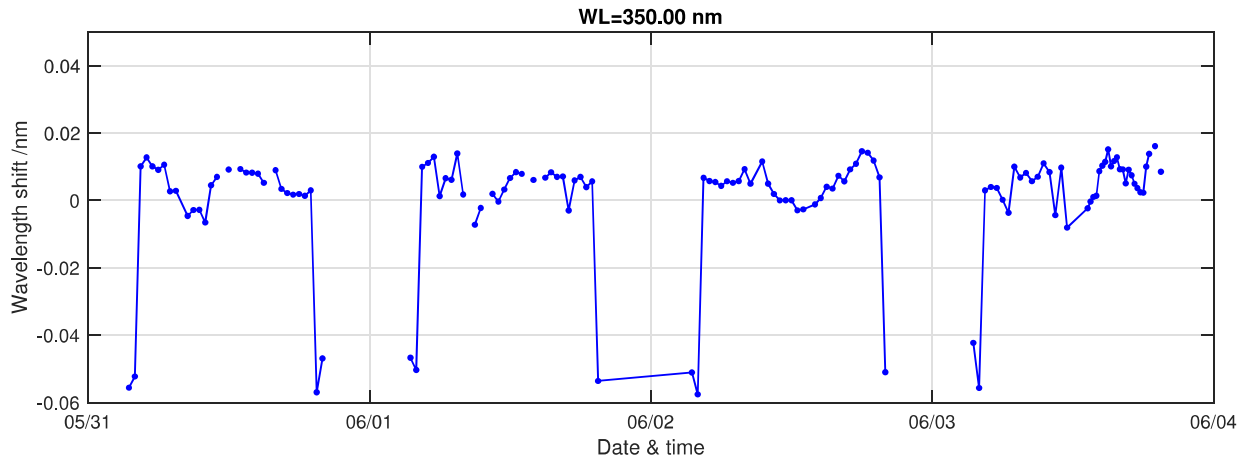
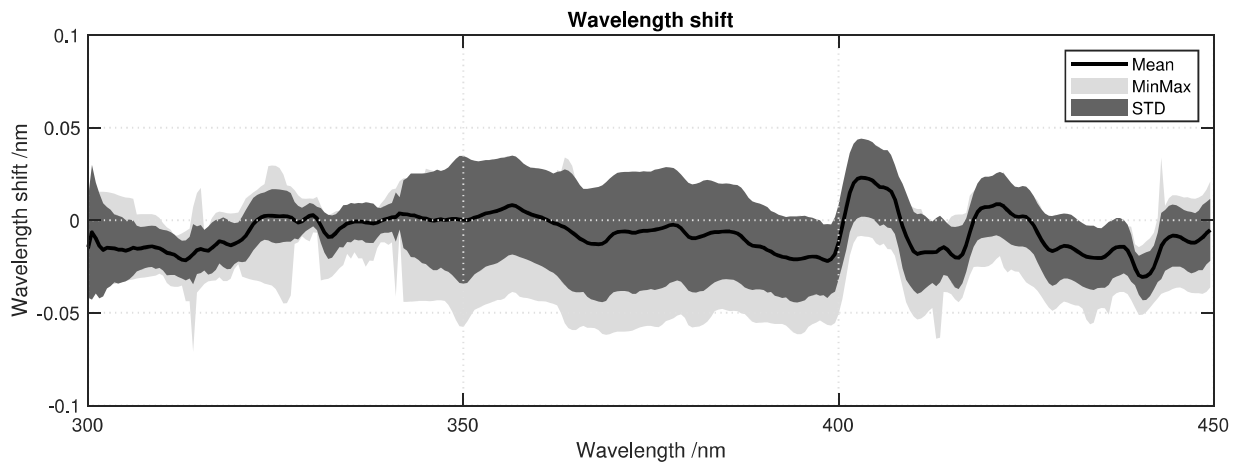




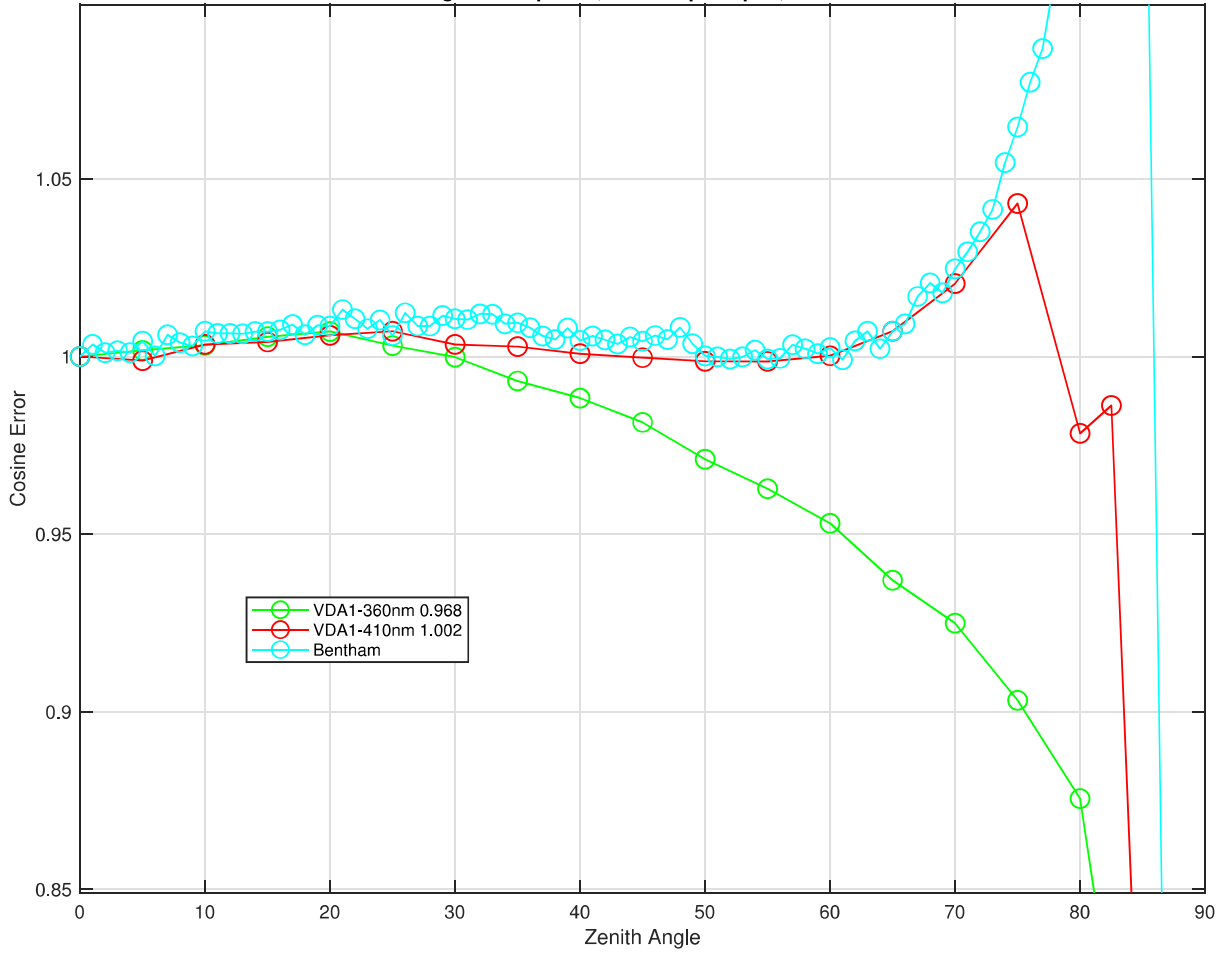




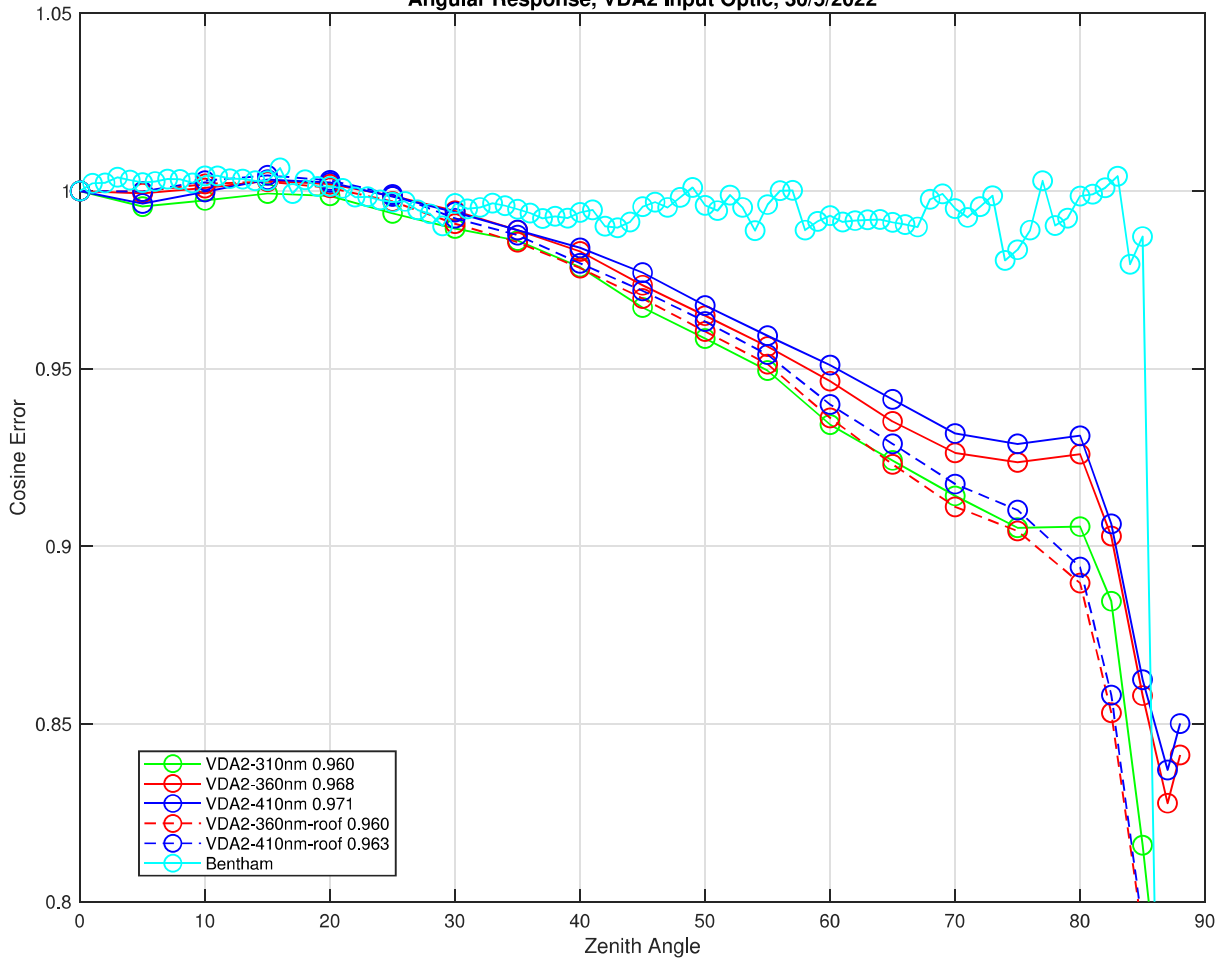




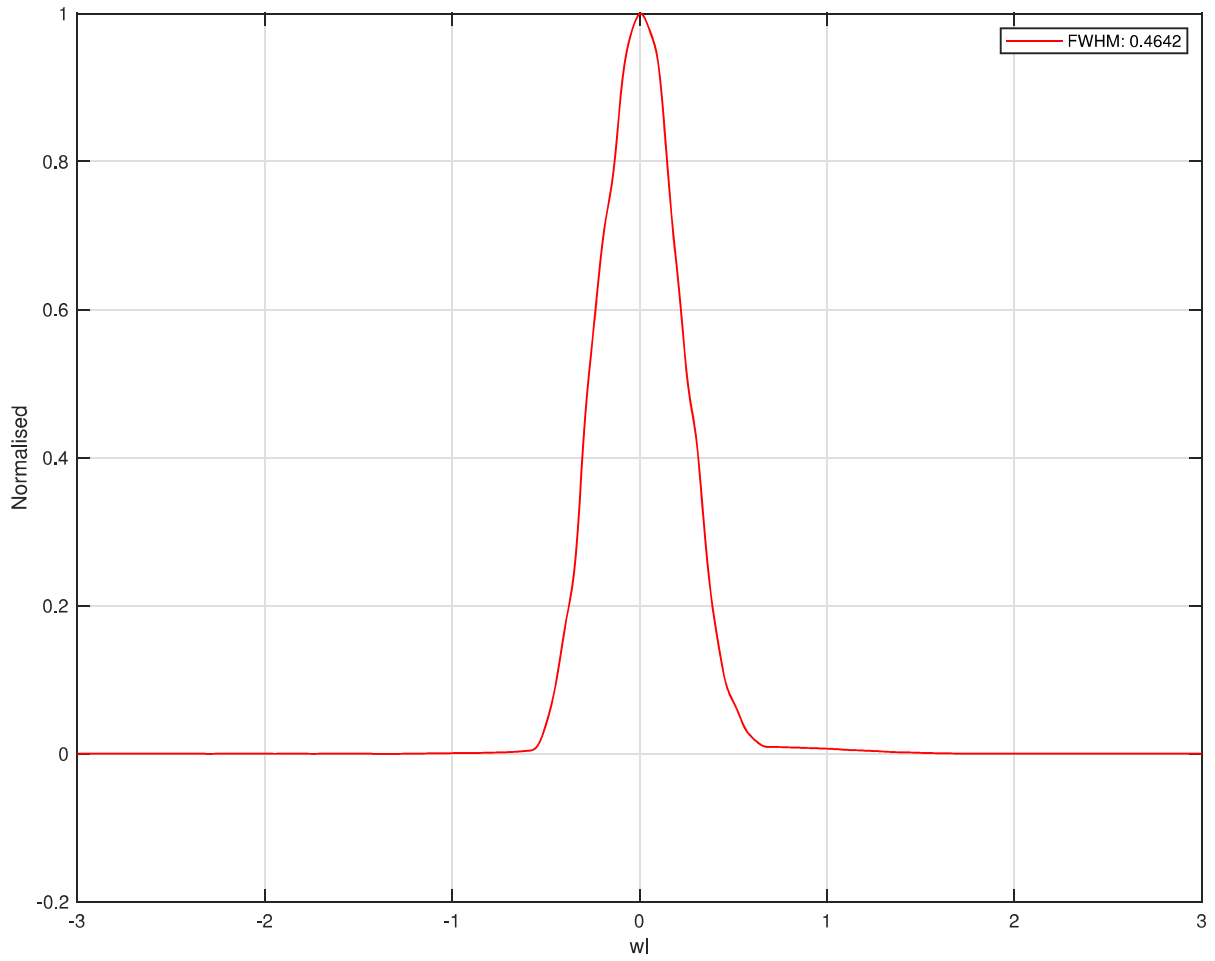
Angular Response, VDA1 Input Optic, 3/6/2022



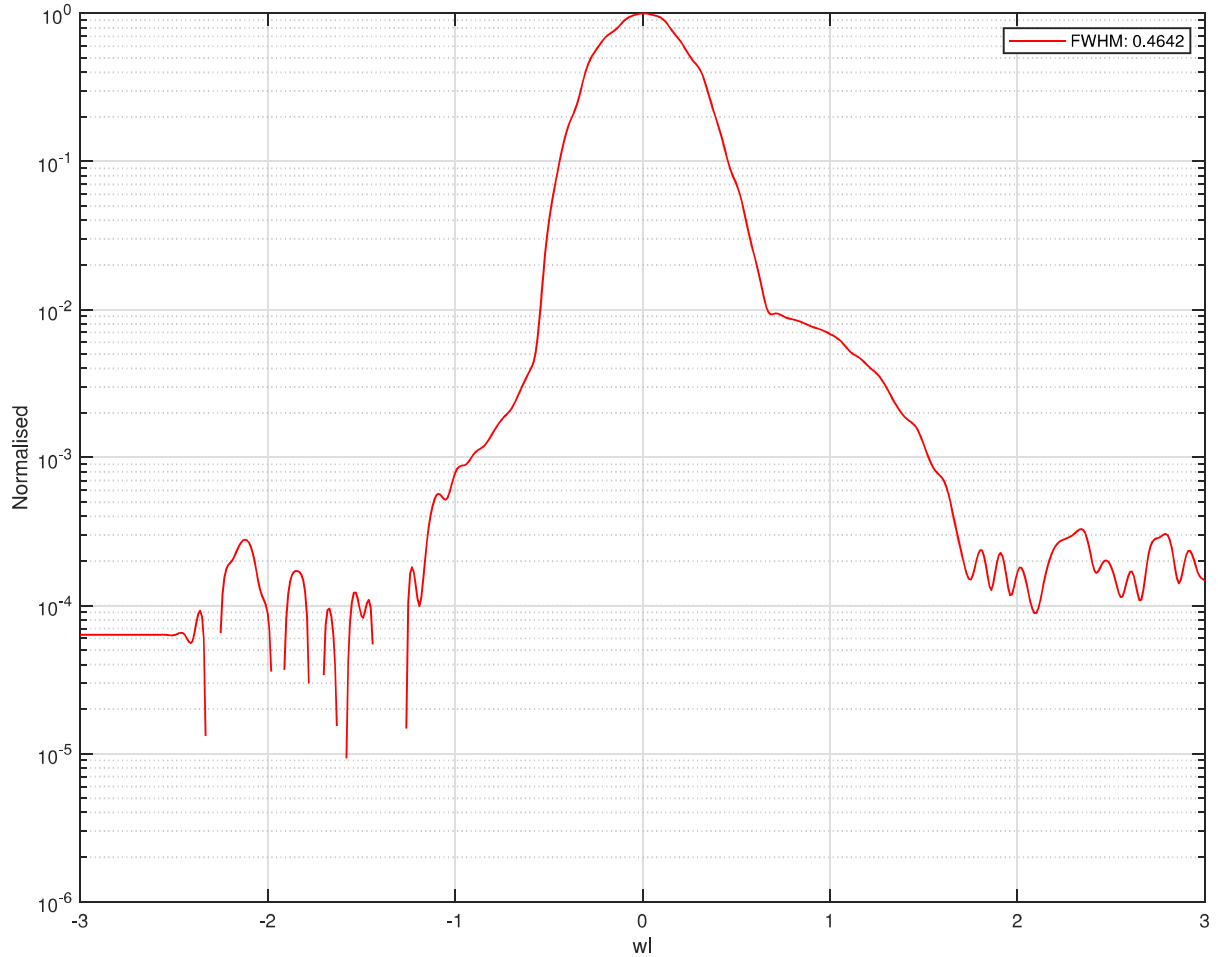
Angular Response, VDA2 Input Optic, 30/5/2022



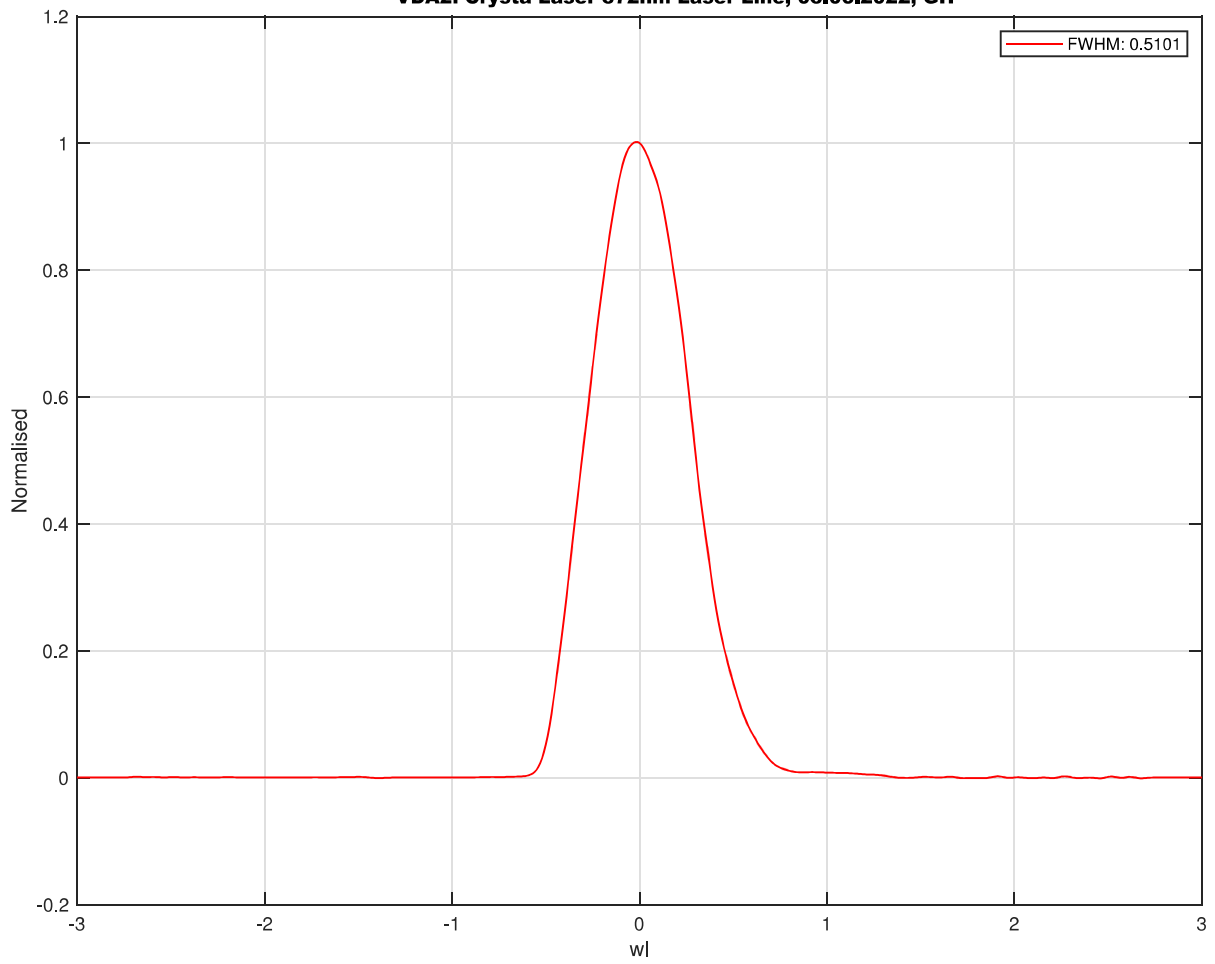
VDA1: Crysta Laser 372nm Laser Line, 03.06.2022, GH



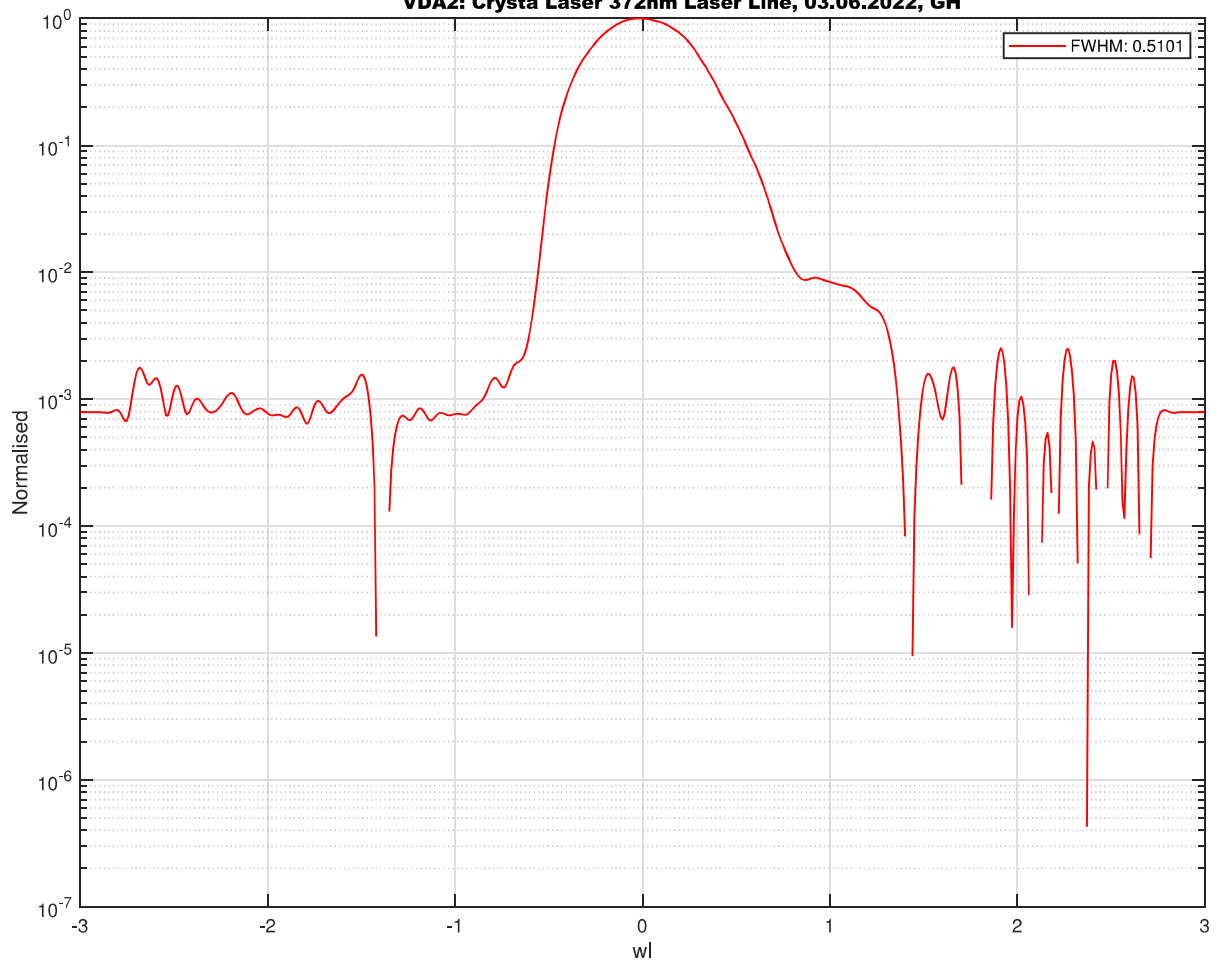
VDA1: Crysta Laser 372nm Laser Line, 03.06.2022, GH



VDA2: Crysta Laser 372nm Laser Line, 03.06.2022, GH



VDA2: Crysta Laser 372nm Laser Line, 03.06.2022, GH



Qasume stability, Lille, June 2022

