MELiSSA

TECHNICAL NOTE 96.10

EnginSoft S.p.A.
e-mail info@enginsoft.it
web www.enginsoft.it
24124 Bergamo - Via Galimberti, 8/D
Tel. (+39) 035-368711 - Fax (+39) 035-362970

Departament d'Enginyeria Química
Escola Tècnica Superior d'Enginyeries
Universitat Autònoma de Barcelona

TECHNICAL NOTE 96.10

HPC1 mapping report

Prepared by/Préparé par	EnginSoft/UAB/NTE-SENER
Reference/Réference	MELiSSA Pilot Plant Frame Contract 19445/05/NL/CP Call Off Order 6 – Installation and characterization of the HPC1 in the MELiSSA Pilot Plant
Issue/Edition	0
Revision/Révision	0
Date of issue/Date d'édition	28th July 2010
Status/Statut	Final

APPROVAL

Title *Titre*	**HPC1 mapping report**	Issue 0 Revision 0 Edition Révision	

Prepared by *Auteur*	J. Duatis (NTE-SENER) and A. Fossen (MPP)	Date *Date*	16th Jul 2010
Checked by *Verifié par*	E.Peiro, A. Fossen (MPP) and L. Bucchieri, G. Perna (EnginSoft)	Date *Date*	27th Jul 2010
Approved by *Approuvé par*	F.Gòdia (UAB)	Date *Date*	28th Jul 2010
Approved by customer *Approuvé par le client*	B. Lamaze	Date *Date*	28/07/2010

CHANGE LOG

Issue/Edition	Revision/Révision	Status/Statut	Date/Date
0	0	Final	28 July 2010

Distribution List

Name/Nom	Company/Société	Quantity/Quantité
Brigitte LAMAZE	ESA	2 hardcopies + electronic version
Oliver Gerbi	SHERPA	Electronic version
Jordi Duatis	NTE-SENER	Electronic version

TABLE OF CONTENTS

TABLE OF FIGURES

Index of Tables

ACRONYMS

CESRF	Controlled Environment Systems Research Facility
CFD	Computational Fluid Dynamics
HPC	Higher Plant Chamber
HVAC	Humidity Ventilation Air Conditioning
MSDS	Material Safety Data Sheet
PAR	Photosynthetically Active Radiation
PAR	Photosynthetically Active Radiation
PP	Polypropylene
PPF	Photosynthetic Photon Flux
RH	Relative Humidity
UAB	Universitat Autònoma de Barcelona
UoG	University of Guelph

1.Scope

The present document presents the results and conclusion of the HPC1 Mapping performed in the frame of Call Off Order 6, as per the requirements expressed in AD5 and the protocols and procedures of AD6, for the following parameters : pressure, temperature, humidity, light and air velocity.

2.Reference and applicable documents

2.1.Applicable documents

AD1	19071/05/NL/CP	Frame Contract between ESA and UAB
AD2	MPP-OFR-08-0001(3)	Proposal for Call Off Order 6 – HPC1 installation and start-up in the MPP
AD3	MPP-QA-07-0001	MPP Quality Manual
AD4	MPP-QA-07-0003	MPP rules for good lab practices
AD5	TN96.8	HPC1 mapping requirements
AD6	TN96.9	HPC1 mapping protocols and procedures

2.2.Reference documents

RD1	TN85.71	HPC1 User Manual
RD2	TN95.1	HPC1 control requirements and software description
RD3	NTE-HPC-HVAC-RP-004(2.0)	Report on the mapping of HPC1 (provided in appendix)

3.Acronyms/Definitions

HPC1	Higher Plant Compartment 1
MPP	MELiSSA Pilot Plant
UAB	Universitat Autònoma de Barcelona
MELiSSA	Micro Ecological Life Support System Alternative
CFD	Computational fluid dynamics
PLC	Programmable logical computer
RH	Relative humidity
HPS	High Pressure Sodium

MH	Metal Halide
HVAC	Heating Ventilation Air Conditioning
SES	Sensor for Electromagnetic Spectrum

4.Test items

4.1.Description (PID, technical drawings, user manual)

- Higher Plants Compartment (HPC1) is described in document RD1
- PID and Sherpa control are described in documents RD2

4.2.Hazards induced by test item and safety measures to be taken

- Mechanical hazard (pump, blower)
  - The protection against these hazard is ensured by the panels preventing access to these equipments
- Pressure hazard (compressed gases mixtures in K-size tanks at 200barg, and N_2 and O_2 building supplies at 6 bars)
  - The presence of gas pressure regulators on the gas cylinders and building supply tubing reduces the delivery pressure down to 2 barg
- Intense light hazard is present for the light mapping activity ; the operator have to wear the adequate sunglasses to avoid blinding effects of the lights

4.3.Instructions for operation

- See user manuals RD1 and RD2

4.4.Instructions for maintenance

- See user manual RD1

5.Presentation of the results

5.1.Light measurement under the glass panel

These measurements were taken separately under one 400W MH lamp and then under one 600W HPS lamp. They were performed on July 28th 2009 in the HPC1 of the MPP.

5.1.1.Sensors characteristics

A first sensor TE1 was used in order to measure in each point the light intensity spectrum for the visible range, in W/cm^2. It is a camera spectrometer, model PR 655.

The Wc/m^2 distribution was measured with three dedicated sensor for each of the three following ranges of wavelengths : TE2 for UVB range 265nm – 332nm, TE3 for UVA range 315nm - 390nm and TE 4 for visible range 380nm-780nm.

All sensors are measuring the light received from the volume above the plane of the sensor cell, integrating it on a 2π steradian solid angle.

For the details on the TE1, TE2, TE3 and TE4 sensors used : see RD3 par.4.1

5.1.2.Measurement points

The light measurement points were placed right below the tempered glass as shown in Figure 1 Light measurement pointsFigure 1, on the diagonal of the glass panel below the lamp to be characterized.

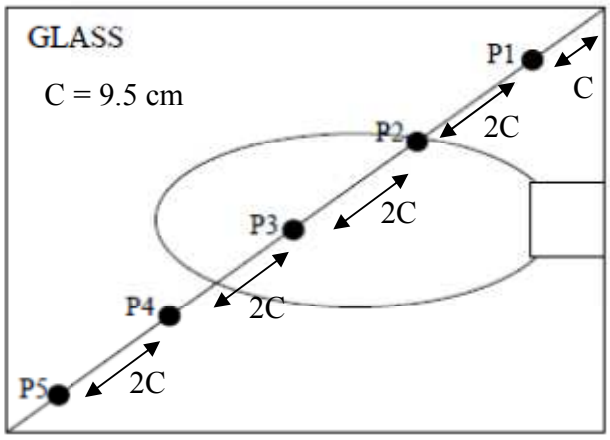


Figure 1 Light measurement points

5.1.3.Results on integrated irradiance

For the 600W HPS lamp, the integrated irradiance results are the following ones :

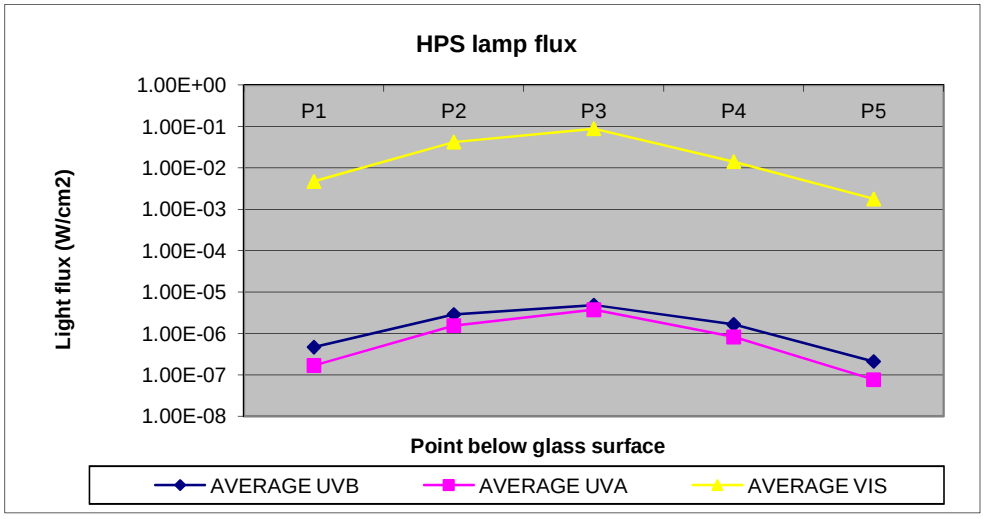


Figure 2 - 600W HPS lamp integrated irradiance below the glass panel

For the 400W MH lamp, the integrated irradiance results are the following ones :

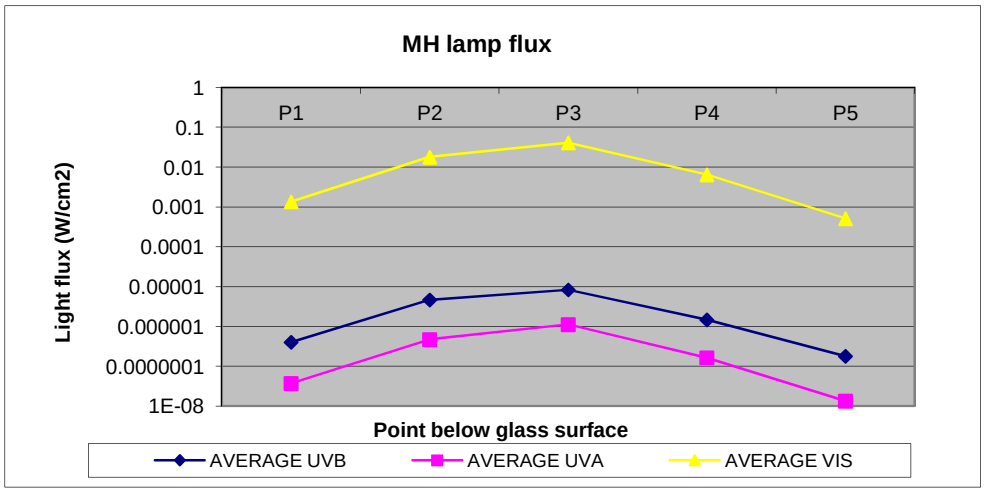


Figure 3 - 400W MH lamp integrated irradiance below the glass panel

For each wavelength the profiles followed by the integrated irradiance (W/cm2) are consistent with the distance to the source of the light, i.e. the bulb of the lamp : they are

maximal for the closest point P3 and then decrease with the distance, which means that P2 has an intensity superior to P4, which in turn is superior to P1, itself superior to P5.

The 600W HPS lamp has a higher integrated irradiance than the 400W MH lamp for the UVA domain (3 to 5 times higher) and visible domain (2 to 3 times higher), but it has a lower integrated irradiance on the UVB domain (up to 2 times lower).

All the measurements for integrated irradiance were performed three times, and the presented results are thus average values on the triplicates. For all the details on the values obtained, please refer to RD3 par.4.2

5.1.4.Results on spectral irradiance

Concerning the light spectrum delivered by each lamp, they were also characterized using TE1 sensor, and the results are presented in the figures below.

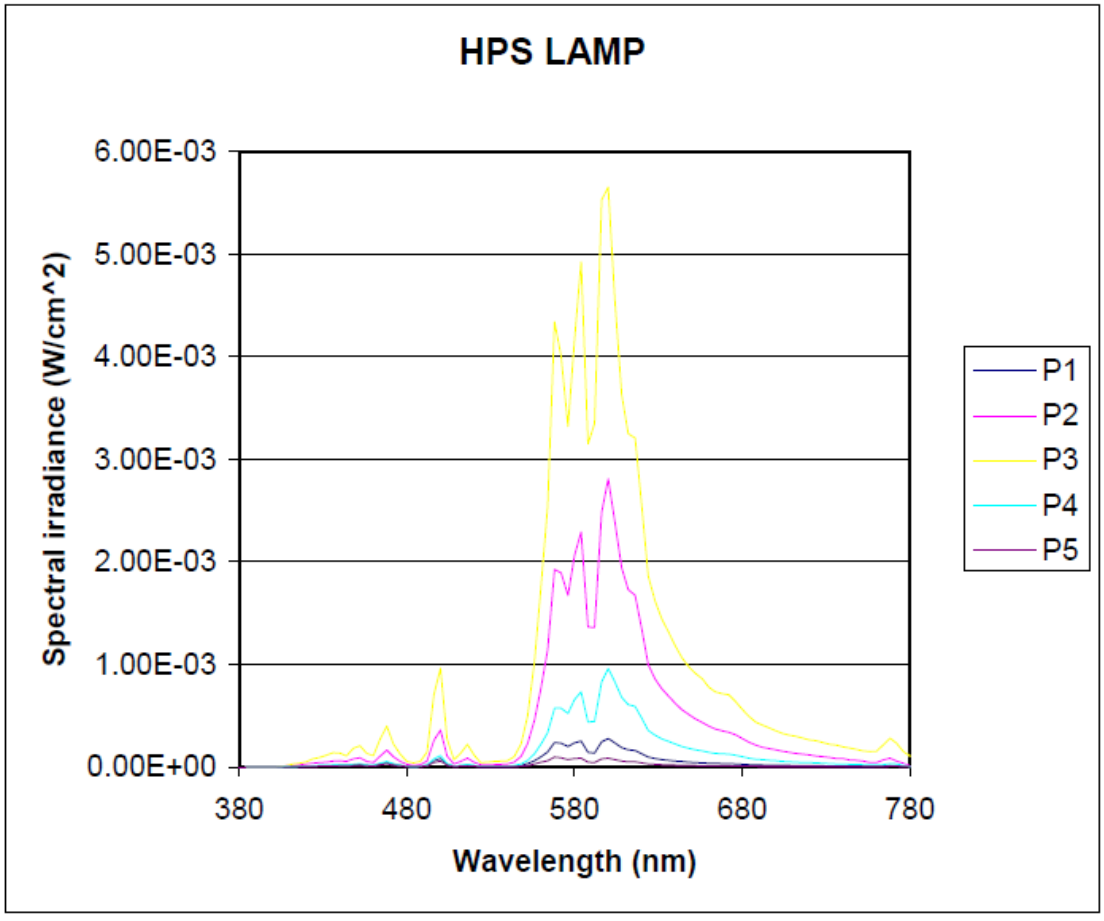


Figure 4 - 600W HPS lamp spectrum below the glass panel

The light emitted by the HPS lamp has a spectrum that presents 3 main peaks centred around the following frequencies (by decreasing order of spectral irradiance measure in P3 location): 600nm (5.65mW/cm^2), 584nm (4.93mW/cm^2), 568nm (4.34mW/cm^2). Around these three peaks, the intensity is superior to 1mW/cm^2) in the range of wavelengths between 556nm and 644nm and in another minor peak at 500nm (1mW/cm^2).

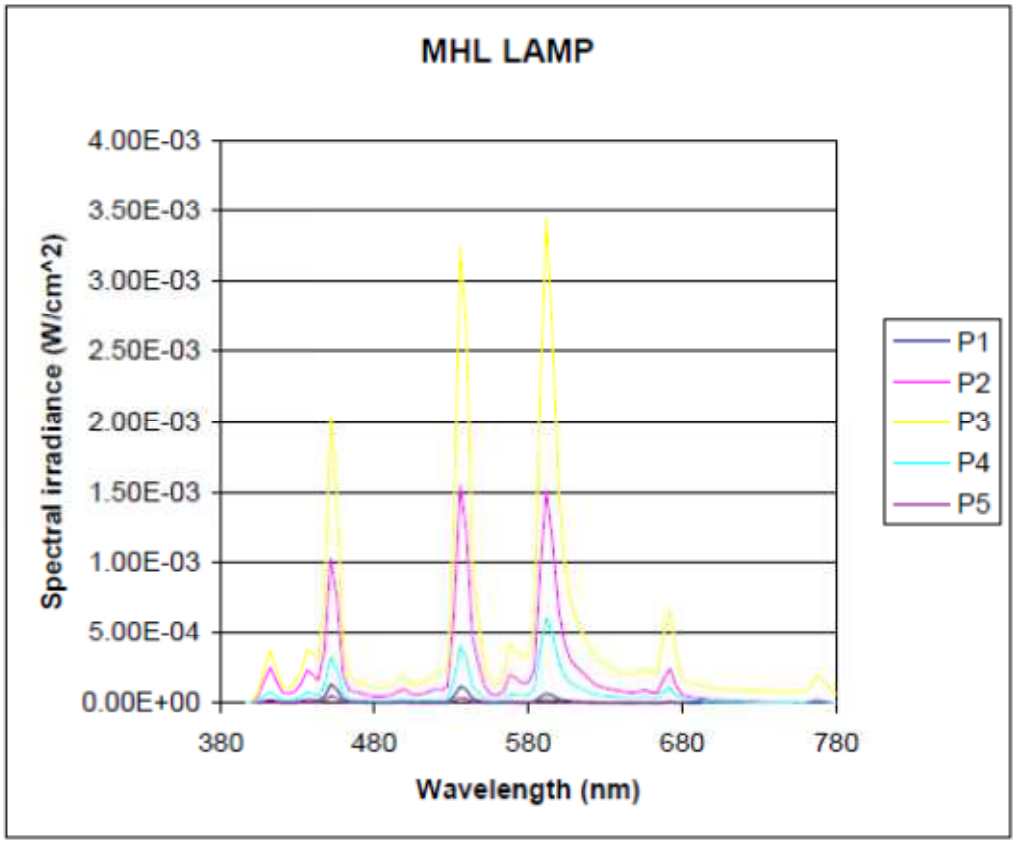


Figure 5- 400W MH lamp spectrum below the glass panel

The light emitted by the MH lamp has a spectrum that presents 3 main peaks centred around the following frequencies (by decreasing order of spectral irradiance measure in P3 location): 452nm (2.03mW/cm^2), 536nm (3.25mW/cm^2), 592nm (3.45mW/cm^2). These three peaks are very narrow : the intensity is superior to 1mW/cm^2 in the ranges of wavelengths between 452nm-456nm, 532nm-540nm and 588nm-600nm.

This is in agreement with the expected light from both HPS and MH bulbs characteristics.

5.1.5. Light measurement below the MH bulb

This measurement was made as requested per AD6, without the interference of the glass panel.
See figure 7 of appendix 3 for the details and graph.

The spectrum is not qualitatively changed by the glass panel in the visible range of frequencies.

5.1.6.Conclusion

The glass panels indeed filter the ultra violet radiations : for both lamp types, the measured light fluxes below the glass panel are at least 30.000 times lower for UVA wavelengths and 3.000 times lower for UVB wavelengths than for the visible wavelengths, which confirms the assumption made by EnginSoft that UVA and UVB can be neglected.

The difference between the HPS lamps and the MH lamps, apart from the intensity of the lighting (600W for the HPS lamps mounted on the HPC1 versus 400W for the MH lamps mounted on the HPC1) appears clearly on the visible spectrum distribution. The association of these two types of lamps provides then a more even spectrum that can be used by the plants for their photosynthesis.

5.2.Light measurement at tray level

The light intensity was measured in proximity of the trays with the TE1 sensor for electromagnetic spectrum, adequate for the spectral characterization.
(see RD3 for the datasheet).
The required measurement points are shown in the following figures. As the measurements did not need to be performed all at the same time, the TE4 sensor was moved from one measurement point to another in order to cover all the specified positions.

In agreement with AD6 , there were three different positions (planes) for this test, and for each of these planes (in a cross section of the chamber, see Figure 6), three points of measurement.

All the lamps were switched on for all the measurements.

The three cross sections selected are as shown on Figure 7:

1. Section 1 (plane A) : under an MH lamp (on the middle plane of the lamp)
2. Section 5 (plane B) : under an HPS lamp (on the middle plane of the lamp)
3. Section 7 (plane C) : in between the chosen MH and HPS lamps

A = 20 cm
Distance between
- Probe
- Wall

B = 20 cm
Distance between
- Probe
- Top of the tray

SES = Sensor able to detect the Electromagnetic Spectrum

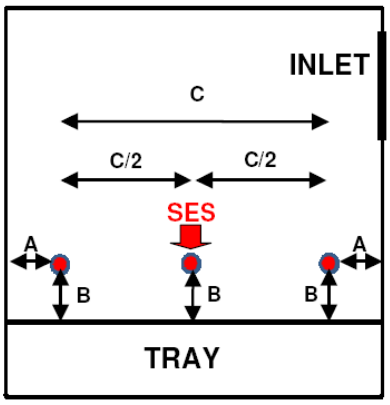


Figure 6 Measurement points in the cross section

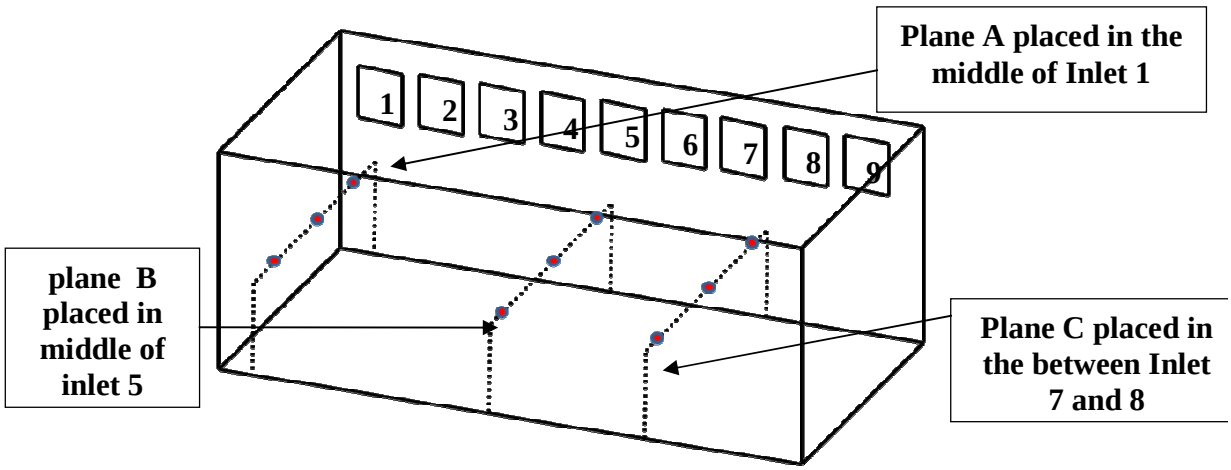


Figure 7 Measurement points along the axis and location wrt the air inlets

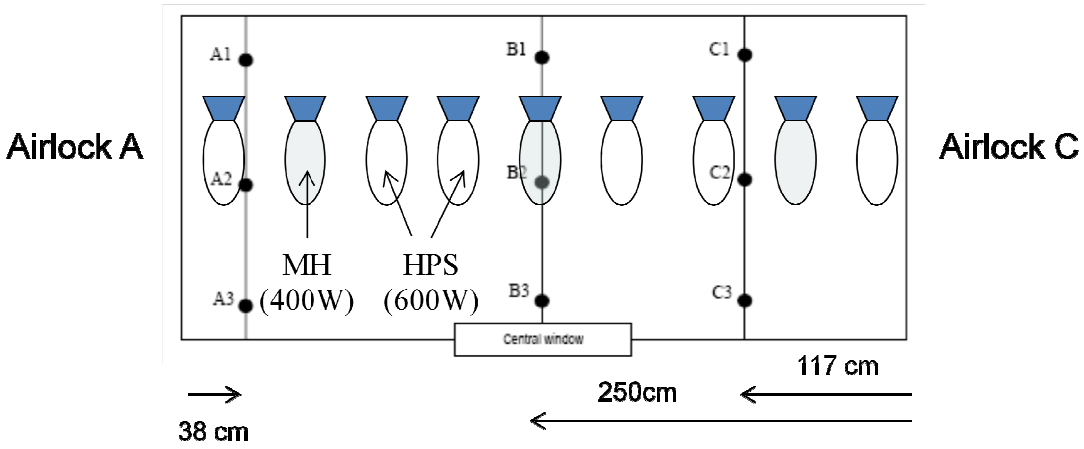


Figure 8 top view of HPC1 with distribution of the measurement points

The planes are defined as follows :

- Plane A is located at 38 cm distance from the airlock A curtain
- Plan B is in the middle of the chamber at 250 cm from Airlocks A and C curtains
- Plane C is located at 117 cm distance from airlock C curtain

In the chamber the position 1 corresponds to the point close to the spigot, position 2 to the middle of the chamber and position 3 to the point near the longitudinal collector for hydroponics solution.

Important remarks :

For this mapping as there was also a requirement to check the light intensity at mid height for one measurement, and since the light available varies with height, each point A1..C3

were measured at the required height of 20 cm above the trays and at the additional height of 40 cm above the trays.

The photosynthetic active radiation sensor of the MPP (Li-Cor model LI189-LI190) was also used to measure the received PAR intensity in the points A2, B2 and C2 at 20 cm height and 40 cm height in order to calibrate them against the sensor TE4.

The trays were all introduced in the chamber in order leave a representative configuration of an empty culture chamber.

5.2.1.Preliminary verification of reflection influence

A preliminary verification of the influence of the trays, the curtains was made in the plane A, position A2, at 20 cm height, with the visible sensor integrated irradiance sensor TE4, with all lamps on in the HPC1.

The results were the following ones :

Curtain A	Door A	20 trays	TE4 reading value (non processed)
Open	Closed	In	15.05
closed	Closed	In	15.31
Closed	Closed	Out	14.98
Open	Closed	out	14.88

Table 1 - influence of reflection of trays and curtains

The maximum light intensity measure inA2 location at 20cm above the tray edge is obtained when trays are installed and curtains are closed. The lowest one is obtained with the trays removed and the curtains open. Yet the difference between the visible light intensities measure all these conditions is lower than 3% of the nominal conditions (curtains and trays installed), therefore the influence is limited.

5.2.2.Results for integrated irradiance

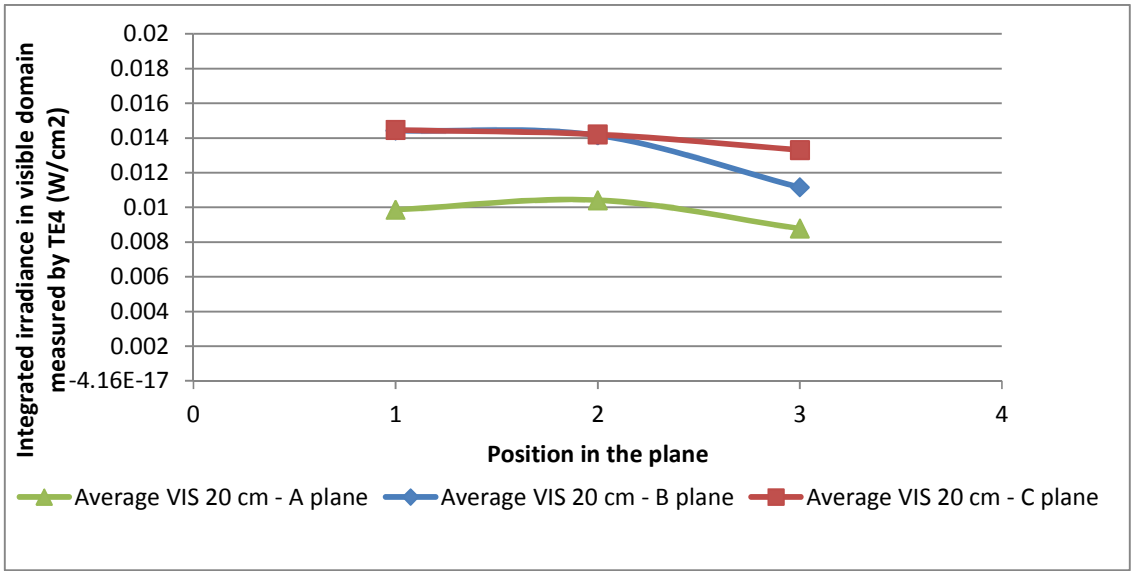


Figure 9 - integrated irradiance in visible domain at 20cm above the tray edge

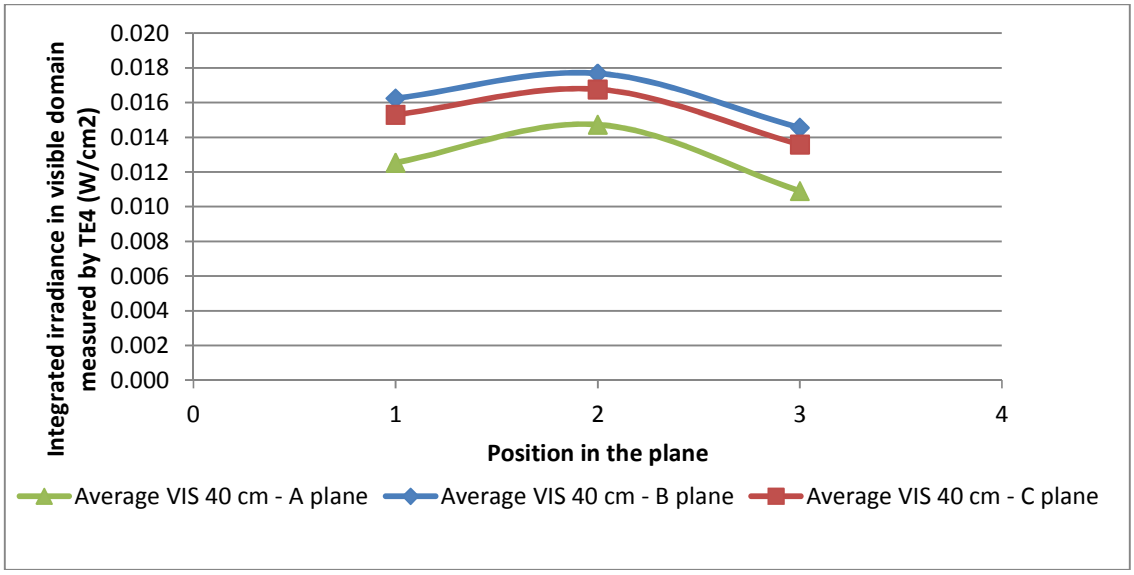


Figure 10 -integrated irradiance in visible domain at 40cm above the tray edge

In all sections, the side of the window (3) is the least enlightened one.
At 40cm above the trays, the central spot (2) is the most enlightened one for all sections.
At 20 cm above the trays, the central spot (2) or the spigot spot (1) are the most enlightened ; the relative difference between positions 1,2 and 3 is lower at 20 cm than at 40cm for sections A and C but has slightly increased for section B.

5.2.3.Results for spectral irradiance

The detailed spectra obtained in each position for the characterization of the spectral irradiance are available in RD3 figures 5 and 6.
The spectra reflect the combination of the frequencies emitted by the HPS and MH lamps, showing the superimposition of their specific peaks, at both 40 cm height and 20 cm height above the trays.
Logically the intensities measured at 40 cm height are higher than the ones measured at 20cm above the trays.

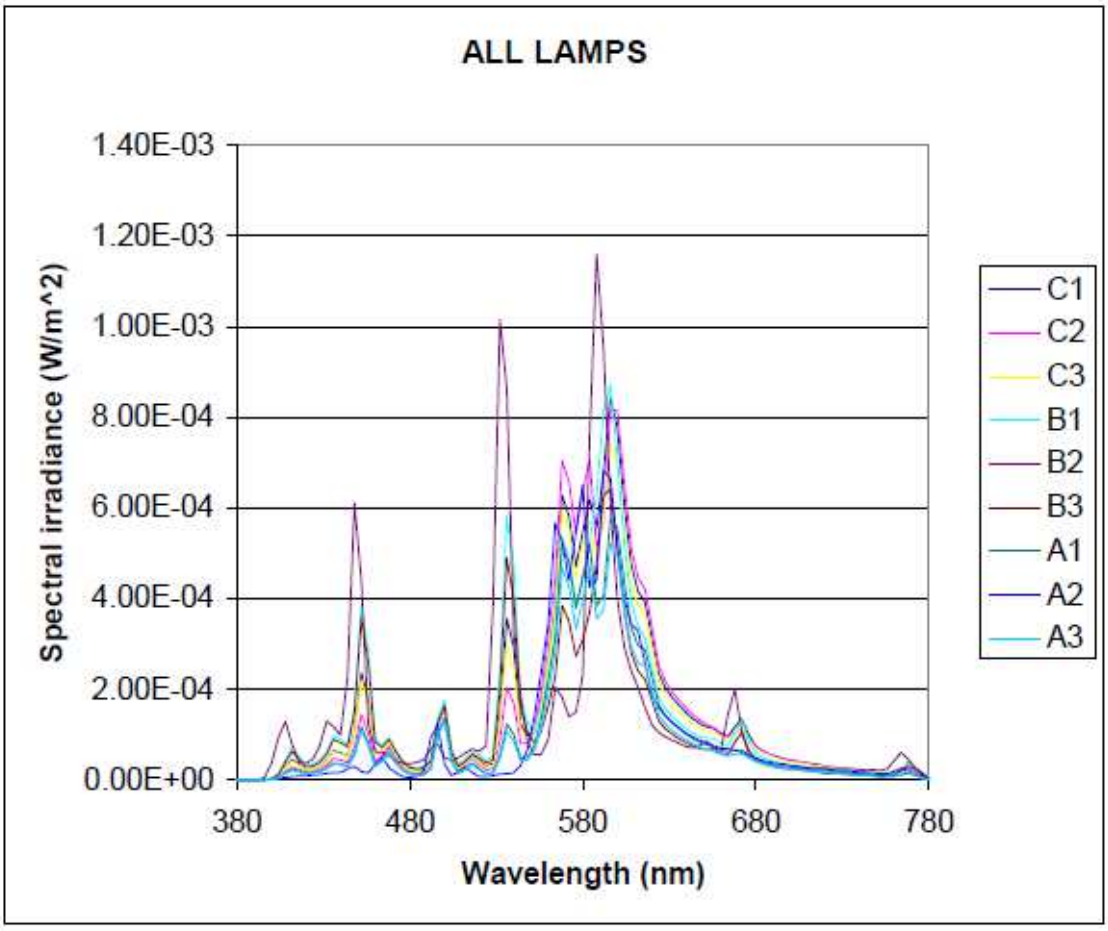


Figure 11 - spectral irradiance measurements at 20cm above the trays

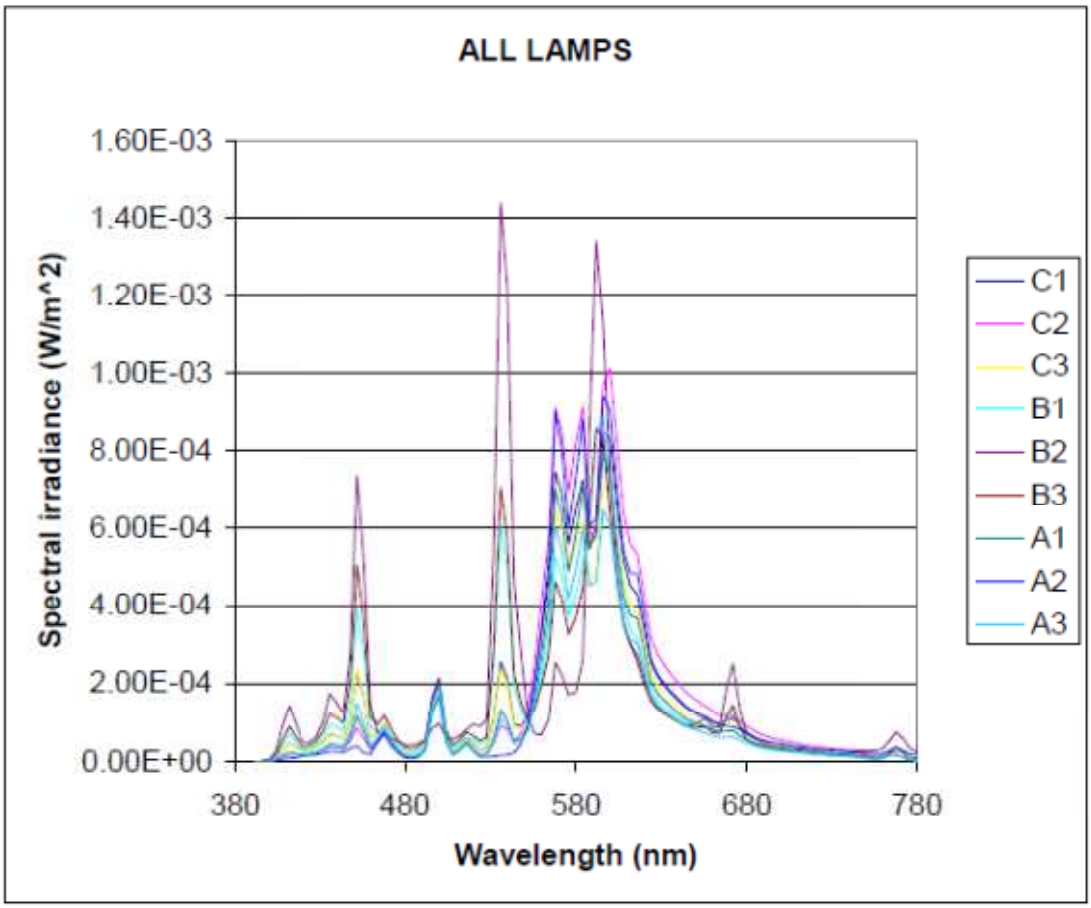


Figure 12 - spectral irradiance measurements at 40cm above the trays

5.2.4.Results for the MPP PAR sensor versus TE4

The measurements of photosynthetically active radiation by the MPP Li-Cor sensor with all lamps on were measured in the central positions as per the following table:

Point	TE4 at 20cm	PAR at 20 cm	TE4 at 40cm	PAR at 40 cm
	W/cm2	µE PAR units	W/cm2	µE PAR units
C2	1.42e-2	471 to 474	1.68e-2	459 to 460
B2	1.41e-2	485 to 486	1.77e-2	570 to 579
A2	1.04e-2	338 to 340	1.47e-2	494 to 497

Table 2 - PAR sensor versus TE4 integrated irradiance measurements

5.2.5.Conclusion

At the height of 20 cm above the edge of the trays, there seems to have a heterogeneity of the visible light intensity received from the lamps as a function of the position along the

chamber axis : as an average, the B section receives 5% less visible light intensity than the C section while the A section receives 31% less visible light intensity than the C section.
At 20 cm, inside each plane there is also a dispersion along the transverse axis of the chamber : the position 3 that is close to the side window receives a visible light intensity that is 8% to 23% lower than the highest intensity received in positions 1 or 2.
Concerning the spectra, the exact profiles could be identified on 9 points, at two different heights for their introduction in the 3D model of the HPC1.

5.3. Additional mapping to check the influence of the ageing of the lamps

On May 3rd 2010, an additional mapping was contracted by the MPP in order to check the influence of the ageing of the lamps on the quality of the light in the culture chamber. Indeed at that point, one 30 days demonstration batch culture and two 40 days batch cultures had been performed, and differences of growth had been observed between the three modules A, B and C of HPC1, possibly due to the ageing of some lights.

The test consisted in measuring the visible spectral irradiance with sensor TE1 and the integrated irradiances in UVB, UVA and visible ranges with the same sensors TE2, TE3 and TE4 as in par.5.2. along the chamber axis in two distinct configurations : the "old configuration" was the one with the lamps as they had been used so far while the "new configuration" was the one with the two HPS lamps and the MH lamp of module B replaced by new lamps that had not been used previously.

The sensors were placed in the trays in the positions 1, 2 and 3 described in Figure 13, and as explained in the Table 3

5.3.1. Location of the sensors

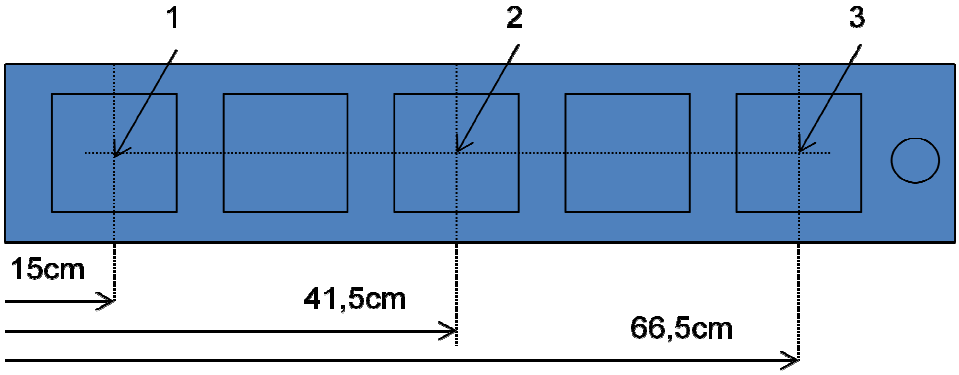


Figure 13- location of sensors at the level of the edge of the tray

5.3.2.Summary of the measurement locations

	door A									
	tray 1	tray 2	tray 3	tray 4	tray 5	tray 6	tray 7	tray 8	tray 9	tray 10
spigot side (position 1)	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1
center tray (position 2)	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4
window side (position 3)	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1

									door C	
	tray 11	tray 12	tray 13	tray 14	tray 15	tray 16	tray 17	tray 18	tray 19	tray 20
spigot side (position 1)	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1
center tray (position 2)	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4	TE1,2,3,4
window side (position 3)	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1	TE1

Table 3 - location of the various measurement points and sensors along the HPC1 chamber axis

5.3.3.Test results for the integrated irradiance

The integrated irradiances were calculated in the middle tray (position 2) for the three sensors TE2, TE3, TE4, and are presented in Figure 14 for the old lamps configuration and the new lamps configuration.

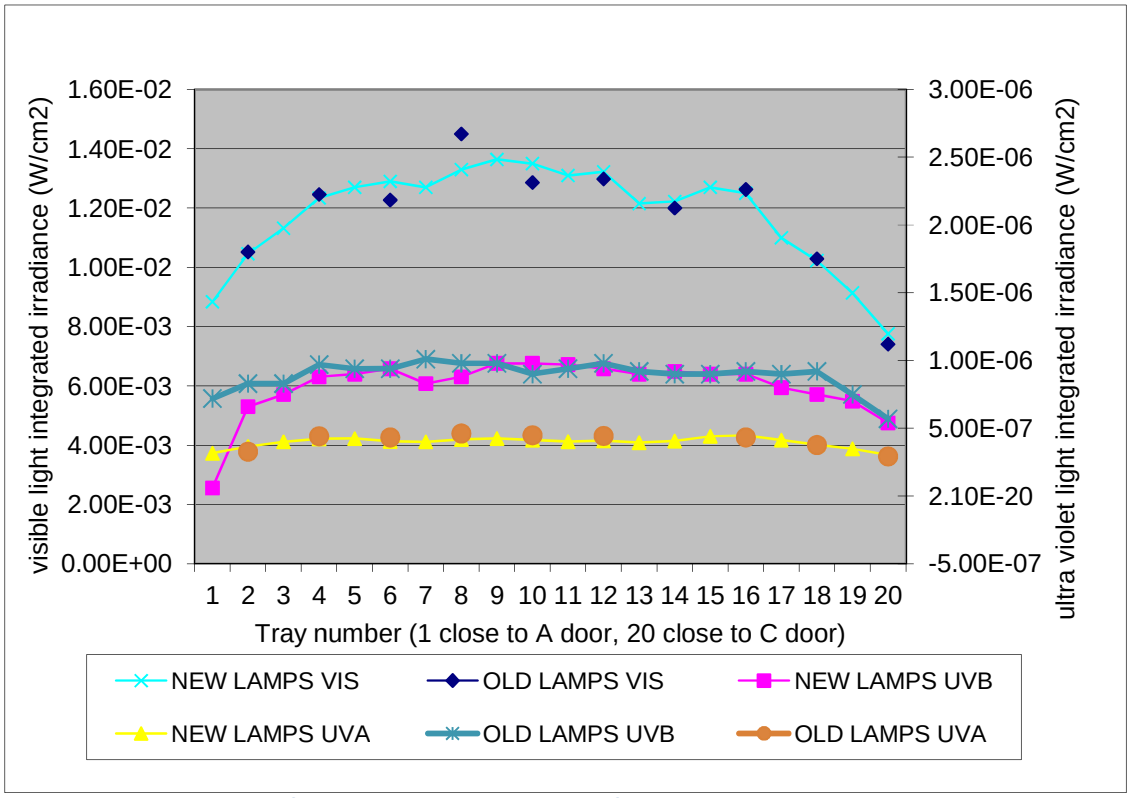


Figure 14- distribution of light integrated irradiances for UVA, UVB and visible domains along the chamber, in position 2 of the tray

- For UVA : the intensity is lower than 5.10^{-7} W/cm2 for any tray, with old and new lamps and follows a flat profile along the chamber axis

- For UVB : the intensity is lower than 1.10^{-6} W/cm2 for any tray, with old and new lamps and follows a flat profile along the chamber axis, except for the tray 1 where the measurement with the new lamps is very low

- For visible : the intensity remains between 7.10^{-3} W/cm2 and $1{,}4.10^{-2}$ W/cm2 for all trays, with old and new lamps.

Except for tray 8 where the old lamps provide a higher intensity than the new lamps (0.0145 instead of 0.0133 W/cm2) the rest of the trays show that both configurations show similar if not equal intensities distribution along the chamber axis.

The maximal intensity Imax is observed in trays 8-9-10-11 (central area) ;
Trays 4 to 16 have an intensity above 85% of Imax
Trays 1 to 3 and 17 to 20 (extremes) have an intensity between 51% and 83% of Imax

5.3.4.Test results for spectral irradiance

The spectral irradiance was measured on positions 1, 2 and 3 of the 20 trays and in both configurations. All the curves are presented in appendix 2.
As shown for integrated irradiance, there is no significant difference between the spectra measured in the old lamp configuration versus the configuration with all lamps new in module B.
The same heterogeneity of the light distribution between the various sides of the chamber can be observed.

5.3.5.Conclusion

The ageing of the lamps did not bring any change in the UVB or UVA intensities received at the level of the trays edge, which is logical since the "old" lamps had approximately less than half a year of use while the suppliers recommend to change them after 12000h of use, ie 1,5 year.
The UVA and UVB intensities remain lower than the visible one by at least 1000 times, with new lamps and with old lamps.
The dispersion of the intensity of the visible light is confirmed along the chamber axis, the trays 4 to 16 being in the range of 85% to 100% of the maximal intensity, while the side trays near door A (trays 1,2 and 3) and door C (trays 17,18,19 and 20) receive between 51% to 83% of the maximal intensity.
For the visible light intensity, the module B trays 7 to 14 have the highest illumination, followed by module A trays 1 to 6 (in average 12% less than in module B) and module C trays 15 to 20 receive the lowest illumination (in average 19% less than in module B).

5.4.HVAC mapping

The cross section of the chamber with the trays in place measures about 75*90 cm^2 (b*h). On this section the measurement points defined by AD 6 are shown in Figure 15:

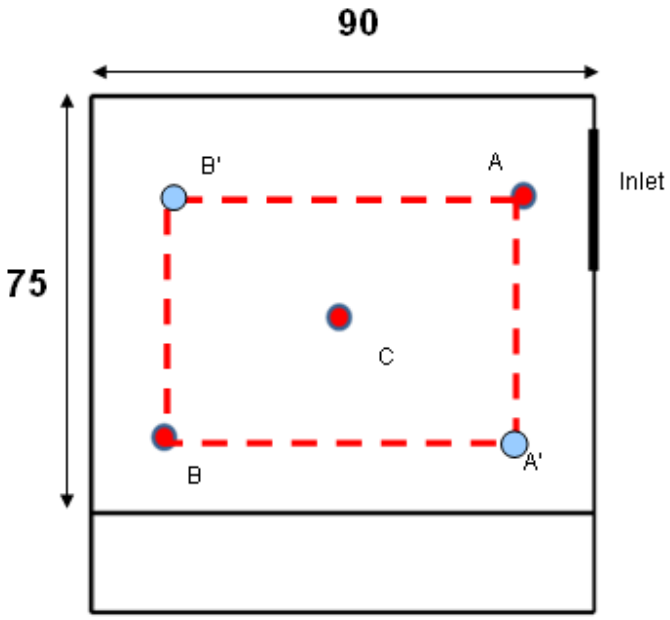


Figure 15 Cross section

- Point A centered on the air inlet at 7-8 cm distance from it.
- Point B positioned 7-8 cm distance from the wall and 7-8 cm distance from the top of the tray
- Point C placed in the middle of the diagonal between point A and B
- Points A' and B' are specular and measurements could be taken during the way back of the movement of the trays, changing the connecting poles.

5.4.1.Implemented sensor configuration

Due to the space occupied by the spigots protruding into the chamber, it was necessary to move the A A' plane away from the wall, obtaining the following final configuration

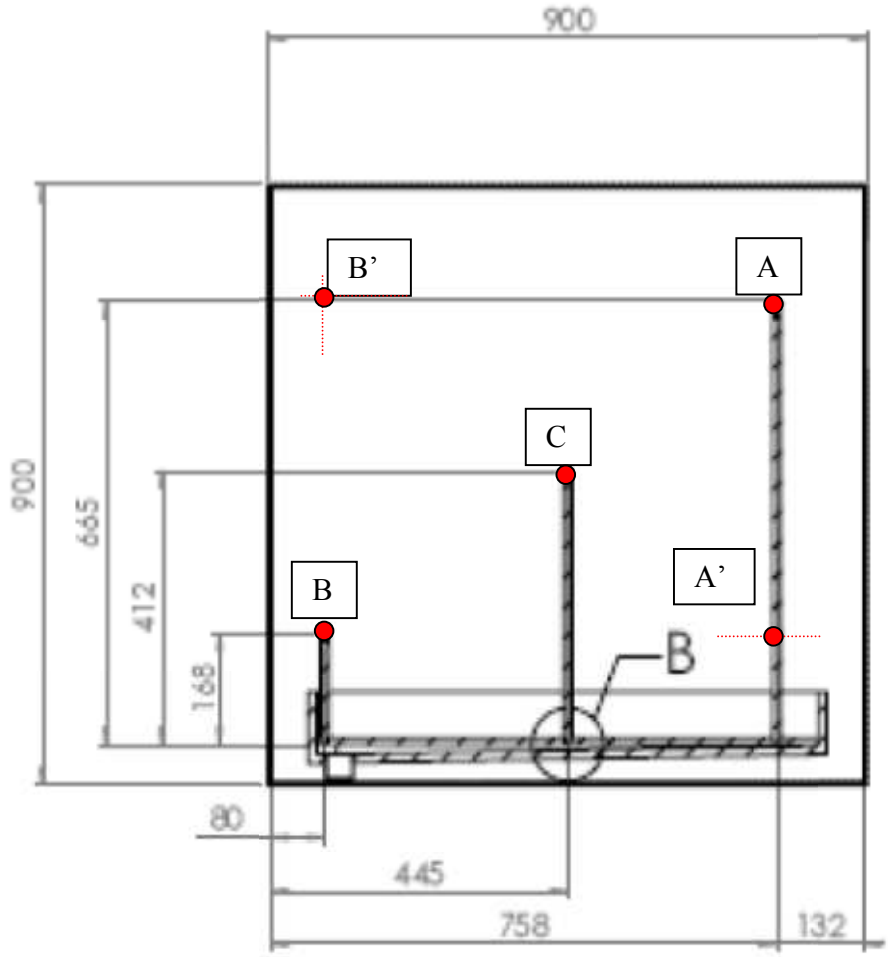


Figure 16 - implemented sensor arrangement for HVAC mapping of HPC1

For the representation of the results the following conventions were adopted :

Point	Distance to plenum wall	Height	Height identification	Transverse coordinate identification
A	132mm	665 mm	High	132mm
A'	820mm	168 mm	Low	820mm
B	132mm	168 mm	Low	132mm
B'	820mm	665 mm	High	820mm
C	455mm	412 mm	mid	455mm

Table 4 - identification of the measurement points

On the longitudinal direction the measurements were scanned as shown in Figure 17, with the following coordinates along the longitudinal axis of the chamber.

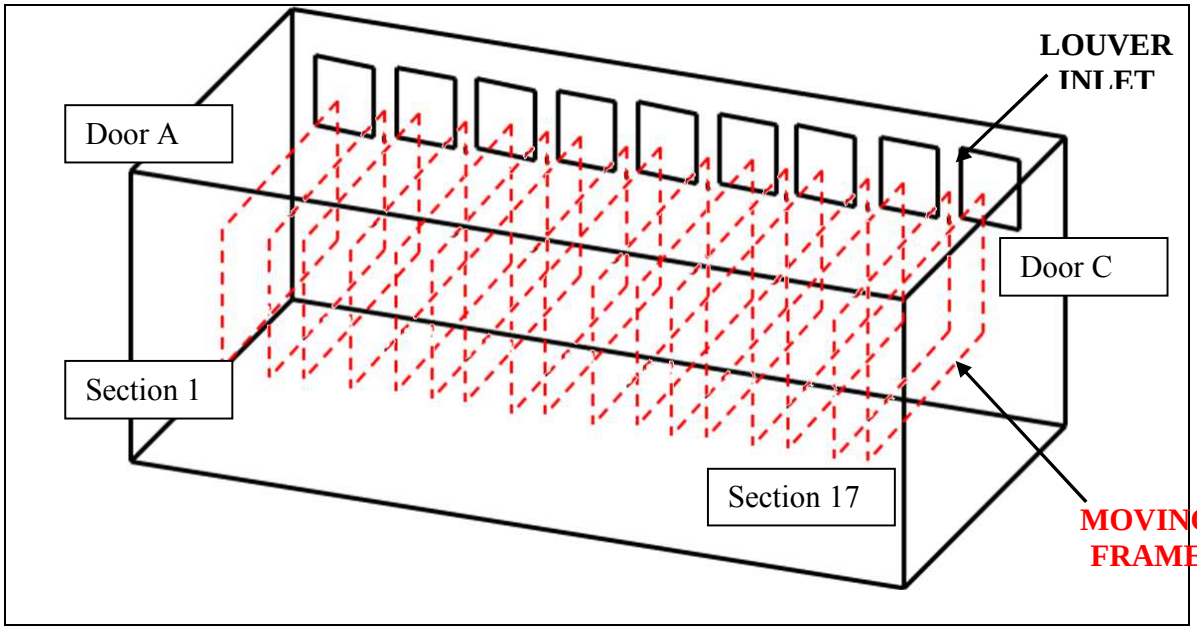


Figure 17 Measurements on the longitudinal direction

Nº	Pos (mm)	Nº	Pos (mm)	Nº	Pos (mm)
1	368	7	1958	13	3568
2	628	8	2228	14	3828
3	908	9	2518	15	4088
4	1168	10	2768	16	4358
5	1428	11	3038	17	4638
6	1678	12	3288		

Table 5 - position of the mapping sections to the chamber A door

5.4.2.Recall of the environment conditions for the four scans

The test consisted in acquiring the HVAC data during 30 seconds in a given section, then displacing the setup by 25 cm for the next acquisition, with a total of 17 positions covered. 4 runs from section 1 to 17 (or vice versa) were performed as per the following table and repeated for 2 different RH, and with the lights on and off, resulting in 4 different runs.

The conditions for each run are summarized in the following table:

Run name	Lighting	Temperature setpoint	Humidity setpoint	Configuration of sensors	Sense
Scan 1	100% ON	26ºC	50%	Long sensor support at plenum's side, short support at window side.	17 to 1
Scan 2	100% OFF	20ºC	60% to 70%	Long sensor support at plenum's side, short support at window side.	1 to 17
Scan 3	100% OFF	20ºC	60% to 70%	Short sensor support at plenum's side, long support at window side.	17 to 1
Scan 4	100% ON	26ºC	50%	Short sensor support at plenum's side, long support at window side	1 to 17

Table 6- environment conditions for the HVAC mapping scans

See RD3 for the detailed drawing of the support and location of sensors

Important remarks :
it has to be underlined that for these HVAC scans, the grids of the louvers had been dismounted and replaced by small, as per the agreement with EnginSoft.

The baffles configuration adopted below the trays was the following one, where L indicates the baffle with large apertures, M indicate the baffle with medium apertures and S the baffle with smaller apertures:

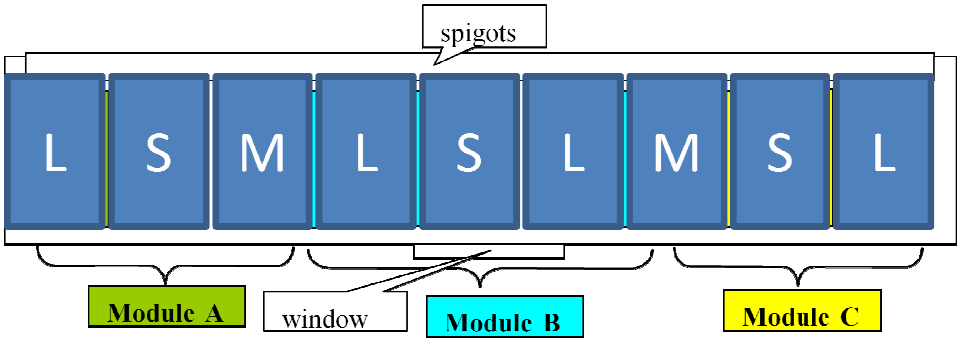


Figure 18 - top view of the HPC1 with distribution of baffle panels for the HVAC mapping - (L: large aperture panels, M: medium aperture panels, S: small aperture panels)

5.4.3.Results

The results obtained for scans 1 and 4 in day conditions are presented in the tables below

distance to plenum		132 mm	455 mm	820 mm	132 mm	455 mm	820 mm	132 mm	132 mm	455 mm	455mm	820mm	820 mm
scan 1		Humidity (%)			Air Velocity (m/s)			Temperature (degC)					
		High	Mid	Low	High	Mid	Low	High		Mid		Low	
	section	P2H	P4H	P8H	P5A	P6A	P1A	P2T	P5T	P4T	P6T	P1T	P8T
door A	1	59.5	53.4	53.5	0.86	0.8	0.27	24.7	25.6	26.3	25.6	26	25.9
	2	53.9	52.7	53.3	0.83	0.7	0.82	26.5	26	26.5	25.9	26	25.7
	3	52.5	51	53.9	0.33	0.34	0.7	27	27.1	27.1	26.4	25.9	25.7
	4	52.2	52	54.8	0.46	0.34	0.63	27.3	26.8	26.9	26.4	25.7	25.3
	5	51.8	51.1	55.4	0.35	0.41	0.71	27.3	26.9	27.2	26	25.5	25
	6	52.4	51.4	56.4	0.4	0.33	0.72	27.1	26.5	27.1	25.8	25.2	24.7
	7	52.4	50.3	56.8	0.36	0.22	0.95	26.9	26.6	27.2	25.9	24.8	24.2
	8	51.7	50.8	56.9	0.34	0.22	0.65	27.1	26.4	27	25.9	24.7	24.2
	9	54.3	51.5	57.8	0.45	0.24	1	26.5	26	26.9	25.8	24.6	24
	10	53.8	52.6	59.2	0.68	0.27	1.16	26.6	25.6	26.5	25.5	24.2	23.7
	11	55.6	53.8	58.7	0.84	0.39	0.94	26.2	25.4	26.3	25.4	24.5	24
	12	53.5	52.9	56.9	0.53	0.5	0.75	26.6	25.9	26.3	25.3	24.8	24.3
	13	53.8	53	56.3	0.4	0.63	0.76	26.7	26.2	26.5	25.5	25	24.5
	14	55	55.1	57.6	0.68	0.64	0.81	26.7	26.2	26.2	25.6	25	24.5
	15	53.3	52.9	54.9	0.5	0.56	0.93	26.3	26.2	26.1	25.7	25	24.6
	16	54.6	55.3	55.9	0.54	0.69	0.74	26.5	26.4	26	25.4	25.4	24.9
door C	17	52.4	55.9	55.1	0.51	0.71	1.1	27.2	26.2	25.6	25	25.6	25.2
	average	53.69	52.69	56.08	0.53	0.47	0.80	26.66	26.24	26.57	25.71	25.17	24.73
	standard deviation	1.88	1.64	1.72	0.18	0.20	0.21	0.61	0.47	0.48	0.37	0.55	0.66

Table 7 - scan 1 results - day conditions

distance to plenum		820 mm	455 mm	132 mm	820 mm	455 mm	132 mm	820 mm	820 mm	455 mm	455 mm	132 mm	132 mm
scan 4		Humidity (%)			Air Velocity (m/s)			Temperature (degC)					
		High	Mid	Low	High	Mid	Low	High		Mid		Low	
	Test	P2H	P4H	P8H	P5A	P6A	P1A	P2T	P5T	P4T	P6T	P1T	P8T
door A	1	53.8	53.7	51.9	0.95	0.76	0.64	26.8	26.8	26.3	25.6	26.2	26.7
	2	50.7	52.3	50.4	0.61	0.78	0.5	27.7	27.2	26.6	25.9	26.7	27
	3	50.6	51.8	50.7	0.5	0.41	0.29	27.9	27.7	26.9	26.3	27.2	27.1
	4	50.7	51.2	48.6	0.83	0.36	0.24	27.7	26.6	27	26.4	27.7	27.8
	5	54.4	50.7	48.6	0.81	0.37	0.3	26.3	26	27.2	26.3	27.4	27.8
	6	52	49.8	47.3	0.52	0.29	0.24	26.9	26.3	27.3	26	27.6	28.1
	7	54.9	50.8	50.1	0.52	0.23	0.43	26.3	26	27.4	26	26.6	27.3
	8	56.2	50.8	50.2	0.78	0.2	0.57	25.8	25.2	27.3	26.1	26.1	27.2
	9	57.2	50.5	50.3	0.84	0.27	0.68	25.1	24.9	27	25.7	25.7	26.8
	10	57.2	52.7	52.3	0.63	0.26	0.69	25.6	25.2	26.6	25.7	25.5	26.5
	11	57	53	51.3	0.73	0.39	0.67	25.5	25.2	26.4	25.6	25.5	26.7
	12	57.7	53.6	51	0.84	0.49	0.66	25.4	25.2	26.4	25.5	25.7	27.1
	13	57.6	53.7	49.9	0.89	0.58	0.69	25.4	25.1	26.4	25.5	26	27.4
	14	56.3	54.3	50.2	0.87	0.59	0.72	25.9	25.4	26.1	25.6	26.1	27.3
	15	55.1	53.8	50.1	1.26	0.54	0.63	26	25.6	26.1	25.7	26.1	27.1
	16	52.3	54.8	51.2	0.8	0.67	0.71	27.3	26.7	25.9	25.4	25.8	26.9
door C	17	53.5	55.4	51.9	0.72	0.71	0.7	26.9	26.4	25.7	25.1	25.9	26.7
	average	54.54	52.52	50.35	0.77	0.46	0.55	26.38	25.97	26.62	25.79	26.34	27.15
	standard deviation	2.55	1.69	1.29	0.19	0.19	0.18	0.90	0.83	0.52	0.36	0.73	0.44

Table 8 - scan 4 results - day conditions

During the day, the following observations could be made at plants level (low heights):

- on the plenum side, the thermal amplitude is 2,6ºC and the average temperature is 26,7ºC and the average humidity is 50% ; the profile of temperatures along the chamber is of M type
- on the window side, the thermal amplitude is 2,3ºC and the average temperature is 24,9ºC and the average humidity 56% ; the profile of temperatures along the chamber is of V type
- between both sides, there can be a difference of 4,4ºC (from 23,7ºC to 28,1ºC)

5.4.4.Results for temperature and humidity profiles

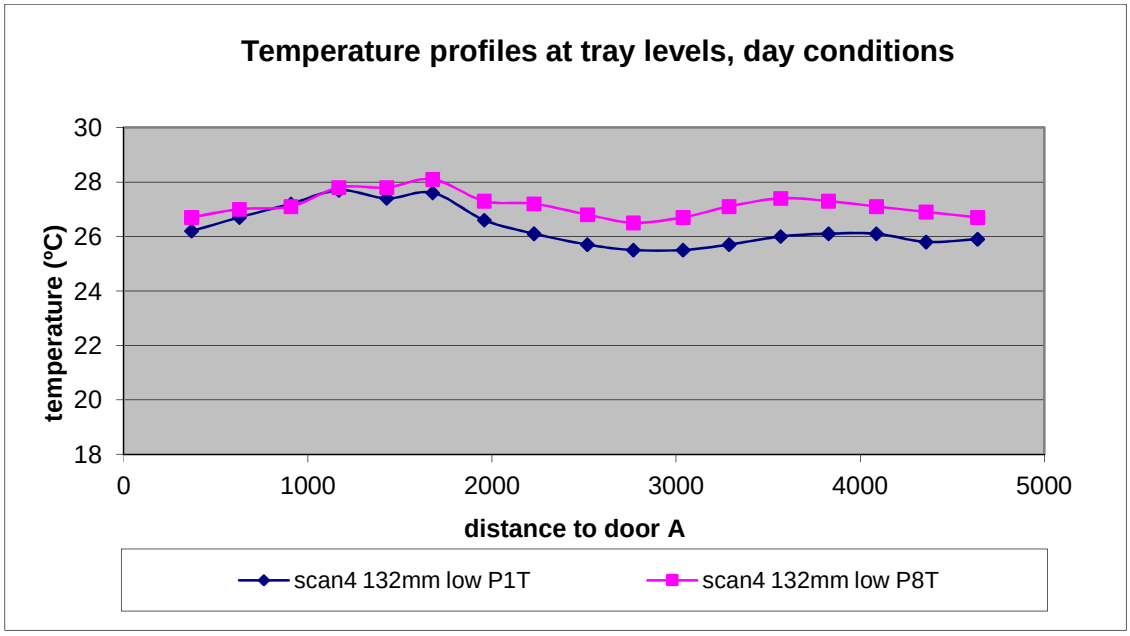


Figure 19 - temperature profiles, day conditions

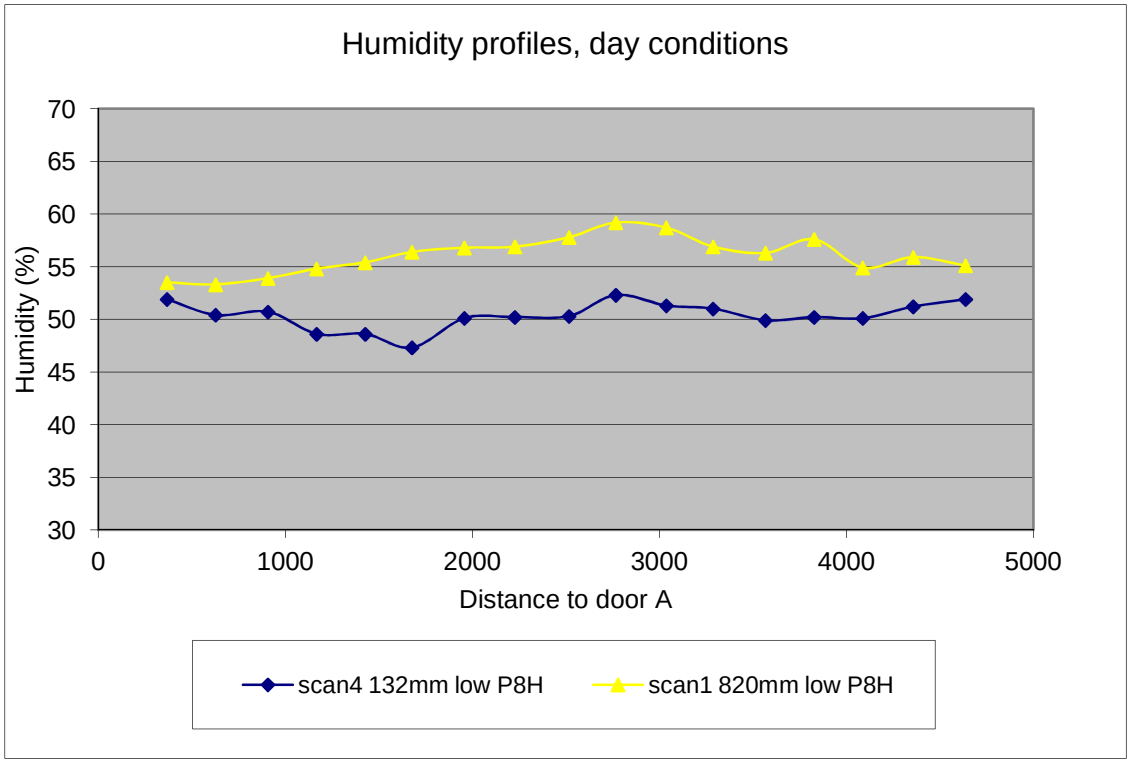


Figure 20- humidity profiles , day conditions

The results obtained for scans 2 and 3 in night conditions are presented in the tables below

distance to plenum		132 mm	455 mm	820 mm	132 mm	455 mm	820 mm	132 mm	132 mm	455 mm	455 mm	820 mm	820 mm
scan 2		Humidity (%)			Air Velocity (m/s)			Temperature (degC)					
		High	Mid	Low	High	Mid	Low	High		Mid		Low	
	Test	P2H	P4H	P8H	P5A	P6A	P1A	P2T	P5T	P4T	P6T	P1T	P8T
door A	1	68.9	65.6	65.3	0.82	0.83	0.25	19.8	20	20.1	19.7	20.2	20.1
	2	68.4	65.8	65.8	0.9	0.76	0.79	19.9	20	20	19.6	19.9	19.9
	3	67.4	65.7	66.4	0.35	0.36	0.63	20.2	20.3	20	19.7	20	19.8
	4	68.1	66.2	66.9	0.42	0.38	0.61	20.1	20.1	19.9	19.6	19.8	19.7
	5	67.8	66.1	67	0.3	0.44	0.66	20.1	20.3	19.9	19.6	19.8	19.7
	6	68	66.1	67	0.38	0.32	0.69	20	20	19.8	19.5	19.7	19.5
	7	67.7	66	66.8	0.31	0.22	0.92	19.9	20	19.7	19.5	19.5	19.5
	8	68.8	66.8	67.7	0.33	0.2	0.64	19.9	20.1	19.8	19.6	19.5	19.5
	9	69.2	67.2	68.1	0.45	0.24	1.01	19.8	20	19.7	19.6	19.4	19.5
	10	68.4	66.6	67.5	0.64	0.25	1.1	19.8	19.9	19.7	19.6	19.4	19.4
	11	69.6	67.6	68.5	0.77	0.39	0.95	19.7	19.9	19.6	19.6	19.3	19.3
	12	68.2	66.3	66.8	0.49	0.5	0.73	19.8	20.1	19.7	19.7	19.5	19.5
	13	68.6	66.8	67.3	0.38	0.6	0.71	19.9	20.2	19.8	19.8	19.6	19.6
	14	68.7	66.9	67.5	0.65	0.59	0.8	20	20.2	19.8	19.8	19.6	19.6
	15	67.8	65.9	66.4	0.52	0.51	0.86	19.9	20.2	19.7	19.9	19.5	19.6
	16	67.9	66.5	66.6	0.46	0.67	0.7	20	20.3	19.8	19.8	19.6	19.8
door C	17	67.9	66.7	66.5	0.55	0.67	1.11	20.1	20.2	19.8	19.6	19.8	19.8
	average	68.32	66.40	66.95	0.51	0.47	0.77	19.94	20.11	19.81	19.66	19.65	19.64
	standard deviation	0.59	0.55	0.79	0.18	0.20	0.21	0.14	0.13	0.13	0.11	0.24	0.20

Table 9 - scan 2 results - night conditions

distance to plenum		820 mm	455 mm	132 mm	820 mm	455 mm	132 mm	820 mm	820 mm	455 mm	455 mm	132 mm	132 mm
scan 3		Humidity (%)			Air Velocity (m/s)			Temperature (degC)					
		High	Mid	Low	High	Mid	Low	High		Mid		Low	
	Test	P2H	P4H	P8H	P5A	P6A	P1A	P2T	P5T	P4T	P6T	P1T	P8T
door A	1	67.7	66.3	65.5	1.05	0.8	0.66	20.2	20.1	19.9	19.5	20	20.2
	2	68	66.7	65.9	0.54	0.75	0.43	20.2	20.2	19.8	19.5	20	20.2
	3	66.8	65.4	64.7	0.52	0.38	0.26	20.2	20.2	19.8	19.5	20.1	20.2
	4	68	66.5	65.6	0.71	0.39	0.2	20.2	20.1	19.9	19.5	20.3	20.2
	5	68.1	66.3	65.4	0.69	0.45	0.24	20	20	19.8	19.4	20.1	20.2
	6	68.7	67	66.1	0.52	0.29	0.22	20	20	19.8	19.5	20.2	20.2
	7	68.8	67.1	66.2	0.48	0.23	0.37	19.9	19.9	19.7	19.5	20	20
	8	69	67.1	66.3	0.73	0.2	0.49	19.9	19.8	19.6	19.5	19.9	20
	9	68.1	66.3	65.7	0.82	0.24	0.64	19.9	19.9	19.7	19.5	19.8	20
	10	69	67.1	66.4	0.54	0.23	0.65	19.9	19.9	19.7	19.6	19.7	19.9
	11	69	67.3	66.1	0.68	0.37	0.62	20	20.1	19.8	19.7	19.9	20.2
	12	68.2	66.5	65.5	0.83	0.44	0.6	20.1	20.1	19.9	19.9	20	20.2
	13	68.4	66.7	65.7	0.8	0.55	0.67	20.1	20.1	19.9	19.9	20	20.2
	14	68.4	66.7	65.6	0.8	0.59	0.68	20.1	20	19.8	19.9	20.1	20.3
	15	68.3	66.7	65.5	1.25	0.52	0.66	20.2	20	19.9	20	20.1	20.3
	16	68.2	66.8	65.6	0.78	0.63	0.68	20.2	20.1	19.8	19.8	20.1	20.3
door C	17	67.3	66	65	0.65	0.68	0.66	20.2	20.2	19.8	19.7	20.1	20.2
	average	68.24	66.62	65.69	0.73	0.46	0.51	20.08	20.04	19.80	19.64	20.02	20.16
	standard deviation	0.60	0.47	0.45	0.20	0.19	0.19	0.13	0.12	0.09	0.19	0.14	0.12

Table 10 - scan 3 results - night conditions

During the night, the following observations could be made at plants level (low heights):

- on the plenum side, the thermal amplitude is 0,6ºC and the average temperature is 20,1ºC and the average humidity is 65.6%
- on the window side, the thermal amplitude is 0,9ºC and the average temperature is 19,6ºC and the average humidity is 67%
- Between both sides, the maximum difference of temperature is 1ºC (19,3ºC to 20,3ºC)

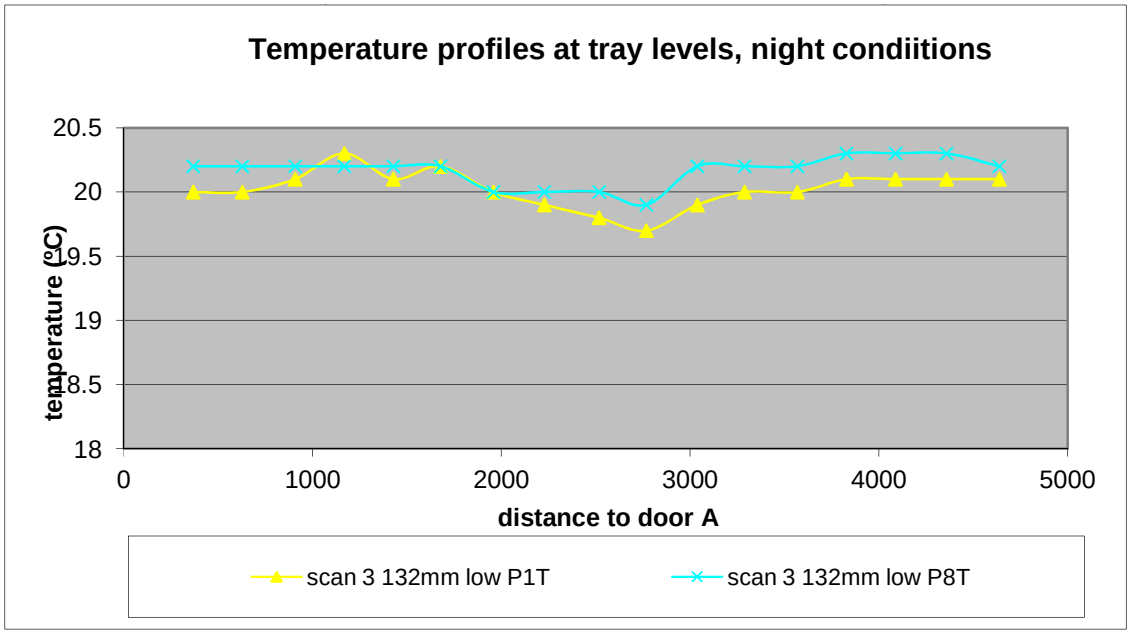


Figure 21 - temperature profiles, night conditions

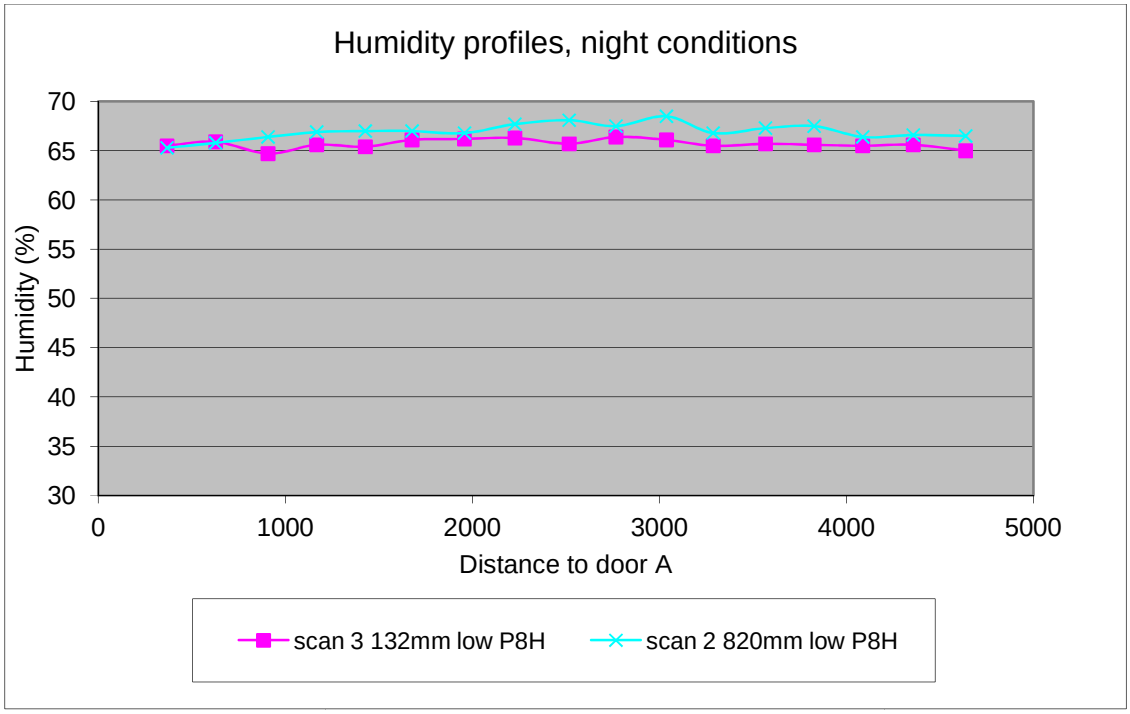


Figure 22 - humidity profiles, night conditions

5.4.1.Results for air velocity profiles

Concerning the velocity profiles observed in the chamber, they can be plotted in three different vertical planes. The C position measurements are presented in Figure 23 where the limits of the 9 louvers are represented

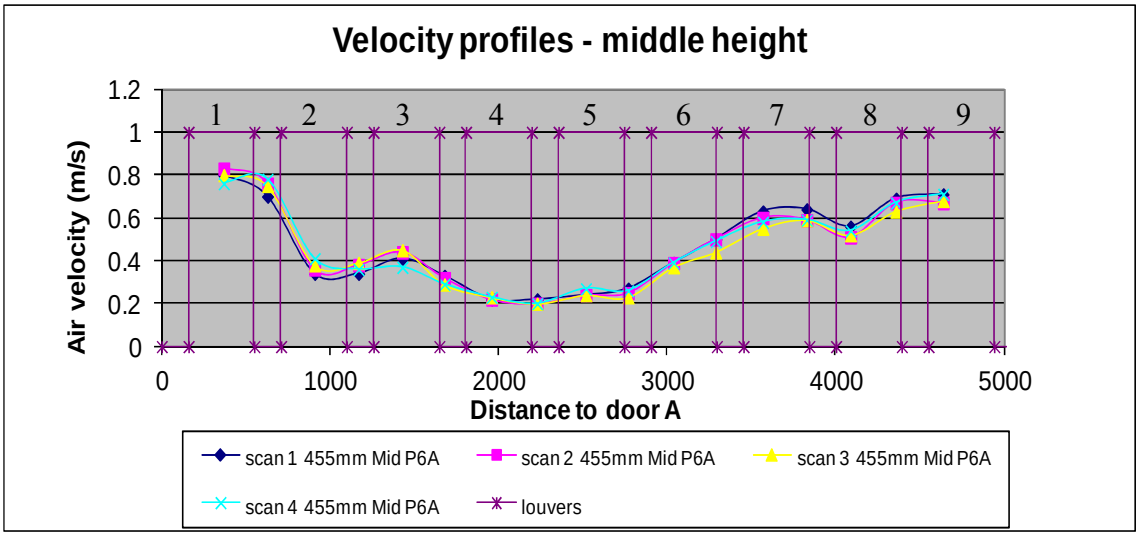


Figure 23 - velocities profiles, mid height

The 4 scans show identical profiles on the C position, which means that the temperature and humidity control do not affect the velocity profiles.

The profiles of velocities at the lower height, i.e. at plant level are plotted in Figure 24

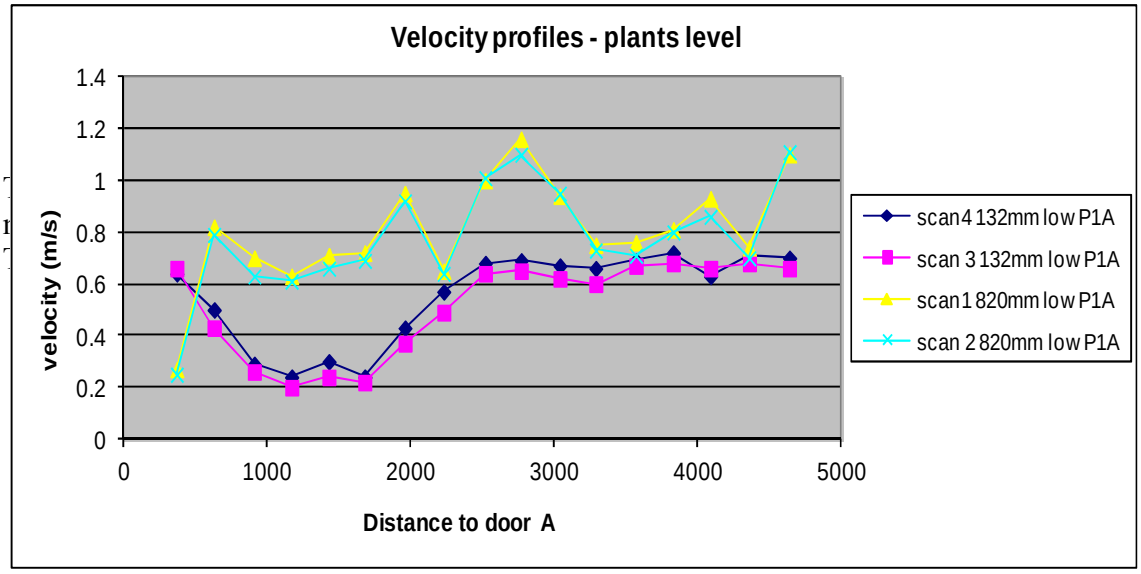


Figure 24- velocity profiles at plants level

It can be noticed that at plants level, the plenum side (132mm) has a very different profile than the window side (820mm). The first profile versus the chamber axis has an average velocity of 0.53m/s and a standard deviation of 0.18m/s, it reaches a minimum value of 0.20 m/s in the zone of 0.9m to 1.7m and then starts increasing again at 2m to stabilize around 0.7m/s from 2.5 m to 5 m.
While the second profile has an average velocity of 0.78m/s and a standard deviation of 0.20 m/s, and tends to increase with the distance to door A in the first two meters of the chamber, reaching 1m/s then it suddenly drops to 0.6m/s at 2.2m and rises again up to 2.2m/s at 2.7m and decreases to stabilize again around 0.8m/s on the zone between 3m and 5m. The aspiration from the culture chamber is located at the 2.2m distance from door A, and can probably explain the sudden decrease of velocity on the window side and increase of velocity on the spigot side between 2m and 2.4m.

5.4.4.Conclusion

The velocity profiles at plant level show a lot of variability on each side of the chamber, there will be there a lot of turbulences that the plants will have to cope with.

5.1.Pressure mapping

The two first probes P1 and P2 are placed in the plenum of the chamber (see RD3), to check the balanced pressurization of the air plenum distribution system.

The P3 probe is placed in proximity of the HVAC return entrance below the air balancing panels and above the chamber floor to evaluate the pressure drop before the HVAC system thermally processes the air.

The P4 probe is placed between the cooler and heater to validate with P3 the pressure drop of the cooler.

The last probe P5 is placed in the lower right of the HVAC system to validate with P4 the pressure drop of the heater and with P1 and P2 the pressure rise of the blower.

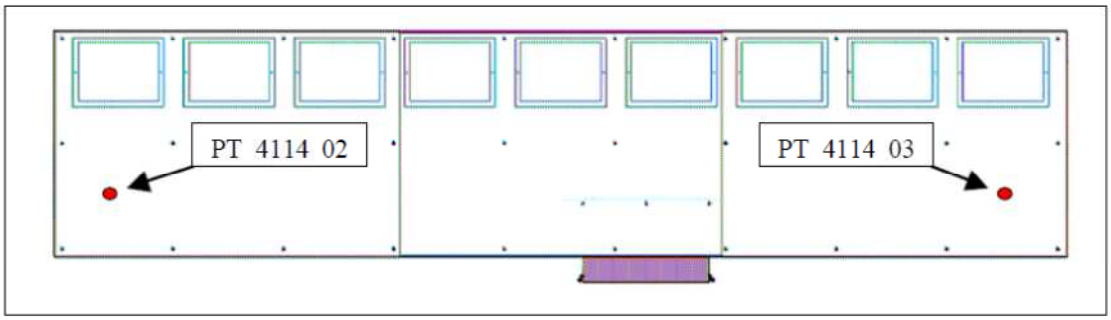
The pressure mapping was made simultaneously and thus in the same conditions as the HVAC mapping (cf. 5.4.2).

The correspondence between HMI tags and instrumentation plan in AD6 is given in Table 11

Name in TN96.9	HMI tag for the mapping tests
P1	PT_4114_02
P2	PT_4114_03
P3	PT_4114_04
P4	PT_4114_05
P5	PT_4114_06

Table 11- pressure sensors identification

5.1.1.Location of the pressure probes



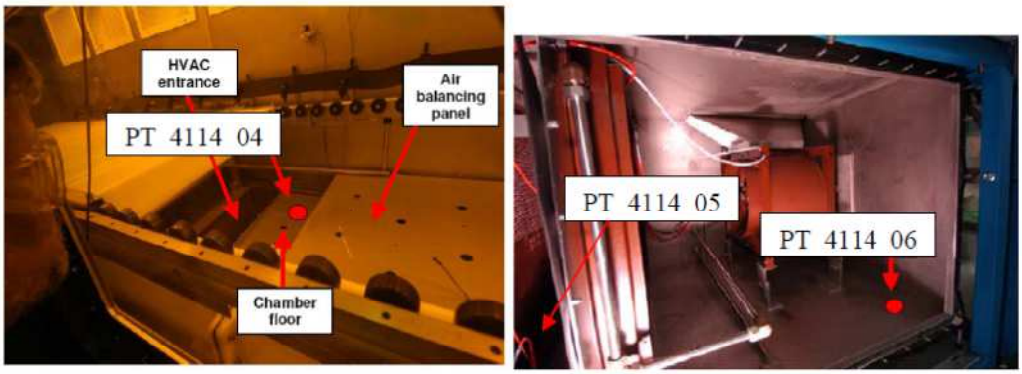


Figure 25 - location of the five pressure sensors

5.1.2.Results

See par. 5.5 of RD3 for the details of the measurements.
The results are very similar between the four scans and inside one scan between the 17 positions acquired for the HVAC mapping.

An example of one position randomly selected for each of the four scans is presented in the
Table 12

Run	scan 1	scan2	scan 3	scan 4
Test	Test 10	Test 4	Test 14	Test 6
Time	day 1 13:33:00	day 1 16:59:00	day 2 13:30:00	day 2 16:18:00
	mbar abs	mbar abs	mbar abs	mbar abs
PT_4114_02 (P1)	998.797	996.684	990.66	992.474
PT_4114_03 (P2)	998.83	997.589	991.354	992.364
PT_4114_04 (P3)	999.269	997.121	991.122	993.036
PT_4114_05 (P4)	996.658	994.348	988.273	990.233
PT_4114_06 (P5)	998.678	996.886	990.909	992.433
P1-P2	-0.033	-0.905	-0.694	0.11
P3-P4	2.611	2.773	2.849	2.803
P4-P5	-2.02	-2.538	-2.636	-2.2

Table 12 - excerpt of pressure gradients

5.1.3.Conclusion

The values of the absolute pressures measured in P1 to P5 are affected by the atmospheric pressure of the laboratory, but their relative differences remain constant in spite of the atmospheric pressure variations.
The temperature and humidity controls during day or night period do not affect the pressure gradients.
P1 and P2 are always equal, there is a balance between both sides of the plenum.
The pressure loss through the cooler (P4-P3) is approximately 2.7 mbar or 270 Pa.
The pressure P5 is lower than P4 by approximately 2.4 mbar or 240Pa. This can be explained by the location of P5 that is not downstream the heat exchanger but in a corner of the compartment containing the blower.

6.Conclusions

All the requested measurements could be performed in order to feed the three dimensional CFD model of the HPC1 chamber without plants (dry model).

On top of these data, a better knowledge of the temperature and humidity profiles in the chamber was obtained, as well as of the velocity profiles at plants level.

There are important heterogeneities in the chamber for light intensity distribution, air velocities and temperature/humidity that can be taken into account in the CFD model.

7.Appendix 1 – Light and HVAC mapping report by NTE-SENER (61 pages)

MELiSSA HPC HVAC MAPPING REPORT

MELISSA HPC HVAC MAPPING

Document n.: NTE-HPC_HVAC-RP-004
Revision: 2.0
Date: 09 March 2010

	Name	Signature	Date
Prepared	Jordi Duatis		10/03/10
Checked	Jordi Carbonell		10/03/2010
Approved	Jordi Duatis		10/03/2010

DISTRIBUTION LIST

NAME	POSITION	COMPANY
Gino Pena		Enginsoft
Arnaud Fossen		UAB

RECORD OF CHANGES

Rev.	Date	Responsable of the modification	Section/Paragraph affected	Changes
1.0	11 Jan 2010	Jordi Duatis		New Document
1.0	11 Jan 2010	Jordi Duatis		Added light mapping report and reformatted.
2.0	09 March 2010	Jordi Duatis	Sec. 5.5	Included data from the 5 pressure sensors added to the chamber for the test.
			Pag. 38	Added time of the tests and explanation about synchronisation.
			Sec. 5.6	Added graphs of values measured during the test of the chamber sensors: temperature, humidity and blower.
			Sec. 5.2	Added sensors accuracy.

TABLE OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

1. SCOPE

This document is meant to describe the process followed to obtain the light spectrum measurements of the lamps and the Air, humidity and air velocity parameters of the Higher Plants Compartment (HPC) 1. For the two tests following information is provided:

- Test set-up and conditions.
- Test procedure details.
- Test results.

2. APPLICABLE AND REFERENCE DOCUMENTS

2.1. Applicable documents

Ref.	Title	Number	Issue
AD1	HPC HVAC MAPPING INSTRUMENTATION PROPOSAL	NTE-HPC_HVAC-OF-001	2.0

2.2. Reference documents

Ref.	Title	Number	Issue
RD1	HPC1Mapping_Rev4.doc		4.0
RD2	MAPPING_CIVb_PLC_HMI_20091126.xls		
RD3	Spectral and Radiometric Characterisation of HPC. UPC-CD6	S00155-487	07/29/09

3. ACRONYMS

HPC	Higher Plants Compartment
HPS	High Pressure Sodium (Lamp)
HVAC	Heat, Ventilating and Air Conditioning
MELiSSA	Micro-Ecological Life Support System Alternative
MHL	Metal HaLide (Lamp)
UVA	Ultraviolet A (400 nm–315 nm)
UVB	Ultraviolet B (315 nm–280 nm)
VIS	VISible (light region)

4. LIGHT MAPPING

4.1. Test Set-up

In this study the spectral and radiometric characterization of the HPC of MELISSA Pilot Plant is carried out. Specifically, measurements of spectral and integrated irradiance (W/cm^2) in the visible region (380 – 780 nm), UVA region (315 – 390 nm), and UVB region (265 – 332 nm) are performed.

The HPC includes two different kinds of light lamps:

- HPS lamps (High-pressure sodium)
- MHL lamps (Metal Halide)

In order to characterize the HPC, the following configurations have been used.

CONFIGURATION 1: GLASS LIGHT CHARACTERIZATION

Measurements take place just below the upper glass (inside the chamber). Measurements are done under the two different light lamps (HPS and MHL) independently. Only one lamp of each type is switched on at the same time. Measurements are performed at five different locations called Position 1 (P1), Position 2 (P2), Position 3 (P3), Position 4 (P4) and Position 5 (P5), which are in the diagonal of each glass module (see figure below).

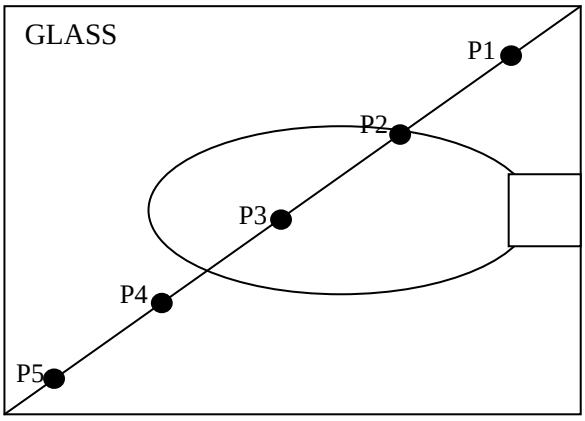


Figure 1: Lamp glass measures.

CONFIGURATION 2: LIGHT CHARACTERIZATION AT 40 CM HEIGHT

Measurements take place 40 cm above the tray of the chamber. Measurements are done under all light lamps of the chamber (6 HPS and 3 MHL) switched on at the same time. Measurements are performed at three different positions along the chamber (A, B, C), and for each of them three points are analyzed (1, 2, 3) (see figure below).

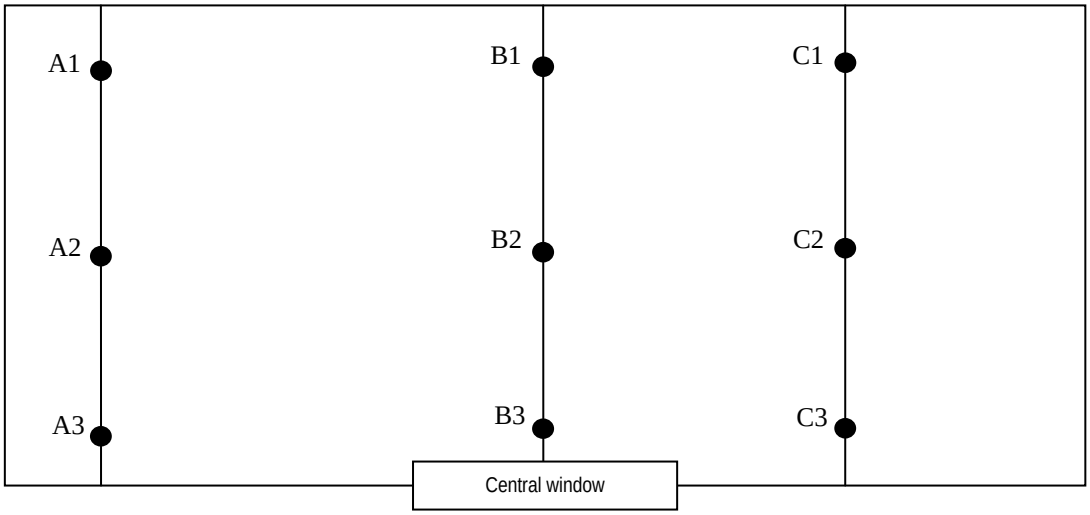


Figure 2: Light characterisation measures at 40 cm.

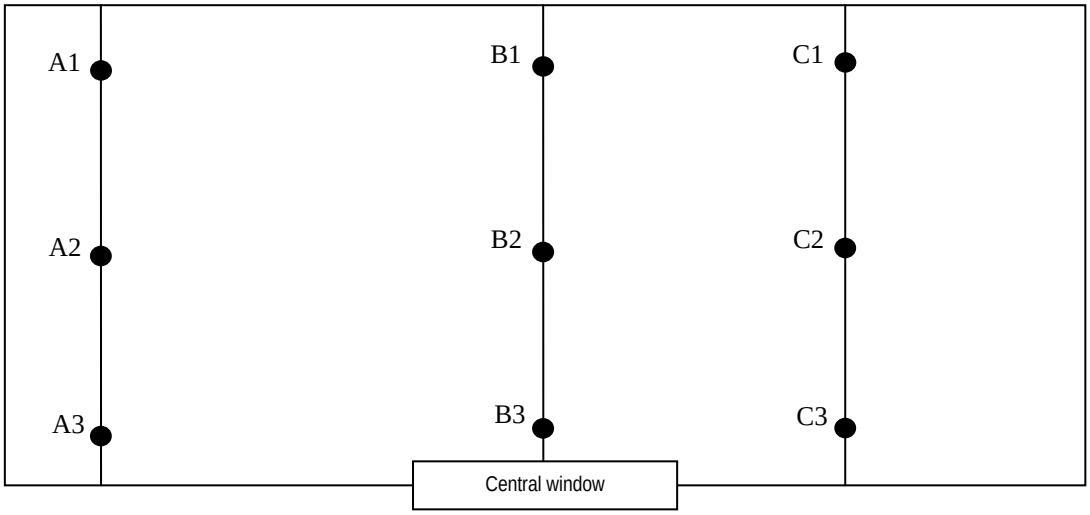
Point A: 38 cm from left

Point B: 250 cm from right

Point C: 117 cm from right.

CONFIGURATION 3: LIGHT CHARACTERIZATION AT 20 CM HEIGHT

Measurements take place 20 cm above the tray of the chamber. Measurements are done under all light lamps of the chamber (6 HPS and 3 MHL) switched on at the same time. Measurements are performed at three different positions along the chamber (A, B, C), and for each of them three points are analyzed (1, 2, 3) (see figure below).



Point A: 38 cm from left

Point B: 250 cm from right

Point C: 117 cm from right.

CONFIGURATION 4: MHL LIGHT CHARACTERIZATION OUTSIDE THE HPS

MHL lamp is measured directly with the sensor placed outside the HPC. Therefore, the upper glass of the HPC is not considered in this measurement.

1) INSTRUMENTATION.

The following instruments have been used in order to spectrally and radiometrically characterize the HPC (MELISSA Pilot Plant):

TE#1: PR-655

Equipment: Tele-spectrocolorimeter PhotoResearch SpectraColorimeter, model PR-655, serial nº 65082002, accessory FP-655 (fiber).

Measurement: Spectral irradiance (W/cm^2) in the visible region (380 – 780 nm) using a 4 nm spectral step.

TE#2: IL-1700 UVB

Equipment: Radiometer International Light, model IL-1700, serial nº 2338, accessory UVB.

Measurement: Integrated irradiance (W/cm^2) in the UVB region (265 – 332 nm).

TE#3: IL-1700 UVA

Equipment: Radiometer International Light, model IL-1700, serial nº 2338, accessory UVA.

Measurement: Integrated irradiance (W/cm^2) in the UVA region (315 – 390 nm).

TE#4: IL-1700 VIS

Equipment: Radiometer International Light, model IL-1700, serial nº 2338, accessory VIS.

Measurement: Integrated irradiance (W/cm^2) in the visible region (380 – 780 nm).

Measurements have been obtained from three averaged and independent readings.

4.2. Results

In the following pages the obtained spectral and integrated irradiance (W/cm^2) for the different measurement configurations and instruments are shown.

CONFIGURATION 1: GLASS LIGHT CHARACTERIZATION

LIGHT LAMP	**HPS**				
TE#2 (UVB)					**TIME**
MEASURE	**M1**	**M2**	**M3**	**AVERAGE**	
P1	5.00E-07	4.40E-07	4.60E-07	4.67E-07	11:10
P2	2.91E-06	2.90E-06	2.85E-06	2.89E-06	
P3	4.67E-06	4.89E-06	4.87E-06	4.81E-06	
P4	1.64E-06	1.64E-06	1.67E-06	1.65E-06	
P5	2.20E-07	1.90E-07	2.20E-07	2.10E-07	
TE#3 (UVA)					**TIME**
MEASURE	**M1**	**M2**	**M3**	**AVERAGE**	
P1	1.69E-07	1.68E-07	1.69E-07	1.69E-07	11:16
P2	1.58E-06	1.56E-06	1.51E-06	1.55E-06	
P3	3.72E-06	3.71E-06	3.72E-06	3.72E-06	
P4	8.05E-07	8.31E-07	8.36E-07	8.24E-07	
P5	7.49E-08	7.64E-08	7.72E-08	7.62E-08	
TE#4 (VIS)					**TIME**
MEASURE	**M1**	**M2**	**M3**	**AVERAGE**	
P1	4.78E-03	4.71E-03	4.68E-03	4.72E-03	11:24
P2	4.23E-02	4.27E-02	4.24E-02	4.25E-02	
P3	8.94E-02	8.89E-02	8.93E-02	8.92E-02	
P4	2.04E-02	2.03E-02	2.04E-03	1.42E-02	
P5	1.78E-03	1.78E-03	1.78E-03	1.78E-03	

Table 1: Integrated irradiance (W/cm^2) in the UVB, UVA and VIS region for a HPS lamp.

LIGHT LAMP	MHL				
TE#2 (UVB)					TIME
MEASURE	M1	M2	M3	AVERAGE	
P1	4.00E-07	4.40E-07	3.70E-07	4.03E-07	12:03
P2	4.63E-06	4.71E-06	4.71E-06	4.68E-06	
P3	8.52E-06	8.45E-06	8.17E-06	8.38E-06	
P4	1.33E-06	1.55E-06	1.54E-06	1.47E-06	
P5	1.80E-07	1.80E-07	1.80E-07	1.80E-07	
TE#3 (UVA)					TIME
MEASURE	M1	M2	M3	AVERAGE	
P1	3.86E-08	3.70E-08	3.68E-08	3.75E-08	12:00
P2	4.75E-07	4.70E-07	4.73E-07	4.73E-07	
P3	1.11E-06	1.13E-06	1.12E-06	1.12E-06	
P4	1.65E-07	1.65E-07	1.66E-07	1.65E-07	
P5	1.36E-08	1.35E-08	1.34E-08	1.35E-08	
TE#4 (VIS)					TIME
MEASURE	M1	M2	M3	AVERAGE	
P1	1.39E-03	1.35E-03	1.33E-03	1.35E-03	12:06
P2	1.80E-02	1.81E-02	1.81E-02	1.81E-02	
P3	4.12E-02	4.11E-02	4.13E-02	4.12E-02	
P4	6.50E-03	6.47E-03	6.61E-03	6.53E-03	
P5	5.12E-04	5.13E-04	5.15E-04	5.13E-04	

Table 2: Integrated irradiance (W/cm^2) in the UVB, UVA and VIS region for a MHL lamp.

LIGHT LAMP	HPS					
Wavelength (nm)	P1	P2	P3	P4	P5	Time
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	11:21
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	14:55 (P3)
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.24E-07	
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.93E-08	
396	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.83E-11	
400	1.02E-07	3.34E-07	0.00E+00	0.00E+00	8.80E-08	
404	9.62E-07	4.20E-06	1.86E-06	2.88E-07	6.20E-07	
408	2.21E-06	1.17E-05	1.05E-05	2.12E-06	1.35E-06	
412	3.59E-06	1.56E-05	2.79E-05	4.15E-06	2.08E-06	
416	4.85E-06	2.23E-05	3.71E-05	6.20E-06	2.98E-06	
420	6.29E-06	3.01E-05	5.09E-05	8.56E-06	3.88E-06	
424	7.51E-06	3.49E-05	7.79E-05	1.07E-05	4.78E-06	
428	9.24E-06	4.15E-05	9.18E-05	1.26E-05	5.73E-06	
432	1.08E-05	4.76E-05	1.12E-04	1.57E-05	7.01E-06	
436	1.31E-05	5.60E-05	1.40E-04	1.81E-05	8.58E-06	
440	1.42E-05	5.88E-05	1.35E-04	1.89E-05	9.38E-06	
444	1.35E-05	5.29E-05	1.08E-04	1.78E-05	9.13E-06	
448	2.02E-05	7.72E-05	1.82E-04	2.63E-05	1.38E-05	
452	2.36E-05	9.05E-05	2.06E-04	3.07E-05	1.60E-05	
456	1.43E-05	5.23E-05	1.30E-04	1.79E-05	9.91E-06	

LIGHT LAMP	HPS					
Wavelength (nm)	P1	P2	P3	P4	P5	Time
460	1.20E-05	4.21E-05	1.10E-04	1.43E-05	8.40E-06	
464	2.78E-05	1.04E-04	2.67E-04	3.41E-05	1.96E-05	
468	4.23E-05	1.62E-04	3.97E-04	5.27E-05	2.98E-05	
472	2.56E-05	9.81E-05	2.24E-04	3.15E-05	1.82E-05	
476	1.35E-05	5.15E-05	1.23E-04	1.51E-05	9.57E-06	
480	6.19E-06	2.49E-05	5.29E-05	7.03E-06	4.54E-06	
484	4.13E-06	1.56E-05	3.91E-05	4.23E-06	3.08E-06	
488	5.54E-06	2.15E-05	5.44E-05	6.20E-06	4.00E-06	
492	1.33E-05	5.62E-05	1.47E-04	1.65E-05	9.54E-06	
496	5.93E-05	2.58E-04	7.06E-04	7.90E-05	4.17E-05	
500	8.11E-05	3.59E-04	9.64E-04	1.09E-04	5.71E-05	
504	2.42E-05	1.08E-04	2.72E-04	3.17E-05	1.70E-05	
508	6.44E-06	2.92E-05	6.94E-05	8.31E-06	4.55E-06	
512	1.04E-05	5.38E-05	1.30E-04	1.47E-05	7.28E-06	
516	1.66E-05	8.64E-05	2.22E-04	2.49E-05	1.13E-05	
520	9.25E-06	4.72E-05	1.18E-04	1.40E-05	6.27E-06	
524	4.05E-06	2.22E-05	4.25E-05	6.21E-06	2.67E-06	
528	3.92E-06	2.14E-05	4.73E-05	6.56E-06	2.45E-06	
532	4.08E-06	2.27E-05	5.19E-05	6.72E-06	2.44E-06	
536	4.19E-06	2.53E-05	5.55E-05	7.20E-06	2.45E-06	
540	4.79E-06	2.97E-05	6.17E-05	8.12E-06	2.70E-06	
544	6.81E-06	4.49E-05	9.93E-05	1.28E-05	3.82E-06	
548	1.48E-05	1.04E-04	2.24E-04	2.93E-05	7.78E-06	
552	3.09E-05	2.25E-04	4.97E-04	6.35E-05	1.54E-05	
556	6.07E-05	4.57E-04	1.03E-03	1.29E-04	2.86E-05	
560	1.01E-04	7.75E-04	1.77E-03	2.23E-04	4.52E-05	
564	1.46E-04	1.14E-03	2.54E-03	3.33E-04	6.07E-05	
568	2.38E-04	1.92E-03	4.34E-03	5.72E-04	9.45E-05	
572	2.31E-04	1.89E-03	4.01E-03	5.72E-04	8.77E-05	
576	1.98E-04	1.67E-03	3.32E-03	5.20E-04	7.09E-05	
580	2.35E-04	2.06E-03	4.17E-03	6.56E-04	8.09E-05	
584	2.51E-04	2.29E-03	4.93E-03	7.31E-04	8.47E-05	
588	1.44E-04	1.36E-03	3.15E-03	4.35E-04	4.67E-05	
592	1.35E-04	1.36E-03	3.35E-03	4.45E-04	4.27E-05	
596	2.44E-04	2.48E-03	5.53E-03	8.29E-04	7.76E-05	
600	2.77E-04	2.81E-03	5.65E-03	9.59E-04	8.66E-05	
604	2.35E-04	2.40E-03	4.56E-03	8.31E-04	7.27E-05	
608	1.89E-04	1.94E-03	3.63E-03	6.80E-04	5.79E-05	
612	1.66E-04	1.73E-03	3.25E-03	6.07E-04	5.10E-05	
616	1.60E-04	1.67E-03	3.21E-03	5.88E-04	4.90E-05	
620	1.29E-04	1.35E-03	2.55E-03	4.77E-04	3.91E-05	
624	9.52E-05	9.98E-04	1.86E-03	3.57E-04	2.88E-05	
628	8.16E-05	8.57E-04	1.61E-03	3.07E-04	2.45E-05	
632	7.24E-05	7.62E-04	1.44E-03	2.74E-04	2.17E-05	
636	6.49E-05	6.87E-04	1.31E-03	2.47E-04	1.95E-05	
640	5.85E-05	6.21E-04	1.18E-03	2.22E-04	1.75E-05	
644	5.20E-05	5.59E-04	1.07E-03	1.98E-04	1.57E-05	
648	4.71E-05	5.13E-04	9.76E-04	1.82E-04	1.44E-05	

LIGHT LAMP	HPS					
Wavelength (nm)	P1	P2	P3	P4	P5	Time
652	4.33E-05	4.70E-04	9.11E-04	1.67E-04	1.33E-05	
656	3.98E-05	4.32E-04	8.59E-04	1.56E-04	1.23E-05	
660	3.62E-05	3.98E-04	7.78E-04	1.42E-04	1.13E-05	
664	3.38E-05	3.68E-04	7.32E-04	1.32E-04	1.05E-05	
668	3.24E-05	3.53E-04	7.14E-04	1.27E-04	1.01E-05	
672	3.14E-05	3.38E-04	7.02E-04	1.23E-04	9.69E-06	
676	2.87E-05	3.14E-04	6.35E-04	1.12E-04	8.77E-06	
680	2.54E-05	2.76E-04	5.60E-04	9.91E-05	7.57E-06	
684	2.24E-05	2.43E-04	4.92E-04	8.63E-05	6.62E-06	
688	1.95E-05	2.14E-04	4.37E-04	7.60E-05	6.00E-06	
692	1.75E-05	1.93E-04	4.08E-04	7.02E-05	5.14E-06	
696	1.56E-05	1.79E-04	3.79E-04	6.37E-05	4.65E-06	
700	1.50E-05	1.65E-04	3.51E-04	5.99E-05	4.28E-06	
704	1.37E-05	1.53E-04	3.26E-04	5.47E-05	3.93E-06	
708	1.26E-05	1.41E-04	3.10E-04	4.94E-05	3.62E-06	
712	1.17E-05	1.30E-04	3.00E-04	4.77E-05	3.14E-06	
716	1.08E-05	1.25E-04	2.79E-04	4.38E-05	3.12E-06	
720	1.02E-05	1.16E-04	2.63E-04	4.14E-05	2.94E-06	
724	9.77E-06	1.08E-04	2.55E-04	3.84E-05	3.03E-06	
728	8.94E-06	9.96E-05	2.38E-04	3.56E-05	2.55E-06	
732	8.10E-06	9.34E-05	2.21E-04	3.18E-05	2.11E-06	
736	6.93E-06	8.32E-05	2.12E-04	2.89E-05	2.13E-06	
740	6.16E-06	8.07E-05	1.96E-04	2.78E-05	2.03E-06	
744	5.23E-06	6.74E-05	1.83E-04	2.39E-05	2.08E-06	
748	4.79E-06	6.22E-05	1.70E-04	2.34E-05	1.90E-06	
752	5.27E-06	5.67E-05	1.58E-04	2.11E-05	2.22E-06	
756	5.32E-06	4.29E-05	1.48E-04	1.85E-05	2.36E-06	
760	5.87E-06	4.17E-05	1.51E-04	1.70E-05	2.69E-06	
764	8.56E-06	6.88E-05	2.12E-04	2.19E-05	4.84E-06	
768	1.25E-05	8.58E-05	2.81E-04	3.34E-05	7.80E-06	
772	1.02E-05	5.65E-05	2.31E-04	2.84E-05	6.58E-06	
776	7.75E-06	3.40E-05	1.49E-04	1.41E-05	4.64E-06	
780	6.02E-06	7.31E-06	1.06E-04	4.59E-06	4.01E-06	

Table 3: Spectral irradiance (W/cm^2) in the VIS region for a HPS lamp.

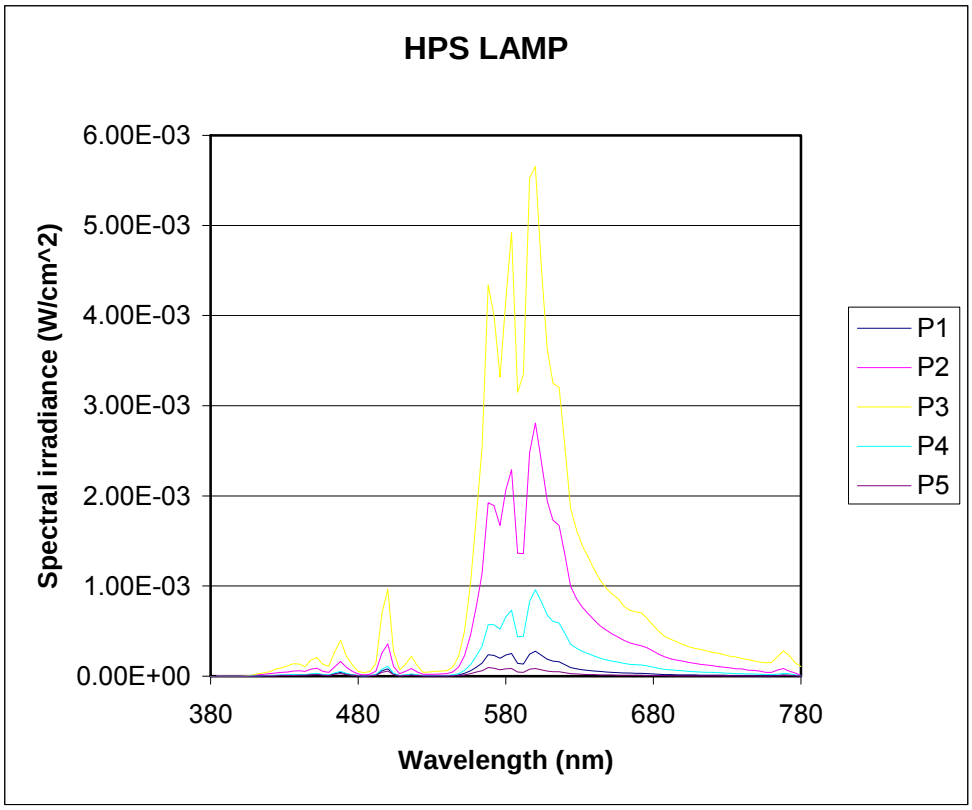


Figure 3: Spectral irradiance (W/cm^2) in the VIS region for a HPS lamp.

LIGHT LAMP	MHL					
Wavelength (nm)	P1	P2	P3	P4	P5	Time
380	0.00E+00	0.00E+00	0.00E+00	3.42E-45	3.33E-46	12:08
384	0.00E+00	0.00E+00	0.00E+00	2.53E-45	2.44E-46	15:10 (P3)
388	0.00E+00	0.00E+00	0.00E+00	2.37E-45	2.33E-46	
392	0.00E+00	0.00E+00	0.00E+00	1.92E-45	1.89E-46	
396	6.60E-10	9.46E-09	0.00E+00	2.41E-09	7.51E-10	
400	5.07E-07	6.69E-06	8.72E-06	2.19E-06	3.54E-07	
404	3.77E-06	4.47E-05	7.19E-05	1.60E-05	1.64E-06	
408	1.32E-05	1.52E-04	2.35E-04	5.01E-05	5.29E-06	
412	2.18E-05	2.49E-04	3.68E-04	8.05E-05	8.57E-06	
416	1.41E-05	1.56E-04	2.37E-04	5.05E-05	5.50E-06	
420	7.02E-06	7.23E-05	1.12E-04	2.34E-05	2.67E-06	
424	6.99E-06	6.76E-05	1.05E-04	2.21E-05	2.66E-06	
428	8.98E-06	8.32E-05	1.41E-04	2.75E-05	3.41E-06	
432	1.50E-05	1.36E-04	2.24E-04	4.45E-05	5.77E-06	
436	2.58E-05	2.30E-04	3.78E-04	7.70E-05	1.02E-05	
440	2.33E-05	1.98E-04	3.45E-04	6.62E-05	9.19E-06	
444	2.05E-05	1.63E-04	3.04E-04	5.36E-05	7.96E-06	
448	4.73E-05	3.73E-04	7.40E-04	1.18E-04	1.81E-05	
452	1.31E-04	1.03E-03	2.03E-03	3.23E-04	4.96E-05	
456	9.73E-05	7.54E-04	1.46E-03	2.38E-04	3.69E-05	

LIGHT LAMP	MHL					
Wavelength (nm)	P1	P2	P3	P4	P5	Time
460	2.72E-05	2.00E-04	3.90E-04	6.51E-05	1.03E-05	
464	1.25E-05	8.51E-05	1.82E-04	2.83E-05	4.65E-06	
468	1.14E-05	8.03E-05	1.68E-04	2.51E-05	4.16E-06	
472	9.91E-06	6.88E-05	1.49E-04	2.21E-05	3.66E-06	
476	8.14E-06	5.54E-05	1.23E-04	1.75E-05	3.01E-06	
480	6.90E-06	4.67E-05	1.11E-04	1.47E-05	2.53E-06	
484	6.74E-06	4.54E-05	1.09E-04	1.46E-05	2.44E-06	
488	6.94E-06	4.95E-05	1.14E-04	1.49E-05	2.49E-06	
492	7.62E-06	5.81E-05	1.27E-04	1.72E-05	2.72E-06	
496	1.08E-05	8.37E-05	1.75E-04	2.38E-05	3.69E-06	
500	1.19E-05	9.64E-05	1.96E-04	2.66E-05	4.03E-06	
504	7.82E-06	6.54E-05	1.38E-04	1.80E-05	2.64E-06	
508	6.72E-06	5.77E-05	1.26E-04	1.61E-05	2.26E-06	
512	7.31E-06	6.71E-05	1.43E-04	1.81E-05	2.47E-06	
516	8.49E-06	8.31E-05	1.74E-04	2.21E-05	2.84E-06	
520	9.61E-06	9.85E-05	2.09E-04	2.63E-05	3.21E-06	
524	8.57E-06	9.25E-05	1.97E-04	2.39E-05	2.83E-06	
528	9.78E-06	1.18E-04	2.39E-04	3.02E-05	3.19E-06	
532	4.82E-05	6.25E-04	1.25E-03	1.60E-04	1.56E-05	
536	1.19E-04	1.55E-03	3.25E-03	3.97E-04	3.85E-05	
540	9.48E-05	1.24E-03	2.69E-03	3.21E-04	3.06E-05	
544	3.39E-05	4.66E-04	9.92E-04	1.21E-04	1.09E-05	
548	1.85E-05	2.71E-04	5.68E-04	7.14E-05	6.03E-06	
552	7.63E-06	1.14E-04	2.47E-04	2.99E-05	2.43E-06	
556	3.86E-06	6.08E-05	1.42E-04	1.63E-05	1.25E-06	
560	3.16E-06	5.35E-05	1.25E-04	1.46E-05	1.00E-06	
564	4.69E-06	8.09E-05	1.79E-04	2.39E-05	1.52E-06	
568	1.12E-05	1.99E-04	4.17E-04	6.21E-05	3.75E-06	
572	9.75E-06	1.78E-04	3.72E-04	5.86E-05	3.40E-06	
576	7.22E-06	1.40E-04	3.17E-04	5.37E-05	2.82E-06	
580	7.17E-06	1.44E-04	3.30E-04	5.94E-05	3.01E-06	
584	1.06E-05	2.27E-04	5.40E-04	9.22E-05	4.45E-06	
588	4.39E-05	9.73E-04	2.28E-03	3.86E-04	1.77E-05	
592	6.90E-05	1.51E-03	3.45E-03	6.09E-04	2.81E-05	
596	5.37E-05	1.14E-03	2.58E-03	4.81E-04	2.27E-05	
600	3.18E-05	6.59E-04	1.52E-03	2.94E-04	1.40E-05	
604	1.98E-05	4.11E-04	9.66E-04	1.88E-04	8.94E-06	
608	1.43E-05	2.97E-04	7.06E-04	1.38E-04	6.46E-06	
612	1.17E-05	2.47E-04	5.83E-04	1.15E-04	5.28E-06	
616	9.70E-06	2.08E-04	4.85E-04	9.55E-05	4.40E-06	
620	7.66E-06	1.65E-04	3.90E-04	7.51E-05	3.42E-06	
624	5.96E-06	1.28E-04	3.09E-04	5.95E-05	2.73E-06	
628	5.15E-06	1.12E-04	2.82E-04	5.28E-05	2.31E-06	
632	4.55E-06	1.01E-04	2.57E-04	4.77E-05	2.11E-06	
636	4.10E-06	9.15E-05	2.36E-04	4.36E-05	1.89E-06	
640	3.72E-06	8.48E-05	2.18E-04	4.08E-05	1.74E-06	
644	3.51E-06	7.68E-05	2.04E-04	3.71E-05	1.64E-06	
648	3.42E-06	7.39E-05	1.99E-04	3.63E-05	1.50E-06	

LIGHT LAMP	MHL					
Wavelength (nm)	P1	P2	P3	P4	P5	Time
652	3.72E-06	8.23E-05	2.19E-04	4.03E-05	1.69E-06	
656	4.53E-06	9.47E-05	2.49E-04	4.53E-05	1.94E-06	
660	3.72E-06	7.24E-05	2.09E-04	3.55E-05	1.52E-06	
664	3.50E-06	7.52E-05	2.17E-04	3.62E-05	1.50E-06	
668	7.86E-06	1.70E-04	4.79E-04	7.77E-05	3.24E-06	
672	1.10E-05	2.40E-04	6.58E-04	1.09E-04	4.60E-06	
676	5.67E-06	1.25E-04	3.52E-04	5.90E-05	2.42E-06	
680	2.43E-06	5.68E-05	1.75E-04	2.95E-05	1.18E-06	
684	1.92E-06	4.80E-05	1.46E-04	2.47E-05	9.24E-07	
688	1.51E-06	3.89E-05	1.35E-04	2.23E-05	7.84E-07	
692	1.29E-06	3.38E-05	1.29E-04	1.77E-05	6.42E-07	
696	1.09E-06	2.97E-05	1.05E-04	1.53E-05	5.51E-07	
700	6.54E-07	2.38E-05	1.01E-04	1.43E-05	4.40E-07	
704	7.26E-07	2.57E-05	9.80E-05	1.34E-05	4.50E-07	
708	1.07E-06	2.10E-05	9.65E-05	1.25E-05	4.10E-07	
712	1.10E-06	1.86E-05	9.33E-05	1.18E-05	3.82E-07	
716	7.50E-07	1.80E-05	9.08E-05	1.28E-05	3.34E-07	
720	6.27E-07	1.74E-05	8.90E-05	1.19E-05	2.73E-07	
724	8.95E-07	1.47E-05	9.04E-05	1.06E-05	1.99E-07	
728	4.75E-07	1.32E-05	8.81E-05	9.74E-06	2.36E-07	
732	1.30E-07	8.03E-06	8.68E-05	1.02E-05	1.06E-07	
736	2.48E-07	6.69E-06	8.08E-05	9.26E-06	2.06E-07	
740	5.22E-09	3.57E-06	7.94E-05	8.87E-06	3.43E-07	
744	0.00E+00	2.32E-07	7.82E-05	8.39E-06	2.94E-07	
748	0.00E+00	2.18E-06	8.03E-05	7.61E-06	1.55E-07	
752	2.67E-09	6.26E-07	8.01E-05	8.40E-06	2.10E-07	
756	4.06E-08	3.94E-07	7.91E-05	6.31E-06	5.12E-07	
760	7.56E-08	1.61E-06	9.34E-05	5.11E-06	8.03E-07	
764	1.62E-06	1.55E-05	1.39E-04	1.45E-05	1.28E-06	
768	2.77E-06	2.90E-05	1.96E-04	2.11E-05	1.80E-06	
772	2.04E-06	1.33E-05	1.58E-04	1.34E-05	1.22E-06	
776	8.50E-07	6.84E-06	1.01E-04	4.36E-06	8.47E-07	
780	9.81E-07	3.65E-44	6.58E-05	5.58E-07	4.71E-07	

Table 4: Spectral irradiance (W/cm^2) in the VIS region for a MHL lamp.

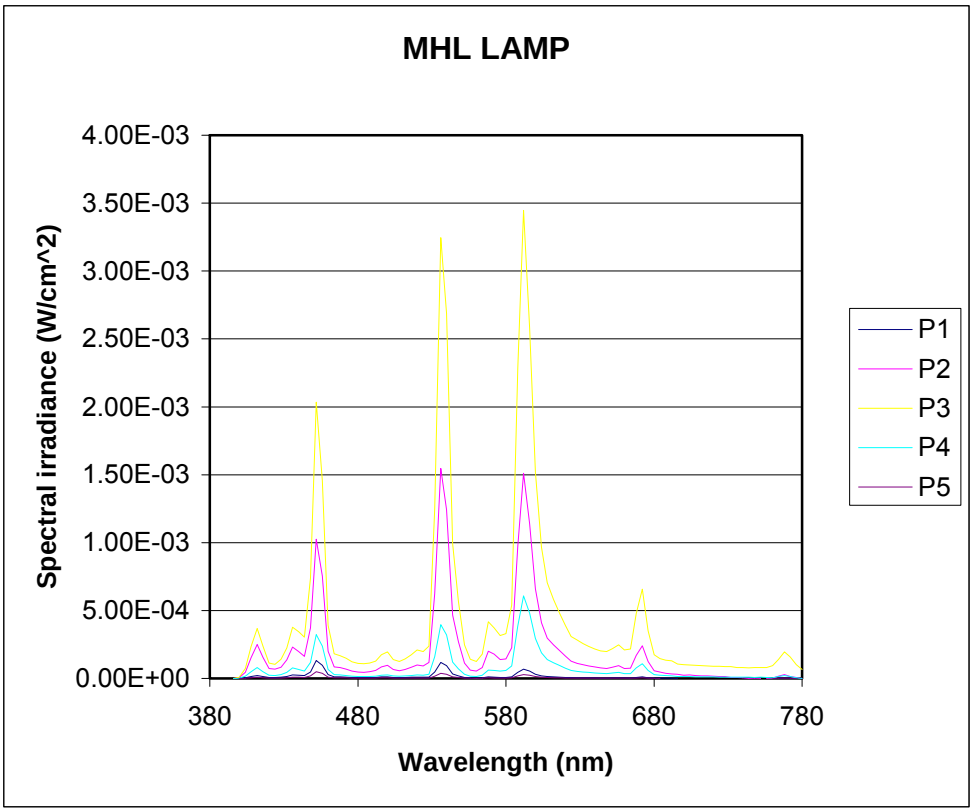


Figure 4: Spectral irradiance (W/cm^2) in the VIS region for a MHL lamp.

CONFIGURATION 2: LIGHT CHARACTERIZATION AT 40 CM HEIGHT

LIGHT LAMP	HPS+MHL				
TE#4 (VIS)					TIME
MEASURE	M1	M2	M3	AVERAGE	
C1	1.53E-02	1.53E-02	1.53E-02	1.53E-02	13:17
C2	1.67E-02	1.67E-02	1.68E-02	1.68E-02	
C3	1.35E-02	1.36E-02	1.36E-02	1.36E-02	
B1	1.63E-02	1.62E-02	1.62E-02	1.62E-02	13:21
B2	1.77E-02	1.77E-02	1.77E-02	1.77E-02	
B3	1.46E-02	1.46E-02	1.45E-02	1.46E-02	
A1	1.25E-02	1.25E-02	1.26E-02	1.25E-02	14:43
A2	1.47E-02	1.47E-02	1.47E-02	1.47E-02	
A3	1.09E-02	1.09E-02	1.10E-02	1.09E-02	

Table 5: Integrated irradiance (W/cm^2) in the VIS region for all lamps (HPS+MHL).

LIGHT LAMP	HPS+MHL									
Wavelength (nm)	C1	C2	C3	B1	B2	B3	A1	A2	A3	Time
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E-43	0.00E+00	0.00E+00	0.00E+00	0.00E+00	13:18 C
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.63E-44	0.00E+00	0.00E+00	0.00E+00	0.00E+00	14:25 B
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.22E-44	0.00E+00	0.00E+00	0.00E+00	0.00E+00	14:50 A
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.28E-44	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
396	0.00E+00	0.00E+00	0.00E+00	6.46E-07	1.47E-44	5.42E-09	0.00E+00	0.00E+00	0.00E+00	
400	7.27E-07	2.35E-07	7.72E-07	1.23E-06	2.73E-06	2.84E-06	2.88E-07	3.43E-07	3.54E-07	
404	8.06E-06	3.39E-06	8.39E-06	1.30E-05	2.62E-05	1.58E-05	4.35E-06	2.10E-06	4.16E-06	
408	2.76E-05	1.05E-05	2.75E-05	4.31E-05	9.11E-05	5.44E-05	1.49E-05	4.39E-06	1.37E-05	
412	4.64E-05	1.55E-05	4.58E-05	7.14E-05	1.42E-04	8.87E-05	2.24E-05	6.73E-06	2.24E-05	
416	3.55E-05	1.59E-05	3.43E-05	4.94E-05	9.36E-05	6.13E-05	1.85E-05	9.07E-06	1.92E-05	
420	2.55E-05	1.56E-05	2.39E-05	2.99E-05	4.79E-05	3.70E-05	1.43E-05	1.32E-05	1.67E-05	
424	2.78E-05	1.80E-05	2.65E-05	3.18E-05	4.78E-05	3.97E-05	1.65E-05	1.52E-05	1.93E-05	
428	3.36E-05	2.11E-05	3.23E-05	4.08E-05	6.11E-05	5.09E-05	1.99E-05	1.68E-05	2.32E-05	
432	4.71E-05	2.76E-05	4.52E-05	6.08E-05	1.01E-04	7.65E-05	2.76E-05	1.97E-05	3.19E-05	
436	6.77E-05	3.58E-05	6.67E-05	9.52E-05	1.73E-04	1.22E-04	3.85E-05	2.37E-05	4.53E-05	
440	6.41E-05	3.50E-05	6.37E-05	8.70E-05	1.49E-04	1.12E-04	3.66E-05	2.38E-05	4.42E-05	
444	5.73E-05	3.17E-05	5.67E-05	7.64E-05	1.23E-04	9.88E-05	3.19E-05	2.19E-05	3.99E-05	
448	1.07E-04	5.19E-05	1.08E-04	1.59E-04	2.75E-04	2.06E-04	5.92E-05	3.28E-05	7.49E-05	
452	2.31E-04	8.52E-05	2.39E-04	3.90E-04	7.35E-04	5.04E-04	1.16E-04	3.88E-05	1.48E-04	
456	1.67E-04	5.76E-05	1.71E-04	2.86E-04	5.23E-04	3.64E-04	7.75E-05	2.13E-05	1.01E-04	
460	6.14E-05	2.99E-05	6.18E-05	9.00E-05	1.45E-04	1.15E-04	3.09E-05	1.73E-05	4.02E-05	
464	7.01E-05	5.44E-05	6.96E-05	7.06E-05	7.22E-05	9.51E-05	4.85E-05	4.90E-05	6.11E-05	
468	9.60E-05	8.10E-05	9.45E-05	8.69E-05	6.80E-05	1.18E-04	7.03E-05	7.22E-05	8.75E-05	
472	6.34E-05	5.01E-05	6.21E-05	6.17E-05	5.96E-05	8.22E-05	4.34E-05	4.02E-05	5.39E-05	
476	3.70E-05	2.81E-05	3.75E-05	4.08E-05	4.96E-05	5.37E-05	2.48E-05	2.18E-05	2.99E-05	
480	2.17E-05	1.38E-05	2.20E-05	2.81E-05	4.23E-05	3.62E-05	1.22E-05	8.62E-06	1.62E-05	
484	1.74E-05	1.03E-05	1.78E-05	2.48E-05	4.23E-05	3.27E-05	9.85E-06	6.55E-06	1.18E-05	
488	2.12E-05	1.34E-05	2.15E-05	2.82E-05	4.54E-05	3.71E-05	1.23E-05	9.97E-06	1.48E-05	
492	4.13E-05	3.29E-05	4.00E-05	4.44E-05	5.37E-05	5.55E-05	2.82E-05	3.14E-05	3.37E-05	

LIGHT LAMP	HPS+MHL									
Wavelength (nm)	C1	C2	C3	B1	B2	B3	A1	A2	A3	Time
496	1.52E-04	1.46E-04	1.46E-04	1.29E-04	8.41E-05	1.65E-04	1.25E-04	1.50E-04	1.42E-04	
500	2.05E-04	2.00E-04	1.96E-04	1.68E-04	9.68E-05	2.14E-04	1.69E-04	2.03E-04	1.92E-04	
504	6.79E-05	6.09E-05	6.51E-05	6.47E-05	6.30E-05	8.11E-05	5.13E-05	5.94E-05	5.84E-05	
508	2.63E-05	1.96E-05	2.54E-05	3.44E-05	5.56E-05	4.15E-05	1.63E-05	1.56E-05	1.83E-05	
512	3.91E-05	3.30E-05	3.77E-05	4.58E-05	6.48E-05	5.50E-05	2.79E-05	2.87E-05	2.99E-05	
516	5.80E-05	5.15E-05	5.49E-05	6.21E-05	8.06E-05	7.45E-05	4.39E-05	4.92E-05	4.60E-05	
520	4.19E-05	3.12E-05	3.88E-05	5.52E-05	9.53E-05	6.60E-05	2.76E-05	2.64E-05	2.79E-05	
524	2.67E-05	1.71E-05	2.55E-05	4.39E-05	8.83E-05	5.13E-05	1.49E-05	1.04E-05	1.46E-05	
528	3.06E-05	1.81E-05	2.82E-05	5.38E-05	1.07E-04	6.26E-05	1.71E-05	1.07E-05	1.56E-05	
532	1.09E-04	4.41E-05	1.01E-04	2.50E-04	5.48E-04	2.89E-04	5.81E-05	1.16E-05	4.98E-05	
536	2.55E-04	9.16E-05	2.35E-04	6.11E-04	1.44E-03	7.07E-04	1.31E-04	1.47E-05	1.10E-04	
540	2.12E-04	7.93E-05	1.93E-04	5.00E-04	1.22E-03	5.74E-04	1.05E-04	1.61E-05	8.83E-05	
544	9.46E-05	4.89E-05	8.52E-05	1.95E-04	4.64E-04	2.25E-04	5.13E-05	2.15E-05	4.43E-05	
548	8.85E-05	7.13E-05	7.98E-05	1.29E-04	2.71E-04	1.49E-04	5.71E-05	4.46E-05	4.99E-05	
552	1.18E-04	1.29E-04	1.05E-04	1.02E-04	1.17E-04	1.05E-04	8.70E-05	9.54E-05	7.72E-05	
556	2.07E-04	2.49E-04	1.82E-04	1.41E-04	6.99E-05	1.32E-04	1.67E-04	1.98E-04	1.49E-04	
560	3.32E-04	4.10E-04	2.90E-04	2.15E-04	6.78E-05	1.95E-04	2.80E-04	3.38E-04	2.48E-04	
564	4.62E-04	5.68E-04	4.02E-04	3.05E-04	1.06E-04	2.70E-04	4.07E-04	5.08E-04	3.57E-04	
568	7.45E-04	9.10E-04	6.47E-04	5.25E-04	2.53E-04	4.61E-04	7.00E-04	9.03E-04	6.05E-04	
572	6.91E-04	8.46E-04	6.03E-04	4.78E-04	2.21E-04	4.17E-04	6.34E-04	8.03E-04	5.46E-04	
576	5.59E-04	6.94E-04	4.91E-04	3.72E-04	1.70E-04	3.27E-04	4.89E-04	6.05E-04	4.17E-04	
580	6.52E-04	8.21E-04	5.67E-04	4.27E-04	1.77E-04	3.71E-04	5.84E-04	7.32E-04	4.95E-04	
584	7.26E-04	9.12E-04	6.17E-04	5.18E-04	2.61E-04	4.47E-04	7.13E-04	8.82E-04	5.97E-04	
588	5.47E-04	5.82E-04	4.56E-04	6.41E-04	8.68E-04	6.38E-04	5.56E-04	6.06E-04	4.51E-04	
592	6.07E-04	5.95E-04	5.02E-04	8.44E-04	1.34E-03	8.57E-04	5.80E-04	6.27E-04	4.64E-04	
596	8.48E-04	9.70E-04	7.08E-04	8.91E-04	1.13E-03	8.35E-04	7.93E-04	9.42E-04	6.49E-04	
600	8.32E-04	1.01E-03	7.07E-04	7.17E-04	7.37E-04	6.40E-04	7.33E-04	9.03E-04	6.10E-04	
604	6.61E-04	8.19E-04	5.74E-04	5.23E-04	4.89E-04	4.60E-04	5.56E-04	6.98E-04	4.65E-04	
608	5.17E-04	6.42E-04	4.55E-04	3.95E-04	3.62E-04	3.48E-04	4.25E-04	5.39E-04	3.55E-04	

LIGHT LAMP	HPS+MHL									
Wavelength (nm)	C1	C2	C3	B1	B2	B3	A1	A2	A3	Time
612	4.51E-04	5.58E-04	4.00E-04	3.38E-04	3.01E-04	2.98E-04	3.75E-04	4.84E-04	3.11E-04	
616	4.29E-04	5.34E-04	3.83E-04	3.12E-04	2.55E-04	2.73E-04	3.67E-04	4.84E-04	3.03E-04	
620	3.42E-04	4.26E-04	3.06E-04	2.45E-04	2.00E-04	2.16E-04	2.86E-04	3.76E-04	2.37E-04	
624	2.53E-04	3.16E-04	2.26E-04	1.80E-04	1.54E-04	1.61E-04	2.04E-04	2.62E-04	1.69E-04	
628	2.17E-04	2.73E-04	1.94E-04	1.54E-04	1.34E-04	1.39E-04	1.74E-04	2.22E-04	1.43E-04	
632	1.93E-04	2.45E-04	1.73E-04	1.38E-04	1.22E-04	1.23E-04	1.54E-04	1.98E-04	1.28E-04	
636	1.73E-04	2.22E-04	1.56E-04	1.24E-04	1.12E-04	1.11E-04	1.38E-04	1.77E-04	1.15E-04	
640	1.56E-04	2.01E-04	1.41E-04	1.13E-04	1.02E-04	1.00E-04	1.24E-04	1.60E-04	1.04E-04	
644	1.40E-04	1.80E-04	1.27E-04	1.02E-04	9.42E-05	9.00E-05	1.10E-04	1.42E-04	9.22E-05	
648	1.29E-04	1.65E-04	1.17E-04	9.46E-05	9.08E-05	8.49E-05	1.01E-04	1.30E-04	8.42E-05	
652	1.21E-04	1.52E-04	1.10E-04	9.27E-05	9.92E-05	8.61E-05	9.48E-05	1.20E-04	7.75E-05	
656	1.14E-04	1.41E-04	1.04E-04	9.22E-05	1.11E-04	8.72E-05	8.82E-05	1.11E-04	7.21E-05	
660	1.02E-04	1.28E-04	9.44E-05	7.94E-05	8.76E-05	7.37E-05	8.04E-05	1.02E-04	6.58E-05	
664	9.59E-05	1.18E-04	8.84E-05	7.42E-05	8.69E-05	7.08E-05	7.49E-05	9.40E-05	6.09E-05	
668	1.05E-04	1.19E-04	9.62E-05	1.10E-04	1.81E-04	1.12E-04	7.67E-05	8.97E-05	6.20E-05	
672	1.12E-04	1.19E-04	1.02E-04	1.36E-04	2.50E-04	1.44E-04	7.82E-05	8.78E-05	6.22E-05	
676	9.03E-05	1.05E-04	8.28E-05	8.87E-05	1.35E-04	8.83E-05	6.51E-05	8.17E-05	5.36E-05	
680	7.21E-05	8.97E-05	6.63E-05	5.75E-05	7.04E-05	5.43E-05	5.37E-05	7.11E-05	4.55E-05	
684	6.23E-05	7.88E-05	5.79E-05	4.85E-05	5.94E-05	4.45E-05	4.75E-05	6.18E-05	4.01E-05	
688	5.41E-05	7.00E-05	5.09E-05	4.31E-05	5.19E-05	3.86E-05	4.34E-05	5.54E-05	3.51E-05	
692	4.88E-05	6.44E-05	4.66E-05	3.79E-05	4.34E-05	3.43E-05	3.83E-05	5.11E-05	3.20E-05	
696	4.38E-05	5.75E-05	4.28E-05	3.20E-05	3.71E-05	3.01E-05	3.52E-05	4.76E-05	2.95E-05	
700	4.11E-05	5.50E-05	3.87E-05	3.01E-05	3.52E-05	2.79E-05	3.28E-05	4.49E-05	2.71E-05	
704	3.93E-05	5.07E-05	3.60E-05	2.89E-05	3.26E-05	2.59E-05	2.98E-05	4.16E-05	2.47E-05	
708	3.61E-05	4.76E-05	3.40E-05	2.78E-05	3.21E-05	2.53E-05	2.63E-05	3.83E-05	2.34E-05	
712	3.19E-05	4.35E-05	3.09E-05	2.53E-05	3.07E-05	2.20E-05	2.47E-05	3.64E-05	2.13E-05	
716	3.06E-05	3.96E-05	2.89E-05	2.35E-05	2.99E-05	2.24E-05	2.36E-05	3.30E-05	1.87E-05	
720	2.90E-05	3.81E-05	2.76E-05	2.24E-05	2.84E-05	2.05E-05	2.05E-05	3.09E-05	1.68E-05	
724	2.62E-05	3.48E-05	2.58E-05	1.95E-05	2.86E-05	1.89E-05	1.96E-05	2.79E-05	1.61E-05	

LIGHT LAMP	HPS+MHL									
Wavelength (nm)	C1	C2	C3	B1	B2	B3	A1	A2	A3	Time
728	2.28E-05	3.24E-05	2.35E-05	1.83E-05	2.88E-05	1.62E-05	1.82E-05	2.78E-05	1.46E-05	
732	2.19E-05	2.95E-05	2.27E-05	1.78E-05	2.82E-05	1.48E-05	1.57E-05	2.53E-05	1.33E-05	
736	2.00E-05	2.86E-05	1.99E-05	1.75E-05	2.83E-05	1.34E-05	1.82E-05	2.49E-05	1.26E-05	
740	2.04E-05	1.93E-05	2.02E-05	1.56E-05	2.79E-05	1.53E-05	1.45E-05	2.25E-05	1.14E-05	
744	1.97E-05	2.26E-05	1.78E-05	1.27E-05	2.69E-05	1.31E-05	1.23E-05	2.12E-05	9.68E-06	
748	1.89E-05	2.21E-05	1.61E-05	1.12E-05	2.69E-05	1.31E-05	1.15E-05	2.01E-05	8.98E-06	
752	1.40E-05	1.97E-05	1.52E-05	9.32E-06	2.71E-05	1.01E-05	9.32E-06	1.98E-05	4.14E-06	
756	1.41E-05	1.35E-05	1.51E-05	1.06E-05	2.64E-05	9.44E-06	4.76E-06	1.87E-05	4.59E-06	
760	1.24E-05	1.41E-05	1.52E-05	1.06E-05	3.12E-05	1.05E-05	6.96E-06	1.91E-05	6.25E-06	
764	1.96E-05	2.24E-05	2.17E-05	2.14E-05	5.06E-05	2.09E-05	1.39E-05	2.67E-05	1.62E-05	
768	2.43E-05	3.10E-05	2.95E-05	3.38E-05	7.42E-05	3.57E-05	1.54E-05	3.45E-05	1.47E-05	
772	2.56E-05	2.21E-05	2.01E-05	2.47E-05	5.82E-05	2.22E-05	9.91E-06	2.71E-05	1.04E-05	
776	9.79E-06	6.89E-06	1.05E-05	1.04E-05	3.33E-05	4.50E-06	0.00E+00	1.79E-05	5.05E-06	
780	7.06E-06	7.05E-07	1.27E-05	1.18E-06	2.30E-05	6.86E-06	0.00E+00	1.48E-05	3.80E-07	

Table 6: Spectral irradiance (W/cm^2) in the VIS region for all lamps (HPS+MHL).

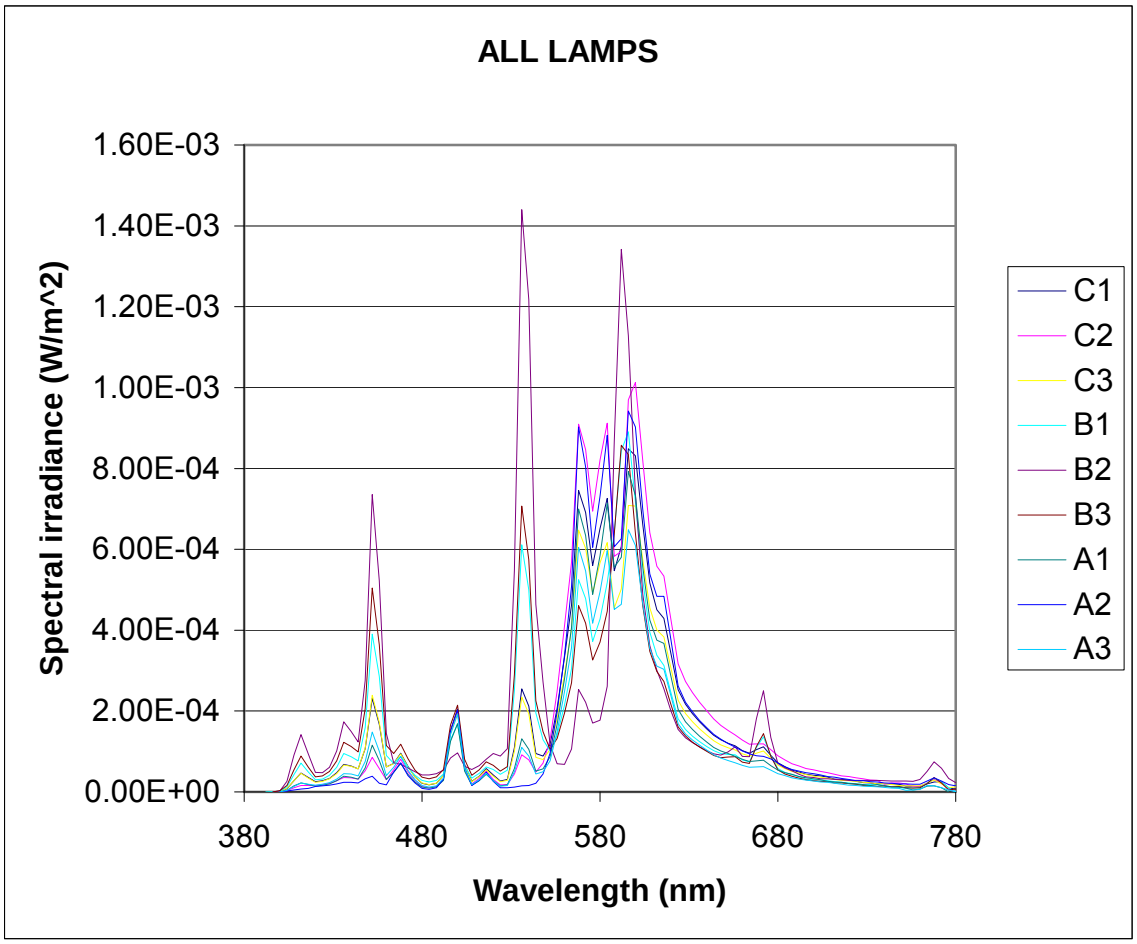


Figure 5: Spectral irradiance (W/cm^2) in the VIS region for all lamps (HPS+MHL).

CONFIGURATION 3: LIGHT CHARACTERIZATION AT 20 CM HEIGHT

LIGHT LAMP	HPS+MHL				
TE#4 (VIS)					TIME
MEASURE	M1	M2	M3	AVERAGE	
C1	1.45E-02	1.45E-02	1.45E-02	1.45E-02	13:44
C2	1.42E-02	1.42E-02	1.42E-02	1.42E-02	
C3	1.33E-02	1.33E-02	1.33E-02	1.33E-02	
B1	1.440E-02	1.44E-02	1.45E-02	1.44E-02	14:15
B2	1.44E-02	1.43E-02	1.38E-02	1.41E-02	
B3	1.03E-02	1.07E-02	1.25E-02	1.12E-02	
A1	9.96E-03	9.89E-03	9.74E-03	9.86E-03	14:40
A2	1.04E-02	1.05E-02	1.03E-02	1.04E-02	
A3	8.79E-03	8.78E-03	8.80E-03	8.79E-03	

Table 7: Integrated irradiance (W/cm^2) in the VIS region for all lamps (HPS+MHL).

LIGHT LAMP	HPS+MHL									
Wavelength (nm)	C1	C2	C3	B1	B2	B3	A1	A2	A3	Time
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	13:20 C
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	14:35 B
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	15:15 A
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
396	1.92E-09	1.34E-09	0.00E+00	4.19E-09	4.95E-06	2.81E-09	1.36E-09	0.00E+00	0.00E+00	
400	1.33E-06	9.68E-07	6.81E-07	2.29E-06	3.45E-05	1.79E-06	8.26E-07	6.41E-07	3.52E-07	
404	8.41E-06	6.38E-06	7.53E-06	1.27E-05	9.35E-05	1.15E-05	5.00E-06	3.17E-06	4.25E-06	
408	2.66E-05	1.75E-05	2.49E-05	4.31E-05	1.28E-04	3.85E-05	1.50E-05	5.01E-06	1.31E-05	
412	4.50E-05	2.75E-05	4.07E-05	7.24E-05	7.71E-05	6.33E-05	2.39E-05	6.20E-06	2.00E-05	
416	3.34E-05	2.24E-05	3.03E-05	5.15E-05	3.73E-05	4.47E-05	1.87E-05	7.74E-06	1.62E-05	
420	2.20E-05	1.77E-05	2.08E-05	3.23E-05	3.58E-05	2.79E-05	1.47E-05	7.84E-06	1.31E-05	
424	2.36E-05	1.93E-05	2.33E-05	3.50E-05	4.57E-05	2.97E-05	1.62E-05	1.04E-05	1.45E-05	
428	2.93E-05	2.39E-05	2.86E-05	4.31E-05	7.43E-05	3.82E-05	1.95E-05	1.17E-05	1.72E-05	
432	4.24E-05	3.27E-05	4.09E-05	6.31E-05	1.30E-04	5.66E-05	2.58E-05	1.41E-05	2.39E-05	
436	6.36E-05	4.63E-05	6.02E-05	9.73E-05	1.17E-04	8.89E-05	3.70E-05	1.60E-05	3.39E-05	
440	5.95E-05	4.37E-05	5.65E-05	8.90E-05	9.93E-05	8.21E-05	3.50E-05	1.49E-05	3.24E-05	
444	5.22E-05	3.80E-05	5.03E-05	7.80E-05	2.28E-04	7.20E-05	3.06E-05	2.47E-05	2.85E-05	
448	1.02E-04	7.01E-05	9.83E-05	1.60E-04	6.10E-04	1.48E-04	5.71E-05	2.91E-05	5.32E-05	
452	2.36E-04	1.44E-04	2.19E-04	3.88E-04	4.39E-04	3.57E-04	1.17E-04	1.78E-05	1.09E-04	
456	1.71E-04	1.02E-04	1.58E-04	2.82E-04	1.23E-04	2.59E-04	8.09E-05	1.41E-05	7.47E-05	
460	5.87E-05	3.99E-05	5.65E-05	9.04E-05	6.23E-05	8.31E-05	3.13E-05	3.40E-05	2.88E-05	
464	5.79E-05	5.12E-05	6.04E-05	7.44E-05	6.11E-05	7.07E-05	4.31E-05	4.97E-05	3.99E-05	
468	7.56E-05	7.17E-05	8.08E-05	9.26E-05	5.26E-05	8.89E-05	6.06E-05	2.71E-05	5.71E-05	
472	5.13E-05	4.66E-05	5.36E-05	6.46E-05	4.10E-05	6.18E-05	3.81E-05	1.52E-05	3.56E-05	
476	3.26E-05	2.72E-05	3.29E-05	4.28E-05	3.61E-05	3.96E-05	2.19E-05	6.57E-06	2.01E-05	
480	2.00E-05	1.59E-05	2.01E-05	2.90E-05	3.56E-05	2.67E-05	1.22E-05	4.44E-06	1.09E-05	
484	1.73E-05	1.25E-05	1.71E-05	2.55E-05	3.84E-05	2.33E-05	9.43E-06	7.16E-06	8.64E-06	
488	2.09E-05	1.56E-05	2.03E-05	2.88E-05	4.41E-05	2.65E-05	1.18E-05	1.95E-05	1.07E-05	

LIGHT LAMP	HPS+MHL									
Wavelength (nm)	C1	C2	C3	B1	B2	B3	A1	A2	A3	Time
492	3.60E-05	3.15E-05	3.65E-05	4.52E-05	6.85E-05	4.19E-05	2.54E-05	9.24E-05	2.32E-05	
496	1.21E-04	1.20E-04	1.27E-04	1.35E-04	7.84E-05	1.25E-04	1.02E-04	1.21E-04	9.54E-05	
500	1.61E-04	1.62E-04	1.68E-04	1.77E-04	4.90E-05	1.64E-04	1.37E-04	3.40E-05	1.28E-04	
504	5.68E-05	5.32E-05	5.75E-05	6.64E-05	4.20E-05	6.07E-05	4.34E-05	9.47E-06	4.06E-05	
508	2.49E-05	2.01E-05	2.45E-05	3.44E-05	4.82E-05	3.00E-05	1.48E-05	1.74E-05	1.34E-05	
512	3.70E-05	3.10E-05	3.57E-05	4.59E-05	5.90E-05	4.02E-05	2.38E-05	2.83E-05	2.19E-05	
516	5.28E-05	4.71E-05	5.14E-05	6.30E-05	6.79E-05	5.54E-05	3.64E-05	1.58E-05	3.33E-05	
520	4.14E-05	3.29E-05	3.87E-05	5.46E-05	6.23E-05	4.79E-05	2.37E-05	6.80E-06	2.14E-05	
524	2.99E-05	2.16E-05	2.70E-05	4.29E-05	7.43E-05	3.67E-05	1.40E-05	6.64E-06	1.21E-05	
528	3.55E-05	2.50E-05	3.11E-05	5.20E-05	3.84E-04	4.38E-05	1.55E-05	8.59E-06	1.35E-05	
532	1.48E-04	8.77E-05	1.25E-04	2.38E-04	1.01E-03	2.01E-04	5.40E-05	1.25E-05	4.65E-05	
536	3.56E-04	2.03E-04	2.98E-04	5.80E-04	8.61E-04	4.89E-04	1.23E-04	1.31E-05	1.06E-04	
540	2.93E-04	1.69E-04	2.44E-04	4.73E-04	3.23E-04	3.99E-04	9.96E-05	1.52E-05	8.55E-05	
544	1.23E-04	7.98E-05	1.03E-04	1.85E-04	1.84E-04	1.58E-04	4.71E-05	3.11E-05	4.04E-05	
548	9.76E-05	8.11E-05	8.68E-05	1.25E-04	8.44E-05	1.06E-04	5.01E-05	6.72E-05	4.35E-05	
552	1.06E-04	1.11E-04	9.91E-05	1.02E-04	5.51E-05	8.07E-05	7.30E-05	1.40E-04	6.29E-05	
556	1.72E-04	1.98E-04	1.64E-04	1.45E-04	5.68E-05	1.08E-04	1.34E-04	2.39E-04	1.17E-04	
560	2.71E-04	3.20E-04	2.60E-04	2.22E-04	8.83E-05	1.62E-04	2.20E-04	3.42E-04	1.93E-04	
564	3.80E-04	4.41E-04	3.63E-04	3.14E-04	2.04E-04	2.27E-04	3.12E-04	5.68E-04	2.77E-04	
568	6.28E-04	7.04E-04	5.95E-04	5.36E-04	1.81E-04	3.84E-04	5.21E-04	5.25E-04	4.68E-04	
572	5.81E-04	6.57E-04	5.51E-04	4.88E-04	1.39E-04	3.49E-04	4.78E-04	4.39E-04	4.26E-04	
576	4.70E-04	5.44E-04	4.46E-04	3.81E-04	1.49E-04	2.72E-04	3.79E-04	5.50E-04	3.33E-04	
580	5.46E-04	6.39E-04	5.16E-04	4.39E-04	2.31E-04	3.09E-04	4.49E-04	6.51E-04	3.94E-04	
584	6.18E-04	7.06E-04	5.73E-04	5.27E-04	7.61E-04	3.71E-04	5.20E-04	4.25E-04	4.68E-04	
588	5.56E-04	5.12E-04	4.86E-04	6.27E-04	1.16E-03	4.78E-04	3.83E-04	4.41E-04	3.56E-04	
592	6.76E-04	5.65E-04	5.76E-04	8.14E-04	9.54E-04	6.28E-04	4.06E-04	6.83E-04	3.74E-04	
596	8.43E-04	8.17E-04	7.42E-04	8.69E-04	6.10E-04	6.41E-04	5.76E-04	6.64E-04	5.22E-04	
600	7.76E-04	8.14E-04	7.00E-04	7.07E-04	4.00E-04	5.08E-04	5.55E-04	5.15E-04	4.94E-04	

LIGHT LAMP	HPS+MHL									
Wavelength (nm)	C1	C2	C3	B1	B2	B3	A1	A2	A3	Time
604	6.08E-04	6.53E-04	5.54E-04	5.20E-04	2.92E-04	3.70E-04	4.34E-04	3.96E-04	3.80E-04	
608	4.75E-04	5.11E-04	4.37E-04	3.94E-04	2.40E-04	2.80E-04	3.36E-04	3.43E-04	2.93E-04	
612	4.15E-04	4.45E-04	3.83E-04	3.37E-04	2.03E-04	2.39E-04	2.96E-04	3.29E-04	2.58E-04	
616	3.92E-04	4.21E-04	3.63E-04	3.12E-04	1.58E-04	2.22E-04	2.87E-04	2.58E-04	2.51E-04	
620	3.13E-04	3.37E-04	2.90E-04	2.45E-04	1.21E-04	1.75E-04	2.26E-04	1.87E-04	1.98E-04	
624	2.33E-04	2.51E-04	2.15E-04	1.80E-04	1.04E-04	1.30E-04	1.64E-04	1.59E-04	1.42E-04	
628	2.02E-04	2.16E-04	1.85E-04	1.55E-04	9.41E-05	1.11E-04	1.40E-04	1.40E-04	1.22E-04	
632	1.80E-04	1.93E-04	1.65E-04	1.38E-04	8.66E-05	9.99E-05	1.25E-04	1.26E-04	1.08E-04	
636	1.63E-04	1.74E-04	1.49E-04	1.24E-04	7.93E-05	9.01E-05	1.12E-04	1.14E-04	9.71E-05	
640	1.48E-04	1.58E-04	1.35E-04	1.12E-04	7.28E-05	8.17E-05	1.01E-04	1.02E-04	8.75E-05	
644	1.33E-04	1.42E-04	1.22E-04	1.01E-04	7.03E-05	7.38E-05	9.01E-05	9.34E-05	7.86E-05	
648	1.23E-04	1.30E-04	1.13E-04	9.39E-05	7.64E-05	6.82E-05	8.24E-05	8.65E-05	7.19E-05	
652	1.17E-04	1.21E-04	1.07E-04	9.17E-05	8.47E-05	6.69E-05	7.70E-05	8.00E-05	6.58E-05	
656	1.13E-04	1.14E-04	1.03E-04	9.09E-05	6.82E-05	6.71E-05	7.18E-05	7.44E-05	6.24E-05	
660	1.01E-04	1.02E-04	9.24E-05	7.79E-05	6.88E-05	5.85E-05	6.53E-05	6.91E-05	5.56E-05	
664	9.53E-05	9.56E-05	8.69E-05	7.40E-05	1.44E-04	5.54E-05	6.07E-05	6.78E-05	5.24E-05	
668	1.17E-04	1.04E-04	1.04E-04	1.06E-04	2.00E-04	8.26E-05	6.38E-05	6.55E-05	5.58E-05	
672	1.34E-04	1.11E-04	1.16E-04	1.31E-04	1.07E-04	1.03E-04	6.59E-05	5.98E-05	5.70E-05	
676	9.93E-05	8.89E-05	8.70E-05	8.63E-05	5.73E-05	6.56E-05	5.48E-05	5.29E-05	4.86E-05	
680	7.39E-05	7.23E-05	6.70E-05	5.65E-05	4.74E-05	4.18E-05	4.58E-05	4.69E-05	3.95E-05	
684	6.31E-05	6.31E-05	5.81E-05	4.84E-05	3.97E-05	3.50E-05	3.98E-05	4.18E-05	3.49E-05	
688	5.60E-05	5.55E-05	5.18E-05	4.31E-05	3.43E-05	3.11E-05	3.49E-05	3.88E-05	3.05E-05	
692	5.10E-05	5.05E-05	4.60E-05	3.81E-05	2.89E-05	2.75E-05	3.18E-05	3.55E-05	2.73E-05	
696	4.56E-05	4.53E-05	4.15E-05	3.38E-05	2.67E-05	2.46E-05	2.87E-05	3.46E-05	2.53E-05	
700	4.26E-05	4.25E-05	3.84E-05	3.13E-05	2.57E-05	2.34E-05	2.67E-05	3.15E-05	2.40E-05	
704	3.96E-05	4.07E-05	3.63E-05	2.79E-05	2.77E-05	2.17E-05	2.48E-05	2.99E-05	2.20E-05	
708	3.78E-05	3.62E-05	3.47E-05	2.81E-05	2.58E-05	2.00E-05	2.30E-05	2.71E-05	2.01E-05	
712	3.52E-05	3.30E-05	3.14E-05	2.33E-05	2.51E-05	1.85E-05	2.01E-05	2.55E-05	1.86E-05	

LIGHT LAMP	HPS+MHL									
Wavelength (nm)	C1	C2	C3	B1	B2	B3	A1	A2	A3	Time
716	3.33E-05	2.95E-05	2.96E-05	2.24E-05	2.39E-05	1.80E-05	1.91E-05	2.43E-05	1.65E-05	
720	2.97E-05	2.69E-05	2.76E-05	2.22E-05	2.49E-05	1.32E-05	1.86E-05	2.36E-05	1.52E-05	
724	2.74E-05	2.64E-05	2.63E-05	2.02E-05	2.39E-05	1.33E-05	1.70E-05	2.18E-05	1.54E-05	
728	2.62E-05	2.39E-05	2.47E-05	1.85E-05	2.44E-05	1.33E-05	1.59E-05	1.99E-05	1.41E-05	
732	2.51E-05	2.26E-05	2.34E-05	1.53E-05	2.34E-05	1.25E-05	1.42E-05	1.86E-05	1.17E-05	
736	2.18E-05	2.05E-05	2.17E-05	1.32E-05	2.37E-05	1.01E-05	1.39E-05	1.80E-05	1.02E-05	
740	2.17E-05	1.86E-05	2.02E-05	1.17E-05	2.21E-05	1.02E-05	1.31E-05	1.69E-05	9.55E-06	
744	1.96E-05	1.70E-05	1.84E-05	1.31E-05	2.12E-05	1.05E-05	1.16E-05	1.56E-05	8.86E-06	
748	1.74E-05	1.65E-05	1.90E-05	1.18E-05	2.16E-05	8.35E-06	9.77E-06	1.46E-05	7.56E-06	
752	1.71E-05	1.57E-05	1.76E-05	1.22E-05	2.06E-05	8.69E-06	8.47E-06	1.32E-05	4.67E-06	
756	1.34E-05	9.91E-06	1.65E-05	1.09E-05	2.42E-05	1.04E-05	8.17E-06	1.30E-05	6.01E-06	
760	1.62E-05	1.31E-05	1.72E-05	1.26E-05	4.14E-05	1.03E-05	8.52E-06	1.83E-05	5.95E-06	
764	2.19E-05	1.88E-05	2.87E-05	2.35E-05	6.04E-05	2.09E-05	1.01E-05	2.49E-05	1.28E-05	
768	3.90E-05	2.61E-05	3.65E-05	3.61E-05	4.54E-05	2.97E-05	1.54E-05	2.00E-05	2.02E-05	
772	2.74E-05	1.70E-05	2.77E-05	2.25E-05	2.58E-05	2.33E-05	9.50E-06	1.26E-05	1.05E-05	
776	1.27E-05	6.70E-06	1.39E-05	1.33E-05	1.60E-05	1.29E-05	6.60E-06	1.00E-05	2.75E-06	
780	3.98E-06	8.92E-07	8.04E-06	9.39E-06	0.00E+00	5.36E-06	4.66E-06	0.00E+00	1.63E-08	

Table 8: Spectral irradiance (W/cm2) in the VIS region for all lamps (HPS+MHL).

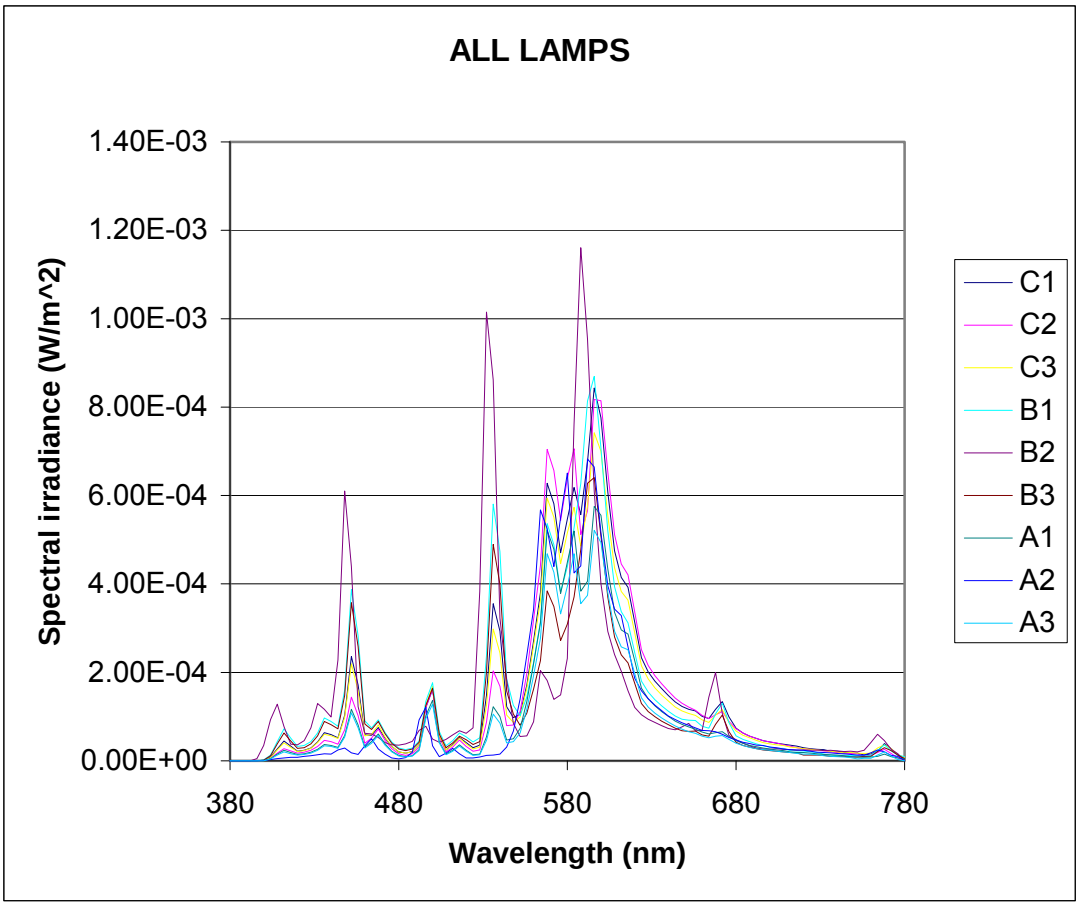


Figure 6: Spectral irradiance (W/cm^2) in the VIS region for all lamps (HPS+MHL).

CONFIGURATION 4: MHL LIGHT CHARACTERIZATION OUTSIDE THE HPS

LIGHT LAMP	MHL
Wavelength (nm)	
380	0.00E+00
384	0.00E+00
388	0.00E+00
392	8.79E-03
396	9.07E-02
400	3.99E-01
404	7.69E-01
408	1.57E+00
412	2.12E+00
416	1.25E+00
420	5.14E-01
424	4.26E-01
428	4.87E-01
432	7.29E-01
436	1.19E+00
440	1.02E+00
444	8.43E-01
448	1.87E+00
452	4.90E+00
456	3.43E+00
460	9.41E-01
464	4.49E-01
468	4.16E-01
472	3.71E-01
476	3.04E-01
480	2.65E-01
484	2.67E-01
488	2.87E-01
492	3.25E-01
496	4.57E-01
500	5.21E-01
504	3.62E-01
508	3.27E-01
512	3.73E-01
516	4.53E-01
520	5.41E-01
524	5.08E-01
528	6.08E-01
532	3.06E+00
536	7.93E+00
540	6.69E+00
544	2.50E+00
548	1.40E+00

LIGHT LAMP	MHL
Wavelength (nm)	
552	6.19E-01
556	3.57E-01
560	3.16E-01
564	4.76E-01
568	1.15E+00
572	1.01E+00
576	7.74E-01
580	7.87E-01
584	1.35E+00
588	5.51E+00
592	8.42E+00
596	6.48E+00
600	3.90E+00
604	2.50E+00
608	1.84E+00
612	1.54E+00
616	1.29E+00
620	1.02E+00
624	8.14E-01
628	7.28E-01
632	6.66E-01
636	6.16E-01
640	5.75E-01
644	5.24E-01
648	5.18E-01
652	5.76E-01
656	6.50E-01
660	5.31E-01
664	5.49E-01
668	1.25E+00
672	1.75E+00
676	9.35E-01
680	4.72E-01
684	3.99E-01
688	3.47E-01
692	3.02E-01
696	2.76E-01
700	2.58E-01
704	2.48E-01
708	2.49E-01
712	2.50E-01
716	2.44E-01
720	2.49E-01
724	2.45E-01
728	2.48E-01
732	2.47E-01

LIGHT LAMP	MHL
Wavelength (nm)	
736	2.40E-01
740	2.46E-01
744	2.49E-01
748	2.43E-01
752	2.43E-01
756	2.34E-01
760	2.82E-01
764	4.71E-01
768	6.74E-01
772	5.36E-01
776	3.31E-01
780	2.47E-01

Table 9: Spectral radiance (W/sr*cm^2) in the VIS region for a MHL lamp.

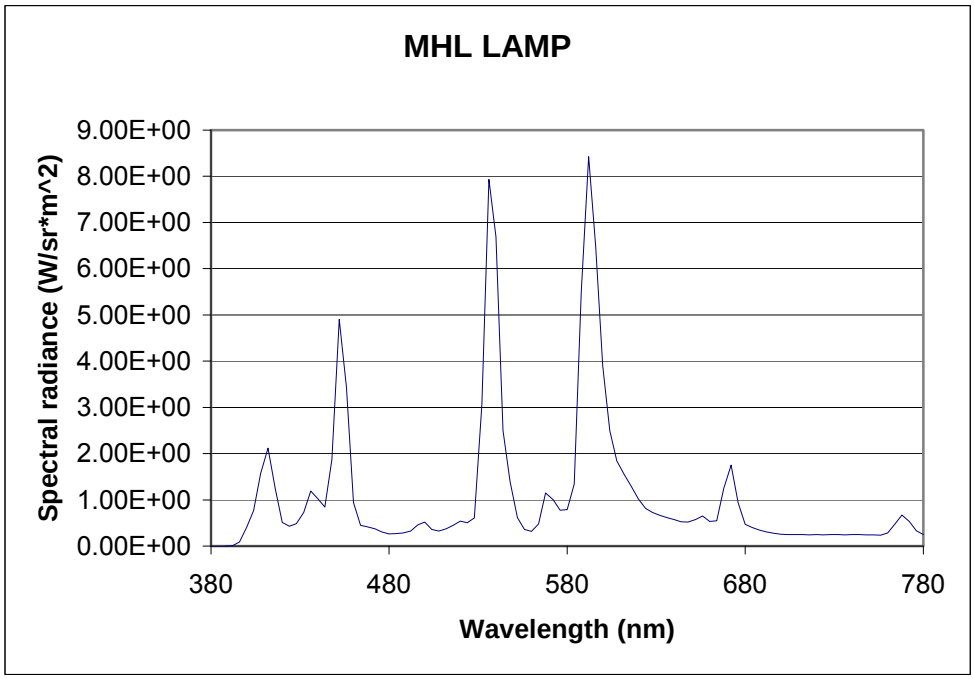


Figure 7: Spectral radiance (W/sr*cm2) in the VIS region for a MHL lamp.

4.3. Instruments Accuracy

The tele-spectracolorimeter PhotoResearch SpectraColorimeter, model PR-655, serial nº 65082002 with the fiber accessory FP-655, has a radiometric accuracy of 2% (±1 digit) and a spectral accuracy of ±2 nm, according to the technical specifications of this instrument.

The radiometer International Light, model IL-1700, serial nº 2338 has a radiometric accuracy of 3%.

5. TEMPERATURE, HUMIDITY AND AIR FLOW MAPPING

5.1. Test conditions

The HPC Mapping has been carried out in 4 different scans, each of them consisting on taking values of humidity, temperature and airflow for 90 seconds in 17 different positions, as described in RD1.

The humidity, temperature and air flow sensors are mounted on a support which is placed on an HPC tray, as shown in 0

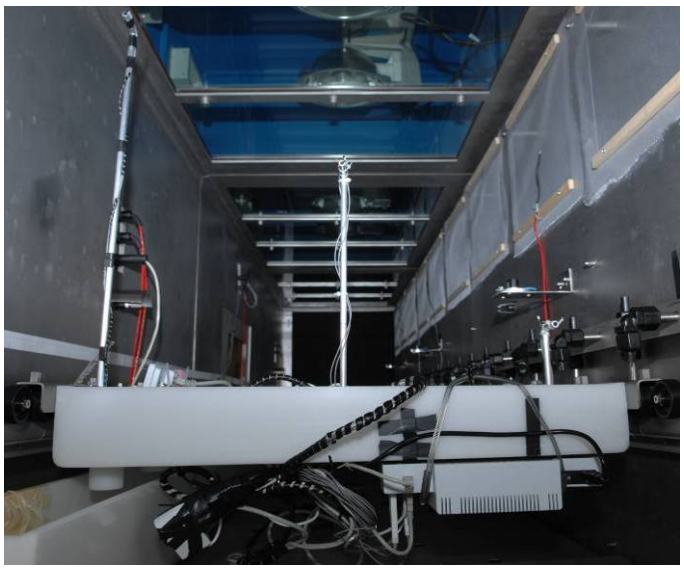


Figure 8: Ambient sensors mounted on its support, assembled in an HPC tray.

The layout of the sensor's support is provided in annex A.

It should be noticed that the support's vertical part corresponding to the plenum side of the HPC (right one in Figure 8) has been moved 52mm to the center of the HPC with respect to the foreseen support described in AD1.

The support is such that the support's vertical parts can be dismounted and exchanged, so that the test configuration can be modified. The medium length part has always been placed in the middle of the support's base. The other two ones (longer and shorter) are mounted at one side or the other depending on desired test conditions, as it is described in each Scan test conditions.

The nominal positions where acquisitions are performed are defined as shown in 0.

Nº	Pos (mm)	Nº	Pos (mm)	Nº	Pos (mm)
1	4732	7	3142	13	1532
2	4472	8	2872	14	1272
3	4192	9	2582	15	1012
4	3932	10	2332	16	742
5	3672	11	2062	17	462
6	3422	12	1812		

Table 10: Sensor's nominal test positions in HPC.

Where position number 1 corresponds to near the HPC door A and position 17 corresponds to position near HPC door C.

The positioning of the tray with the sensor has been measured by using an IP video camera (provided and installed by EnginSoft) looking at a metric scale fixed on the HPC wall. A straight paper fixed on the tray carrying the sensors is used as the "Position Reference" defining the tray's position (0).

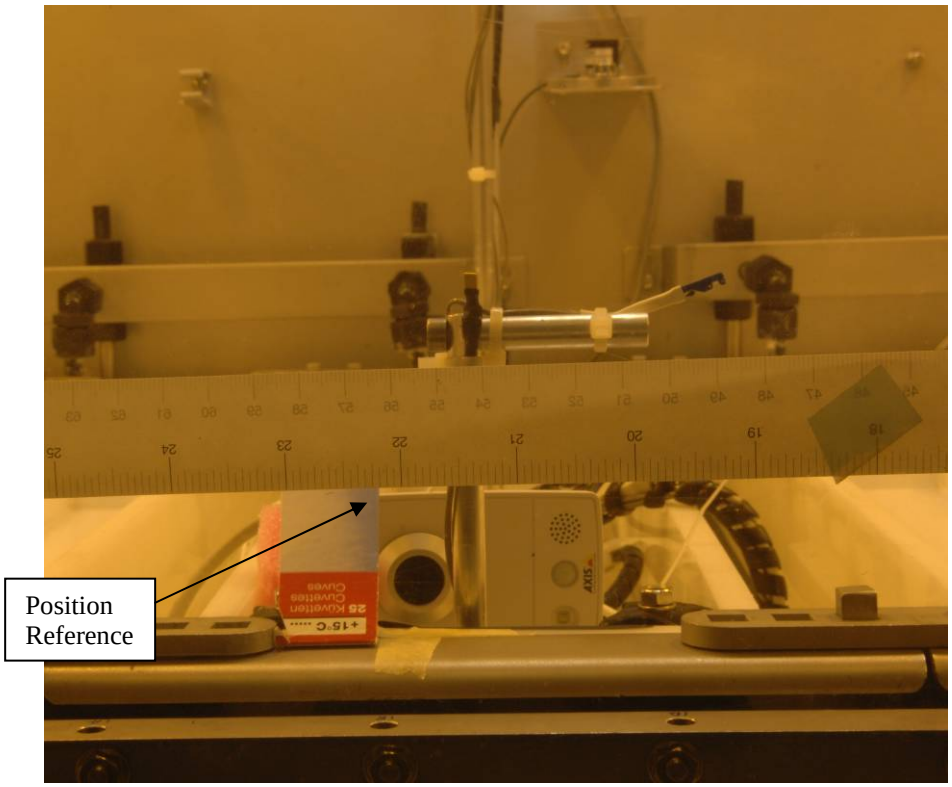


Figure 9: Camera mounted on the sensor's tray, measuring the tray's position by filming a fixed meter and a reference moving with the tray.

Thus, the tray's position is defined as the position indicated by the "Position Reference" where it crosses the metric scale, as can be seen on the IP camera image. For this test, a ±5mm error is tolerated in sensor's tray positioning.

The irrigation pump is kept ON during tests, and a pipe is mounted to bring water to the main collector. Water flows from side C to A. A bucket full of water has also been placed between the warm radiator and the blower.

These two elements have been added to the test set-up to increase humidity on the chamber, making HPC conditions closer to those when growing plants are in the trays.

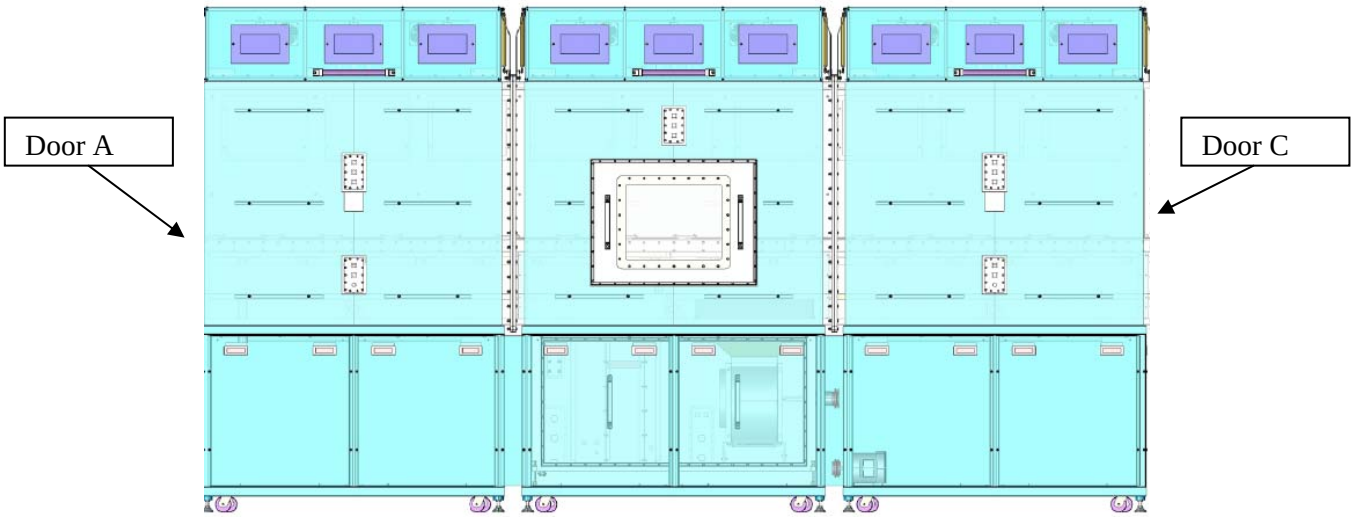


Figure 10: HPC doors A and C situation

Scan	Lights	Temperature	Humidity	Test frame position	Measurements sequence
1	100% (ON)	26 ºC	50%	Long sensor support at plenum's side, short support at window side.	From door C to A.
2	0% (OFF)	20ºC	63%	Long sensor support at plenum's side, short support at window side.	From door A to C.
3	0% (OFF)	20ºC	63%	Short sensor support at plenum's side, long support at window side.	From door C to A
4	100% (ON)	26ºC	50%	Short sensor support at plenum's side, long support at window side.	From door A to C

Table 11: Test conditions for every scan (1 to 4)

Pressure Sensors Set-up

In addition to the Humidity, Air flow and Temperature sensors, a group of 5 pressure sensors were installed specifically for this test. The sensors were connected to the PLC and the data acquired with the SCADA system. The sensors are named as follows in the SCADA database:

Sensor	Location
PT_4114_02	Module A pressure
PT_4114_03	Module C pressure
PT_4114_04	Module B pressure
PT_4114_05	Pressure between heater and cooler

PT_4114_06	HVAC chamber

Table 12: Identification of the pressure sensors installed for the test.

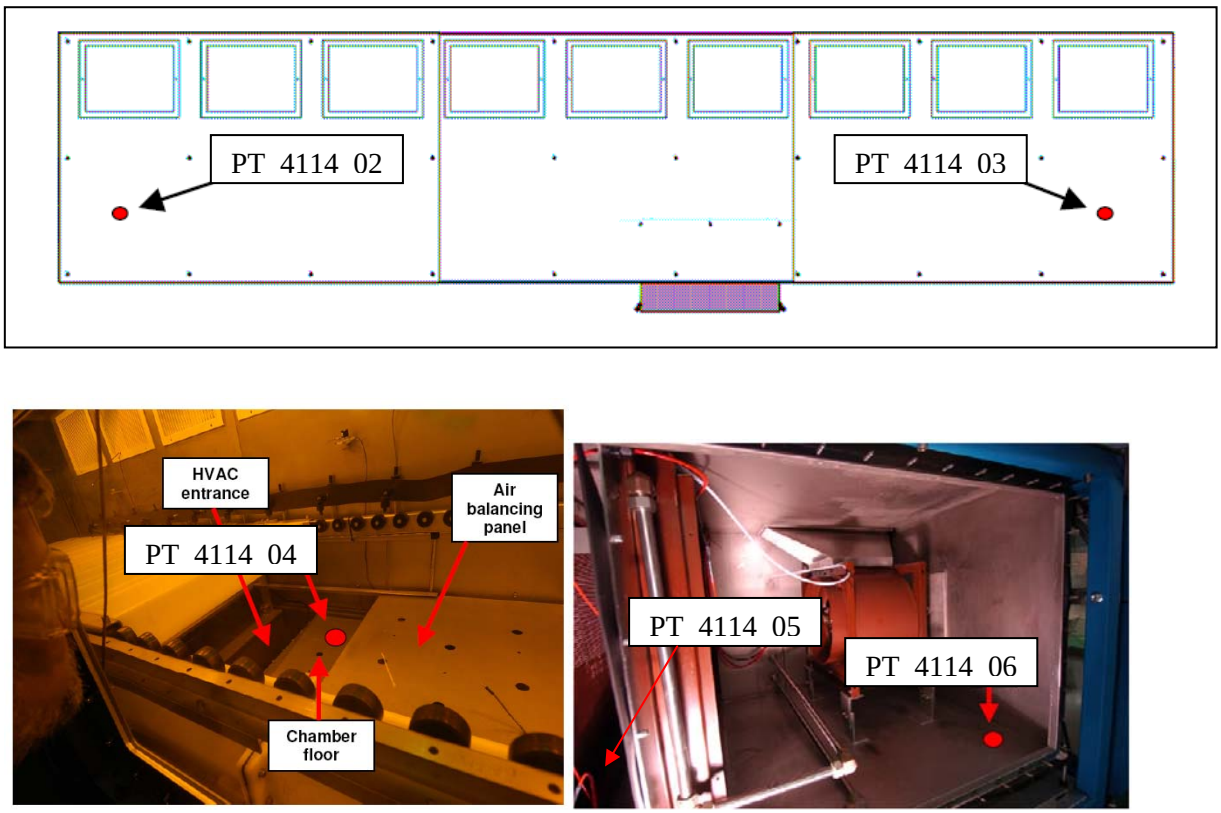


Figure 11: Location of pressure sensors installed for the test.

As the pressure sensors and the Humidity, Air Velocity and Temperature sensors are connected to different acquisition systems, the clocks of both systems were synchronised at the start of the test. This gives an accuracy of +/-1 second of synchronisation between both measurement systems.

5.2. Sensors accuracy

Sensor	Model	Range	Accuracy
Air Velocity	UAS1100XS	0.15 to 1 m/s	+/-5%
Humidity	UHS1000	0-100%	+/-3%
Temperature	UHS1000	0-70	+/-0.5 ºC
Pressure	PTX7517	800-1200	0.1%

5.3. Test Procedure Details

Test procedure is mainly described in RD1. However, a few details could not be defined till test time. The aim of this section is to describe these details.

As stated in RD1, this test mainly consists on taking ambient measurements on different positions inside the HPC. The sensors are placed on one of the trays in the HPC and to move them the whole set of trays are shifted inside the compartment. This means that trays are added to one side of the compartment and removed from the other. The procedure followed is indicated below:

1. The sensor's harness is placed at one end of the HPC and as many trays as possible (6 or 7) are placed between the curtain and the door, at the side where the sensors are. The gap between the door and the curtain at the other side is kept empty
2. The HPC is closed and the test conditions are introduced as control loop set points.
3. An initial stabilization time is left so that the set-point values are reached and HPC is steady. This time is not formally defined, although it is always longer than 10', and typically around an hour.
4. When HPC is steady, a 90sec data acquisition is performed. Sample time is 1 second. Data details are described in section 5.4. It was agreed before starting the test to make the data acquisition time longer than stated in RD1, so that the instability of airflow measurements could be numerically compensated by EnginSoft
5. Trays are shifted without opening the HPC doors (whenever possible). HPC stabilization time after this manipulation has been chosen to be 30 sec.

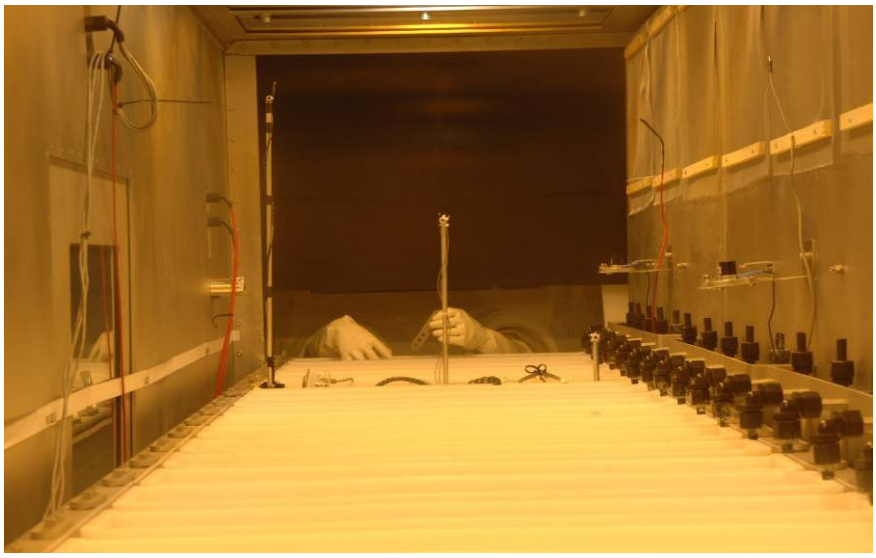


Figure 12: Trays shifting without opening the HPC doors.

6. Steps 4 and 5 are repeated as long as there are available trays stored between the curtain and the door. When this condition is not true any more, HPC doors are opened (without opening the curtains) and trays accumulated at one side of the compartment are removed and brought to the other. Stabilization time after this manipulation is established as 10 minutes.

Ideally, the HPC is opened three times for every Scan, although unexpected minor issues eventually forced to open the HPC a few more times. A 10 minutes stabilization time was always respected before resuming measurements.

5.4. Results summary

Below a table with the averages measured for each point is presented.

5.4.1. Scan 1 results

Date: 02/12/2009

		Humidity (%)			Air Velocity (m/s)			Temperature (degC)					
		High	Mid	Low	High	Mid	Low	High		Mid		Low	
Test	Time	P2H	P4H	P8H	P5A	P6A	P1A	P2T	P5T	P4T	P6T	P1T	P8T
1	11:21:32	52.4	55.9	55.1	0.51	0.71	1.10	27.2	26.2	25.6	25.0	25.6	25.2
2	11:31:59	54.6	55.3	55.9	0.54	0.69	0.74	26.5	26.4	26.0	25.4	25.4	24.9
3	11:45:02	53.3	52.9	54.9	0.50	0.56	0.93	26.3	26.2	26.1	25.7	25.0	24.6
4	11:53:51	55.0	55.1	57.6	0.68	0.64	0.81	26.7	26.2	26.2	25.6	25.0	24.5
5	12:01:36	53.8	53.0	56.3	0.40	0.63	0.76	26.7	26.2	26.5	25.5	25.0	24.5
6	12:31:47	53.5	52.9	56.9	0.53	0.50	0.75	26.6	25.9	26.3	25.3	24.8	24.3
7	12:39:03	55.6	53.8	58.7	0.84	0.39	0.94	26.2	25.4	26.3	25.4	24.5	24.0
8	12:47:18	53.8	52.6	59.2	0.68	0.27	1.16	26.6	25.6	26.5	25.5	24.2	23.7
9	12:59:24	54.3	51.5	57.8	0.45	0.24	1.00	26.5	26.0	26.9	25.8	24.6	24.0
10	13:33:14	51.7	50.8	56.9	0.34	0.22	0.65	27.1	26.4	27.0	25.9	24.7	24.2
11	13:42:37	52.4	50.3	56.8	0.36	0.22	0.95	26.9	26.6	27.2	25.9	24.8	24.2
12	13:49:00	52.4	51.4	56.4	0.40	0.33	0.72	27.1	26.5	27.1	25.8	25.2	24.7
13	13:55:31	51.8	51.1	55.4	0.35	0.41	0.71	27.3	26.9	27.2	26.0	25.5	25.0
14	14:03:59	52.2	52.0	54.8	0.46	0.34	0.63	27.3	26.8	26.9	26.4	25.7	25.3
15	14:12:48	52.5	51.0	53.9	0.33	0.34	0.70	27.0	27.1	27.1	26.4	25.9	25.7
16	14:32:08	53.9	52.7	53.3	0.83	0.70	0.82	26.5	26.0	26.5	25.9	26.0	25.7
17	14:40:56	59.5	53.4	53.5	0.86	0.80	0.27	24.7	25.6	26.3	25.6	26.0	25.9

Table 13: Averages of Scan 1 HVAC measures.

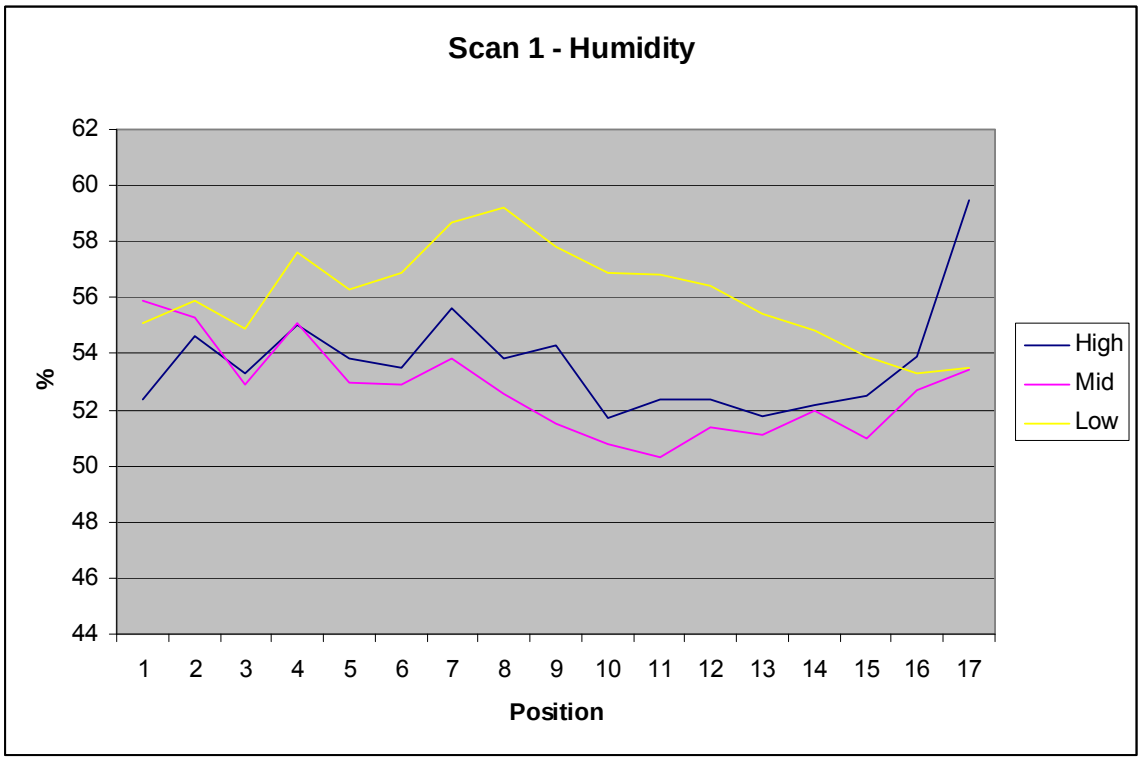


Figure 13 Scan 1 - Humidity average per position.

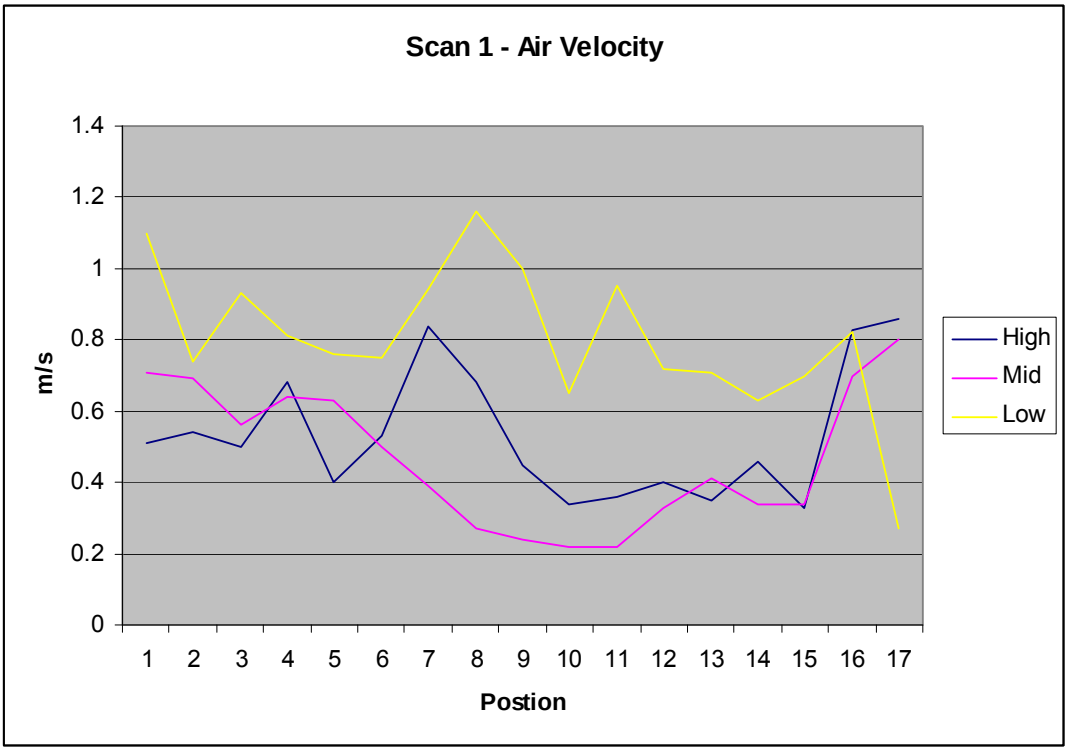


Figure 14 Scan 1 – Air velocity average per position.

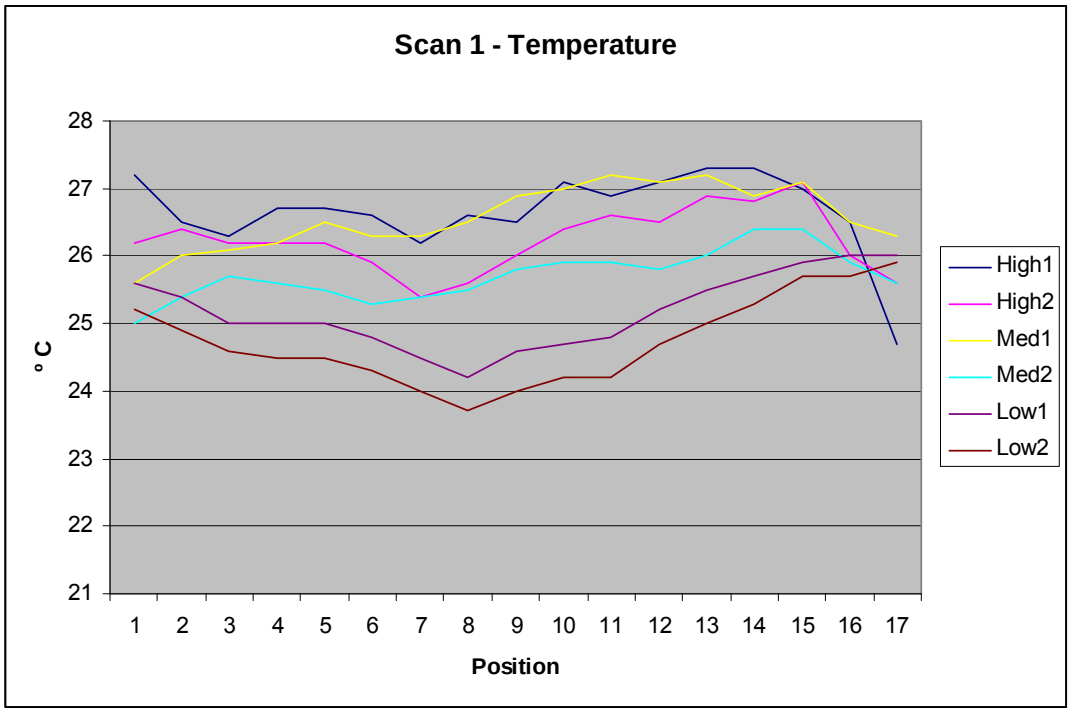


Figure 15 Scan 1 – Temperature average per position.

5.4.2. Scan 2 results

Date: 02/12/2009

		Humidity (%)			Air Velocity (m/s)			Temperature (degC)					
		High	Mid	Low	High	Mid	Low	High		Mid		Low	
Test	Time	P2H	P4H	P8H	P5A	P6A	P1A	P2T	P5T	P4T	P6T	P1T	P8T
1	16:20:18	68.9	65.6	65.3	0.82	0.83	0.25	19.8	20.0	20.1	19.7	20.2	20.1
2	16:30:34	68.4	65.8	65.8	0.90	0.76	0.79	19.9	20.0	20.0	19.6	19.9	19.9
3	16:43:27	67.4	65.7	66.4	0.35	0.36	0.63	20.2	20.3	20.0	19.7	20.0	19.8
4	16:59:46	68.1	66.2	66.9	0.42	0.38	0.61	20.1	20.1	19.9	19.6	19.8	19.7
5	17:16:44	67.8	66.1	67.0	0.30	0.44	0.66	20.1	20.3	19.9	19.6	19.8	19.7
6	17:26:30	68.0	66.1	67.0	0.38	0.32	0.69	20.0	20.0	19.8	19.5	19.7	19.5
7	17:47:22	67.7	66.0	66.8	0.31	0.22	0.92	19.9	20.0	19.7	19.5	19.5	19.5
8	17:56:05	68.8	66.8	67.7	0.33	0.20	0.64	19.9	20.1	19.8	19.6	19.5	19.5
9	18:01:47	69.2	67.2	68.1	0.45	0.24	1.01	19.8	20.0	19.7	19.6	19.4	19.5
10	18:07:42	68.4	66.6	67.5	0.64	0.25	1.10	19.8	19.9	19.7	19.6	19.4	19.4
11	18:14:33	69.6	67.6	68.5	0.77	0.39	0.95	19.7	19.9	19.6	19.6	19.3	19.3
12	18:22:33	68.2	66.3	66.8	0.49	0.50	0.73	19.8	20.1	19.7	19.7	19.5	19.5
13	18:47:21	68.6	66.8	67.3	0.38	0.60	0.71	19.9	20.2	19.8	19.8	19.6	19.6
14	18:52:43	68.7	66.9	67.5	0.65	0.59	0.80	20.0	20.2	19.8	19.8	19.6	19.6

		Humidity (%)			Air Velocity (m/s)			Temperature (degC)					
		High	Mid	Low	High	Mid	Low	High		Mid		Low	
Test	Time	P2H	P4H	P8H	P5A	P6A	P1A	P2T	P5T	P4T	P6T	P1T	P8T
15	19:07:31	67.8	65.9	66.4	0.52	0.51	0.86	19.9	20.2	19.7	19.9	19.5	19.6
16	19:33:04	67.9	66.5	66.6	0.46	0.67	0.70	20.0	20.3	19.8	19.8	19.6	19.8
17	19:40:01	67.9	66.7	66.5	0.55	0.67	1.11	20.1	20.2	19.8	19.6	19.8	19.8

Table 14: Averages of Scan 2 HVAC measures.

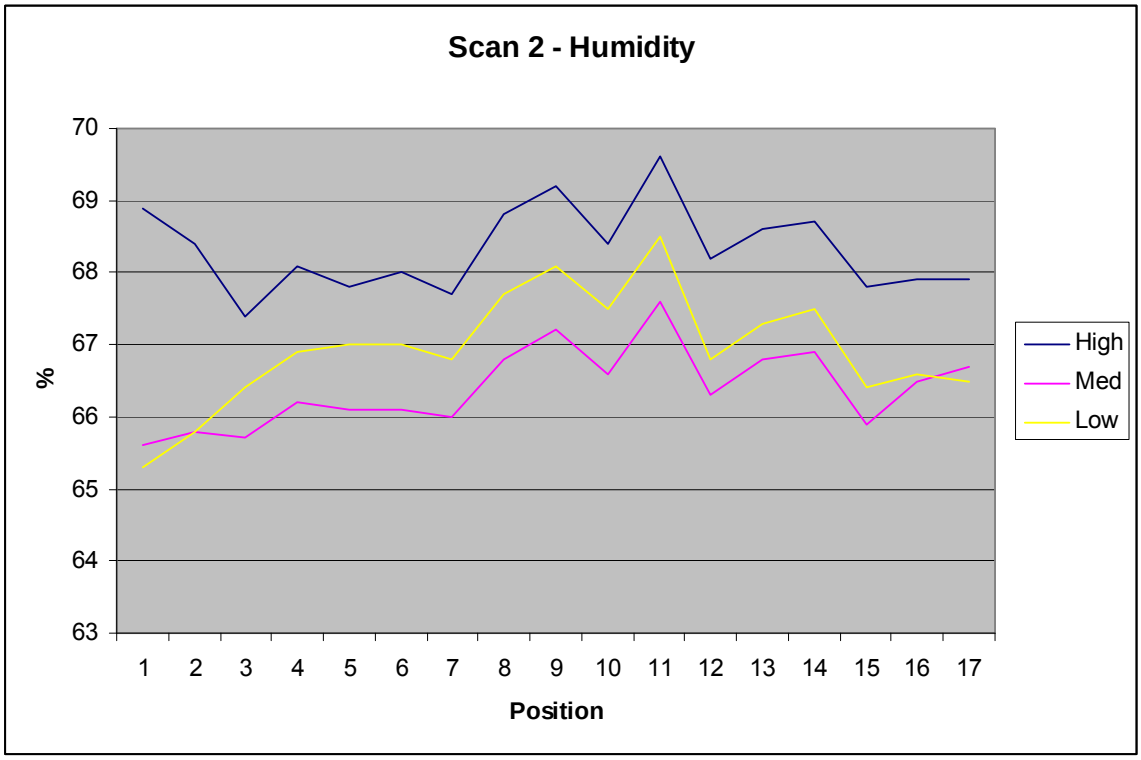


Figure 16 Scan 2 - Humidity average per position

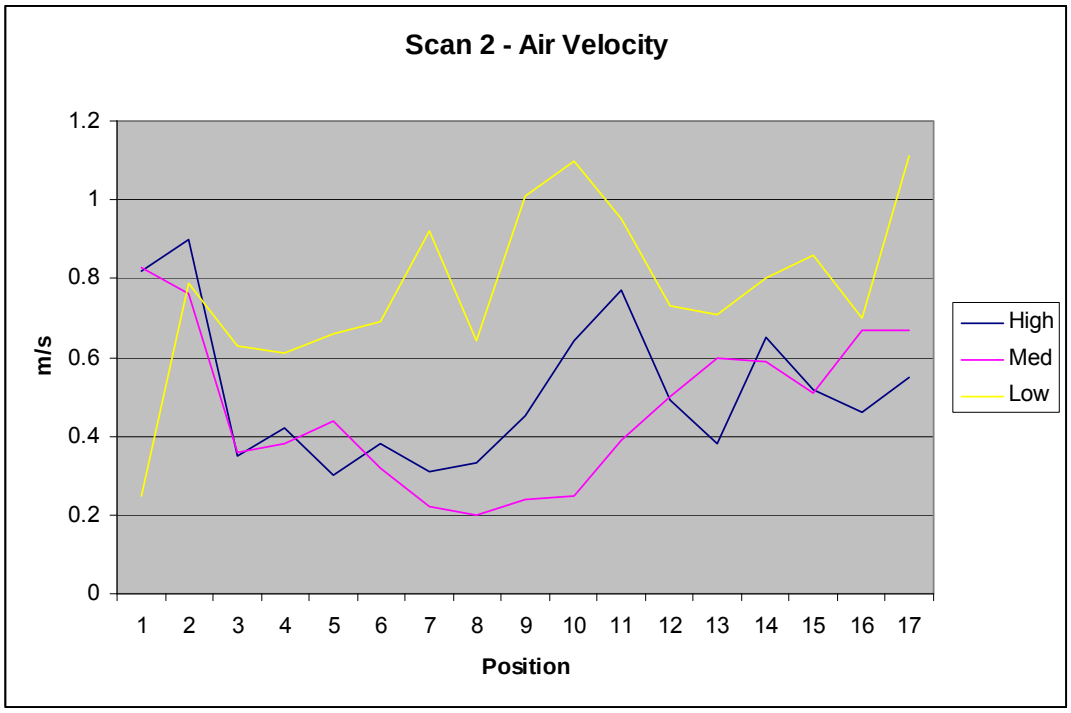


Figure 17 Scan 2 - Air velocity average per position

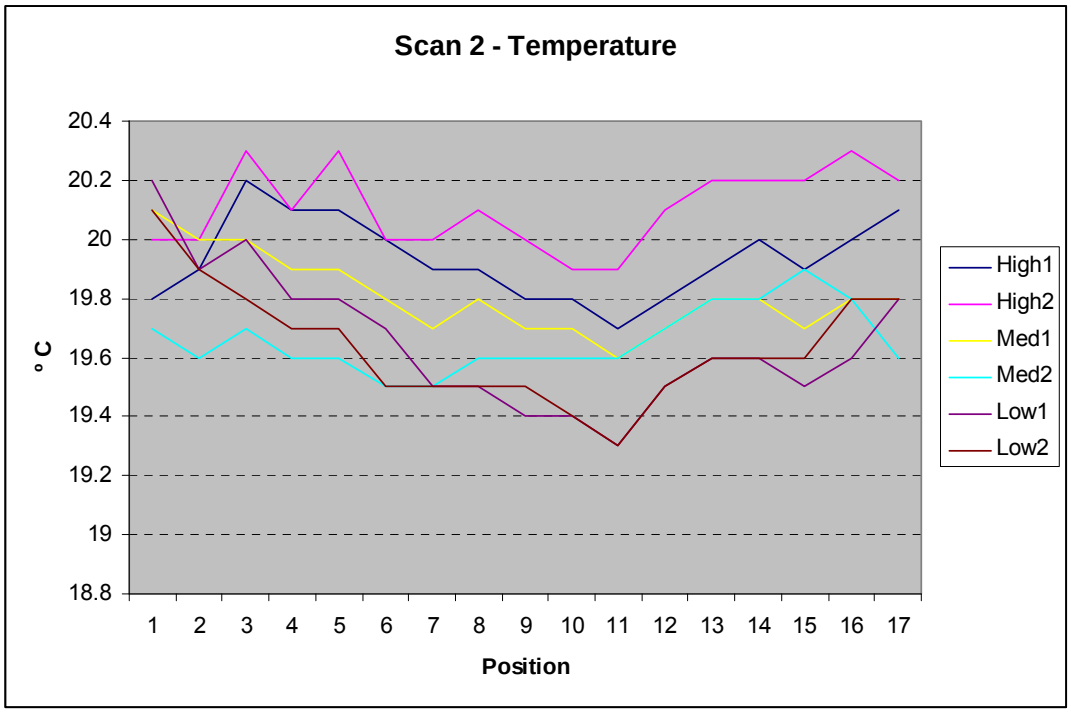


Figure 18 Scan 2 - Temperature average per position

5.4.3. Scan 3 results

Date: 03/12/2009

		Humidity (%)			Air Velocity (m/s)			Temperature (degC)					
		High	Mid	Low	High	Mid	Low	High		Mid		Low	
Test	Time	P2H	P4H	P8H	P5A	P6A	P1A	P2T	P5T	P4T	P6T	P1T	P8T
1	10:11:27	67.3	66.0	65.0	0.65	0.68	0.66	20.2	20.2	19.8	19.7	20.1	20.2
2	10:20:46	68.2	66.8	65.6	0.78	0.63	0.68	20.2	20.1	19.8	19.8	20.1	20.3
3	10:27:20	68.3	66.7	65.5	1.25	0.52	0.66	20.2	20.0	19.9	20.0	20.1	20.3
4	10:46:46	68.4	66.7	65.6	0.80	0.59	0.68	20.1	20.0	19.8	19.9	20.1	20.3
5	10:54:11	68.4	66.7	65.7	0.80	0.55	0.67	20.1	20.1	19.9	19.9	20.0	20.2
6	11:06:39	68.2	66.5	65.5	0.83	0.44	0.60	20.1	20.1	19.9	19.9	20.0	20.2
7	11:15:24	69.0	67.3	66.1	0.68	0.37	0.62	20.0	20.1	19.8	19.7	19.9	20.2
8	12:00:21	69.0	67.1	66.4	0.54	0.23	0.65	19.9	19.9	19.7	19.6	19.7	19.9
9	12:13:34	68.1	66.3	65.7	0.82	0.24	0.64	19.9	19.9	19.7	19.5	19.8	20.0
10	12:44:12	69.0	67.1	66.3	0.73	0.20	0.49	19.9	19.8	19.6	19.5	19.9	20.0
11	12:51:12	68.8	67.1	66.2	0.48	0.23	0.37	19.9	19.9	19.7	19.5	20.0	20.0
12	12:58:57	68.7	67.0	66.1	0.52	0.29	0.22	20.0	20.0	19.8	19.5	20.2	20.2
13	13:05:46	68.1	66.3	65.4	0.69	0.45	0.24	20.0	20.0	19.8	19.4	20.1	20.2
14	13:30:36	68.0	66.5	65.6	0.71	0.39	0.20	20.2	20.1	19.9	19.5	20.3	20.2
15	13:37:29	66.8	65.4	64.7	0.52	0.38	0.26	20.2	20.2	19.8	19.5	20.1	20.2
16	13:45:51	68.0	66.7	65.9	0.54	0.75	0.43	20.2	20.2	19.8	19.5	20.0	20.2
17	13:54:48	67.7	66.3	65.5	1.05	0.80	0.66	20.2	20.1	19.9	19.5	20.0	20.2

Table 15: Averages of Scan 3 HVAC measures.

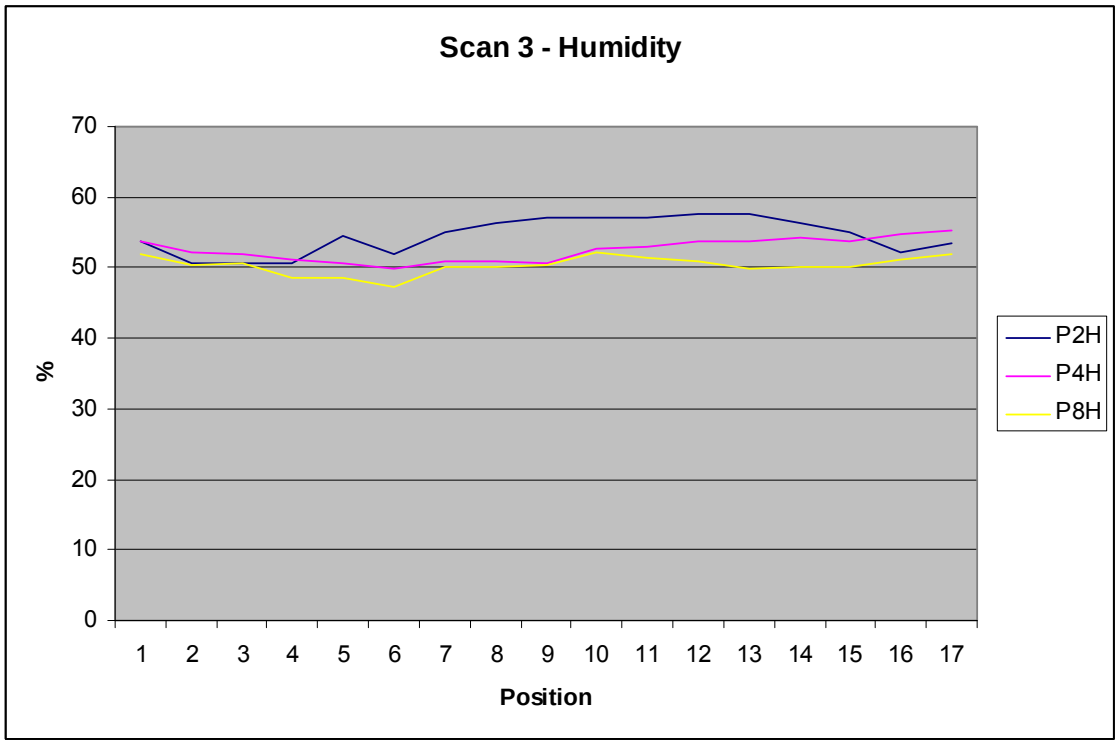


Figure 19 Scan 3 - Humidity average per position

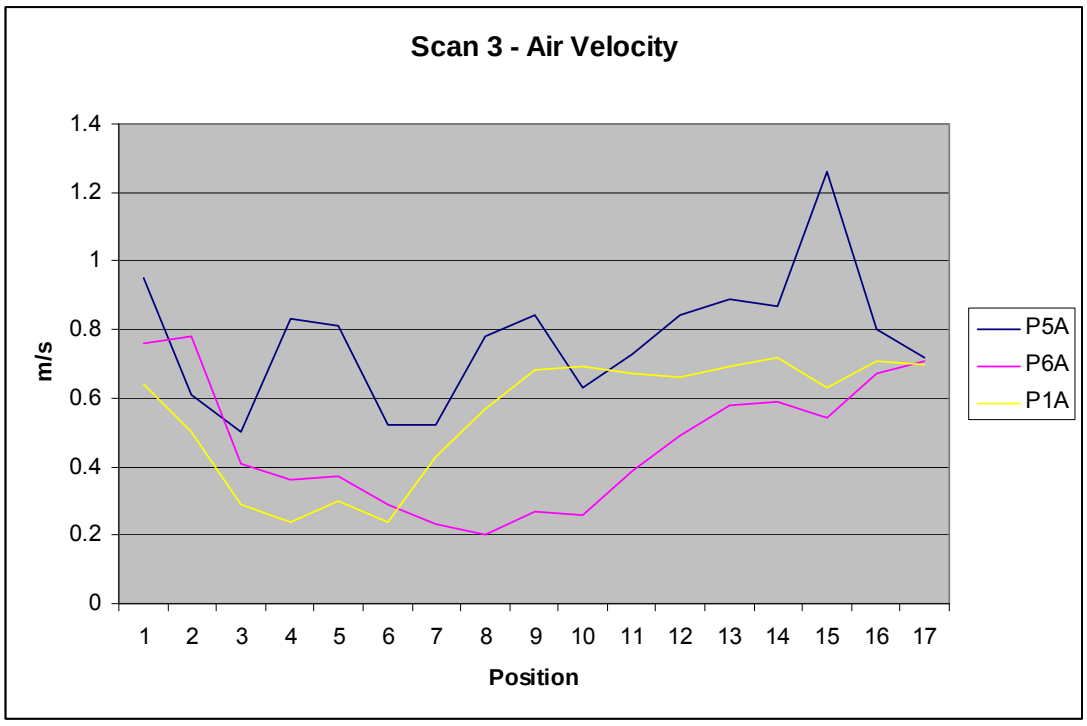


Figure 20 Scan 3 - Air velocity average per position

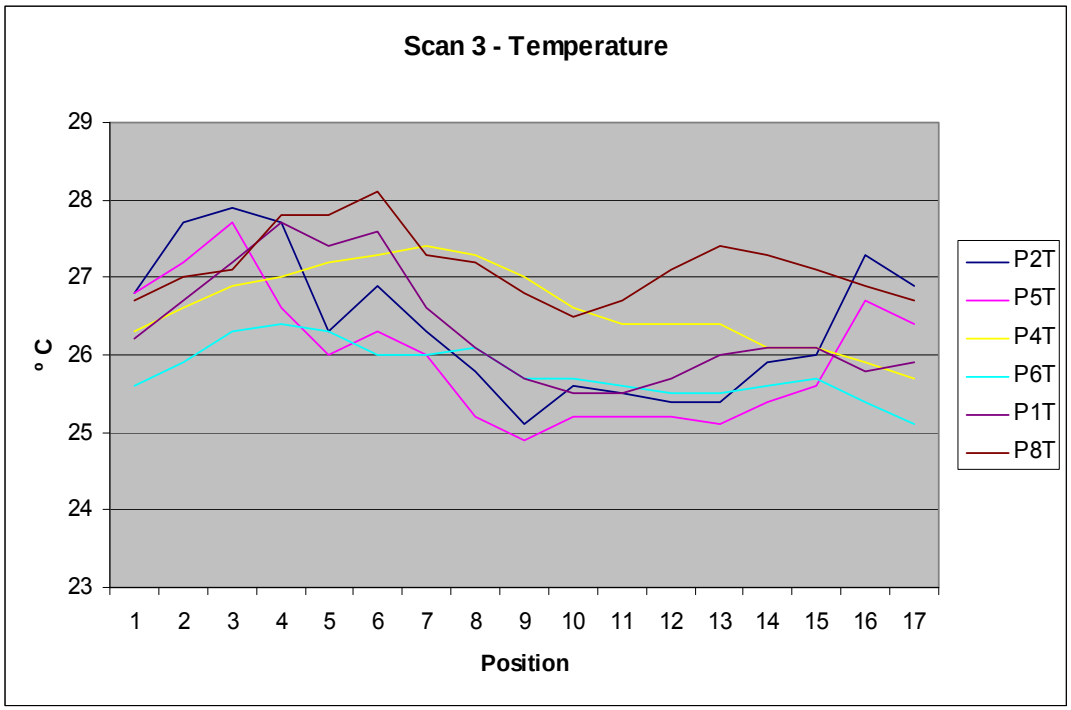


Figure 21 Scan 3 - Temperature average per position

5.4.4. Scan 4 results

Date: 03/12/2009

		Humidity (%)			Air Velocity (m/s)			Temperature (degC)					
		High	Mid	Low	High	Mid	Low	High		Mid		Low	
Test	Time	P2H	P4H	P8H	P5A	P6A	P1A	P2T	P5T	P4T	P6T	P1T	P8T
1	15:48:36	53.8	53.7	51.9	0.95	0.76	0.64	26.8	26.8	26.3	25.6	26.2	26.7
2	15:54:48	50.7	52.3	50.4	0.61	0.78	0.50	27.7	27.2	26.6	25.9	26.7	27.0
3	16:00:28	50.6	51.8	50.7	0.50	0.41	0.29	27.9	27.7	26.9	26.3	27.2	27.1
4	16:07:10	50.7	51.2	48.6	0.83	0.36	0.24	27.7	26.6	27.0	26.4	27.7	27.8
5	16:12:51	54.4	50.7	48.6	0.81	0.37	0.30	26.3	26.0	27.2	26.3	27.4	27.8
6	16:18:28	52.0	49.8	47.3	0.52	0.29	0.24	26.9	26.3	27.3	26.0	27.6	28.1
7	16:44:08	54.9	50.8	50.1	0.52	0.23	0.43	26.3	26.0	27.4	26.0	26.6	27.3
8	16:50:48	56.2	50.8	50.2	0.78	0.20	0.57	25.8	25.2	27.3	26.1	26.1	27.2
9	16:56:21	57.2	50.5	50.3	0.84	0.27	0.68	25.1	24.9	27.0	25.7	25.7	26.8
10	17:03:39	57.2	52.7	52.3	0.63	0.26	0.69	25.6	25.2	26.6	25.7	25.5	26.5
11	17:09:39	57.0	53.0	51.3	0.73	0.39	0.67	25.5	25.2	26.4	25.6	25.5	26.7
12	17:15:00	57.7	53.6	51.0	0.84	0.49	0.66	25.4	25.2	26.4	25.5	25.7	27.1
13	17:40:29	57.6	53.7	49.9	0.89	0.58	0.69	25.4	25.1	26.4	25.5	26.0	27.4

14	17:50:32	56.3	54.3	50.2	0.87	0.59	0.72	25.9	25.4	26.1	25.6	26.1	27.3
15	17:57:33	55.1	53.8	50.1	1.26	0.54	0.63	26.0	25.6	26.1	25.7	26.1	27.1
16	18:04:11	52.3	54.8	51.2	0.80	0.67	0.71	27.3	26.7	25.9	25.4	25.8	26.9
17	18:09:33	53.5	55.4	51.9	0.72	0.71	0.70	26.9	26.4	25.7	25.1	25.9	26.7

Table 16: Averages of Scan 4 HVAC measures.

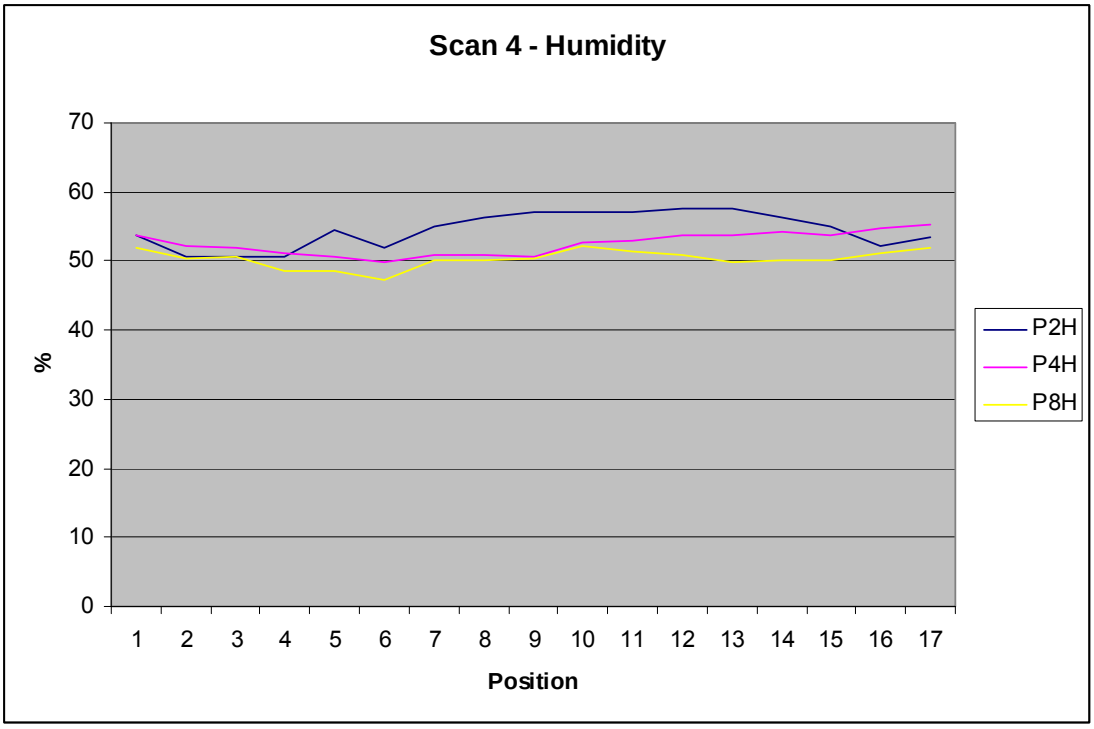


Figure 22 Scan 4 - Humidity average per position

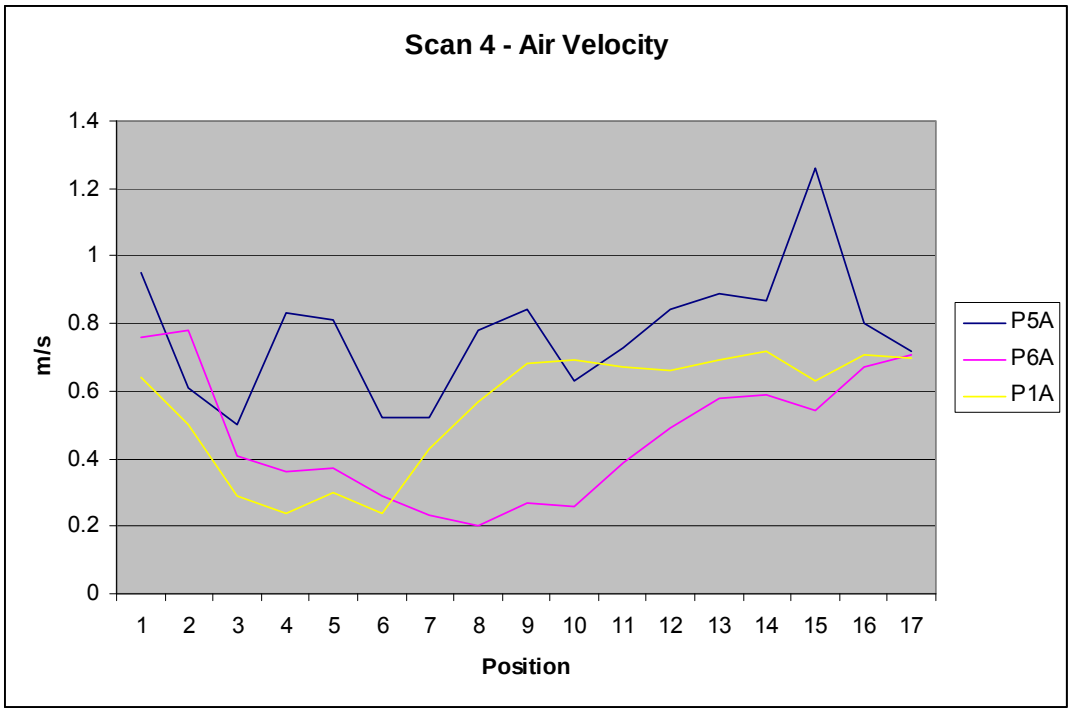


Figure 23 Scan 4 - Air velocity average per position

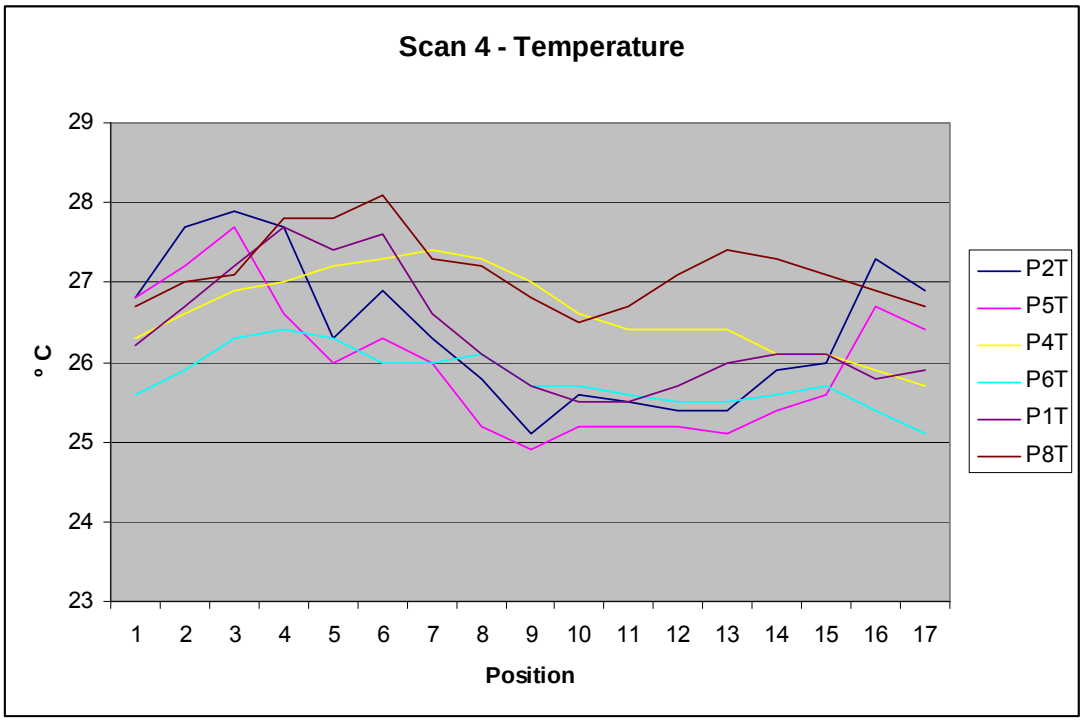


Figure 24 Scan 4 - Temperature average per position

5.5. Pressure Sensors Results

5.5.1. Scan 1 results

Date: 12/02/2009

Test	Time	PT_4114_02	PT_4114_03	PT_4114_04	PT_4114_05	PT_4114_06
Test 1	11:21:00	1000.304	1000.234	1000.788	998.221	1000.165
Test 2	11:31:00	1000.454	1000.431	1000.958	998.494	1000.351
Test 3	11:45:00	1000.191	1000.108	1000.678	997.923	1000.042
Test 4	11:53:00	1000.144	1000.093	1000.685	998.131	999.998
Test 5	12:01:00	1000.092	999.991	1000.598	998.010	999.928
Test 6	12:31:00	999.728	999.724	1000.210	997.658	999.599
Test 7	12:39:00	999.623	999.615	1000.092	997.610	999.484
Test 8	12:47:00	999.539	999.552	999.998	997.458	999.420
Test 9	12:59:00	999.335	999.345	999.860	997.284	999.241
Test 10	13:33:00	998.797	998.830	999.269	996.658	998.678
Test 11	13:42:00	998.517	998.564	999.051	996.423	998.389
Test 12	13:49:00	998.607	998.613	999.069	996.484	998.469
Test 13	13:55:00	998.534	998.579	999.062	996.438	998.416
Test 14	14:03:00	998.405	998.432	998.925	996.348	998.232
Test 15	14:12:00	998.455	998.482	998.933	996.313	998.294
Test 16	14:32:00	998.204	998.208	998.709	996.059	998.014
Test 17	14:40:00	998.138	998.144	998.642	995.955	998.038

Table 17: Averages of Scan 1 Pressure measures.

5.5.2. Scan 2 results

Date: 12/02/2009

Test	Time	PT_4114_02	PT_4114_03	PT_4114_04	PT_4114_05	PT_4114_06
Test 1	16:20:00	996.880	997.810	997.327	994.551	997.108
Test 2	16:30:00	996.913	997.766	997.313	994.582	997.112
Test 3	16:43:00	996.806	997.628	997.161	994.403	996.943
Test 4	16:59:00	996.684	997.589	997.121	994.348	996.886
Test 5	17:16:00	996.697	997.511	997.090	994.339	996.858
Test 6	17:26:00	996.878	997.700	997.248	994.516	997.022
Test 7	17:47:00	996.608	997.461	997.049	994.234	996.748
Test 8	17:56:00	996.652	997.458	997.074	994.302	996.779
Test 9	18:01:00	996.535	997.363	996.948	994.184	996.704

Test	Time	PT_4114_02	PT_4114_03	PT_4114_04	PT_4114_05	PT_4114_06
Test 10	18:07:00	996.431	997.301	996.903	994.050	996.655
Test 11	18:14:00	996.329	997.226	996.777	994.001	996.499
Test 12	18:22:00	996.346	997.238	996.830	993.974	996.542
Test 13	18:47:00	996.360	997.198	996.744	994.021	996.556
Test 14	18:52:00	996.334	997.222	996.818	993.998	996.566
Test 15	19:07:00	996.477	997.377	996.945	994.136	996.639
Test 16	19:33:00	996.297	997.176	996.774	993.973	996.529
Test 17	19:40:00	996.262	997.113	996.714	993.918	996.438

Table 18: Averages of Scan 2 Pressure measures.

5.5.3. Scan 3 results

Date: 12/03/2009

Test	Time	PT_4114_02	PT_4114_03	PT_4114_04	PT_4114_05	PT_4114_06
Test 1	10:11:00	990.590	991.314	991.049	988.223	990.811
Test 2	10:20:00	990.713	991.419	991.192	988.333	990.999
Test 3	10:27:00	990.860	991.599	991.395	988.539	991.099
Test 4	10:46:00	990.977	991.709	991.453	988.655	991.222
Test 5	10:54:00	990.966	991.683	991.453	988.643	991.153
Test 6	11:06:00	990.876	991.609	991.350	988.502	991.113
Test 7	11:15:00	990.801	991.587	991.319	988.476	991.036
Test 8	12:00:00	990.776	991.523	991.221	988.425	990.973
Test 9	12:13:00	990.684	991.457	991.141	988.287	990.933
Test 10	12:44:00	990.787	991.494	991.246	988.422	991.049
Test 11	12:51:00	990.756	991.489	991.191	988.427	990.989
Test 12	12:58:00	990.764	991.513	991.269	988.393	991.019
Test 13	13:05:00	990.708	991.420	991.195	988.304	990.985
Test 14	13:30:00	990.660	991.354	991.122	988.273	990.909
Test 15	13:37:00	990.582	991.330	991.062	988.167	990.872
Test 16	13:45:00	990.512	991.213	990.989	988.108	990.792
Test 17	13:54:00	990.654	991.365	991.114	988.256	990.918

Table 19: Averages of Scan 3 Pressure measures.

5.5.4. Scan 4 results

Date: 12/03/2009

Test	Time	PT_4114_02	PT_4114_03	PT_4114_04	PT_4114_05	PT_4114_06
Test 1	15:48:00	992.125	991.975	992.677	989.916	992.029
Test 2	15:54:00	992.137	992.026	992.701	989.886	992.038
Test 3	16:00:00	992.249	992.102	992.794	990.044	992.165
Test 4	16:07:00	992.249	992.102	992.794	990.044	992.165
Test 5	16:12:00	992.479	992.322	993.007	990.168	992.381
Test 6	16:18:00	992.474	992.364	993.036	990.233	992.433
Test 7	16:44:00	992.782	992.667	993.327	990.590	992.723
Test 8	16:50:00	992.823	992.723	993.392	990.622	992.803
Test 9	16:56:00	992.913	992.817	993.440	990.647	992.834
Test 10	17:03:00	993.065	992.950	993.605	990.825	992.979
Test 11	17:09:00	993.180	993.052	993.717	990.925	993.086
Test 12	17:15:00	993.325	993.239	993.852	991.143	993.264
Test 13	17:40:00	993.546	993.378	994.034	991.345	993.438
Test 14	17:50:00	993.662	993.553	994.212	991.493	993.602
Test 15	17:57:00	993.774	993.678	994.312	991.512	993.675
Test 16	18:04:00	993.890	993.789	994.425	991.660	993.797
Test 17	18:09:00	993.915	993.815	994.482	991.681	993.839

Table 20: Averages of Scan 4 Pressure measures.

5.6. Chamber Temperature and Humidity

Apart from the temperature and humidity sensors used with the specific acquisition system, the chamber has also a temperature (TT_) and humidity (AT_) sensor in each module. The distribution of the temperature and humidity sensors is as follows:

Figure 25 Position of chamber temperature and humidity sensors.

The acquisition average measures during the tests are provided in the graphs below:

5.6.1. Scan1 measures

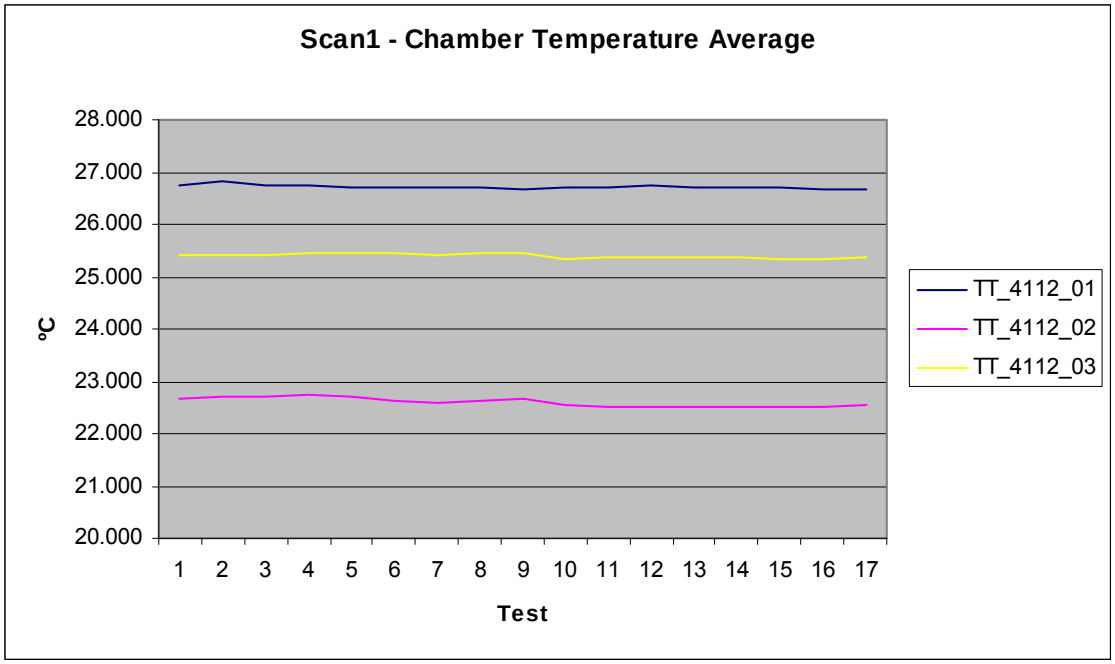


Figure 26 Scan1 – Chamber Temperature Average

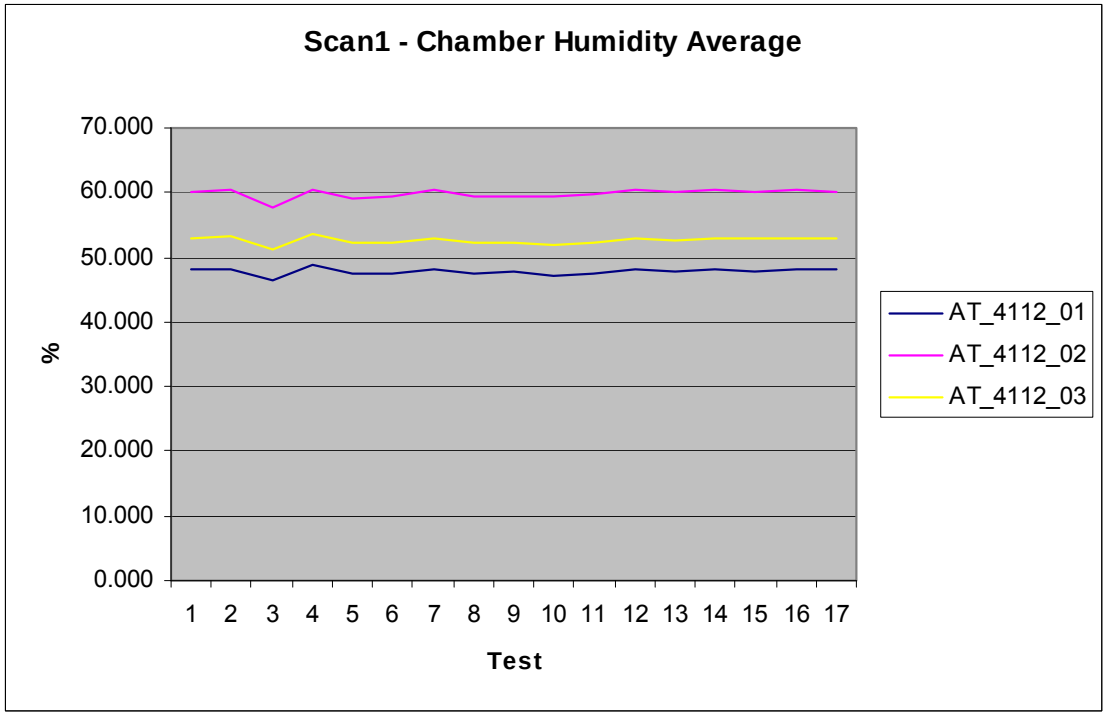


Figure 27 Scan1 - Chamber Humidity Average

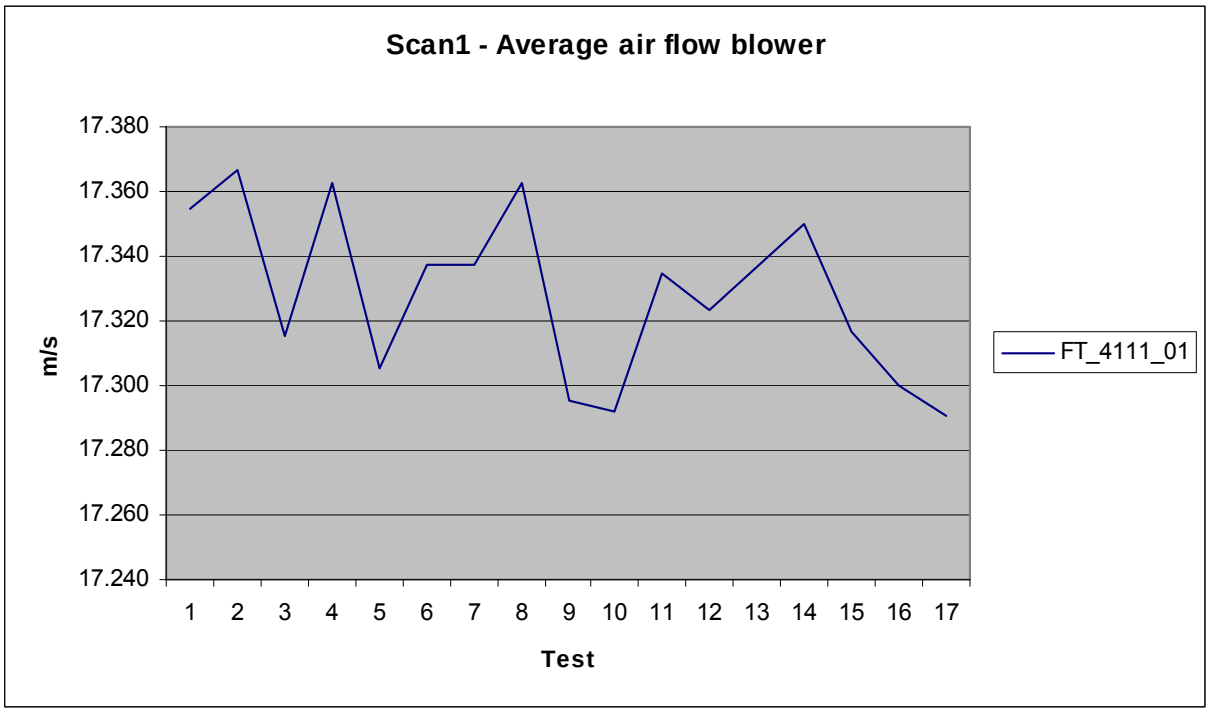


Figure 28 Scan1 – Average air flow blower

5.6.2. Scan2 measures

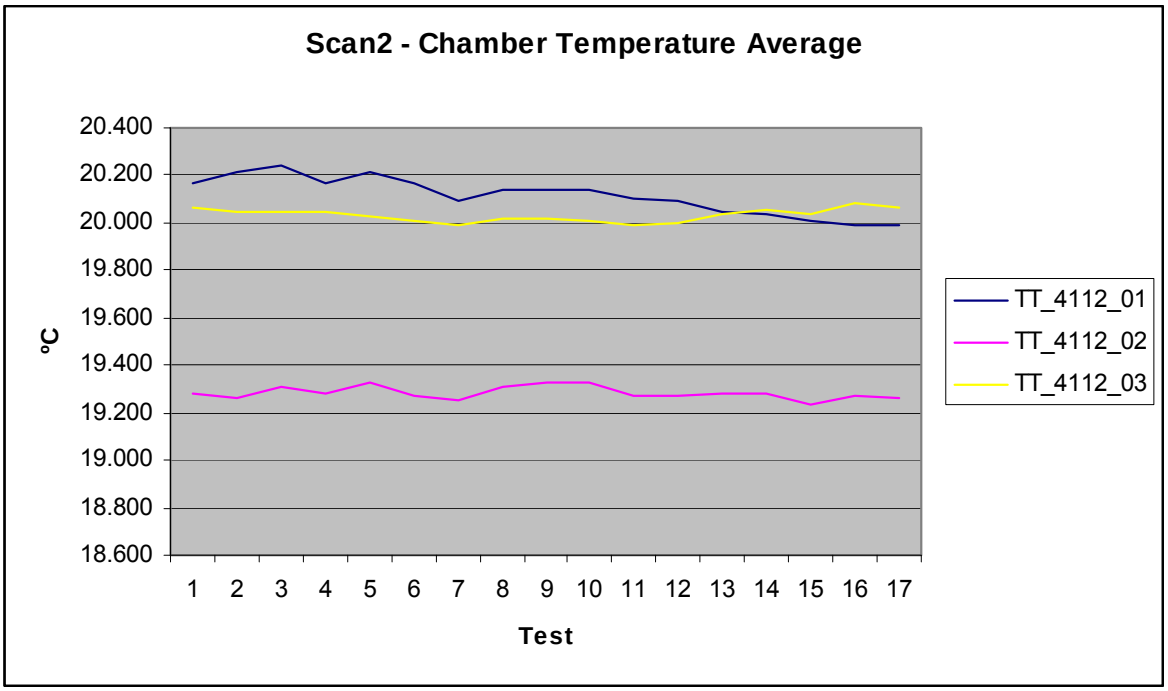


Figure 29 Scan2 – Chamber Temperature Average

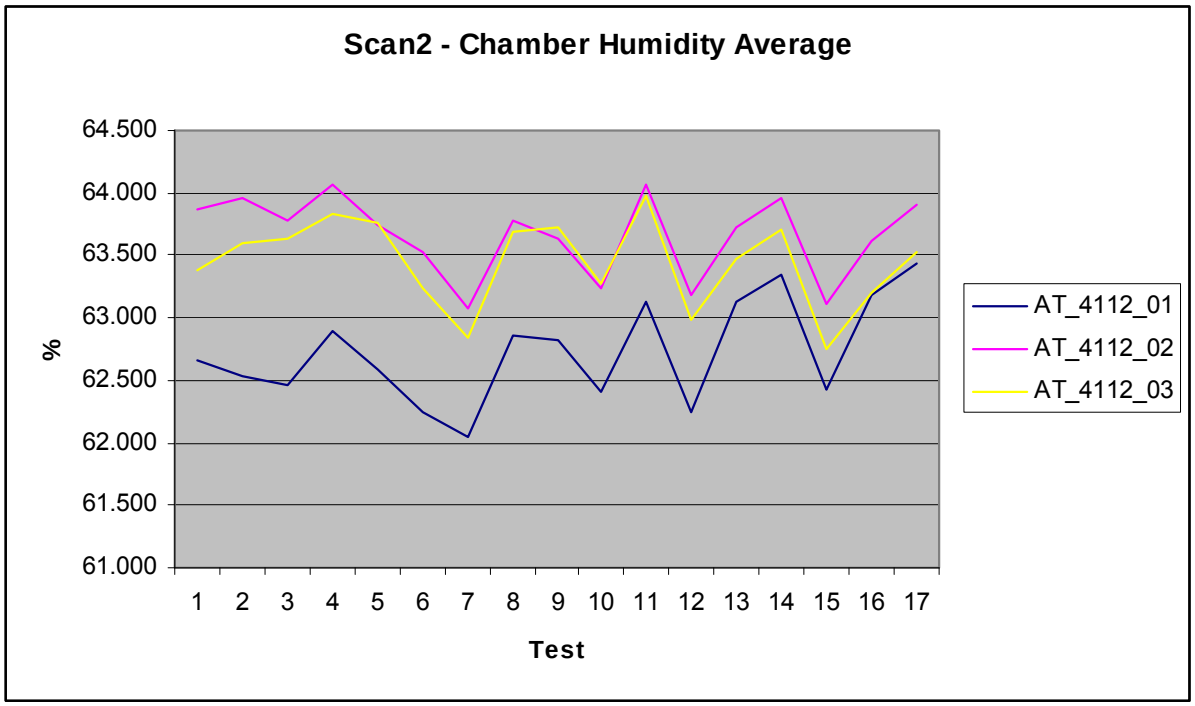


Figure 30 Scan2 – Chamber Humidity Average

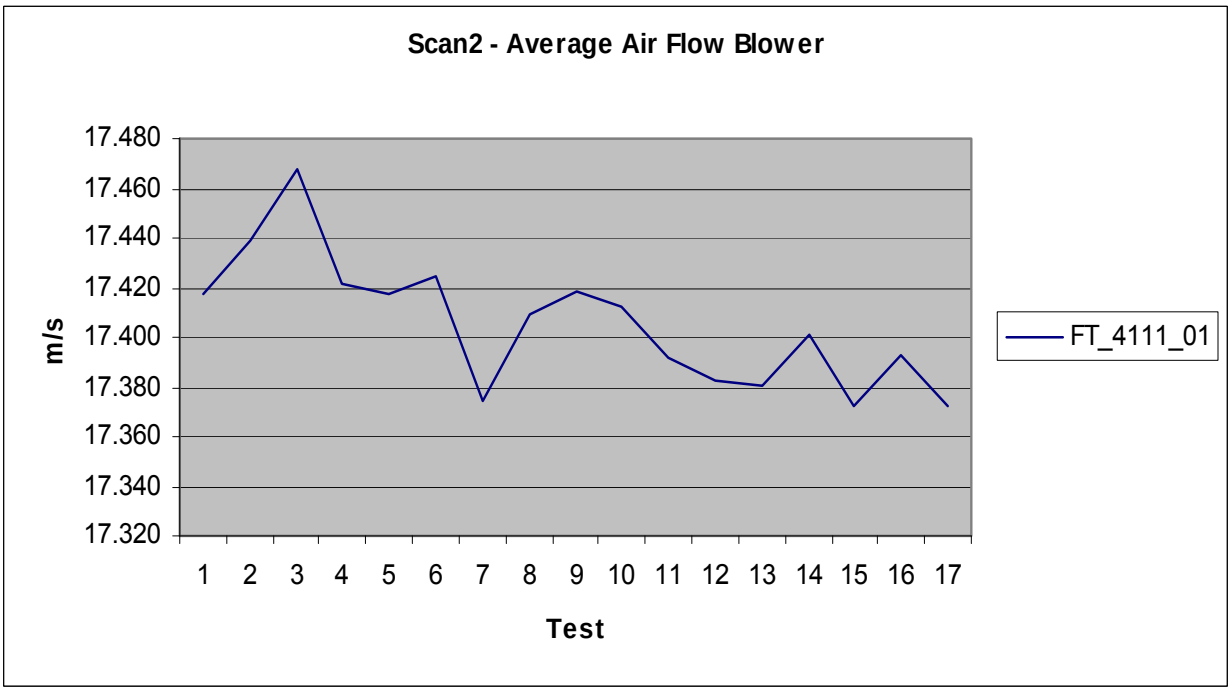


Figure 31 Scan2 – Average air flow blower

5.6.3. Scan 3 measures

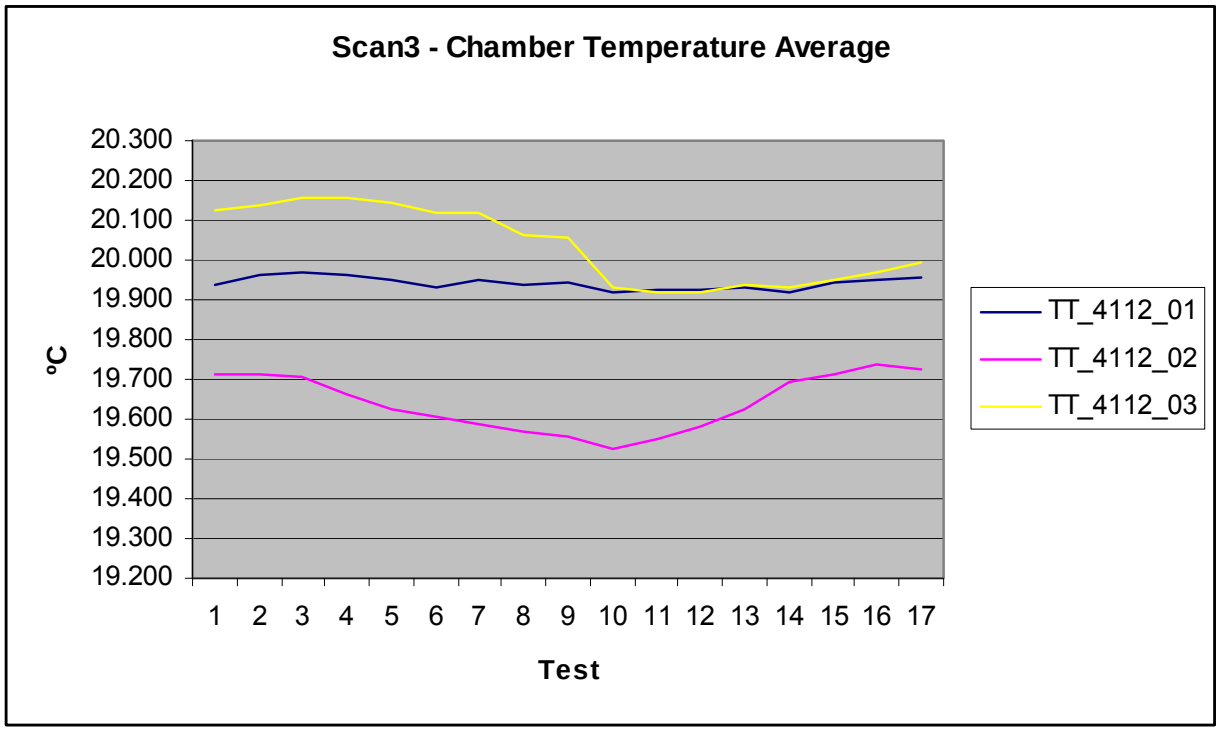


Figure 32 Scan3 – Chamber Temperature Average

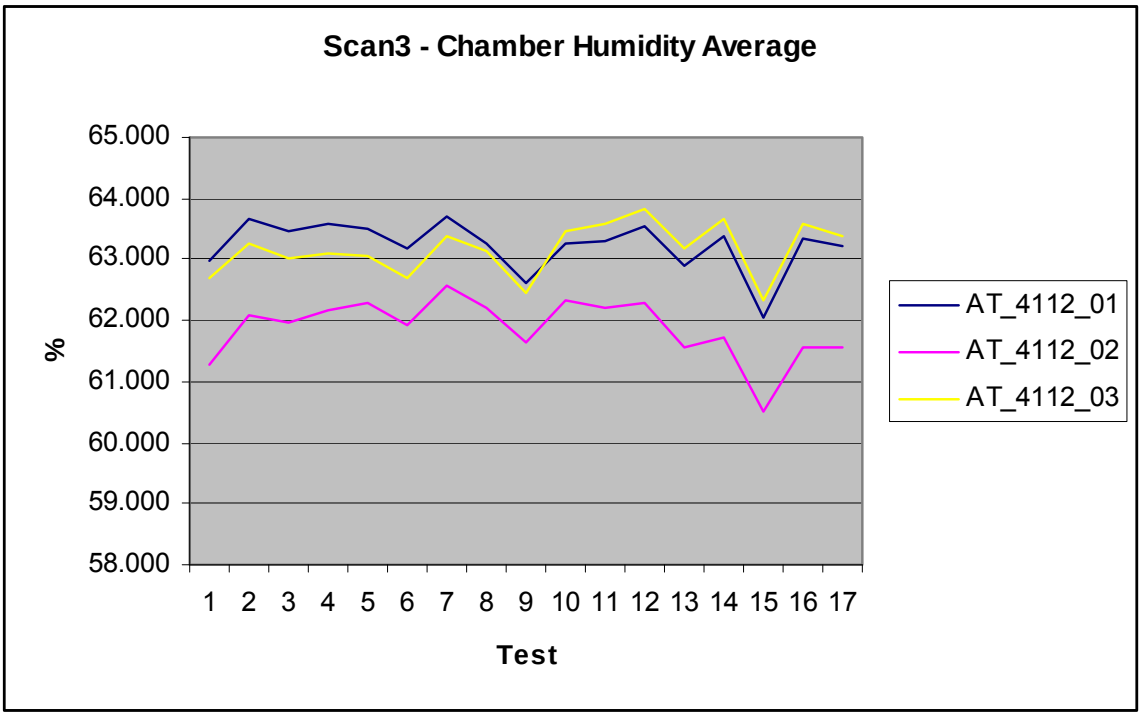


Figure 33 Scan3 – Chamber Humidity Average

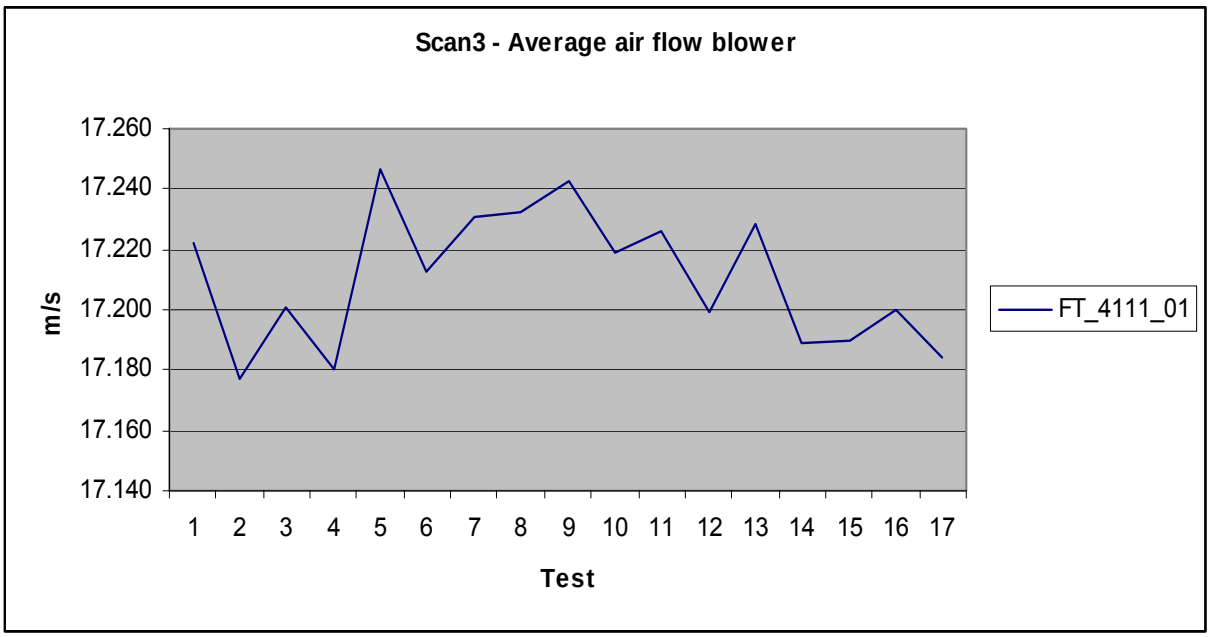


Figure 34 Scan2 – Average air flow blower

5.6.4. Scan 4 measures

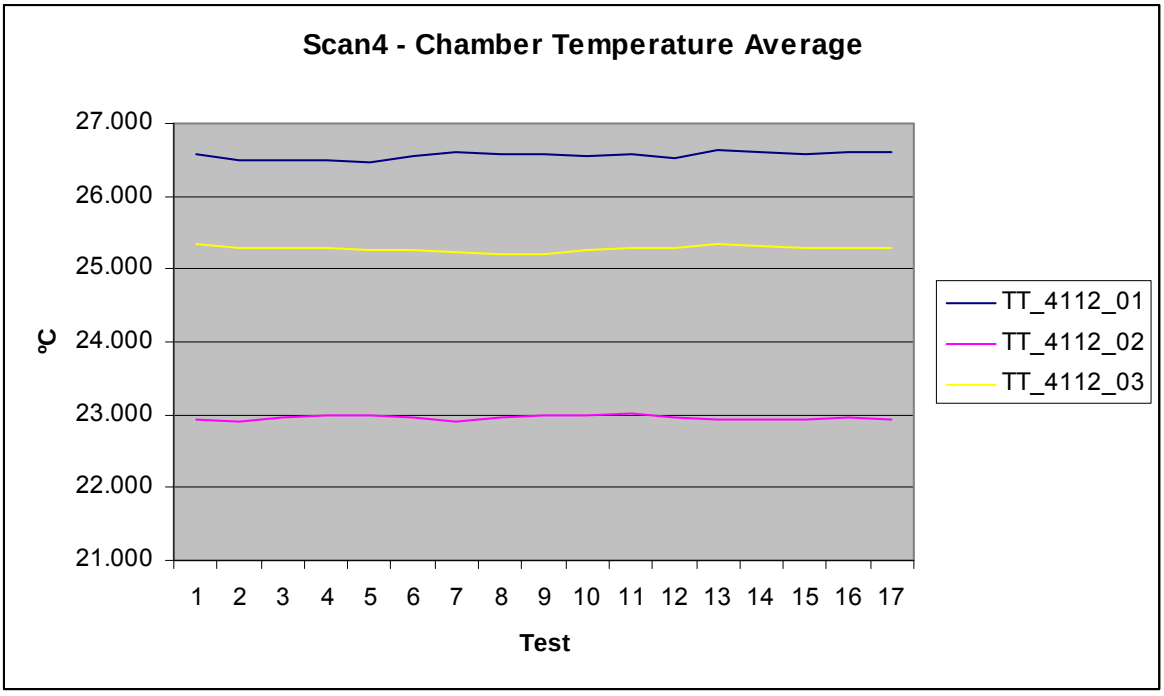


Figure 35 Scan4 – Chamber Temperature Average

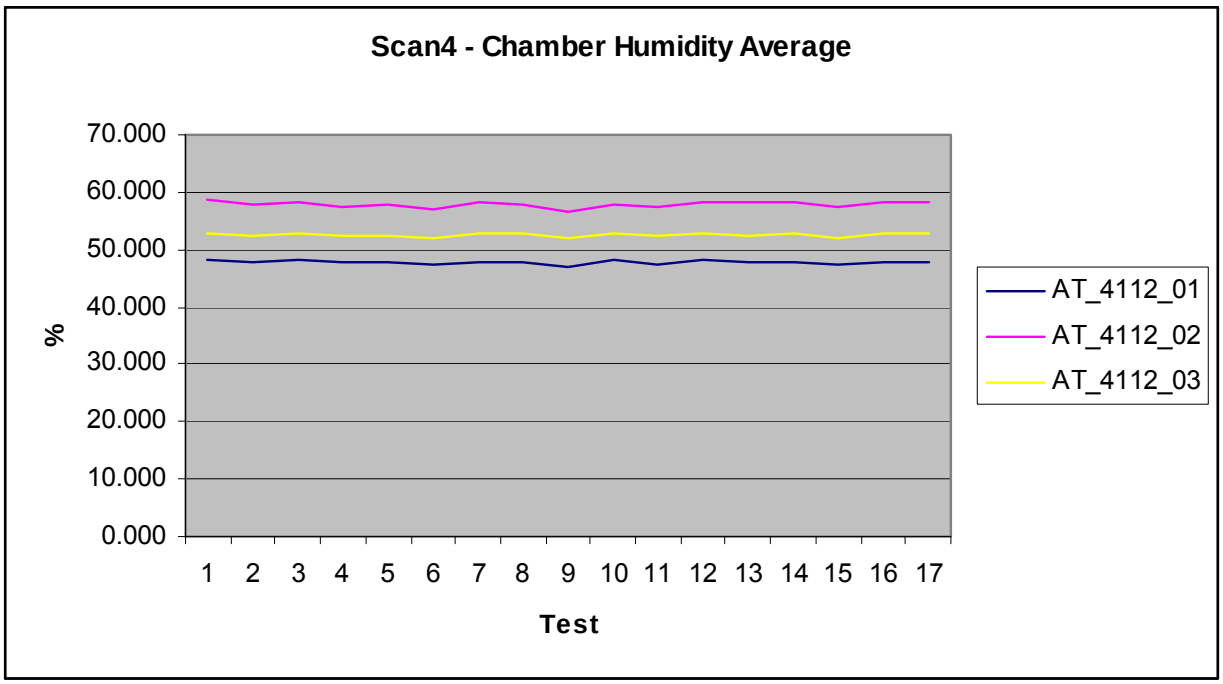


Figure 36 Scan3 – Chamber Humidity Average

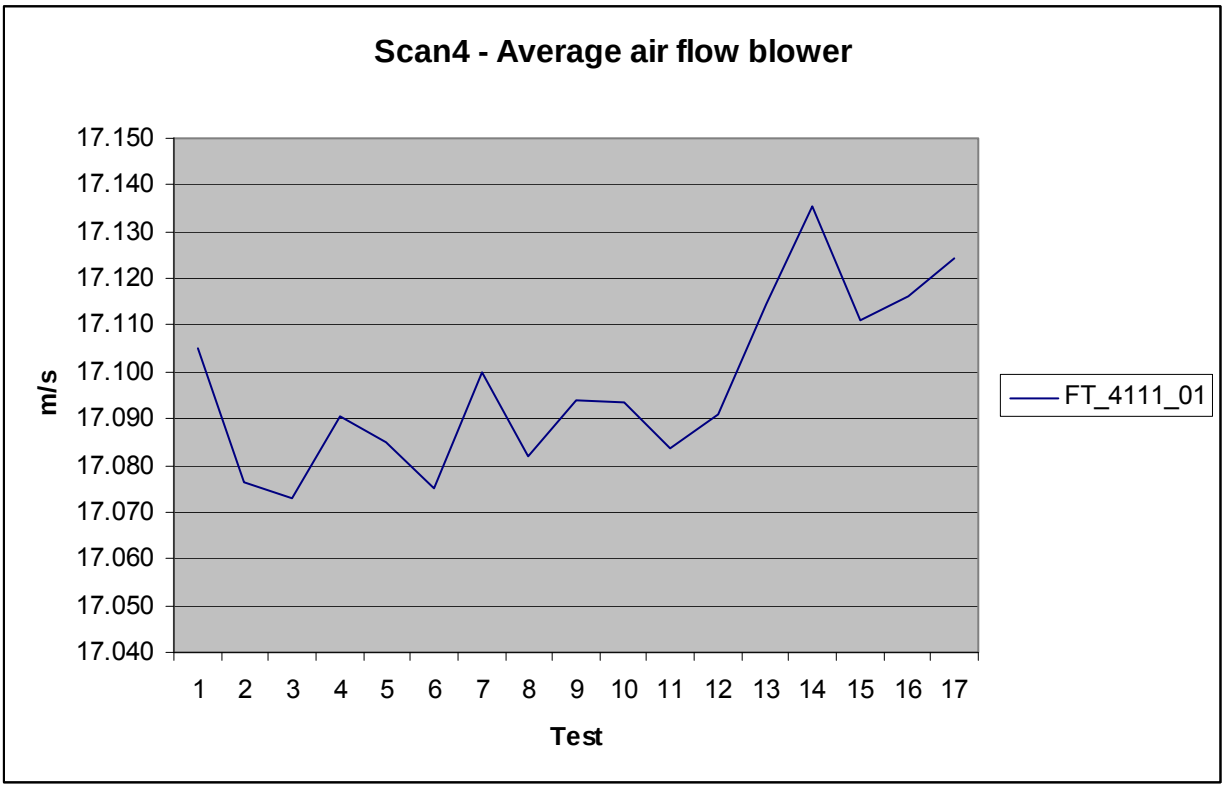


Figure 37 Scan4 – Average air flow blower

5.7. Result files

HPC Mapping data is delivered in 4 folders called Scan 1, Scan 2, Scan 3 and Scan 4 corresponding to the 4 scans described in the previous section. Each of these folders contains files called

Position1.xls

Position2.xls

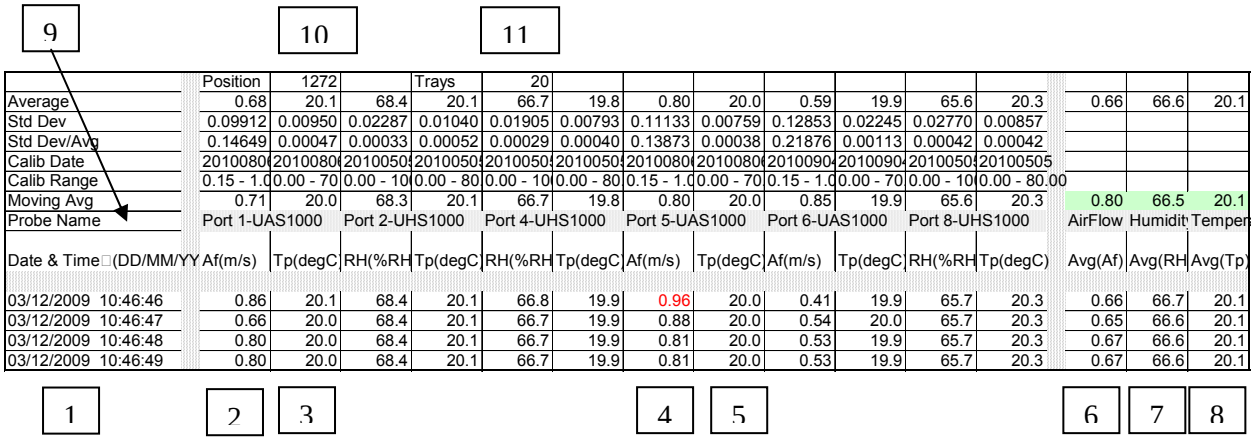
…

corresponding to the measurements taken at each position. The file number corresponds to the sensor's position for each acquisition, as acquisitions were chronologically taken so, for example, if *Scan 1* was performed from A to C, *Position1.xls* contains the measurements taken next to door A.

If, for any reason, an acquisition could not be fully completed, incomplete or incorrect data has been saved, but another acquisition at the same position has been launched. In these cases the incomplete or wrong file is called *PositionX.xls*, and the good one is called *PositionX_2.xls*.

In these cases the first file (*PositionX.xls*) may be ignored.

PositionX.xls files are formatted as shown in Figure 38: PositionsX.xls format.



	Position	1272		Trays	20										
Average	0.68	20.1	68.4	20.1	66.7	19.8	0.80	20.0	0.59	19.9	65.6	20.3	0.66	66.6	20.1
Std Dev	0.09912	0.00950	0.02287	0.01040	0.01905	0.00793	0.11133	0.00759	0.12853	0.02245	0.02770	0.00857			
Std Dev/Avg	0.14649	0.00047	0.00033	0.00052	0.00029	0.00040	0.13873	0.00038	0.21876	0.00113	0.00042	0.00042			
Calib Date	2010080	2010080	2010050	2010050	2010050	2010050	2010080	2010080	2010090	2010090	2010050	20100505			
Calib Range	0.15 - 1.0	0.00 - 70	0.00 - 10	0.00 - 80	0.00 - 10	0.00 - 80	0.15 - 1.0	0.00 - 70	0.15 - 1.0	0.00 - 70	0.00 - 10	0.00 - 80.00			
Moving Avg	0.71	20.0	68.3	20.1	66.7	19.8	0.80	20.0	0.85	19.9	65.6	20.3	0.80	66.5	20.1
Probe Name	Port 1-UAS1000		Port 2-UHS1000		Port 4-UHS1000		Port 5-UAS1000		Port 6-UAS1000		Port 8-UHS1000		AirFlow	Humidit	Temper
Date & Time (DD/MM/YY	Af(m/s)	Tp(degC	RH(%RH	Tp(degC	RH(%RH	Tp(degC	Af(m/s)	Tp(degC	Af(m/s)	Tp(degC	RH(%RH	Tp(degC)	Avg(Af)	Avg(RH	Avg(Tp)
03/12/2009 10:46:46	0.86	20.1	68.4	20.1	66.8	19.9	0.96	20.0	0.41	19.9	65.7	20.3	0.66	66.7	20.1
03/12/2009 10:46:47	0.66	20.0	68.4	20.1	66.7	19.9	0.88	20.0	0.54	20.0	65.7	20.3	0.65	66.6	20.1
03/12/2009 10:46:48	0.80	20.0	68.4	20.1	66.7	19.9	0.81	20.0	0.53	19.9	65.7	20.3	0.67	66.6	20.1
03/12/2009 10:46:49	0.80	20.0	68.4	20.1	66.7	19.9	0.81	20.0	0.53	19.9	65.7	20.3	0.67	66.6	20.1

Figure 38: PositionsX.xls format.

The most relevant information displayed in the file is described hereafter:

1. Measurement time column (date and time)
2. Relative humidity value column (measured by relative humidity sensor)
3. Temperature value column. (measured by relative humidity sensor)
4. Airflow column value (measured by airflow sensor)
5. Temperature column. (measured by airflow sensor)
6. Airflow mean value column. It displays the instantaneous mean value from the 3 airflow sensors
7. Humidity mean value column. It displays the instantaneous mean value from the 3 airflow sensors.

8. Temperature mean value column. It displays the instantaneous mean value from the 6 temperature measurements.
9. Probe name row. It specifies the probe providing the values. Probes are mounted in the sensor's structure in the following way:
    a. High height: port 2 and port 5.
    b. Middle height: port 4 and port 6.
    c. Low height: port 8 and port 1.
10. Sensor's position, as it is displayed by the IP-camera mounted on the tray during acquisitions. This value is manually added after reading the value on the IP camera image.
11. Number of trays inside the HPC during acquisition. This value is manually added after moving the trays.

For every acquisition, corresponding PLC data has also been recovered from the server database. The stored data can be found in:

\HPCmapping_HMIdata\Scan1\Test1_Position1.csv (file corresponding to acquisition in file Position1.xls, during Scan1)

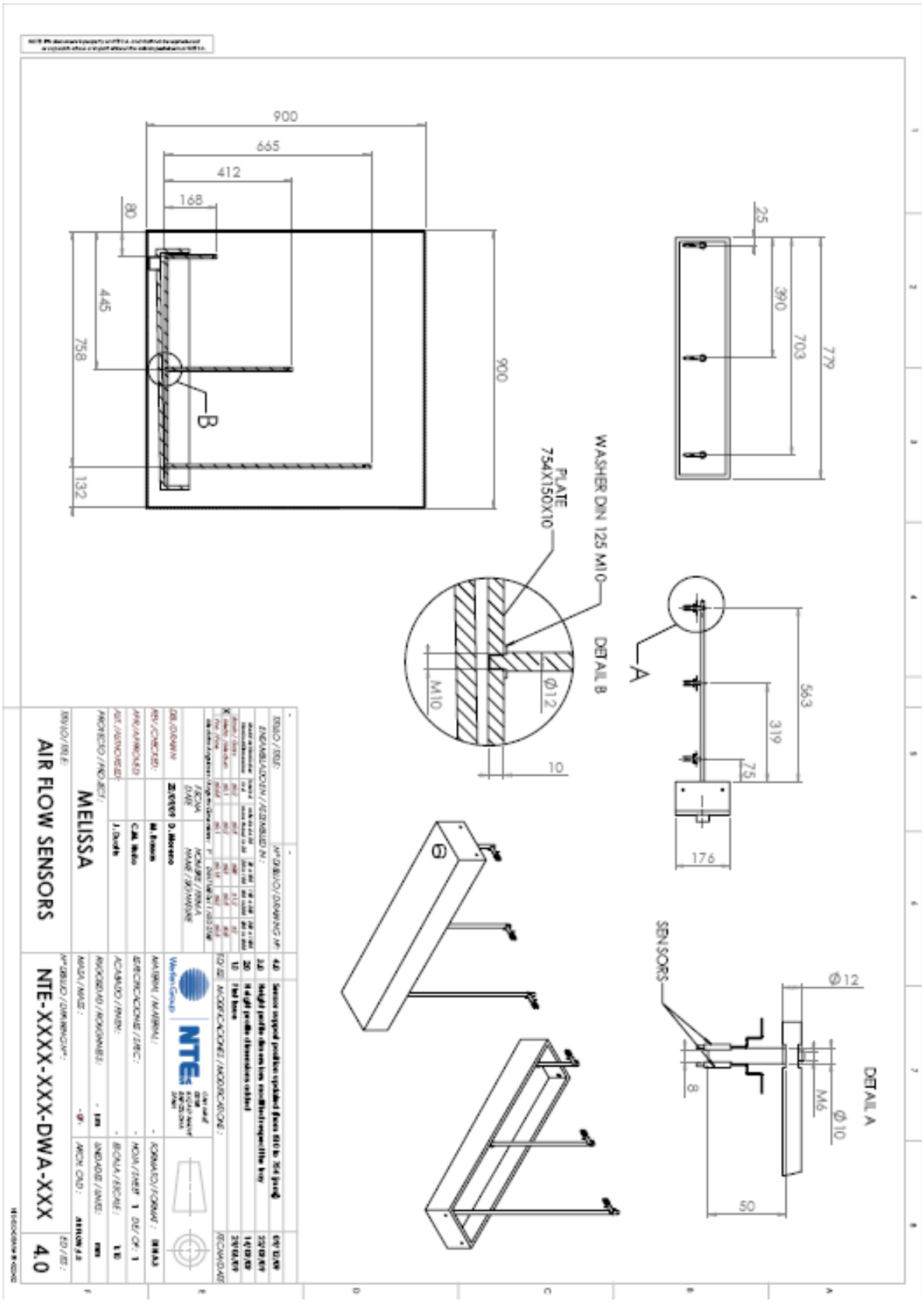
The format of these files is CSV (Coma Separated Values). The first column indicates measurement date and time, while the others display TAG's values. An example is shown in Figure 39: PLC values file format.

DATE AND TIME	ZS_4100_01	ZS_4101_01	PT_4102_01	PS_4102_01	PT_4103_01	...
12/02/2009 11:03:00	0	0	1001.781	0	1002.939	...
12/02/2009 11:03:02	0	0	1001.781	0	1002.939	...
12/02/2009 11:03:04	0	0	1001.781	0	1002.939	...
12/02/2009 11:03:06	0	0	1001.781	0	1002.939	...
12/02/2009 11:03:08	0	0	1001.781	0	1002.939	...
12/02/2009 11:03:10	0	0	1001.781	0	1002.939	...

Figure 39: PLC values file format.

The units of these values are these of the corresponding TAGs, as they are defined in RD2.

A ACCU-SENSOR SENSOR'S SUPPORT.



8.Appendix 2 – Light mapping report by UPC-CD6 (61 pages)

TECHNICAL REPORT Nº: S01448-502

SOLICITED BY: EUROPEAN SPACE AGENCY, MELISSA Pilot Plant (Arnaud Fossen)

STUDY TO PERFORM: Measurements of integrated irradiance (W/cm^2) in the visible region (380 – 780 nm), UVA region (315 – 390 nm), and UVB region (265 – 332 nm). Measurements of spectral radiance ($W/sr*m^2$) in the visible region (380 – 780 nm).

Measurements date: May 3rd, 2010.

Report realization date: May 6th, 2010.

1) MATERIAL AND MEASUREMENTS.

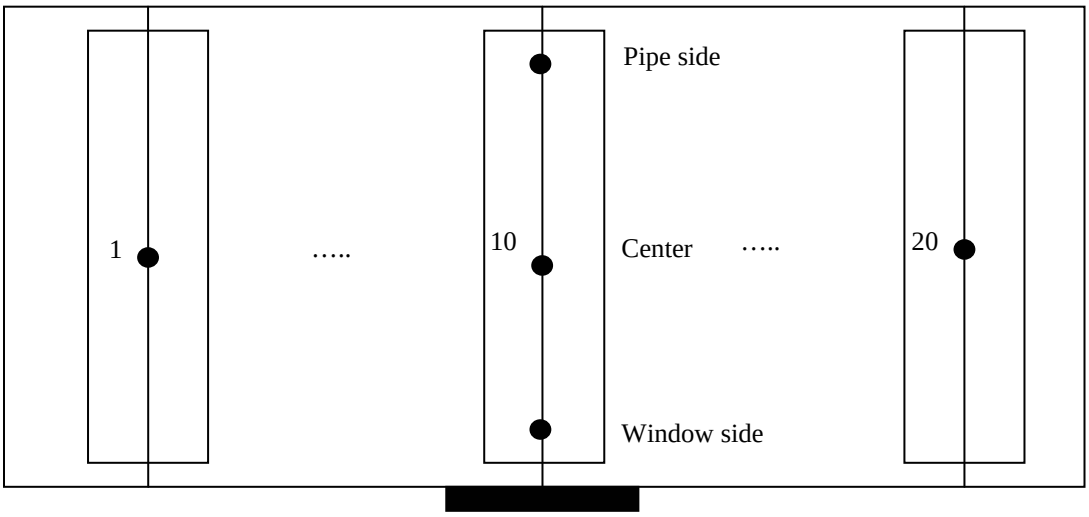
In this study the spectral and radiometric characterization of the HPC of MELISSA Pilot Plant is carried out. Specifically, measurements of integrated irradiance (W/cm^2) in the visible region (380 – 780 nm), UVA region (315 – 390 nm), and UVB region (265 – 332 nm) have been performed as well as measurements of spectral radiance ($W/sr*m^2$) in the visible region (380 – 780 nm).

The HPC includes two different kinds of light lamps:

- HPS lamps (High-pressure sodium)
- MHL lamps (Metal Halide)

In order to characterize the HPC, measurements of integrated irradiance (W/cm^2) have been carried out with the sensor placed at the center of each tray of the chamber (there are 20 trays), and at 0 cm height (at the level of the tray).

Measurements of spectral radiance ($W/sr*m^2$) in the visible region (380 – 780 nm) have been also performed placing the sensor at two sides of each tray, besides the central one (Window and pipe sides) (see figure bellow).



Measurements have been done under all light lamps of the chamber (6 HPS and 3 MHL) switched on at the same time. Measurements have been performed using a new and an old set of lamps.

Finally, measurements of integrated irradiance (W/cm^2) in the visible region (380 – 780 nm) at three light levels have been also carried out in order to calibrate the external and internal Melissa sensors.

2) INSTRUMENTATION.

The following instruments have been used in order to spectrally and radiometrically characterize the HPC (MELISSA Pilot Plant):

TE#1: PR-655

Equipment: Tele-spectrocolorimeter PhotoResearch SpectraColorimeter, model PR-655, serial nº 65082002, accessory FP-655 (fiber).

Measurement: Spectral radiance ($W/sr*m^2$) in the visible region (380 – 780 nm) using a 4 nm spectral step.

TE#2: IL-1700 UVB

Equipment: Radiometer International Light, model IL-1700, serial nº 2338, accessory UVB.

Measurement: Integrated irradiance (W/cm^2) in the UVB region (265 – 332 nm).

TE#3: IL-1700 UVA

Equipment: Radiometer International Light, model IL-1700, serial nº 2338, accessory UVA.

Measurement: Integrated irradiance (W/cm^2) in the UVA region (315 – 390 nm).

TE#4: IL-1700 VIS

Equipment: Radiometer International Light, model IL-1700, serial nº 2338, accessory VIS.

Measurement: Integrated irradiance (W/cm^2) in the visible region (380 – 780 nm).

3) RESULTS.

Tables 1 and 2 show the measured integrated irradiance (W/cm^2) in the visible region (380 – 780 nm), UVA region (315 – 390 nm), and UVB region (265 – 332 nm) measured at the central position of each tray. Results are given for the two sets of tested lamps (new and old).

NEW LAMPS			
TRAY	**TE#2 (UVB)**	**TE#3 (UVA)**	**TE#4 (VIS)**
1	6.00E-08	3.16E-07	8.84E-03
2	6.60E-07	3.66E-07	1.05E-02
3	7.50E-07	4.00E-07	1.13E-02
4	8.80E-07	4.22E-07	1.23E-02
5	9.00E-07	4.24E-07	1.27E-02
6	9.40E-07	4.04E-07	1.29E-02
7	8.30E-07	4.00E-07	1.27E-02
8	8.80E-07	4.17E-07	1.33E-02
9	9.80E-07	4.25E-07	1.36E-02
10	9.80E-07	4.14E-07	1.35E-02
11	9.70E-07	4.01E-07	1.31E-02
12	9.40E-07	4.08E-07	1.32E-02
13	9.00E-07	3.94E-07	1.22E-02
14	9.20E-07	4.06E-07	1.22E-02
15	9.00E-07	4.42E-07	1.27E-02
16	9.00E-07	4.48E-07	1.25E-02
17	8.00E-07	4.13E-07	1.10E-02
18	7.50E-07	3.78E-07	1.02E-02
19	7.00E-07	3.49E-07	9.14E-03
20	5.40E-07	3.03E-07	7.76E-03

Table 1. Integrated irradiance (W/cm^2) in the UVB, UVA and VIS region for the set of new lamps.

OLD LAMPS			
TRAY	**TE#2 (UVB)**	**TE#3 (UVA)**	**TE#4 (VIS)**
1	7.20E-07	-	-
2	8.30E-07	3.28E-07	1.05E-02
3	8.30E-07	-	-
4	9.70E-07	4.42E-07	1.25E-02
5	9.40E-07	-	-
6	9.40E-07	4.33E-07	1.23E-02
7	1.01E-06	-	-
8	9.80E-07	4.62E-07	1.45E-02
9	9.80E-07	-	-
10	9.00E-07	4.49E-07	1.29E-02
11	9.40E-07	-	-
12	9.80E-07	4.44E-07	1.30E-02
13	9.20E-07	-	-
14	9.00E-07	4.31E-02	1.20E-02
15	9.00E-07	-	-
16	9.20E-07	4.33E-07	1.26E-02
17	9.00E-07	-	-
18	9.20E-07	3.77E-07	1.03E-02
19	7.50E-07	-	-
20	5.70E-07	2.93E-07	7.41E-03

Table 2. Integrated irradiance (W/cm^2) in the UVB, UVA and VIS region for the set of old lamps.

Tables 3 - 8 and figures 1 – 6 show the spectral radiance ($W/sr*m^2$) in the visible region (380 – 780 nm) measured at the central position of each tray as well as at the window and pipe sides. Results are given for the two sets of tested lamps (new and old).

NEW LAMPS Central							
λ (nm)	TRAY						
	1	2	3	4	5	6	7
380	0.00E+00	0.00E+00	0.00E+00	1.62E-41	0.00E+00	1.62E-41	0.00E+00
384	0.00E+00	0.00E+00	0.00E+00	1.20E-41	0.00E+00	1.20E-41	0.00E+00
388	0.00E+00	5.95E-04	0.00E+00	1.13E-41	0.00E+00	1.13E-41	0.00E+00
392	0.00E+00	1.61E-02	0.00E+00	9.15E-42	0.00E+00	9.15E-42	0.00E+00
396	0.00E+00	1.98E-03	1.45E-03	8.57E-03	5.28E-07	7.18E-42	0.00E+00
400	1.25E-04	1.30E-04	7.57E-03	2.34E-02	7.07E-04	6.07E-42	0.00E+00
404	8.25E-04	2.95E-03	2.76E-02	7.28E-02	4.34E-03	1.96E-03	2.99E-04
408	3.32E-03	1.38E-02	8.55E-02	2.21E-01	8.92E-03	1.59E-02	1.90E-03
412	8.78E-03	2.33E-02	1.36E-01	3.61E-01	1.49E-02	3.20E-02	3.33E-03
416	1.09E-02	3.39E-02	8.76E-02	2.42E-01	1.44E-02	3.76E-02	3.06E-03
420	1.39E-02	3.29E-02	4.35E-02	1.25E-01	1.27E-02	4.58E-02	2.71E-03
424	1.76E-02	3.85E-02	4.20E-02	1.23E-01	1.52E-02	5.43E-02	3.13E-03
428	1.96E-02	3.33E-02	4.90E-02	1.43E-01	1.78E-02	6.67E-02	3.77E-03
432	2.32E-02	5.72E-02	7.63E-02	1.90E-01	2.16E-02	8.42E-02	5.02E-03
436	2.86E-02	7.07E-02	1.28E-01	2.78E-01	2.95E-02	1.09E-01	6.97E-03
440	2.96E-02	7.22E-02	1.15E-01	2.79E-01	3.13E-02	1.15E-01	6.99E-03
444	2.71E-02	6.03E-02	9.38E-02	2.60E-01	2.83E-02	1.02E-01	5.52E-03
448	4.39E-02	9.44E-02	1.86E-01	4.73E-01	4.29E-02	1.60E-01	9.84E-03
452	5.35E-02	1.48E-01	4.90E-01	1.26E+00	7.70E-02	2.24E-01	1.88E-02
456	3.42E-02	9.18E-02	3.63E-01	9.66E-01	5.25E-02	1.42E-01	1.36E-02
460	2.59E-02	5.64E-02	1.03E-01	2.84E-01	2.51E-02	9.38E-02	6.28E-03
464	5.15E-02	1.10E-01	5.37E-02	1.47E-01	4.05E-02	2.26E-01	9.43E-03
468	8.09E-02	1.66E-01	5.49E-02	1.41E-01	6.34E-02	3.68E-01	1.44E-02
472	5.38E-02	1.08E-01	4.68E-02	1.27E-01	4.12E-02	2.34E-01	9.13E-03
476	2.72E-02	6.03E-02	3.44E-02	1.01E-01	2.23E-02	1.22E-01	4.91E-03
480	1.25E-02	3.06E-02	3.01E-02	8.36E-02	1.13E-02	6.04E-02	2.65E-03
484	9.30E-03	2.61E-02	2.93E-02	8.47E-02	9.09E-03	4.08E-02	1.70E-03
488	1.29E-02	2.71E-02	3.13E-02	8.66E-02	1.21E-02	6.23E-02	2.20E-03
492	3.18E-02	5.57E-02	3.74E-02	9.69E-02	2.56E-02	1.54E-01	5.27E-03
496	1.42E-01	2.36E-01	6.89E-02	1.54E-01	1.02E-01	7.10E-01	2.35E-02
500	2.04E-01	3.31E-01	8.28E-02	1.80E-01	1.51E-01	1.05E+00	3.45E-02
504	6.81E-02	1.00E-01	4.61E-02	1.16E-01	5.18E-02	3.33E-01	1.15E-02
508	2.02E-02	4.43E-02	3.47E-02	9.88E-02	1.66E-02	9.09E-02	3.39E-03
512	3.21E-02	6.58E-02	4.16E-02	1.09E-01	2.40E-02	1.60E-01	5.54E-03
516	5.23E-02	9.50E-02	5.20E-02	1.32E-01	3.92E-02	2.70E-01	9.02E-03
520	3.20E-02	6.44E-02	5.71E-02	1.52E-01	2.66E-02	1.58E-01	5.90E-03
524	1.68E-02	4.19E-02	4.98E-02	1.35E-01	1.49E-02	7.38E-02	3.69E-03
528	1.65E-02	4.87E-02	6.51E-02	1.56E-01	1.56E-02	7.70E-02	3.51E-03
532	2.19E-02	7.18E-02	3.23E-01	7.14E-01	3.69E-02	1.08E-01	1.02E-02
536	3.17E-02	1.16E-01	8.05E-01	1.84E+00	8.17E-02	1.62E-01	2.37E-02
540	3.15E-02	1.11E-01	6.64E-01	1.53E+00	7.25E-02	1.66E-01	2.08E-02
544	3.25E-02	9.99E-02	2.62E-01	5.05E-01	4.07E-02	1.80E-01	1.09E-02
548	6.55E-02	1.91E-01	1.67E-01	2.24E-01	5.49E-02	3.53E-01	1.27E-02

552	1.33E-01	3.92E-01	9.04E-02	1.46E-01	9.33E-02	7.21E-01	2.01E-02
556	2.53E-01	7.54E-01	7.78E-02	1.40E-01	1.72E-01	1.39E+00	3.78E-02
560	4.11E-01	1.23E+00	9.79E-02	1.65E-01	2.82E-01	2.31E+00	6.33E-02
564	5.75E-01	1.52E+00	1.35E-01	2.21E-01	3.93E-01	3.32E+00	8.96E-02
568	9.15E-01	1.95E+00	2.46E-01	4.18E-01	6.29E-01	5.70E+00	1.50E-01
572	8.80E-01	1.98E+00	2.35E-01	3.79E-01	6.07E-01	5.44E+00	1.43E-01
576	7.23E-01	2.02E+00	1.97E-01	2.63E-01	4.97E-01	4.27E+00	1.13E-01
580	8.34E-01	2.49E+00	2.19E-01	2.86E-01	5.71E-01	4.94E+00	1.31E-01
584	8.94E-01	2.68E+00	2.69E-01	4.65E-01	6.21E-01	5.44E+00	1.52E-01
588	5.23E-01	1.54E+00	6.13E-01	1.46E+00	4.06E-01	3.21E+00	1.12E-01
592	4.85E-01	1.45E+00	8.75E-01	2.28E+00	3.91E-01	2.94E+00	1.11E-01
596	8.68E-01	2.62E+00	7.10E-01	1.87E+00	6.32E-01	5.35E+00	1.65E-01
600	9.82E-01	2.94E+00	4.72E-01	1.20E+00	6.92E-01	6.04E+00	1.67E-01
604	8.30E-01	2.49E+00	3.24E-01	7.91E-01	5.78E-01	5.10E+00	1.34E-01
608	6.61E-01	1.99E+00	2.44E-01	5.74E-01	4.62E-01	4.09E+00	1.05E-01
612	5.81E-01	1.68E+00	2.08E-01	4.74E-01	4.04E-01	3.66E+00	9.25E-02
616	5.61E-01	1.48E+00	1.86E-01	4.09E-01	3.83E-01	3.66E+00	8.98E-02
620	4.56E-01	1.23E+00	1.49E-01	3.29E-01	3.09E-01	2.96E+00	7.18E-02
624	3.39E-01	9.93E-01	1.15E-01	2.63E-01	2.28E-01	2.14E+00	5.27E-02
628	2.91E-01	8.67E-01	9.97E-02	2.35E-01	1.94E-01	1.84E+00	4.53E-02
632	2.61E-01	7.75E-01	8.94E-02	2.07E-01	1.73E-01	1.66E+00	4.03E-02
636	2.36E-01	6.85E-01	8.09E-02	1.88E-01	1.57E-01	1.50E+00	3.62E-02
640	2.13E-01	6.28E-01	7.80E-02	1.73E-01	1.41E-01	1.36E+00	3.29E-02
644	1.91E-01	5.75E-01	7.15E-02	1.60E-01	1.30E-01	1.23E+00	3.02E-02
648	1.74E-01	5.19E-01	6.43E-02	1.46E-01	1.19E-01	1.14E+00	2.72E-02
652	1.60E-01	4.85E-01	6.82E-02	1.42E-01	1.09E-01	1.06E+00	2.50E-02
656	1.49E-01	4.49E-01	7.36E-02	1.45E-01	1.02E-01	9.91E-01	2.39E-02
660	1.37E-01	4.16E-01	6.08E-02	1.30E-01	9.53E-02	9.19E-01	2.18E-02
664	1.27E-01	3.84E-01	5.68E-02	1.37E-01	8.90E-02	8.61E-01	1.97E-02
668	1.25E-01	3.78E-01	1.05E-01	2.62E-01	8.72E-02	8.43E-01	2.00E-02
672	1.19E-01	3.75E-01	1.45E-01	3.68E-01	8.86E-02	8.25E-01	2.08E-02
676	1.12E-01	3.42E-01	8.60E-02	2.04E-01	7.72E-02	7.82E-01	1.77E-02
680	9.91E-02	2.96E-01	4.71E-02	1.05E-01	6.71E-02	6.70E-01	1.49E-02
684	8.60E-02	2.59E-01	3.92E-02	8.73E-02	5.85E-02	5.89E-01	1.32E-02
688	8.22E-02	2.31E-01	3.44E-02	7.48E-02	5.02E-02	5.24E-01	1.05E-02
692	6.91E-02	2.11E-01	2.91E-02	6.67E-02	4.63E-02	4.85E-01	1.04E-02
696	6.58E-02	2.00E-01	2.68E-02	6.37E-02	4.21E-02	4.54E-01	1.04E-02
700	6.12E-02	1.85E-01	2.52E-02	5.85E-02	3.99E-02	4.29E-01	9.32E-03
704	5.54E-02	1.70E-01	2.42E-02	5.36E-02	3.69E-02	3.97E-01	8.65E-03
708	5.16E-02	1.68E-01	2.15E-02	4.80E-02	3.42E-02	3.79E-01	8.47E-03
712	4.65E-02	1.58E-01	2.04E-02	5.89E-02	3.24E-02	3.46E-01	1.00E-02
716	4.38E-02	1.46E-01	1.90E-02	3.47E-02	3.09E-02	3.26E-01	7.25E-03
720	4.44E-02	1.40E-01	1.70E-02	3.82E-02	2.79E-02	3.28E-01	6.52E-03
724	3.92E-02	1.28E-01	1.75E-02	4.69E-02	2.51E-02	2.87E-01	6.02E-03
728	3.26E-02	9.43E-02	1.59E-02	3.65E-02	2.77E-02	2.72E-01	5.52E-03
732	2.76E-02	1.06E-01	1.58E-02	1.95E-02	2.61E-02	2.52E-01	6.26E-03
736	2.83E-02	9.77E-02	1.45E-02	3.31E-02	1.99E-02	2.36E-01	5.09E-03
740	2.62E-02	8.26E-02	1.05E-02	1.34E-02	1.88E-02	2.23E-01	3.80E-03

744	1.57E-02	8.04E-02	9.56E-03	1.26E-02	1.78E-02	1.95E-01	3.49E-03
748	2.44E-02	7.16E-02	9.09E-03	1.49E-02	1.96E-02	1.76E-01	3.82E-03
752	2.31E-02	5.71E-02	4.97E-03	1.42E-02	8.61E-03	2.14E-01	3.17E-03
756	1.74E-02	5.00E-02	4.60E-03	1.57E-02	1.23E-02	1.36E-01	2.80E-03
760	2.35E-02	6.08E-02	5.10E-03	5.38E-03	1.40E-02	1.48E-01	2.49E-03
764	2.09E-02	1.03E-01	1.53E-02	2.56E-02	1.57E-02	2.21E-01	2.23E-03
768	2.89E-02	1.48E-01	3.40E-02	6.80E-02	2.14E-02	3.34E-01	5.03E-03
772	2.47E-02	1.20E-01	1.78E-02	4.10E-02	2.49E-03	2.53E-01	3.45E-03
776	1.89E-02	3.84E-02	3.70E-03	1.00E-02	0.00E+00	1.57E-01	8.35E-04
780	4.04E-03	2.43E-02	0.00E+00	7.00E-03	2.57E-03	9.98E-02	0.00E+00

Table 3. Spectral radiance ($W/sr*m^2$) at the central position in the VIS region for the set of new lamps.

NEW LAMPS Central							
λ (nm)	TRAY						
	8	9	10	11	12	13	14
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.61E-03
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-03
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.34E-05
396	0.00E+00	7.85E-07	0.00E+00	0.00E+00	3.15E-04	8.47E-06	9.15E-06
400	2.05E-04	1.62E-03	4.17E-04	1.93E-03	1.81E-03	4.13E-03	8.12E-05
404	1.62E-03	1.36E-02	4.85E-03	2.36E-02	5.12E-03	2.15E-02	1.03E-03
408	3.00E-03	3.13E-02	1.80E-02	1.16E-01	1.41E-02	4.78E-02	2.92E-03
412	5.06E-03	4.90E-02	3.15E-02	2.31E-01	2.38E-02	6.11E-02	4.69E-03
416	6.05E-03	6.18E-02	2.23E-02	1.61E-01	1.77E-02	7.86E-02	5.14E-03
420	7.00E-03	6.78E-02	1.12E-02	7.28E-02	1.08E-02	9.70E-02	4.61E-03
424	8.05E-03	7.66E-02	1.11E-02	7.23E-02	1.18E-02	1.15E-01	5.59E-03
428	9.91E-03	9.04E-02	1.37E-02	8.96E-02	1.38E-02	1.36E-01	6.58E-03
432	1.20E-02	1.12E-01	2.10E-02	1.29E-01	1.96E-02	1.56E-01	8.39E-03
436	1.54E-02	1.32E-01	3.47E-02	2.07E-01	3.04E-02	1.86E-01	1.15E-02
440	1.60E-02	1.32E-01	3.18E-02	2.05E-01	2.83E-02	1.93E-01	1.14E-02
444	1.39E-02	1.15E-01	2.59E-02	1.96E-01	2.39E-02	1.72E-01	9.72E-03
448	2.12E-02	1.68E-01	5.46E-02	4.24E-01	4.62E-02	2.45E-01	1.56E-02
452	3.15E-02	2.37E-01	1.51E-01	1.31E+00	1.17E-01	3.08E-01	2.75E-02
456	2.10E-02	1.45E-01	1.20E-01	1.08E+00	9.11E-02	1.89E-01	1.95E-02
460	1.23E-02	9.04E-02	3.59E-02	3.03E-01	2.98E-02	1.34E-01	9.19E-03
464	2.44E-02	2.05E-01	2.20E-02	1.30E-01	2.66E-02	3.12E-01	1.57E-02
468	3.84E-02	3.27E-01	2.67E-02	1.22E-01	3.60E-02	5.05E-01	2.45E-02
472	2.45E-02	2.00E-01	1.97E-02	1.02E-01	2.43E-02	3.12E-01	1.55E-02
476	1.24E-02	9.76E-02	1.29E-02	8.05E-02	1.45E-02	1.57E-01	8.12E-03
480	5.48E-03	3.76E-02	8.45E-03	6.50E-02	8.74E-03	6.81E-02	3.67E-03
484	3.00E-03	1.75E-02	7.75E-03	7.09E-02	6.71E-03	3.66E-02	2.70E-03
488	4.62E-03	3.52E-02	9.65E-03	7.64E-02	7.96E-03	4.96E-02	3.74E-03
492	1.31E-02	9.10E-02	1.41E-02	9.19E-02	1.50E-02	1.42E-01	8.72E-03
496	6.44E-02	4.85E-01	3.90E-02	1.49E-01	5.55E-02	7.73E-01	4.03E-02
500	9.65E-02	7.21E-01	5.49E-02	1.81E-01	8.07E-02	1.14E+00	6.02E-02
504	3.16E-02	2.09E-01	2.22E-02	1.08E-01	3.00E-02	3.38E-01	1.99E-02
508	7.66E-03	5.08E-02	1.09E-02	9.46E-02	1.09E-02	7.61E-02	5.32E-03
512	1.26E-02	9.42E-02	1.46E-02	1.12E-01	1.53E-02	1.41E-01	8.64E-03
516	2.17E-02	1.59E-01	2.07E-02	1.46E-01	2.37E-02	2.45E-01	1.45E-02
520	1.26E-02	9.03E-02	1.90E-02	1.73E-01	1.85E-02	1.34E-01	9.08E-03
524	4.86E-03	3.80E-02	1.47E-02	1.61E-01	1.25E-02	5.09E-02	4.31E-03
528	4.74E-03	3.98E-02	1.72E-02	1.84E-01	1.39E-02	5.03E-02	4.41E-03
532	1.02E-02	6.88E-02	8.38E-02	1.01E+00	6.23E-02	6.58E-02	1.25E-02
536	2.11E-02	1.22E-01	2.19E-01	2.73E+00	1.62E-01	9.85E-02	2.90E-02
540	1.94E-02	1.17E-01	1.90E-01	2.33E+00	1.40E-01	9.55E-02	2.56E-02
544	1.36E-02	9.65E-02	7.42E-02	8.43E-01	5.64E-02	1.14E-01	1.40E-02
548	2.10E-02	1.76E-01	4.66E-02	4.60E-01	4.09E-02	2.35E-01	1.69E-02

552	4.02E-02	3.84E-01	3.37E-02	2.16E-01	3.94E-02	5.25E-01	2.81E-02
556	8.58E-02	8.84E-01	4.55E-02	1.51E-01	6.55E-02	1.19E+00	5.70E-02
560	1.52E-01	1.60E+00	7.24E-02	1.69E-01	1.11E-01	2.12E+00	1.00E-01
564	2.23E-01	2.13E+00	1.06E-01	2.39E-01	1.64E-01	2.91E+00	1.45E-01
568	3.87E-01	3.17E+00	1.92E-01	4.95E-01	2.92E-01	4.60E+00	2.52E-01
572	3.63E-01	3.03E+00	1.80E-01	4.65E-01	2.74E-01	4.34E+00	2.37E-01
576	2.67E-01	2.58E+00	1.33E-01	3.72E-01	2.00E-01	3.50E+00	1.76E-01
580	3.07E-01	3.18E+00	1.52E-01	4.08E-01	2.28E-01	4.24E+00	2.03E-01
584	3.90E-01	4.17E+00	1.97E-01	5.69E-01	2.92E-01	5.49E+00	2.52E-01
588	3.15E-01	3.42E+00	2.55E-01	1.94E+00	3.01E-01	4.35E+00	1.99E-01
592	3.00E-01	3.26E+00	3.19E-01	3.12E+00	3.40E-01	4.08E+00	1.94E-01
596	4.24E-01	4.55E+00	3.28E-01	2.49E+00	3.93E-01	5.85E+00	2.77E-01
600	4.08E-01	4.26E+00	2.57E-01	1.52E+00	3.39E-01	5.59E+00	2.71E-01
604	3.13E-01	3.22E+00	1.84E-01	9.66E-01	2.52E-01	4.26E+00	2.12E-01
608	2.38E-01	2.45E+00	1.38E-01	6.94E-01	1.91E-01	3.24E+00	1.64E-01
612	2.06E-01	2.05E+00	1.19E-01	5.79E-01	1.65E-01	2.74E+00	1.43E-01
616	2.04E-01	1.87E+00	1.13E-01	5.03E-01	1.60E-01	2.55E+00	1.41E-01
620	1.64E-01	1.51E+00	8.97E-02	4.03E-01	1.28E-01	2.05E+00	1.12E-01
624	1.16E-01	1.14E+00	6.48E-02	3.27E-01	9.12E-02	1.52E+00	7.96E-02
628	9.79E-02	9.78E-01	5.56E-02	2.79E-01	7.71E-02	1.29E+00	6.76E-02
632	8.68E-02	8.64E-01	4.93E-02	2.52E-01	6.83E-02	1.13E+00	6.06E-02
636	7.82E-02	7.74E-01	4.44E-02	2.30E-01	6.12E-02	1.01E+00	5.44E-02
640	6.98E-02	6.91E-01	4.04E-02	2.12E-01	5.53E-02	9.01E-01	4.90E-02
644	6.19E-02	6.25E-01	3.68E-02	1.94E-01	5.00E-02	8.11E-01	4.35E-02
648	5.68E-02	5.66E-01	3.44E-02	1.86E-01	4.59E-02	7.38E-01	4.01E-02
652	5.19E-02	5.12E-01	3.31E-02	2.15E-01	4.48E-02	6.73E-01	3.75E-02
656	4.85E-02	4.76E-01	3.27E-02	2.42E-01	4.27E-02	6.23E-01	3.50E-02
660	4.45E-02	4.33E-01	2.91E-02	1.98E-01	3.73E-02	5.68E-01	3.19E-02
664	4.11E-02	3.96E-01	2.68E-02	1.90E-01	3.46E-02	5.17E-01	2.95E-02
668	4.08E-02	3.82E-01	3.64E-02	3.69E-01	4.07E-02	5.03E-01	2.99E-02
672	4.09E-02	3.67E-01	4.40E-02	5.49E-01	4.70E-02	4.97E-01	3.03E-02
676	3.61E-02	3.34E-01	3.10E-02	3.08E-01	3.53E-02	4.39E-01	2.65E-02
680	3.16E-02	2.95E-01	2.00E-02	1.59E-01	2.65E-02	3.70E-01	2.21E-02
684	2.74E-02	2.42E-01	1.72E-02	1.41E-01	2.26E-02	3.20E-01	1.88E-02
688	2.40E-02	2.14E-01	1.57E-02	1.23E-01	1.98E-02	2.78E-01	1.62E-02
692	2.15E-02	1.91E-01	1.44E-02	9.40E-02	1.81E-02	2.48E-01	1.51E-02
696	1.90E-02	1.80E-01	1.10E-02	8.80E-02	1.52E-02	2.20E-01	1.41E-02
700	1.82E-02	1.54E-01	1.18E-02	8.12E-02	1.41E-02	2.11E-01	1.26E-02
704	1.53E-02	1.49E-01	1.08E-02	7.70E-02	1.31E-02	1.91E-01	1.21E-02
708	1.38E-02	1.39E-01	9.73E-03	7.66E-02	1.27E-02	1.69E-01	1.11E-02
712	1.32E-02	1.24E-01	9.98E-03	7.24E-02	1.14E-02	1.68E-01	1.01E-02
716	1.15E-02	1.11E-01	1.09E-02	7.02E-02	1.13E-02	1.55E-01	9.30E-03
720	1.30E-02	1.04E-01	8.51E-03	7.59E-02	8.13E-03	1.27E-01	8.50E-03
724	1.10E-02	8.57E-02	7.21E-03	7.13E-02	9.98E-03	1.09E-01	7.84E-03
728	7.60E-03	8.27E-02	6.29E-03	7.74E-02	9.46E-03	9.81E-02	6.73E-03
732	8.54E-03	7.69E-02	5.99E-03	9.39E-02	8.50E-03	8.39E-02	4.79E-03
736	8.06E-03	5.94E-02	5.85E-03	7.68E-02	8.79E-03	1.07E-01	5.95E-03
740	6.87E-03	2.33E-02	5.00E-03	6.09E-02	7.63E-03	6.33E-02	5.53E-03

744	4.55E-03	4.63E-02	4.74E-03	6.52E-02	7.59E-03	4.01E-02	4.32E-03
748	4.02E-03	2.54E-02	5.59E-03	5.51E-02	5.72E-03	2.69E-02	4.01E-03
752	3.71E-03	1.88E-02	4.60E-03	5.07E-02	4.76E-03	2.02E-02	3.24E-03
756	3.18E-03	7.73E-03	5.19E-03	3.74E-02	5.51E-03	4.17E-03	2.26E-03
760	1.23E-03	4.88E-02	6.45E-03	5.19E-02	4.67E-03	5.45E-03	1.77E-04
764	4.61E-03	6.45E-02	1.13E-02	7.60E-02	6.74E-03	2.85E-02	4.45E-03
768	7.64E-03	1.69E-01	1.05E-02	9.43E-02	2.85E-03	7.70E-02	1.05E-02
772	5.75E-04	5.60E-02	8.40E-03	6.73E-02	7.09E-03	4.61E-02	7.02E-03
776	1.73E-03	0.00E+00	2.54E-03	1.04E-02	1.81E-03	3.96E-03	4.86E-03
780	3.48E-04	0.00E+00	2.48E-03	0.00E+00	5.17E-04	0.00E+00	2.11E-03

Table 3 (cont.). Spectral radiance ($W/sr*m^2$) at the central position in the VIS region for the set of new lamps.

NEW LAMPS Central						
λ (nm)	TRAY					
	15	16	17	18	19	20
380	0.00E+00	1.62E-41	0.00E+00	2.00E-02	0.00E+00	0.00E+00
384	0.00E+00	1.20E-41	0.00E+00	1.20E-41	0.00E+00	0.00E+00
388	0.00E+00	1.13E-41	0.00E+00	1.13E-41	0.00E+00	0.00E+00
392	0.00E+00	9.15E-42	2.92E-03	9.15E-42	1.97E-03	0.00E+00
396	0.00E+00	7.18E-42	3.66E-04	4.60E-05	3.94E-04	0.00E+00
400	1.38E-04	6.07E-42	1.10E-03	1.84E-02	7.21E-04	5.84E-04
404	1.53E-03	7.32E-05	6.84E-03	6.69E-02	3.54E-03	7.36E-03
408	3.98E-03	1.58E-04	2.16E-02	2.09E-01	1.13E-02	2.00E-02
412	6.51E-03	2.74E-03	3.58E-02	3.46E-01	1.87E-02	2.79E-02
416	8.23E-03	6.45E-03	2.45E-02	2.38E-01	1.38E-02	4.13E-02
420	1.04E-02	9.39E-03	1.36E-02	1.31E-01	9.49E-03	5.27E-02
424	1.27E-02	1.17E-02	1.36E-02	1.27E-01	9.74E-03	6.21E-02
428	1.58E-02	1.88E-02	1.67E-02	1.53E-01	1.22E-02	7.55E-02
432	1.90E-02	2.52E-02	2.53E-02	2.10E-01	1.73E-02	9.01E-02
436	2.38E-02	3.39E-02	4.16E-02	3.25E-01	2.68E-02	1.07E-01
440	2.53E-02	3.58E-02	3.94E-02	3.28E-01	2.58E-02	1.15E-01
444	2.29E-02	3.31E-02	3.30E-02	3.11E-01	2.22E-02	1.05E-01
448	3.30E-02	4.96E-02	5.95E-02	5.52E-01	3.79E-02	1.52E-01
452	4.71E-02	9.77E-02	1.54E-01	1.49E+00	8.91E-02	1.93E-01
456	3.03E-02	6.36E-02	1.18E-01	1.18E+00	6.66E-02	1.15E-01
460	1.99E-02	3.43E-02	3.48E-02	3.41E-01	2.25E-02	8.99E-02
464	4.18E-02	6.20E-02	2.25E-02	1.64E-01	2.10E-02	1.92E-01
468	6.71E-02	1.03E-01	2.64E-02	1.57E-01	2.82E-02	3.07E-01
472	4.25E-02	7.00E-02	2.00E-02	1.35E-01	2.02E-02	1.95E-01
476	2.19E-02	4.18E-02	1.43E-02	1.05E-01	1.29E-02	1.04E-01
480	1.15E-02	1.90E-02	1.07E-02	9.74E-02	8.21E-03	4.57E-02
484	7.11E-03	1.74E-02	1.04E-02	9.65E-02	6.94E-03	3.60E-02
488	9.34E-03	2.06E-02	1.12E-02	1.02E-01	8.22E-03	4.25E-02
492	2.43E-02	4.33E-02	1.43E-02	1.17E-01	1.31E-02	8.67E-02
496	1.13E-01	1.97E-01	3.57E-02	1.67E-01	4.30E-02	4.30E-01
500	1.70E-01	2.93E-01	4.91E-02	1.94E-01	6.09E-02	6.34E-01
504	5.85E-02	1.02E-01	2.20E-02	1.34E-01	2.40E-02	2.01E-01
508	1.67E-02	3.94E-02	1.28E-02	1.13E-01	1.02E-02	6.59E-02
512	2.55E-02	6.21E-02	1.60E-02	1.24E-01	1.35E-02	1.05E-01
516	4.19E-02	9.61E-02	2.13E-02	1.51E-01	1.95E-02	1.63E-01
520	2.61E-02	6.53E-02	2.02E-02	1.73E-01	1.56E-02	1.08E-01
524	1.25E-02	4.31E-02	1.66E-02	1.60E-01	1.12E-02	6.23E-02
528	1.20E-02	4.71E-02	1.98E-02	1.80E-01	1.29E-02	6.34E-02
532	1.79E-02	6.65E-02	9.14E-02	8.51E-01	5.13E-02	7.49E-02
536	2.90E-02	1.09E-01	2.32E-01	2.23E+00	1.27E-01	9.80E-02
540	2.88E-02	9.90E-02	1.97E-01	1.87E+00	1.08E-01	1.01E-01

544	2.61E-02	1.01E-01	7.96E-02	6.13E-01	4.59E-02	1.18E-01
548	5.03E-02	2.02E-01	5.43E-02	2.81E-01	3.85E-02	2.62E-01
552	1.02E-01	4.25E-01	4.09E-02	1.71E-01	4.14E-02	5.61E-01
556	1.99E-01	8.44E-01	5.09E-02	1.54E-01	6.51E-02	1.11E+00
560	3.31E-01	1.42E+00	7.52E-02	1.77E-01	1.03E-01	1.83E+00
564	4.62E-01	1.86E+00	1.04E-01	2.35E-01	1.43E-01	2.31E+00
568	7.42E-01	2.71E+00	1.75E-01	4.48E-01	2.31E-01	3.09E+00
572	7.16E-01	2.72E+00	1.69E-01	4.10E-01	2.25E-01	3.08E+00
576	5.78E-01	2.51E+00	1.38E-01	2.80E-01	1.85E-01	2.94E+00
580	6.54E-01	3.03E+00	1.57E-01	2.95E-01	2.09E-01	3.57E+00
584	7.05E-01	3.28E+00	1.80E-01	5.07E-01	2.27E-01	3.85E+00
588	4.25E-01	1.89E+00	2.37E-01	1.77E+00	1.98E-01	2.23E+00
592	3.83E-01	1.73E+00	3.13E-01	2.82E+00	2.27E-01	2.00E+00
596	6.81E-01	3.25E+00	3.11E-01	2.28E+00	2.83E-01	3.64E+00
600	7.82E-01	3.80E+00	2.51E-01	1.43E+00	2.75E-01	4.14E+00
604	6.64E-01	3.30E+00	1.90E-01	9.25E-01	2.24E-01	3.51E+00
608	5.32E-01	2.69E+00	1.47E-01	6.66E-01	1.78E-01	2.79E+00
612	4.65E-01	2.36E+00	1.27E-01	5.44E-01	1.55E-01	2.36E+00
616	4.45E-01	2.22E+00	1.19E-01	4.63E-01	1.47E-01	2.10E+00
620	3.60E-01	1.85E+00	9.65E-02	3.77E-01	1.19E-01	1.74E+00
624	2.65E-01	1.43E+00	7.24E-02	3.07E-01	8.90E-02	1.38E+00
628	2.25E-01	1.26E+00	6.26E-02	2.66E-01	7.65E-02	1.19E+00
632	2.01E-01	1.13E+00	5.61E-02	2.42E-01	6.82E-02	1.06E+00
636	1.83E-01	1.03E+00	5.05E-02	2.21E-01	6.13E-02	9.56E-01
640	1.65E-01	9.40E-01	4.59E-02	2.04E-01	5.37E-02	8.63E-01
644	1.50E-01	8.58E-01	4.30E-02	1.84E-01	4.96E-02	7.64E-01
648	1.38E-01	7.99E-01	3.88E-02	1.68E-01	4.58E-02	7.06E-01
652	1.27E-01	7.49E-01	3.75E-02	1.72E-01	4.32E-02	6.53E-01
656	1.18E-01	7.06E-01	3.78E-02	1.76E-01	4.23E-02	5.98E-01
660	1.09E-01	6.57E-01	3.36E-02	1.47E-01	3.74E-02	5.48E-01
664	1.00E-01	6.15E-01	3.18E-02	1.62E-01	3.36E-02	5.03E-01
668	9.51E-02	6.00E-01	4.51E-02	3.21E-01	4.06E-02	4.83E-01
672	9.47E-02	5.84E-01	5.69E-02	4.77E-01	4.72E-02	4.71E-01
676	8.51E-02	5.44E-01	3.69E-02	2.69E-01	3.59E-02	4.30E-01
680	7.49E-02	4.86E-01	2.45E-02	1.36E-01	2.72E-02	3.79E-01
684	6.55E-02	4.26E-01	2.05E-02	1.06E-01	2.39E-02	3.32E-01
688	5.85E-02	3.76E-01	1.82E-02	7.95E-02	2.11E-02	2.86E-01
692	5.43E-02	3.47E-01	1.66E-02	7.59E-02	1.91E-02	2.63E-01
696	5.07E-02	3.33E-01	1.46E-02	6.44E-02	1.76E-02	2.49E-01
700	4.59E-02	3.16E-01	1.37E-02	6.55E-02	1.66E-02	2.20E-01
704	4.30E-02	2.92E-01	1.31E-02	6.56E-02	1.54E-02	2.07E-01
708	4.00E-02	2.72E-01	1.26E-02	6.23E-02	1.61E-02	1.92E-01
712	3.58E-02	2.58E-01	1.15E-02	7.57E-02	1.38E-02	1.68E-01
716	3.20E-02	2.42E-01	1.06E-02	5.18E-02	1.33E-02	1.64E-01
720	3.01E-02	2.33E-01	1.04E-02	4.79E-02	1.23E-02	1.52E-01
724	2.68E-02	2.26E-01	1.04E-02	4.25E-02	1.09E-02	1.39E-01
728	2.56E-02	2.17E-01	9.75E-03	4.70E-02	1.20E-02	1.20E-01
732	2.53E-02	1.97E-01	7.82E-03	4.12E-02	1.09E-02	1.14E-01

736	2.19E-02	1.78E-01	8.31E-03	3.98E-02	7.81E-03	1.03E-01
740	1.94E-02	1.57E-01	6.92E-03	4.17E-02	5.82E-03	9.45E-02
744	1.87E-02	1.55E-01	6.66E-03	2.79E-02	5.79E-03	9.90E-02
748	1.81E-02	1.59E-01	3.77E-03	2.83E-02	3.09E-03	8.36E-02
752	1.89E-02	1.55E-01	6.23E-03	3.69E-02	4.12E-03	7.03E-02
756	1.80E-02	1.27E-01	4.97E-03	1.41E-02	3.19E-03	5.80E-02
760	1.51E-02	1.31E-01	3.82E-03	2.20E-02	5.47E-03	5.92E-02
764	2.04E-02	1.73E-01	8.71E-03	5.60E-02	7.12E-03	9.31E-02
768	2.70E-02	2.73E-01	1.44E-02	9.84E-02	1.14E-02	1.32E-01
772	2.47E-02	2.38E-01	1.03E-02	6.99E-02	1.00E-02	1.07E-01
776	1.29E-02	1.41E-01	4.45E-03	1.09E-02	7.21E-03	4.84E-02
780	1.90E-03	1.01E-01	4.83E-04	3.24E-41	2.21E-03	7.87E-03

Table 3 (cont.). Spectral radiance (W/sr*m^2) at the central position in the VIS region for the set of new lamps.

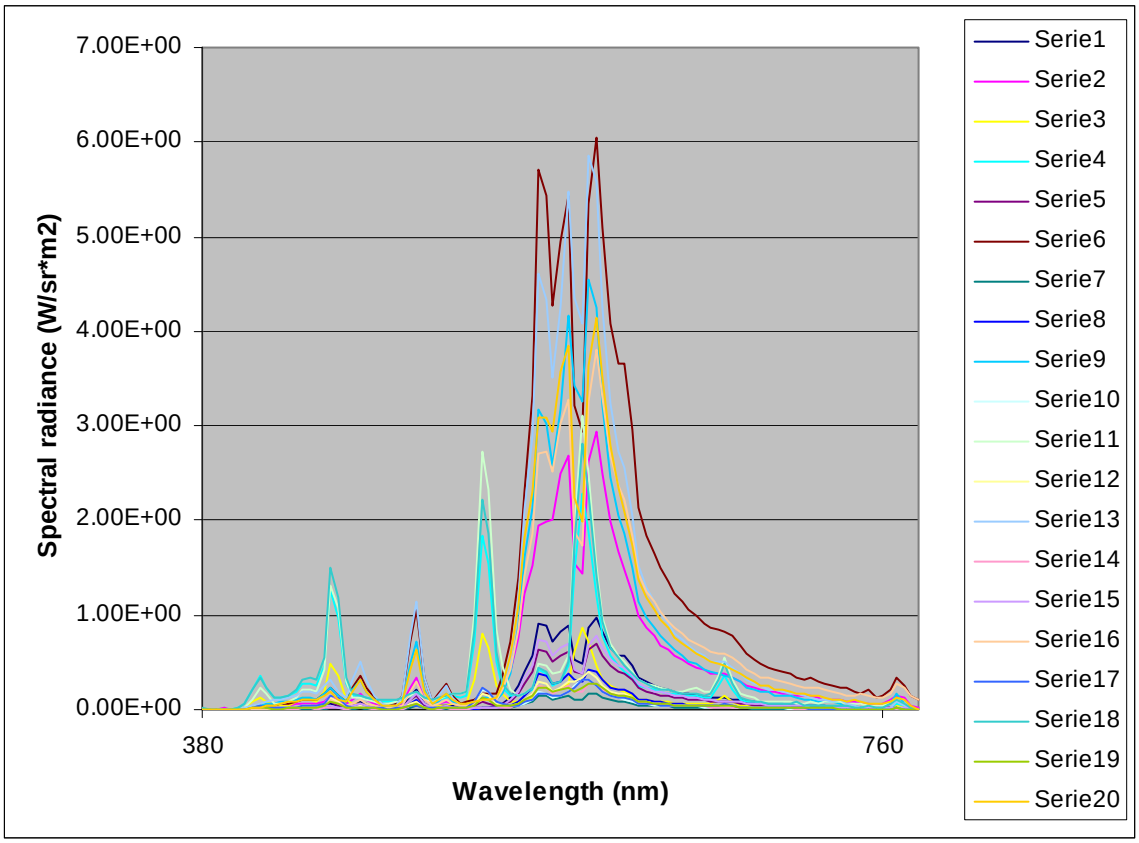


Figure 1. Spectral radiance (W/sr*m^2) at the central position in the VIS region for the set of new lamps (Table 3).

NEW LAMPS Window side							
λ (nm)	TRAY						
	1	2	3	4	5	6	7
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.33E-05	0.00E+00
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.76E-05	0.00E+00
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.09E-06	0.00E+00
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
396	9.20E-07	1.39E-07	1.88E-05	2.26E-06	0.00E+00	0.00E+00	0.00E+00
400	2.43E-04	2.32E-04	6.60E-03	9.95E-04	1.98E-04	9.64E-05	8.92E-05
404	5.70E-04	1.88E-03	1.50E-02	3.86E-03	2.03E-03	9.07E-04	8.94E-04
408	3.43E-03	4.86E-03	4.08E-02	1.09E-02	5.78E-03	2.42E-03	2.09E-03
412	5.52E-03	7.67E-03	6.53E-02	1.75E-02	9.48E-03	4.04E-03	3.20E-03
416	5.69E-03	6.67E-03	4.27E-02	1.23E-02	1.23E-02	3.84E-03	3.00E-03
420	5.56E-03	5.56E-03	2.28E-02	7.36E-03	1.16E-02	4.23E-03	2.55E-03
424	6.22E-03	6.70E-03	2.11E-02	7.50E-03	1.29E-02	4.23E-03	3.09E-03
428	7.05E-03	8.06E-03	2.63E-02	9.09E-03	1.48E-02	5.46E-03	3.59E-03
432	9.54E-03	1.02E-02	4.04E-02	1.29E-02	1.84E-02	6.72E-03	4.67E-03
436	1.24E-02	1.38E-02	6.70E-02	1.98E-02	2.33E-02	8.96E-03	6.64E-03
440	1.25E-02	1.36E-02	6.09E-02	1.89E-02	2.33E-02	9.11E-03	6.61E-03
444	1.14E-02	1.23E-02	5.03E-02	1.57E-02	2.08E-02	8.17E-03	5.97E-03
448	1.80E-02	2.05E-02	9.61E-02	2.94E-02	3.29E-02	1.34E-02	1.01E-02
452	3.02E-02	3.91E-02	2.60E-01	7.22E-02	5.13E-02	2.51E-02	2.00E-02
456	2.11E-02	2.76E-02	1.88E-01	5.32E-02	3.43E-02	1.70E-02	1.41E-02
460	1.08E-02	1.17E-02	5.34E-02	1.71E-02	1.87E-02	8.07E-03	5.87E-03
464	1.85E-02	1.74E-02	2.98E-02	1.36E-02	3.69E-02	1.27E-02	8.77E-03
468	2.81E-02	2.64E-02	3.15E-02	1.65E-02	5.63E-02	1.99E-02	1.33E-02
472	1.77E-02	1.72E-02	2.56E-02	1.23E-02	3.49E-02	1.26E-02	8.75E-03
476	9.81E-03	9.76E-03	1.83E-02	8.28E-03	1.95E-02	6.71E-03	4.68E-03
480	4.86E-03	5.52E-03	1.52E-02	5.60E-03	9.10E-03	3.53E-03	2.46E-03
484	3.57E-03	3.99E-03	1.42E-02	5.11E-03	6.19E-03	2.62E-03	1.72E-03
488	5.22E-03	4.96E-03	1.59E-02	5.74E-03	8.39E-03	3.22E-03	2.29E-03
492	1.07E-02	1.04E-02	1.92E-02	7.82E-03	2.03E-02	7.26E-03	5.18E-03
496	4.50E-02	4.28E-02	3.95E-02	2.37E-02	9.13E-02	3.14E-02	2.18E-02
500	6.47E-02	6.12E-02	5.08E-02	3.26E-02	1.31E-01	4.54E-02	3.18E-02
504	2.14E-02	2.02E-02	2.66E-02	1.32E-02	4.17E-02	1.50E-02	1.04E-02
508	6.81E-03	6.64E-03	1.86E-02	6.78E-03	1.23E-02	5.10E-03	3.23E-03
512	1.07E-02	1.04E-02	2.22E-02	8.80E-03	2.04E-02	7.39E-03	5.11E-03
516	1.76E-02	1.66E-02	2.86E-02	1.21E-02	3.33E-02	1.17E-02	8.15E-03
520	1.07E-02	1.08E-02	2.99E-02	1.05E-02	2.01E-02	7.17E-03	5.29E-03
524	5.74E-03	6.28E-03	2.70E-02	8.30E-03	1.06E-02	3.66E-03	2.77E-03
528	5.76E-03	6.78E-03	3.36E-02	9.70E-03	1.09E-02	4.13E-03	3.09E-03
532	1.24E-02	1.92E-02	1.67E-01	4.25E-02	2.17E-02	1.04E-02	1.01E-02
536	2.44E-02	4.24E-02	4.24E-01	1.06E-01	4.10E-02	2.27E-02	2.38E-02
540	2.11E-02	3.56E-02	3.46E-01	8.77E-02	3.75E-02	1.97E-02	2.05E-02
544	1.46E-02	1.94E-02	1.35E-01	3.52E-02	2.67E-02	1.12E-02	9.86E-03
548	2.23E-02	2.39E-02	8.97E-02	2.56E-02	4.31E-02	1.48E-02	1.07E-02

552	4.14E-02	3.82E-02	4.84E-02	2.14E-02	8.04E-02	2.55E-02	1.55E-02
556	7.63E-02	6.84E-02	4.32E-02	2.97E-02	1.54E-01	4.75E-02	2.99E-02
560	1.23E-01	1.10E-01	5.67E-02	4.52E-02	2.51E-01	7.79E-02	5.11E-02
564	1.69E-01	1.53E-01	7.80E-02	6.29E-02	3.45E-01	1.09E-01	7.34E-02
568	2.64E-01	2.47E-01	1.42E-01	1.05E-01	5.47E-01	1.78E-01	1.26E-01
572	2.54E-01	2.35E-01	1.35E-01	9.96E-02	5.22E-01	1.69E-01	1.18E-01
576	2.12E-01	1.91E-01	1.11E-01	8.01E-02	4.30E-01	1.34E-01	8.97E-02
580	2.45E-01	2.20E-01	1.26E-01	9.17E-02	5.01E-01	1.56E-01	1.04E-01
584	2.61E-01	2.37E-01	1.51E-01	1.05E-01	5.42E-01	1.74E-01	1.25E-01
588	1.57E-01	1.53E-01	3.31E-01	1.19E-01	3.29E-01	1.15E-01	9.92E-02
592	1.47E-01	1.54E-01	4.72E-01	1.50E-01	3.11E-01	1.13E-01	1.01E-01
596	2.54E-01	2.47E-01	3.84E-01	1.61E-01	5.38E-01	1.79E-01	1.41E-01
600	2.84E-01	2.66E-01	2.60E-01	1.37E-01	5.94E-01	1.89E-01	1.37E-01
604	2.40E-01	2.22E-01	1.79E-01	1.05E-01	4.98E-01	1.55E-01	1.08E-01
608	1.91E-01	1.76E-01	1.36E-01	8.14E-02	3.98E-01	1.23E-01	8.37E-02
612	1.67E-01	1.55E-01	1.14E-01	7.05E-02	3.48E-01	1.08E-01	7.35E-02
616	1.61E-01	1.50E-01	1.04E-01	6.62E-02	3.32E-01	1.05E-01	7.20E-02
620	1.31E-01	1.22E-01	8.30E-02	5.30E-02	2.68E-01	8.33E-02	5.75E-02
624	9.76E-02	8.98E-02	6.34E-02	3.93E-02	1.98E-01	6.17E-02	4.12E-02
628	8.44E-02	7.68E-02	5.40E-02	3.40E-02	1.70E-01	5.32E-02	3.52E-02
632	7.51E-02	6.84E-02	4.87E-02	3.02E-02	1.51E-01	4.73E-02	3.13E-02
636	6.76E-02	6.25E-02	4.39E-02	2.74E-02	1.36E-01	4.22E-02	2.85E-02
640	6.04E-02	5.66E-02	4.02E-02	2.48E-02	1.23E-01	3.79E-02	2.59E-02
644	5.42E-02	5.03E-02	3.80E-02	2.21E-02	1.10E-01	3.40E-02	2.29E-02
648	5.00E-02	4.62E-02	3.62E-02	2.06E-02	1.03E-01	3.18E-02	2.10E-02
652	4.56E-02	4.33E-02	3.62E-02	2.04E-02	9.51E-02	2.97E-02	1.97E-02
656	4.16E-02	4.07E-02	3.92E-02	2.03E-02	8.92E-02	2.77E-02	1.88E-02
660	3.95E-02	3.60E-02	3.21E-02	1.74E-02	8.09E-02	2.50E-02	1.69E-02
664	3.67E-02	3.46E-02	3.02E-02	1.67E-02	7.49E-02	2.34E-02	1.57E-02
668	3.63E-02	3.55E-02	5.68E-02	2.23E-02	7.42E-02	2.35E-02	1.64E-02
672	3.62E-02	3.60E-02	8.02E-02	2.73E-02	7.39E-02	2.33E-02	1.71E-02
676	3.25E-02	3.16E-02	4.63E-02	1.87E-02	6.51E-02	2.06E-02	1.43E-02
680	2.82E-02	2.72E-02	2.65E-02	1.32E-02	5.57E-02	1.68E-02	1.19E-02
684	2.42E-02	2.33E-02	2.13E-02	1.13E-02	4.96E-02	1.53E-02	1.05E-02
688	2.21E-02	1.99E-02	1.77E-02	1.00E-02	4.38E-02	1.34E-02	9.43E-03
692	1.93E-02	1.83E-02	1.62E-02	9.19E-03	4.04E-02	1.21E-02	8.24E-03
696	1.80E-02	1.71E-02	1.45E-02	8.46E-03	3.69E-02	1.08E-02	7.55E-03
700	1.67E-02	1.55E-02	1.16E-02	7.74E-03	3.45E-02	1.05E-02	7.45E-03
704	1.57E-02	1.28E-02	1.17E-02	7.81E-03	3.07E-02	9.51E-03	6.63E-03
708	1.40E-02	1.39E-02	1.28E-02	6.83E-03	3.01E-02	8.45E-03	6.22E-03
712	1.24E-02	1.35E-02	1.48E-02	6.74E-03	2.73E-02	7.25E-03	5.64E-03
716	1.18E-02	1.19E-02	1.08E-02	6.23E-03	2.50E-02	7.27E-03	5.60E-03
720	1.19E-02	1.22E-02	1.04E-02	5.27E-03	2.44E-02	6.59E-03	4.91E-03
724	9.80E-03	1.05E-02	8.90E-03	6.40E-03	2.13E-02	6.82E-03	4.47E-03
728	9.34E-03	8.58E-03	9.83E-03	5.05E-03	1.97E-02	6.31E-03	3.69E-03
732	1.13E-02	1.02E-02	1.35E-02	4.38E-03	1.62E-02	6.01E-03	3.60E-03
736	8.83E-03	9.01E-03	8.90E-03	3.66E-03	1.64E-02	5.32E-03	4.06E-03
740	8.00E-03	7.89E-03	8.66E-03	3.84E-03	1.45E-02	5.27E-03	2.47E-03

744	6.91E-03	7.61E-03	9.09E-03	3.41E-03	1.12E-02	5.32E-03	2.66E-03
748	5.95E-03	8.60E-03	5.12E-03	3.27E-03	9.04E-03	4.98E-03	2.05E-03
752	6.60E-03	8.02E-03	5.98E-03	2.13E-03	4.72E-03	7.26E-03	1.18E-03
756	4.09E-03	4.36E-03	2.99E-03	2.31E-03	4.93E-03	3.15E-03	1.32E-03
760	3.39E-03	5.86E-03	3.60E-03	3.38E-03	1.17E-02	3.14E-03	2.12E-03
764	5.48E-03	9.48E-03	7.89E-03	5.20E-03	1.51E-02	4.45E-03	2.92E-03
768	9.93E-03	1.01E-02	9.64E-03	8.53E-03	2.66E-02	8.00E-03	4.29E-03
772	5.87E-03	2.25E-03	3.83E-03	5.68E-03	1.61E-02	5.29E-03	2.92E-03
776	1.45E-03	5.73E-03	8.47E-04	1.36E-03	3.84E-03	4.21E-04	1.06E-03
780	4.32E-04	1.09E-03	1.36E-41	6.16E-04	3.89E-04	3.72E-05	6.60E-05

Table 4. Spectral radiance ($W/sr*m^2$) at the window side in the VIS region for the set of new lamps.

NEW LAMPS Window side							
λ (nm)	TRAY						
	8	9	10	11	12	13	14
380	0.00E+00	3.89E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.88E-04	0.00E+00
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-04	0.00E+00
396	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.99E-05	0.00E+00	0.00E+00
400	1.09E-04	2.62E-04	4.48E-04	4.07E-04	8.36E-04	1.41E-04	0.00E+00
404	1.70E-03	2.00E-03	5.92E-03	4.07E-03	2.61E-03	1.25E-03	2.54E-04
408	6.74E-03	4.37E-03	2.47E-02	1.37E-02	6.66E-03	3.63E-03	1.49E-03
412	1.07E-02	7.70E-03	4.29E-02	2.45E-02	1.02E-02	6.76E-03	2.71E-03
416	1.15E-02	6.37E-03	2.85E-02	1.65E-02	1.11E-02	6.71E-03	2.59E-03
420	8.55E-03	4.84E-03	1.29E-02	8.68E-03	1.07E-02	6.90E-03	2.30E-03
424	1.54E-02	5.27E-03	1.32E-02	7.94E-03	1.30E-02	8.14E-03	2.82E-03
428	1.71E-02	7.31E-03	1.67E-02	1.06E-02	1.56E-02	9.69E-03	3.48E-03
432	2.16E-02	8.71E-03	2.76E-02	1.71E-02	1.88E-02	1.23E-02	4.55E-03
436	2.71E-02	1.24E-02	4.84E-02	2.84E-02	2.55E-02	1.61E-02	6.49E-03
440	2.69E-02	1.20E-02	4.24E-02	2.50E-02	2.59E-02	1.62E-02	6.47E-03
444	2.52E-02	1.05E-02	3.45E-02	2.08E-02	2.15E-02	1.47E-02	5.76E-03
448	3.88E-02	1.90E-02	7.61E-02	4.41E-02	3.50E-02	2.32E-02	9.54E-03
452	5.92E-02	4.24E-02	2.21E-01	1.25E-01	5.79E-02	3.88E-02	1.86E-02
456	4.01E-02	3.24E-02	1.72E-01	9.61E-02	4.04E-02	2.66E-02	1.33E-02
460	2.34E-02	1.13E-02	4.82E-02	2.76E-02	2.11E-02	1.33E-02	5.73E-03
464	4.55E-02	1.27E-02	2.43E-02	1.66E-02	3.69E-02	2.40E-02	8.28E-03
468	6.76E-02	1.90E-02	2.57E-02	1.93E-02	5.61E-02	3.69E-02	1.22E-02
472	4.18E-02	1.24E-02	2.02E-02	1.43E-02	3.46E-02	2.31E-02	7.36E-03
476	2.12E-02	7.04E-03	1.44E-02	9.36E-03	1.83E-02	1.20E-02	4.15E-03
480	1.02E-02	3.64E-03	1.13E-02	6.62E-03	8.02E-03	5.61E-03	2.34E-03
484	5.32E-03	2.50E-03	9.00E-03	5.98E-03	6.19E-03	3.83E-03	1.78E-03
488	7.98E-03	3.29E-03	1.14E-02	6.69E-03	8.26E-03	5.12E-03	2.30E-03
492	2.31E-02	7.45E-03	1.51E-02	9.96E-03	1.97E-02	1.32E-02	4.94E-03
496	1.15E-01	3.03E-02	3.38E-02	2.69E-02	9.16E-02	6.14E-02	2.01E-02
500	1.68E-01	4.37E-02	4.48E-02	3.61E-02	1.34E-01	8.94E-02	2.94E-02
504	5.18E-02	1.46E-02	2.12E-02	1.53E-02	4.21E-02	2.80E-02	9.90E-03
508	1.22E-02	4.86E-03	1.38E-02	8.38E-03	1.14E-02	7.30E-03	3.21E-03
512	2.19E-02	7.37E-03	1.71E-02	1.07E-02	1.86E-02	1.23E-02	4.91E-03
516	3.81E-02	1.18E-02	2.28E-02	1.48E-02	3.11E-02	2.11E-02	7.79E-03
520	2.11E-02	8.45E-03	2.40E-02	1.44E-02	1.84E-02	1.23E-02	5.20E-03
524	8.15E-03	5.13E-03	2.14E-02	1.19E-02	8.58E-03	5.81E-03	2.83E-03
528	8.36E-03	5.60E-03	2.51E-02	1.42E-02	9.12E-03	5.58E-03	3.16E-03
532	1.80E-02	2.11E-02	1.31E-01	7.23E-02	2.26E-02	1.37E-02	9.99E-03
536	3.84E-02	5.26E-02	3.47E-01	1.89E-01	4.78E-02	2.97E-02	2.33E-02
540	3.42E-02	4.52E-02	2.94E-01	1.60E-01	4.22E-02	2.60E-02	2.00E-02
544	2.43E-02	1.96E-02	1.12E-01	6.06E-02	2.51E-02	1.54E-02	1.02E-02
548	3.60E-02	1.63E-02	6.73E-02	3.75E-02	3.36E-02	2.12E-02	1.12E-02
552	6.66E-02	1.96E-02	3.56E-02	2.33E-02	5.99E-02	3.79E-02	1.69E-02
556	1.44E-01	3.62E-02	3.29E-02	2.76E-02	1.25E-01	7.80E-02	3.14E-02

560	2.55E-01	6.19E-02	4.60E-02	4.19E-02	2.19E-01	1.36E-01	5.24E-02
564	3.75E-01	9.02E-02	6.50E-02	6.04E-02	3.15E-01	1.98E-01	7.42E-02
568	6.66E-01	1.58E-01	1.22E-01	1.10E-01	5.38E-01	3.46E-01	1.23E-01
572	6.13E-01	1.46E-01	1.14E-01	1.03E-01	5.00E-01	3.19E-01	1.16E-01
576	4.41E-01	1.08E-01	8.78E-02	7.75E-02	3.76E-01	2.34E-01	9.17E-02
580	5.09E-01	1.24E-01	9.82E-02	8.76E-02	4.40E-01	2.69E-01	1.06E-01
584	6.54E-01	1.57E-01	1.25E-01	1.11E-01	5.53E-01	3.33E-01	1.21E-01
588	5.22E-01	1.41E-01	2.56E-01	1.68E-01	4.32E-01	2.54E-01	8.90E-02
592	4.99E-01	1.49E-01	3.68E-01	2.25E-01	4.14E-01	2.43E-01	9.07E-02
596	7.08E-01	1.90E-01	3.15E-01	2.13E-01	5.99E-01	3.57E-01	1.33E-01
600	6.70E-01	1.72E-01	2.14E-01	1.60E-01	5.80E-01	3.51E-01	1.35E-01
604	5.10E-01	1.31E-01	1.46E-01	1.13E-01	4.50E-01	2.74E-01	1.09E-01
608	3.91E-01	1.00E-01	1.08E-01	8.49E-02	3.46E-01	2.12E-01	8.64E-02
612	3.45E-01	8.76E-02	9.01E-02	7.25E-02	3.03E-01	1.87E-01	7.59E-02
616	3.45E-01	8.62E-02	8.21E-02	6.82E-02	2.96E-01	1.85E-01	7.37E-02
620	2.74E-01	6.91E-02	6.49E-02	5.39E-02	2.36E-01	1.47E-01	5.96E-02
624	1.93E-01	4.84E-02	4.79E-02	3.92E-02	1.70E-01	1.04E-01	4.35E-02
628	1.64E-01	4.09E-02	4.14E-02	3.39E-02	1.44E-01	8.79E-02	3.72E-02
632	1.45E-01	3.64E-02	3.71E-02	3.03E-02	1.30E-01	7.84E-02	3.32E-02
636	1.31E-01	3.27E-02	3.36E-02	2.72E-02	1.17E-01	7.05E-02	3.00E-02
640	1.19E-01	2.92E-02	3.11E-02	2.48E-02	1.06E-01	6.34E-02	2.72E-02
644	1.06E-01	2.65E-02	2.85E-02	2.28E-02	9.35E-02	5.68E-02	2.41E-02
648	9.54E-02	2.43E-02	2.73E-02	2.12E-02	8.53E-02	5.17E-02	2.25E-02
652	8.68E-02	2.30E-02	2.68E-02	2.12E-02	7.90E-02	4.93E-02	2.09E-02
656	7.90E-02	2.11E-02	2.99E-02	2.15E-02	7.11E-02	4.53E-02	1.98E-02
660	7.24E-02	1.99E-02	2.55E-02	1.85E-02	6.69E-02	4.04E-02	1.82E-02
664	6.68E-02	1.83E-02	2.28E-02	1.77E-02	6.13E-02	3.84E-02	1.68E-02
668	6.57E-02	2.00E-02	3.84E-02	2.63E-02	6.10E-02	3.82E-02	1.75E-02
672	6.62E-02	2.16E-02	5.40E-02	3.41E-02	6.18E-02	3.77E-02	1.81E-02
676	5.94E-02	1.72E-02	2.91E-02	2.16E-02	5.46E-02	3.33E-02	1.56E-02
680	5.06E-02	1.39E-02	1.65E-02	1.37E-02	4.54E-02	2.83E-02	1.30E-02
684	4.27E-02	1.20E-02	1.49E-02	1.22E-02	4.05E-02	2.46E-02	1.13E-02
688	3.67E-02	1.06E-02	1.31E-02	1.05E-02	3.52E-02	2.14E-02	9.97E-03
692	3.33E-02	9.83E-03	1.12E-02	9.38E-03	3.12E-02	1.95E-02	9.04E-03
696	3.13E-02	8.48E-03	9.98E-03	7.36E-03	2.79E-02	1.72E-02	8.20E-03
700	2.76E-02	8.13E-03	1.02E-02	6.92E-03	2.72E-02	1.62E-02	7.73E-03
704	2.51E-02	7.56E-03	7.52E-03	6.31E-03	2.51E-02	1.46E-02	7.01E-03
708	2.66E-02	6.79E-03	7.21E-03	5.90E-03	2.33E-02	1.33E-02	6.50E-03
712	2.21E-02	5.97E-03	7.09E-03	6.57E-03	2.12E-02	1.21E-02	6.21E-03
716	1.99E-02	5.82E-03	5.18E-03	5.79E-03	1.91E-02	1.13E-02	6.04E-03
720	2.04E-02	5.40E-03	6.86E-03	5.70E-03	1.76E-02	9.99E-03	5.33E-03
724	2.01E-02	5.57E-03	6.02E-03	4.76E-03	1.38E-02	1.25E-02	5.36E-03
728	1.53E-02	4.82E-03	5.92E-03	3.91E-03	1.28E-02	8.47E-03	5.15E-03
732	9.48E-03	4.16E-03	6.11E-03	3.40E-03	1.23E-02	7.76E-03	4.34E-03
736	8.33E-03	3.40E-03	1.15E-02	2.94E-03	1.13E-02	6.89E-03	4.16E-03
740	9.57E-03	3.55E-03	4.38E-03	3.21E-03	8.07E-03	5.34E-03	3.53E-03
744	8.06E-03	3.59E-03	3.51E-03	2.73E-03	6.46E-03	6.21E-03	3.31E-03
748	2.97E-03	3.29E-03	4.33E-03	3.03E-03	8.90E-03	7.16E-03	3.99E-03

752	1.03E-03	2.88E-03	2.64E-03	1.72E-03	9.92E-03	4.52E-03	3.03E-03
756	1.30E-03	2.31E-03	2.71E-03	2.10E-03	4.60E-03	2.27E-03	1.72E-03
760	6.85E-03	1.54E-03	1.64E-03	3.44E-03	4.58E-03	5.01E-03	1.59E-03
764	9.74E-03	3.65E-03	1.08E-03	6.84E-03	4.47E-03	4.10E-03	3.51E-03
768	1.84E-02	3.40E-03	5.91E-03	7.34E-03	1.32E-02	2.77E-03	6.10E-03
772	2.60E-02	2.76E-03	4.86E-03	3.37E-03	8.63E-03	5.95E-03	4.73E-03
776	1.67E-03	1.64E-03	1.51E-03	0.00E+00	5.42E-03	2.16E-03	5.42E-03
780	0.00E+00	1.94E-04	3.36E-04	0.00E+00	0.00E+00	1.97E-03	2.46E-03

Table 4 (cont.). Spectral radiance ($W/sr*m^2$) at the window side in the VIS region for the set of new lamps.

NEW LAMPS Window side						
λ (nm)	TRAY					
	15	16	17	18	19	20
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
396	0.00E+00	0.00E+00	0.00E+00	2.15E-04	0.00E+00	0.00E+00
400	0.00E+00	1.58E-04	6.25E-04	1.58E-03	2.57E-04	3.40E-05
404	6.66E-04	1.07E-03	7.44E-03	4.92E-03	1.81E-03	4.41E-04
408	4.10E-03	3.32E-03	2.91E-02	1.36E-02	3.39E-03	2.63E-03
412	7.30E-03	7.53E-03	4.90E-02	2.16E-02	6.94E-03	5.66E-03
416	8.16E-03	6.17E-03	3.15E-02	1.44E-02	7.43E-03	6.55E-03
420	9.49E-03	4.97E-03	1.61E-02	8.30E-03	7.60E-03	6.86E-03
424	1.09E-02	5.67E-03	1.65E-02	8.99E-03	9.49E-03	5.73E-03
428	1.37E-02	6.80E-03	2.10E-02	1.09E-02	1.19E-02	1.00E-02
432	1.78E-02	9.28E-03	3.29E-02	1.64E-02	1.55E-02	1.31E-02
436	2.16E-02	1.32E-02	5.48E-02	2.66E-02	1.96E-02	1.66E-02
440	2.14E-02	1.28E-02	5.05E-02	2.48E-02	1.99E-02	1.71E-02
444	2.06E-02	1.15E-02	4.18E-02	2.12E-02	1.85E-02	1.55E-02
448	3.16E-02	1.93E-02	8.17E-02	3.98E-02	2.84E-02	2.41E-02
452	4.84E-02	3.95E-02	2.15E-01	1.02E-01	4.57E-02	3.59E-02
456	3.17E-02	2.81E-02	1.56E-01	7.39E-02	3.12E-02	2.37E-02
460	1.82E-02	1.17E-02	4.31E-02	2.17E-02	1.58E-02	1.35E-02
464	3.58E-02	1.50E-02	2.43E-02	1.43E-02	2.89E-02	2.62E-02
468	5.53E-02	2.19E-02	2.60E-02	1.67E-02	4.43E-02	4.01E-02
472	3.50E-02	1.45E-02	2.11E-02	1.26E-02	2.75E-02	2.44E-02
476	1.82E-02	8.16E-03	1.56E-02	1.04E-02	1.50E-02	1.41E-02
480	9.41E-03	4.92E-03	1.18E-02	7.21E-03	7.06E-03	7.17E-03
484	6.07E-03	4.10E-03	1.26E-02	6.66E-03	5.57E-03	4.55E-03
488	8.28E-03	4.90E-03	1.34E-02	7.06E-03	7.41E-03	6.07E-03
492	2.04E-02	8.68E-03	1.63E-02	9.32E-03	1.68E-02	1.45E-02
496	9.19E-02	3.51E-02	3.27E-02	2.20E-02	7.55E-02	6.75E-02
500	1.33E-01	4.98E-02	4.31E-02	2.87E-02	1.10E-01	9.66E-02
504	4.37E-02	1.67E-02	2.15E-02	1.31E-02	3.69E-02	3.05E-02
508	1.29E-02	6.32E-03	1.58E-02	8.20E-03	1.13E-02	9.06E-03
512	2.14E-02	9.43E-03	1.85E-02	9.98E-03	1.77E-02	1.53E-02
516	3.42E-02	1.38E-02	2.34E-02	1.30E-02	2.82E-02	2.46E-02
520	1.99E-02	9.49E-03	2.46E-02	1.28E-02	1.74E-02	1.47E-02
524	1.08E-02	5.71E-03	2.18E-02	1.10E-02	8.81E-03	7.93E-03
528	1.10E-02	6.44E-03	2.70E-02	1.36E-02	9.05E-03	7.69E-03
532	1.97E-02	2.03E-02	1.36E-01	6.40E-02	1.89E-02	1.39E-02
536	3.62E-02	4.62E-02	3.43E-01	1.61E-01	3.78E-02	2.54E-02
540	3.33E-02	3.86E-02	2.76E-01	1.31E-01	3.36E-02	2.35E-02
544	2.53E-02	1.93E-02	1.07E-01	5.15E-02	2.27E-02	1.85E-02
548	4.30E-02	2.16E-02	7.16E-02	3.53E-02	3.55E-02	3.20E-02
552	8.29E-02	3.18E-02	3.95E-02	2.31E-02	6.56E-02	6.11E-02
556	1.57E-01	5.75E-02	3.62E-02	2.62E-02	1.23E-01	1.17E-01

560	2.57E-01	9.30E-02	4.74E-02	3.70E-02	2.02E-01	1.92E-01
564	3.56E-01	1.27E-01	6.51E-02	5.08E-02	2.80E-01	2.64E-01
568	5.73E-01	2.02E-01	1.17E-01	8.75E-02	4.50E-01	4.22E-01
572	5.44E-01	1.93E-01	1.11E-01	8.27E-02	4.28E-01	4.02E-01
576	4.37E-01	1.59E-01	9.23E-02	6.82E-02	3.48E-01	3.31E-01
580	4.99E-01	1.84E-01	1.03E-01	7.69E-02	3.98E-01	3.81E-01
584	5.29E-01	1.98E-01	1.23E-01	8.76E-02	4.24E-01	4.07E-01
588	3.07E-01	1.34E-01	2.76E-01	1.41E-01	2.53E-01	2.36E-01
592	2.88E-01	1.37E-01	3.94E-01	1.95E-01	2.38E-01	2.20E-01
596	5.17E-01	2.10E-01	3.16E-01	1.78E-01	4.14E-01	3.94E-01
600	5.89E-01	2.23E-01	2.11E-01	1.34E-01	4.64E-01	4.44E-01
604	5.03E-01	1.87E-01	1.46E-01	9.85E-02	3.94E-01	3.77E-01
608	4.03E-01	1.49E-01	1.10E-01	7.57E-02	3.16E-01	3.03E-01
612	3.56E-01	1.31E-01	9.45E-02	6.52E-02	2.80E-01	2.67E-01
616	3.45E-01	1.25E-01	8.39E-02	5.96E-02	2.71E-01	2.58E-01
620	2.79E-01	1.01E-01	6.79E-02	4.81E-02	2.19E-01	2.09E-01
624	2.07E-01	7.52E-02	5.20E-02	3.62E-02	1.62E-01	1.55E-01
628	1.79E-01	6.45E-02	4.50E-02	3.18E-02	1.40E-01	1.34E-01
632	1.61E-01	5.81E-02	4.12E-02	2.86E-02	1.25E-01	1.20E-01
636	1.46E-01	5.28E-02	3.72E-02	2.57E-02	1.13E-01	1.09E-01
640	1.32E-01	4.81E-02	3.39E-02	2.33E-02	1.01E-01	9.81E-02
644	1.17E-01	4.33E-02	3.13E-02	2.13E-02	9.09E-02	8.76E-02
648	1.10E-01	3.93E-02	2.84E-02	1.99E-02	8.40E-02	7.99E-02
652	1.02E-01	3.70E-02	2.97E-02	1.99E-02	7.66E-02	7.48E-02
656	9.52E-02	3.51E-02	3.21E-02	2.06E-02	7.13E-02	6.97E-02
660	8.51E-02	3.14E-02	2.72E-02	1.78E-02	6.60E-02	6.27E-02
664	8.11E-02	2.90E-02	2.66E-02	1.68E-02	6.04E-02	5.91E-02
668	7.93E-02	3.06E-02	4.80E-02	2.70E-02	6.08E-02	5.78E-02
672	7.60E-02	3.31E-02	6.82E-02	3.57E-02	6.05E-02	5.67E-02
676	6.78E-02	2.70E-02	3.97E-02	2.21E-02	5.46E-02	5.12E-02
680	5.92E-02	2.23E-02	2.14E-02	1.32E-02	4.72E-02	4.45E-02
684	5.20E-02	1.93E-02	1.81E-02	1.13E-02	4.12E-02	4.00E-02
688	4.67E-02	1.68E-02	1.62E-02	1.02E-02	3.57E-02	3.46E-02
692	4.11E-02	1.56E-02	1.24E-02	9.05E-03	3.25E-02	3.25E-02
696	3.93E-02	1.36E-02	1.06E-02	7.51E-03	3.02E-02	3.09E-02
700	3.63E-02	1.35E-02	1.04E-02	6.99E-03	2.88E-02	2.71E-02
704	3.49E-02	1.21E-02	1.01E-02	6.34E-03	2.60E-02	2.63E-02
708	3.17E-02	1.13E-02	1.01E-02	6.17E-03	2.44E-02	2.27E-02
712	2.85E-02	1.01E-02	9.99E-03	5.73E-03	2.32E-02	2.13E-02
716	2.75E-02	9.37E-03	9.79E-03	6.28E-03	2.13E-02	2.01E-02
720	2.58E-02	9.05E-03	9.11E-03	6.17E-03	2.02E-02	1.94E-02
724	2.48E-02	8.54E-03	7.83E-03	5.51E-03	1.96E-02	1.75E-02
728	2.20E-02	8.22E-03	6.44E-03	5.42E-03	1.82E-02	1.67E-02
732	1.96E-02	7.99E-03	5.24E-03	6.95E-03	1.68E-02	1.57E-02
736	1.42E-02	7.31E-03	5.58E-03	5.86E-03	1.60E-02	1.46E-02
740	1.50E-02	6.67E-03	5.61E-03	6.04E-03	1.22E-02	1.27E-02
744	1.36E-02	5.85E-03	5.12E-03	4.19E-03	1.03E-02	1.19E-02
748	1.46E-02	4.90E-03	4.84E-03	4.38E-03	9.26E-03	9.32E-03

752	1.59E-02	4.85E-03	6.12E-03	3.79E-03	7.09E-03	1.02E-02
756	1.17E-02	4.81E-03	4.69E-03	5.33E-03	5.62E-03	6.67E-03
760	1.29E-02	5.89E-03	6.24E-03	2.65E-03	7.87E-03	8.86E-03
764	1.67E-02	5.92E-03	8.22E-03	6.19E-03	9.57E-03	1.26E-02
768	2.18E-02	4.09E-03	8.04E-03	7.75E-03	1.42E-02	1.64E-02
772	1.53E-02	7.94E-03	6.61E-03	5.56E-03	1.35E-02	1.16E-02
776	1.24E-03	5.47E-03	0.00E+00	2.16E-03	3.62E-03	6.21E-03
780	4.19E-04	2.77E-03	0.00E+00	7.88E-04	3.55E-04	4.06E-03

Table 4 (cont.). Spectral radiance (W/sr*m^2) at the window side in the VIS region for the set of new lamps.

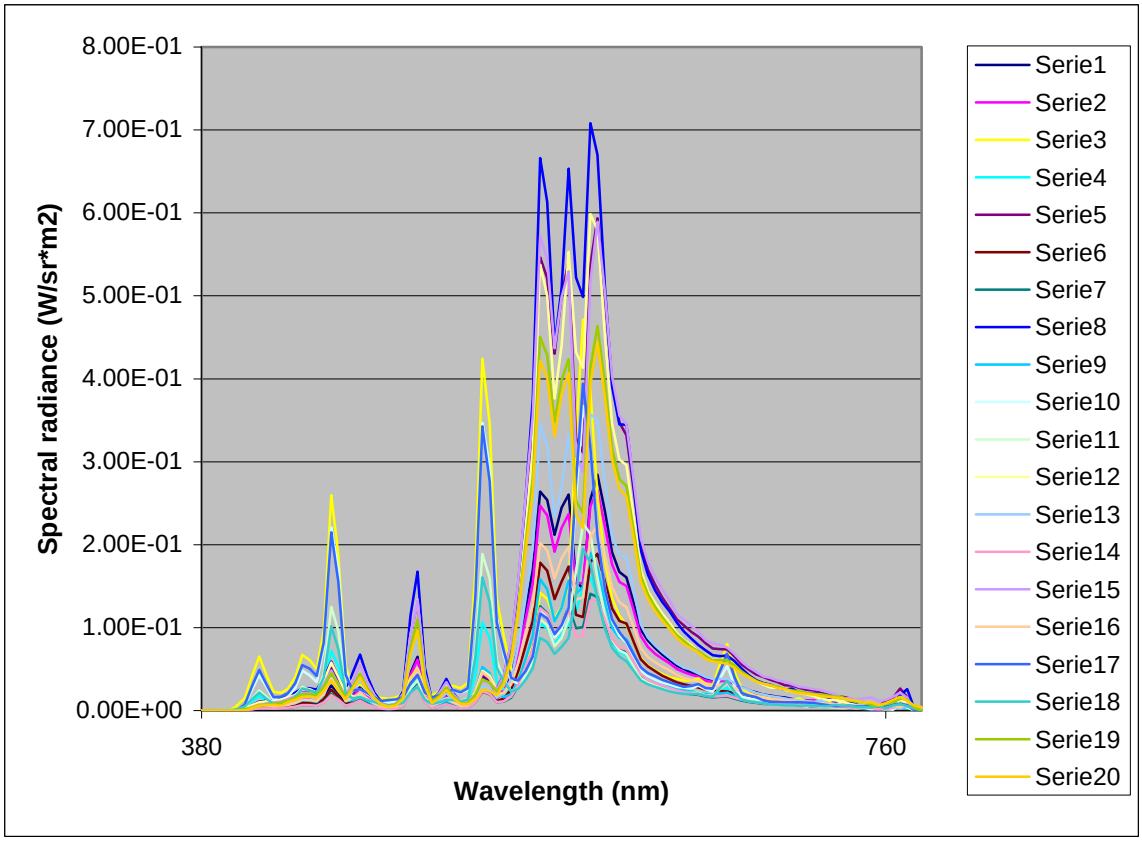


Figure 2. Spectral radiance (W/sr*m^2) at the window side in the VIS region for the set of new lamps (Table 4).

NEW LAMPS Pipe side							
λ (nm)	TRAY						
	1	2	3	4	5	6	7
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-04	0.00E+00	0.00E+00
396	9.94E-07	1.83E-06	2.32E-06	2.73E-05	6.88E-05	0.00E+00	0.00E+00
400	3.19E-04	1.67E-03	1.71E-03	1.35E-02	1.77E-03	5.14E-04	0.00E+00
404	5.33E-04	1.12E-02	1.09E-02	6.46E-02	4.46E-03	7.55E-03	4.37E-04
408	1.62E-03	2.32E-02	3.23E-02	2.03E-01	1.24E-02	2.27E-02	2.81E-03
412	3.12E-03	3.67E-02	5.11E-02	3.31E-01	1.94E-02	3.61E-02	5.60E-03
416	3.39E-03	4.62E-02	3.43E-02	2.16E-01	1.39E-02	4.51E-02	5.13E-03
420	3.58E-03	5.32E-02	1.90E-02	1.10E-01	9.07E-03	5.45E-02	5.35E-03
424	4.69E-03	6.65E-02	1.84E-02	1.03E-01	9.65E-03	6.06E-02	6.30E-03
428	5.76E-03	8.19E-02	2.21E-02	1.24E-01	1.17E-02	7.60E-02	7.14E-03
432	6.85E-03	9.48E-02	3.21E-02	1.78E-01	1.62E-02	9.08E-02	9.07E-03
436	8.59E-03	1.15E-01	5.08E-02	2.88E-01	2.41E-02	1.13E-01	1.24E-02
440	8.87E-03	1.18E-01	4.76E-02	2.67E-01	2.28E-02	1.15E-01	1.24E-02
444	8.30E-03	1.05E-01	4.10E-02	2.33E-01	2.00E-02	1.06E-01	1.05E-02
448	1.21E-02	1.51E-01	7.58E-02	4.40E-01	3.52E-02	1.57E-01	1.67E-02
452	1.77E-02	1.91E-01	1.87E-01	1.15E+00	8.04E-02	2.09E-01	2.85E-02
456	1.21E-02	1.19E-01	1.40E-01	8.68E-01	5.84E-02	1.35E-01	1.95E-02
460	7.17E-03	9.07E-02	4.34E-02	2.46E-01	2.00E-02	9.59E-02	9.51E-03
464	1.40E-02	1.94E-01	2.84E-02	1.17E-01	1.91E-02	2.10E-01	1.67E-02
468	2.07E-02	2.97E-01	3.30E-02	1.16E-01	2.55E-02	3.23E-01	2.52E-02
472	1.34E-02	1.87E-01	2.46E-02	9.92E-02	1.78E-02	2.01E-01	1.61E-02
476	7.24E-03	1.00E-01	1.76E-02	7.96E-02	1.18E-02	1.09E-01	9.03E-03
480	3.48E-03	5.16E-02	1.43E-02	6.30E-02	7.77E-03	5.21E-02	4.44E-03
484	2.55E-03	3.66E-02	1.33E-02	6.23E-02	6.54E-03	3.31E-02	3.33E-03
488	3.68E-03	4.67E-02	1.40E-02	6.71E-02	7.55E-03	4.91E-02	4.29E-03
492	7.31E-03	1.03E-01	1.90E-02	7.46E-02	1.22E-02	1.29E-01	9.60E-03
496	3.46E-02	4.79E-01	4.46E-02	1.27E-01	3.96E-02	5.88E-01	4.16E-02
500	5.00E-02	6.82E-01	5.84E-02	1.57E-01	5.48E-02	8.55E-01	5.94E-02
504	1.66E-02	2.14E-01	2.65E-02	9.55E-02	2.09E-02	2.76E-01	1.93E-02
508	5.24E-03	6.29E-02	1.61E-02	7.88E-02	9.31E-03	7.20E-02	5.63E-03
512	8.09E-03	1.03E-01	2.05E-02	9.10E-02	1.28E-02	1.25E-01	9.50E-03
516	1.25E-02	1.67E-01	2.72E-02	1.15E-01	1.82E-02	2.12E-01	1.53E-02
520	7.79E-03	9.91E-02	2.60E-02	1.25E-01	1.49E-02	1.24E-01	9.71E-03
524	4.36E-03	5.06E-02	2.18E-02	1.14E-01	1.07E-02	5.49E-02	5.61E-03
528	4.29E-03	5.14E-02	2.62E-02	1.38E-01	1.26E-02	5.36E-02	5.90E-03
532	7.02E-03	6.96E-02	1.17E-01	6.55E-01	5.07E-02	7.90E-02	1.46E-02
536	1.24E-02	1.05E-01	2.88E-01	1.68E+00	1.23E-01	1.29E-01	3.13E-02
540	1.16E-02	1.04E-01	2.42E-01	1.41E+00	1.03E-01	1.28E-01	2.71E-02
544	9.20E-03	1.08E-01	9.81E-02	5.08E-01	4.39E-02	1.24E-01	1.61E-02
548	1.63E-02	2.12E-01	6.59E-02	2.71E-01	3.60E-02	2.32E-01	2.16E-02

552	3.14E-02	4.18E-01	5.12E-02	1.42E-01	3.84E-02	4.57E-01	3.65E-02
556	5.81E-02	7.84E-01	6.45E-02	1.17E-01	6.05E-02	8.61E-01	6.80E-02
560	9.36E-02	1.27E+00	9.50E-02	1.35E-01	9.54E-02	1.42E+00	1.12E-01
564	1.28E-01	1.72E+00	1.31E-01	1.82E-01	1.33E-01	2.09E+00	1.57E-01
568	1.99E-01	2.65E+00	2.21E-01	3.83E-01	2.18E-01	3.66E+00	2.55E-01
572	1.92E-01	2.54E+00	2.10E-01	3.49E-01	2.09E-01	3.44E+00	2.41E-01
576	1.60E-01	2.16E+00	1.73E-01	2.48E-01	1.71E-01	2.60E+00	1.95E-01
580	1.83E-01	2.50E+00	1.96E-01	2.66E-01	1.95E-01	2.94E+00	2.24E-01
584	1.91E-01	2.60E+00	2.23E-01	3.99E-01	2.15E-01	3.20E+00	2.47E-01
588	1.10E-01	1.45E+00	2.89E-01	1.16E+00	1.90E-01	1.90E+00	1.62E-01
592	1.03E-01	1.32E+00	3.84E-01	1.78E+00	2.21E-01	1.77E+00	1.60E-01
596	1.84E-01	2.42E+00	3.90E-01	1.46E+00	2.75E-01	3.13E+00	2.57E-01
600	2.11E-01	2.78E+00	3.22E-01	9.38E-01	2.63E-01	3.48E+00	2.74E-01
604	1.81E-01	2.37E+00	2.45E-01	6.16E-01	2.12E-01	2.90E+00	2.26E-01
608	1.46E-01	1.89E+00	1.91E-01	4.54E-01	1.68E-01	2.31E+00	1.79E-01
612	1.27E-01	1.65E+00	1.64E-01	3.81E-01	1.46E-01	2.07E+00	1.56E-01
616	1.21E-01	1.55E+00	1.52E-01	3.32E-01	1.38E-01	2.07E+00	1.51E-01
620	9.82E-02	1.26E+00	1.23E-01	2.68E-01	1.11E-01	1.66E+00	1.21E-01
624	7.34E-02	9.41E-01	9.29E-02	2.06E-01	8.18E-02	1.18E+00	8.84E-02
628	6.30E-02	8.03E-01	8.06E-02	1.68E-01	7.05E-02	1.00E+00	7.58E-02
632	5.64E-02	7.12E-01	7.24E-02	1.61E-01	6.22E-02	8.96E-01	6.82E-02
636	5.08E-02	6.40E-01	6.41E-02	1.48E-01	5.62E-02	8.09E-01	6.16E-02
640	4.60E-02	5.67E-01	5.88E-02	1.33E-01	5.10E-02	7.38E-01	5.52E-02
644	4.08E-02	5.08E-01	5.33E-02	1.16E-01	4.61E-02	6.64E-01	4.99E-02
648	3.71E-02	4.66E-01	4.97E-02	1.12E-01	4.26E-02	6.10E-01	4.58E-02
652	3.44E-02	4.32E-01	4.86E-02	1.13E-01	4.10E-02	5.64E-01	4.21E-02
656	3.23E-02	3.98E-01	4.84E-02	1.19E-01	3.93E-02	5.23E-01	3.90E-02
660	2.97E-02	3.60E-01	4.45E-02	9.66E-02	3.52E-02	4.81E-01	3.57E-02
664	2.83E-02	3.35E-01	4.02E-02	9.76E-02	3.30E-02	4.43E-01	3.38E-02
668	2.72E-02	3.26E-01	5.63E-02	1.90E-01	3.91E-02	4.31E-01	3.38E-02
672	2.62E-02	3.35E-01	7.10E-02	2.71E-01	4.41E-02	4.26E-01	3.35E-02
676	2.39E-02	2.78E-01	4.82E-02	1.55E-01	3.40E-02	3.93E-01	2.93E-02
680	2.07E-02	2.44E-01	3.13E-02	7.21E-02	2.65E-02	3.47E-01	2.42E-02
684	1.78E-02	2.17E-01	2.72E-02	6.28E-02	2.18E-02	3.02E-01	2.21E-02
688	1.59E-02	1.88E-01	2.47E-02	5.78E-02	2.00E-02	2.64E-01	1.92E-02
692	1.43E-02	1.65E-01	2.12E-02	4.70E-02	1.77E-02	2.47E-01	1.74E-02
696	1.27E-02	1.47E-01	1.80E-02	4.18E-02	1.80E-02	2.28E-01	1.59E-02
700	1.24E-02	1.47E-01	1.86E-02	3.59E-02	1.48E-02	2.11E-01	1.47E-02
704	1.16E-02	1.40E-01	1.67E-02	3.45E-02	1.43E-02	1.95E-01	1.38E-02
708	1.10E-02	1.32E-01	1.60E-02	2.81E-02	1.32E-02	1.87E-01	1.35E-02
712	1.08E-02	1.22E-01	1.34E-02	3.35E-02	1.15E-02	1.71E-01	1.25E-02
716	9.77E-03	1.11E-01	1.30E-02	3.54E-02	8.94E-03	1.60E-01	1.12E-02
720	9.14E-03	8.93E-02	1.33E-02	2.52E-02	9.02E-03	1.53E-01	1.02E-02
724	8.55E-03	8.96E-02	1.19E-02	4.43E-02	9.21E-03	1.35E-01	9.10E-03
728	7.07E-03	9.60E-02	1.08E-02	1.99E-02	9.16E-03	1.28E-01	7.32E-03
732	6.28E-03	6.82E-02	9.83E-03	2.35E-02	7.53E-03	1.18E-01	7.58E-03
736	6.45E-03	5.75E-02	8.09E-03	2.94E-02	6.50E-03	1.12E-01	6.43E-03
740	4.53E-03	4.76E-02	4.64E-03	2.59E-02	6.93E-03	9.92E-02	6.61E-03

744	5.30E-03	4.63E-02	8.92E-03	1.62E-02	7.04E-03	9.22E-02	6.05E-03
748	5.49E-03	3.38E-02	7.49E-03	1.45E-02	7.44E-03	8.18E-02	5.47E-03
752	4.94E-03	2.49E-02	8.10E-03	9.68E-03	6.04E-03	5.75E-02	5.31E-03
756	3.74E-03	1.54E-02	8.39E-03	1.62E-02	5.41E-03	1.17E-01	6.02E-03
760	4.11E-03	1.04E-02	1.17E-02	7.36E-03	4.67E-03	5.28E-02	4.67E-03
764	6.83E-03	3.60E-02	1.50E-02	1.63E-02	9.64E-03	6.83E-02	9.24E-03
768	8.33E-03	5.01E-02	1.70E-02	2.40E-02	1.19E-02	1.23E-01	9.33E-03
772	5.59E-03	1.69E-02	1.33E-02	2.07E-02	1.13E-02	7.79E-02	5.38E-03
776	3.53E-03	7.69E-02	4.09E-03	5.00E-03	4.36E-03	1.21E-02	2.90E-03
780	1.47E-03	2.19E-02	1.11E-03	4.68E-41	2.45E-03	4.14E-04	9.56E-04

Table 5. Spectral radiance (W/sr*m^2) at the pipe side in the VIS region for the set of new lamps.

NEW LAMPS Pipe side							
λ (nm)	TRAY						
	8	9	10	11	12	13	14
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
396	9.24E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
400	0.00E+00	1.48E-03	1.33E-03	2.34E-04	4.02E-04	1.15E-03	0.00E+00
404	4.51E-04	1.31E-02	1.57E-02	2.67E-03	4.22E-03	1.45E-02	3.49E-04
408	2.03E-03	2.56E-02	6.24E-02	8.26E-03	1.47E-02	2.94E-02	3.13E-03
412	2.90E-03	3.89E-02	1.16E-01	1.38E-02	2.54E-02	3.39E-02	6.11E-03
416	3.10E-03	5.07E-02	7.98E-02	1.09E-02	1.74E-02	4.76E-02	6.55E-03
420	3.71E-03	6.43E-02	3.88E-02	7.67E-03	9.86E-03	5.81E-02	6.97E-03
424	3.90E-03	7.40E-02	3.69E-02	8.32E-03	9.76E-03	7.01E-02	8.06E-03
428	4.76E-03	8.31E-02	4.79E-02	1.02E-02	1.24E-02	8.28E-02	1.04E-02
432	5.92E-03	1.00E-01	6.67E-02	1.37E-02	1.86E-02	1.01E-01	1.30E-02
436	8.03E-03	1.24E-01	1.03E-01	2.04E-02	2.95E-02	1.23E-01	1.67E-02
440	7.95E-03	1.23E-01	9.92E-02	1.91E-02	2.67E-02	1.26E-01	1.65E-02
444	6.83E-03	1.08E-01	9.27E-02	1.63E-02	2.24E-02	1.18E-01	1.46E-02
448	1.08E-02	1.59E-01	2.05E-01	3.10E-02	4.72E-02	1.66E-01	2.25E-02
452	1.87E-02	1.99E-01	5.86E-01	7.00E-02	1.25E-01	2.05E-01	3.66E-02
456	1.31E-02	1.21E-01	4.69E-01	5.19E-02	9.57E-02	1.28E-01	2.52E-02
460	6.56E-03	8.22E-02	1.35E-01	1.86E-02	2.82E-02	9.35E-02	1.32E-02
464	1.13E-02	2.04E-01	6.65E-02	2.02E-02	2.01E-02	2.08E-01	2.41E-02
468	1.74E-02	3.20E-01	6.61E-02	2.79E-02	2.47E-02	3.22E-01	3.68E-02
472	1.15E-02	1.94E-01	5.22E-02	1.78E-02	1.75E-02	1.97E-01	2.34E-02
476	5.90E-03	9.83E-02	3.91E-02	9.65E-03	1.13E-02	9.96E-02	1.22E-02
480	2.77E-03	4.31E-02	3.24E-02	5.38E-03	7.82E-03	3.59E-02	5.54E-03
484	1.82E-03	2.28E-02	2.93E-02	4.72E-03	6.57E-03	1.88E-02	3.61E-03
488	2.59E-03	3.89E-02	3.13E-02	5.61E-03	7.81E-03	3.33E-02	5.34E-03
492	6.49E-03	1.16E-01	3.98E-02	1.16E-02	1.22E-02	1.05E-01	1.43E-02
496	2.92E-02	5.54E-01	8.01E-02	4.61E-02	3.68E-02	5.16E-01	6.23E-02
500	4.20E-02	8.07E-01	1.03E-01	6.49E-02	5.06E-02	7.55E-01	8.96E-02
504	1.36E-02	2.54E-01	5.25E-02	2.15E-02	2.01E-02	2.33E-01	2.91E-02
508	3.58E-03	5.63E-02	3.89E-02	7.83E-03	9.72E-03	5.32E-02	7.50E-03
512	6.08E-03	1.00E-01	4.27E-02	1.18E-02	1.31E-02	9.45E-02	1.28E-02
516	1.01E-02	1.79E-01	5.53E-02	1.84E-02	1.87E-02	1.63E-01	2.18E-02
520	6.15E-03	9.70E-02	6.53E-02	1.33E-02	1.70E-02	8.98E-02	1.29E-02
524	2.83E-03	3.28E-02	5.87E-02	8.59E-03	1.40E-02	3.35E-02	5.92E-03
528	2.76E-03	3.06E-02	6.45E-02	1.04E-02	1.53E-02	3.27E-02	6.02E-03
532	7.83E-03	4.90E-02	3.32E-01	3.99E-02	7.44E-02	4.91E-02	1.56E-02
536	1.75E-02	8.49E-02	8.78E-01	9.90E-02	1.92E-01	7.75E-02	3.44E-02
540	1.53E-02	8.64E-02	7.54E-01	8.51E-02	1.63E-01	7.56E-02	3.04E-02
544	8.61E-03	8.51E-02	2.57E-01	3.61E-02	6.41E-02	7.48E-02	1.77E-02
548	1.11E-02	1.47E-01	1.20E-01	2.90E-02	4.22E-02	1.39E-01	2.32E-02
552	1.90E-02	2.89E-01	7.39E-02	3.32E-02	3.19E-02	2.93E-01	4.00E-02
556	3.86E-02	6.28E-01	7.88E-02	6.09E-02	4.50E-02	6.33E-01	8.16E-02

560	6.66E-02	1.11E+00	1.07E-01	1.05E-01	7.20E-02	1.11E+00	1.41E-01
564	9.64E-02	1.69E+00	1.57E-01	1.52E-01	1.05E-01	1.60E+00	2.07E-01
568	1.64E-01	3.07E+00	3.00E-01	2.67E-01	1.86E-01	2.70E+00	3.60E-01
572	1.53E-01	2.81E+00	2.74E-01	2.47E-01	1.72E-01	2.50E+00	3.34E-01
576	1.15E-01	1.96E+00	1.91E-01	1.84E-01	1.30E-01	1.87E+00	2.48E-01
580	1.33E-01	2.23E+00	2.12E-01	2.14E-01	1.49E-01	2.20E+00	2.85E-01
584	1.64E-01	2.91E+00	3.12E-01	2.73E-01	1.88E-01	2.79E+00	3.49E-01
588	1.29E-01	2.39E+00	7.16E-01	2.55E-01	2.32E-01	2.15E+00	2.66E-01
592	1.27E-01	2.27E+00	1.07E+00	2.75E-01	2.89E-01	2.02E+00	2.57E-01
596	1.80E-01	3.13E+00	9.25E-01	3.39E-01	3.01E-01	2.93E+00	3.73E-01
600	1.74E-01	2.90E+00	6.18E-01	3.01E-01	2.43E-01	2.81E+00	3.67E-01
604	1.36E-01	2.19E+00	4.11E-01	2.26E-01	1.77E-01	2.15E+00	2.88E-01
608	1.05E-01	1.67E+00	2.99E-01	1.72E-01	1.33E-01	1.64E+00	2.25E-01
612	9.16E-02	1.48E+00	2.50E-01	1.51E-01	1.15E-01	1.42E+00	1.99E-01
616	9.00E-02	1.49E+00	2.24E-01	1.47E-01	1.09E-01	1.38E+00	1.96E-01
620	7.17E-02	1.18E+00	1.81E-01	1.15E-01	8.67E-02	1.09E+00	1.56E-01
624	5.13E-02	8.10E-01	1.36E-01	8.24E-02	6.30E-02	7.85E-01	1.10E-01
628	4.40E-02	6.81E-01	1.19E-01	7.02E-02	5.39E-02	6.63E-01	9.36E-02
632	3.90E-02	6.01E-01	1.06E-01	6.25E-02	4.80E-02	5.89E-01	8.27E-02
636	3.51E-02	5.35E-01	9.75E-02	5.58E-02	4.38E-02	5.24E-01	7.36E-02
640	3.12E-02	4.78E-01	1.00E-01	5.02E-02	3.95E-02	4.62E-01	6.65E-02
644	2.81E-02	4.24E-01	8.20E-02	4.59E-02	3.53E-02	4.10E-01	6.02E-02
648	2.58E-02	3.85E-01	7.93E-02	4.13E-02	3.33E-02	3.71E-01	5.46E-02
652	2.40E-02	3.49E-01	7.87E-02	3.91E-02	3.25E-02	3.35E-01	5.05E-02
656	2.23E-02	3.26E-01	7.83E-02	3.79E-02	3.21E-02	3.11E-01	4.78E-02
660	2.06E-02	2.98E-01	6.71E-02	3.40E-02	2.76E-02	2.83E-01	4.38E-02
664	1.91E-02	2.76E-01	6.65E-02	3.16E-02	2.56E-02	2.62E-01	4.03E-02
668	1.90E-02	2.69E-01	1.12E-01	3.50E-02	3.51E-02	2.59E-01	4.05E-02
672	1.87E-02	2.62E-01	1.52E-01	3.86E-02	4.28E-02	2.50E-01	4.03E-02
676	1.68E-02	2.33E-01	9.44E-02	3.04E-02	2.96E-02	2.24E-01	3.56E-02
680	1.47E-02	2.05E-01	5.32E-02	2.33E-02	2.05E-02	1.93E-01	3.03E-02
684	1.22E-02	1.78E-01	4.30E-02	2.00E-02	1.75E-02	1.61E-01	2.64E-02
688	1.06E-02	1.58E-01	3.66E-02	1.76E-02	1.61E-02	1.49E-01	2.25E-02
692	9.29E-03	1.37E-01	3.38E-02	1.64E-02	1.37E-02	1.21E-01	2.07E-02
696	8.78E-03	1.23E-01	2.95E-02	1.46E-02	1.19E-02	8.86E-02	2.03E-02
700	8.07E-03	1.15E-01	2.27E-02	1.41E-02	1.10E-02	1.02E-01	1.71E-02
704	7.94E-03	1.04E-01	1.36E-02	1.21E-02	1.03E-02	9.05E-02	1.57E-02
708	7.03E-03	9.95E-02	2.37E-02	1.11E-02	9.63E-03	7.99E-02	1.44E-02
712	6.39E-03	8.29E-02	2.37E-02	1.03E-02	1.15E-02	7.34E-02	1.31E-02
716	5.94E-03	7.75E-02	2.36E-02	9.49E-03	7.70E-03	5.62E-02	1.03E-02
720	5.61E-03	7.44E-02	1.96E-02	9.12E-03	7.11E-03	5.69E-02	1.02E-02
724	5.27E-03	6.26E-02	2.29E-02	7.01E-03	7.76E-03	5.09E-02	1.12E-02
728	5.15E-03	6.23E-02	2.11E-02	6.94E-03	7.35E-03	3.13E-02	9.89E-03
732	4.25E-03	5.26E-02	2.00E-02	5.70E-03	5.63E-03	5.04E-02	9.10E-03
736	3.29E-03	4.33E-02	1.65E-02	5.41E-03	5.87E-03	5.34E-02	7.13E-03
740	2.66E-03	3.72E-02	1.26E-02	4.66E-03	5.64E-03	2.91E-02	5.68E-03
744	2.93E-03	3.25E-02	7.69E-03	4.69E-03	4.26E-03	2.29E-02	6.17E-03
748	2.50E-03	3.16E-02	2.57E-03	5.21E-03	3.99E-03	1.30E-02	1.86E-03

752	2.24E-03	2.83E-02	8.59E-04	3.84E-03	3.48E-03	2.41E-03	2.38E-03
756	2.62E-03	2.84E-03	6.25E-03	4.75E-03	5.44E-03	2.67E-03	4.55E-03
760	2.24E-03	1.25E-02	1.19E-02	4.75E-03	3.72E-03	4.35E-02	4.26E-03
764	2.25E-03	3.03E-02	1.47E-02	8.34E-03	5.73E-03	2.85E-02	3.96E-03
768	6.49E-03	4.99E-02	4.54E-02	1.07E-02	7.69E-03	1.40E-02	8.74E-03
772	4.69E-03	3.62E-02	3.35E-02	9.20E-03	2.98E-03	3.51E-03	7.05E-03
776	5.05E-03	4.35E-02	1.53E-02	5.11E-03	4.73E-04	0.00E+00	1.84E-03
780	1.42E-03	1.26E-02	2.57E-03	2.09E-03	1.60E-04	0.00E+00	0.00E+00

Table 5 (cont.). Spectral radiance ($W/sr*m^2$) at the pipe side in the VIS region for the set of new lamps.

NEW LAMPS Pipe side						
λ (nm)	TRAY					
	15	16	17	18	19	20
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
384	0.00E+00	0.00E+00	0.00E+00	4.27E-04	0.00E+00	0.00E+00
388	0.00E+00	0.00E+00	0.00E+00	2.88E-04	0.00E+00	0.00E+00
392	0.00E+00	2.52E-03	0.00E+00	9.18E-07	0.00E+00	0.00E+00
396	0.00E+00	3.13E-04	9.62E-07	8.75E-04	5.71E-06	0.00E+00
400	0.00E+00	1.96E-04	4.60E-04	2.54E-03	2.14E-03	5.46E-05
404	1.58E-04	3.05E-03	1.98E-03	1.85E-02	6.32E-03	1.71E-03
408	1.31E-03	9.57E-03	6.09E-03	5.93E-02	1.96E-02	7.22E-03
412	2.41E-03	1.49E-02	1.01E-02	9.68E-02	3.23E-02	1.37E-02
416	2.46E-03	1.78E-02	7.93E-03	6.60E-02	2.17E-02	1.61E-02
420	2.84E-03	2.17E-02	5.93E-03	3.72E-02	1.22E-02	1.90E-02
424	3.18E-03	2.96E-02	6.71E-03	3.66E-02	1.22E-02	2.23E-02
428	3.59E-03	3.20E-02	8.17E-03	4.65E-02	1.58E-02	2.82E-02
432	4.81E-03	4.04E-02	1.12E-02	6.86E-02	2.34E-02	3.44E-02
436	6.52E-03	4.92E-02	1.66E-02	1.13E-01	3.84E-02	4.31E-02
440	6.67E-03	5.00E-02	1.60E-02	1.06E-01	3.63E-02	4.42E-02
444	6.01E-03	4.62E-02	1.40E-02	9.17E-02	3.06E-02	4.08E-02
448	9.61E-03	6.77E-02	2.39E-02	1.73E-01	5.66E-02	6.05E-02
452	1.69E-02	9.62E-02	5.15E-02	4.48E-01	1.45E-01	8.92E-02
456	1.21E-02	6.24E-02	3.73E-02	3.33E-01	1.06E-01	5.96E-02
460	5.80E-03	4.03E-02	1.35E-02	9.51E-02	3.06E-02	3.54E-02
464	9.33E-03	8.38E-02	1.49E-02	5.06E-02	1.92E-02	7.02E-02
468	1.40E-02	1.30E-01	2.10E-02	5.05E-02	2.14E-02	1.09E-01
472	8.73E-03	8.29E-02	1.43E-02	4.09E-02	1.67E-02	6.94E-02
476	4.90E-03	4.49E-02	8.76E-03	3.28E-02	1.19E-02	3.68E-02
480	2.37E-03	2.24E-02	5.41E-03	2.86E-02	8.96E-03	1.83E-02
484	1.72E-03	1.61E-02	4.59E-03	2.60E-02	7.94E-03	1.30E-02
488	2.18E-03	2.03E-02	5.43E-03	2.84E-02	9.12E-03	1.79E-02
492	5.34E-03	4.87E-02	9.65E-03	3.40E-02	1.23E-02	4.16E-02
496	2.29E-02	2.20E-01	3.38E-02	5.97E-02	2.88E-02	1.83E-01
500	3.33E-02	3.16E-01	4.71E-02	7.35E-02	3.83E-02	2.65E-01
504	1.08E-02	1.02E-01	1.68E-02	4.06E-02	1.75E-02	8.86E-02
508	3.38E-03	3.07E-02	7.07E-03	3.06E-02	1.05E-02	2.64E-02
512	5.42E-03	4.93E-02	1.01E-02	3.65E-02	1.38E-02	4.29E-02
516	8.62E-03	8.04E-02	1.47E-02	4.62E-02	1.82E-02	6.81E-02
520	5.03E-03	4.93E-02	1.10E-02	5.08E-02	1.75E-02	4.21E-02
524	2.64E-03	2.30E-02	7.62E-03	4.63E-02	1.48E-02	2.24E-02
528	3.22E-03	2.52E-02	8.66E-03	5.63E-02	1.88E-02	2.41E-02
532	8.65E-03	4.08E-02	3.14E-02	2.72E-01	9.07E-02	4.27E-02
536	1.89E-02	6.97E-02	7.43E-02	6.84E-01	2.26E-01	7.87E-02
540	1.65E-02	6.59E-02	6.24E-02	5.64E-01	1.85E-01	7.15E-02
544	9.60E-03	5.82E-02	2.86E-02	2.13E-01	7.27E-02	5.42E-02
548	1.17E-02	1.07E-01	2.71E-02	1.28E-01	4.88E-02	9.23E-02
552	1.95E-02	2.13E-01	3.37E-02	7.25E-02	3.29E-02	1.75E-01
556	3.61E-02	4.05E-01	5.65E-02	6.68E-02	3.95E-02	3.30E-01

560	5.98E-02	6.65E-01	9.04E-02	8.55E-02	5.75E-02	5.39E-01
564	8.36E-02	9.13E-01	1.24E-01	1.19E-01	7.99E-02	7.39E-01
568	1.36E-01	1.43E+00	1.98E-01	2.20E-01	1.37E-01	1.16E+00
572	1.28E-01	1.37E+00	1.89E-01	2.07E-01	1.30E-01	1.11E+00
576	1.03E-01	1.14E+00	1.56E-01	1.61E-01	1.07E-01	9.23E-01
580	1.18E-01	1.31E+00	1.80E-01	1.77E-01	1.20E-01	1.05E+00
584	1.32E-01	1.39E+00	1.95E-01	2.26E-01	1.36E-01	1.10E+00
588	9.15E-02	8.02E-01	1.51E-01	5.30E-01	1.98E-01	6.41E-01
592	9.11E-02	7.38E-01	1.68E-01	7.81E-01	2.69E-01	6.00E-01
596	1.40E-01	1.33E+00	2.30E-01	6.53E-01	2.57E-01	1.07E+00
600	1.47E-01	1.53E+00	2.31E-01	4.39E-01	2.03E-01	1.22E+00
604	1.21E-01	1.30E+00	1.88E-01	2.99E-01	1.52E-01	1.05E+00
608	9.60E-02	1.05E+00	1.50E-01	2.26E-01	1.18E-01	8.44E-01
612	8.41E-02	9.23E-01	1.30E-01	1.91E-01	1.02E-01	7.43E-01
616	8.11E-02	8.84E-01	1.24E-01	1.69E-01	9.33E-02	7.12E-01
620	6.56E-02	7.19E-01	1.00E-01	1.35E-01	7.47E-02	5.80E-01
624	4.82E-02	5.37E-01	7.45E-02	1.02E-01	5.67E-02	4.32E-01
628	4.11E-02	4.63E-01	6.47E-02	8.83E-02	4.89E-02	3.72E-01
632	3.69E-02	4.14E-01	5.83E-02	8.07E-02	4.42E-02	3.31E-01
636	3.35E-02	3.73E-01	5.21E-02	7.33E-02	3.98E-02	2.99E-01
640	3.05E-02	3.37E-01	4.69E-02	6.70E-02	3.58E-02	2.69E-01
644	2.73E-02	3.02E-01	4.21E-02	6.04E-02	3.30E-02	2.43E-01
648	2.50E-02	2.76E-01	3.86E-02	5.69E-02	3.10E-02	2.21E-01
652	2.33E-02	2.55E-01	3.65E-02	5.92E-02	3.06E-02	2.06E-01
656	2.21E-02	2.39E-01	3.42E-02	6.14E-02	3.09E-02	1.93E-01
660	1.98E-02	2.19E-01	3.15E-02	5.25E-02	2.68E-02	1.77E-01
664	1.87E-02	2.04E-01	2.94E-02	5.23E-02	2.56E-02	1.65E-01
668	1.91E-02	2.00E-01	3.32E-02	9.52E-02	3.78E-02	1.63E-01
672	1.91E-02	1.97E-01	3.64E-02	1.29E-01	4.85E-02	1.57E-01
676	1.67E-02	1.77E-01	2.89E-02	7.63E-02	3.13E-02	1.42E-01
680	1.43E-02	1.56E-01	2.31E-02	4.43E-02	2.00E-02	1.24E-01
684	1.20E-02	1.35E-01	1.97E-02	3.18E-02	1.68E-02	1.10E-01
688	1.09E-02	1.20E-01	1.76E-02	2.88E-02	1.46E-02	9.76E-02
692	9.90E-03	1.12E-01	1.59E-02	2.37E-02	1.30E-02	8.65E-02
696	8.86E-03	9.91E-02	1.38E-02	2.15E-02	1.15E-02	7.63E-02
700	8.35E-03	9.29E-02	1.26E-02	2.15E-02	1.12E-02	7.37E-02
704	7.50E-03	8.59E-02	1.19E-02	2.14E-02	1.11E-02	6.88E-02
708	7.29E-03	7.91E-02	1.18E-02	2.20E-02	9.92E-03	6.31E-02
712	6.46E-03	7.30E-02	1.13E-02	2.24E-02	9.15E-03	5.87E-02
716	6.59E-03	6.46E-02	1.02E-02	1.88E-02	8.54E-03	5.10E-02
720	5.92E-03	6.67E-02	9.35E-03	1.80E-02	8.55E-03	4.87E-02
724	5.62E-03	6.23E-02	7.99E-03	1.27E-02	7.70E-03	4.66E-02
728	5.16E-03	5.56E-02	8.47E-03	1.01E-02	8.23E-03	4.45E-02
732	4.86E-03	4.66E-02	7.19E-03	9.63E-03	6.94E-03	4.07E-02
736	4.56E-03	3.83E-02	6.41E-03	1.33E-02	7.44E-03	4.07E-02
740	3.45E-03	4.13E-02	6.31E-03	1.03E-02	5.98E-03	3.34E-02
744	3.40E-03	3.98E-02	5.92E-03	6.56E-03	4.86E-03	2.79E-02
748	2.58E-03	3.52E-02	6.45E-03	4.20E-03	5.09E-03	2.56E-02

752	4.69E-04	2.96E-02	5.49E-03	1.32E-03	4.13E-03	2.33E-02
756	2.40E-03	2.19E-02	3.49E-03	1.71E-03	6.21E-03	1.86E-02
760	9.64E-04	2.55E-02	3.04E-03	3.97E-06	5.01E-03	2.64E-02
764	2.92E-03	4.57E-02	6.58E-03	8.62E-03	3.74E-03	3.78E-02
768	5.51E-03	5.48E-02	1.02E-02	1.88E-02	1.10E-02	4.89E-02
772	5.64E-03	4.37E-02	8.00E-03	2.13E-03	8.14E-03	2.78E-02
776	3.52E-03	2.89E-02	5.15E-03	1.22E-03	1.85E-03	1.41E-02
780	1.27E-03	1.01E-02	1.72E-03	2.17E-41	3.28E-04	1.43E-03

Table 5 (cont.). Spectral radiance (W/sr*m^2) at the pipe side in the VIS region for the set of new lamps.

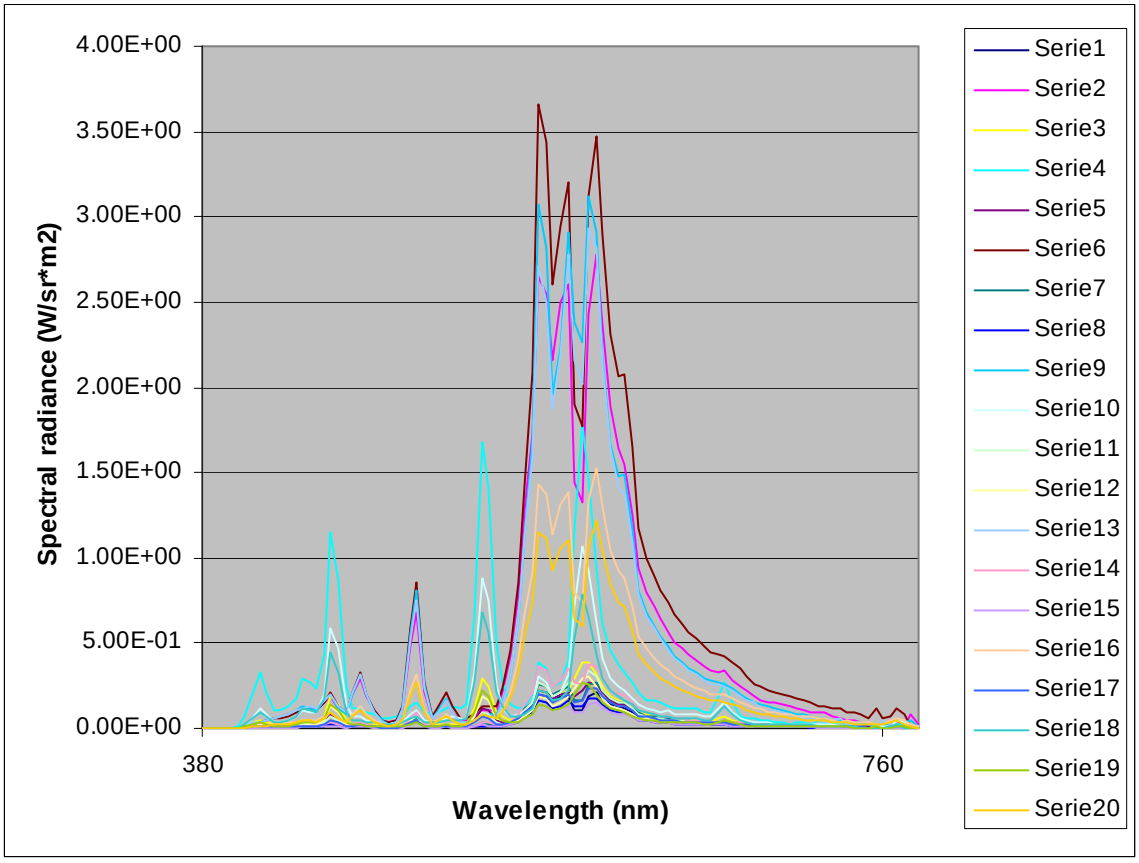


Figure 3. Spectral radiance (W/sr*m^2) at the pipe side in the VIS region for the set of new lamps (Table 5).

OLD LAMPS	Central						
λ (nm)	TRAY						
	1	2	3	4	5	6	7
380		0.00E+00		0.00E+00		0.00E+00	
384		0.00E+00		0.00E+00		0.00E+00	
388		0.00E+00		0.00E+00		0.00E+00	
392		0.00E+00		0.00E+00		0.00E+00	
396		0.00E+00		3.18E-05		4.55E-06	
400		1.28E-03		1.33E-02		1.38E-03	
404		1.39E-02		5.04E-02		2.84E-03	
408		2.94E-02		1.50E-01		9.73E-03	
412		3.68E-02		2.37E-01		1.54E-02	
416		4.63E-02		1.54E-01		1.81E-02	
420		5.90E-02		7.78E-02		2.13E-02	
424		6.76E-02		7.36E-02		2.48E-02	
428		8.28E-02		9.00E-02		2.84E-02	
432		1.01E-01		1.40E-01		3.64E-02	
436		1.21E-01		2.36E-01		4.35E-02	
440		1.24E-01		2.13E-01		4.48E-02	
444		1.15E-01		1.73E-01		4.17E-02	
448		1.65E-01		3.29E-01		6.17E-02	
452		2.03E-01		8.71E-01		8.45E-02	
456		1.29E-01		6.50E-01		5.46E-02	
460		9.45E-02		1.86E-01		3.45E-02	
464		2.22E-01		8.99E-02		7.39E-02	
468		3.46E-01		8.94E-02		1.17E-01	
472		2.15E-01		7.46E-02		7.35E-02	
476		1.05E-01		5.94E-02		4.13E-02	
480		5.40E-02		5.19E-02		1.81E-02	
484		3.58E-02		5.05E-02		1.34E-02	
488		4.96E-02		5.40E-02		1.79E-02	
492		1.32E-01		6.23E-02		4.01E-02	
496		5.99E-01		9.91E-02		1.85E-01	
500		8.65E-01		1.21E-01		2.66E-01	
504		2.82E-01		7.40E-02		8.42E-02	
508		7.46E-02		6.16E-02		2.52E-02	
512		1.25E-01		7.12E-02		4.11E-02	
516		2.10E-01		8.80E-02		6.70E-02	
520		1.22E-01		1.02E-01		4.05E-02	
524		4.84E-02		9.38E-02		2.26E-02	
528		5.33E-02		1.16E-01		2.33E-02	
532		6.62E-02		5.70E-01		3.50E-02	
536		9.25E-02		1.45E+00		5.61E-02	
540		9.70E-02		1.21E+00		5.40E-02	
544		1.14E-01		4.77E-01		4.98E-02	
548		2.29E-01		2.97E-01		9.66E-02	
552		4.58E-01		1.43E-01		1.96E-01	
556		8.61E-01		1.01E-01		3.78E-01	

560		1.41E+00		1.13E-01		6.20E-01	
564		2.02E+00		1.56E-01		8.23E-01	
568		3.38E+00		3.17E-01		1.22E+00	
572		3.21E+00		2.99E-01		1.19E+00	
576		2.51E+00		2.46E-01		1.04E+00	
580		2.85E+00		2.70E-01		1.24E+00	
584		3.04E+00		3.32E-01		1.34E+00	
588		1.72E+00		8.93E-01		7.96E-01	
592		1.57E+00		1.34E+00		7.38E-01	
596		2.87E+00		1.10E+00		1.31E+00	
600		3.27E+00		7.13E-01		1.47E+00	
604		2.76E+00		4.76E-01		1.24E+00	
608		2.21E+00		3.53E-01		9.87E-01	
612		1.95E+00		2.97E-01		8.48E-01	
616		1.92E+00		2.61E-01		7.91E-01	
620		1.54E+00		2.10E-01		6.45E-01	
624		1.11E+00		1.64E-01		4.91E-01	
628		9.43E-01		1.42E-01		4.24E-01	
632		8.40E-01		1.28E-01		3.78E-01	
636		7.56E-01		1.16E-01		3.41E-01	
640		6.81E-01		1.04E-01		3.08E-01	
644		6.15E-01		9.83E-02		2.72E-01	
648		5.67E-01		9.38E-02		2.54E-01	
652		5.19E-01		1.02E-01		2.33E-01	
656		4.85E-01		1.14E-01		2.14E-01	
660		4.37E-01		9.43E-02		1.96E-01	
664		4.05E-01		8.82E-02		1.87E-01	
668		3.93E-01		1.68E-01		1.86E-01	
672		3.82E-01		2.36E-01		1.76E-01	
676		3.50E-01		1.34E-01		1.63E-01	
680		3.10E-01		6.92E-02		1.43E-01	
684		2.71E-01		5.51E-02		1.24E-01	
688		2.38E-01		5.05E-02		1.10E-01	
692		2.18E-01		4.44E-02		1.02E-01	
696		2.04E-01		3.99E-02		8.83E-02	
700		1.84E-01		3.91E-02		8.27E-02	
704		1.69E-01		3.49E-02		7.84E-02	
708		1.50E-01		3.08E-02		7.31E-02	
712		1.32E-01		2.14E-02		6.42E-02	
716		1.20E-01		2.83E-02		6.24E-02	
720		1.20E-01		2.56E-02		5.72E-02	
724		1.10E-01		2.62E-02		5.63E-02	
728		1.00E-01		2.52E-02		4.98E-02	
732		9.72E-02		2.00E-02		4.67E-02	
736		9.08E-02		2.22E-02		4.46E-02	
740		8.48E-02		2.26E-02		4.21E-02	
744		8.71E-02		2.04E-02		3.70E-02	
748		6.54E-02		2.36E-02		3.51E-02	

752		4.39E-02		1.62E-02		3.85E-02	
756		3.64E-02		7.71E-03		3.10E-02	
760		1.14E-02		4.77E-03		2.74E-02	
764		6.32E-02		1.66E-02		4.75E-02	
768		1.52E-01		2.88E-02		5.21E-02	
772		5.16E-02		7.07E-03		3.08E-02	
776		4.55E-03		0.00E+00		1.22E-02	
780		3.38E-03		0.00E+00		1.06E-02	

Table 6. Spectral radiance ($W/sr*m^2$) at the central position in the VIS region for the set of old lamps.

OLD LAMPS Central							
λ (nm)	TRAY						
	8	9	10	11	12	13	14
380	0.00E+00		0.00E+00		6.94E-04		0.00E+00
384	0.00E+00		2.08E-04		6.31E-04		0.00E+00
388	0.00E+00		1.39E-04		0.00E+00		0.00E+00
392	0.00E+00		0.00E+00		0.00E+00		0.00E+00
396	0.00E+00		4.22E-06		7.99E-04		0.00E+00
400	6.73E-05		1.75E-03		2.66E-04		7.12E-05
404	9.72E-04		6.33E-03		2.76E-03		5.98E-04
408	4.03E-03		2.07E-02		6.27E-03		1.58E-03
412	7.28E-03		3.51E-02		9.60E-03		2.89E-03
416	9.91E-03		2.39E-02		9.52E-03		2.68E-03
420	1.25E-02		1.36E-02		8.97E-03		2.49E-03
424	1.45E-02		1.38E-02		1.02E-02		2.90E-03
428	1.64E-02		1.81E-02		1.23E-02		3.39E-03
432	2.06E-02		2.77E-02		1.60E-02		4.73E-03
436	2.54E-02		4.56E-02		2.22E-02		6.40E-03
440	2.59E-02		4.23E-02		2.19E-02		6.41E-03
444	2.32E-02		3.58E-02		1.91E-02		5.76E-03
448	3.47E-02		6.72E-02		3.26E-02		9.25E-03
452	4.88E-02		1.75E-01		6.07E-02		1.70E-02
456	3.19E-02		1.31E-01		4.29E-02		1.20E-02
460	2.00E-02		3.89E-02		1.82E-02		5.40E-03
464	4.19E-02		2.34E-02		2.80E-02		8.35E-03
468	6.61E-02		2.59E-02		4.21E-02		1.24E-02
472	4.06E-02		2.09E-02		2.67E-02		8.02E-03
476	2.20E-02		1.51E-02		1.49E-02		4.33E-03
480	1.01E-02		1.15E-02		7.93E-03		2.63E-03
484	7.57E-03		1.06E-02		6.00E-03		2.00E-03
488	1.04E-02		1.13E-02		7.43E-03		2.39E-03
492	2.39E-02		1.57E-02		1.64E-02		5.07E-03
496	1.08E-01		3.41E-02		6.99E-02		2.10E-02
500	1.57E-01		4.41E-02		1.01E-01		3.00E-02
504	4.96E-02		2.09E-02		3.34E-02		9.93E-03
508	1.49E-02		1.39E-02		1.13E-02		3.23E-03
512	2.47E-02		1.66E-02		1.75E-02		5.24E-03
516	4.00E-02		2.15E-02		2.78E-02		8.24E-03
520	2.41E-02		2.16E-02		1.81E-02		5.54E-03
524	1.23E-02		1.88E-02		1.03E-02		3.45E-03
528	1.21E-02		2.34E-02		1.11E-02		3.64E-03
532	1.86E-02		1.10E-01		3.11E-02		1.04E-02
536	3.18E-02		2.79E-01		6.97E-02		2.35E-02
540	3.05E-02		2.34E-01		6.06E-02		2.01E-02
544	2.73E-02		9.13E-02		3.24E-02		1.07E-02
548	5.19E-02		5.88E-02		3.96E-02		1.30E-02
552	1.03E-01		3.72E-02		6.29E-02		2.05E-02
556	1.99E-01		4.05E-02		1.15E-01		3.76E-02

560	3.27E-01		5.67E-02		1.89E-01		6.14E-02
564	4.38E-01		7.80E-02		2.64E-01		8.52E-02
568	6.67E-01		1.36E-01		4.32E-01		1.37E-01
572	6.44E-01		1.29E-01		4.12E-01		1.31E-01
576	5.46E-01		1.04E-01		3.32E-01		1.08E-01
580	6.27E-01		1.16E-01		3.81E-01		1.25E-01
584	6.57E-01		1.36E-01		4.18E-01		1.36E-01
588	3.71E-01		2.36E-01		2.75E-01		9.09E-02
592	3.37E-01		3.42E-01		2.74E-01		9.18E-02
596	6.16E-01		3.15E-01		4.37E-01		1.44E-01
600	7.10E-01		2.33E-01		4.66E-01		1.54E-01
604	6.09E-01		1.67E-01		3.86E-01		1.27E-01
608	4.92E-01		1.27E-01		3.06E-01		1.01E-01
612	4.32E-01		1.08E-01		2.69E-01		8.90E-02
616	4.13E-01		9.83E-02		2.61E-01		8.54E-02
620	3.36E-01		7.78E-02		2.10E-01		6.92E-02
624	2.53E-01		5.97E-02		1.54E-01		5.12E-02
628	2.18E-01		5.13E-02		1.33E-01		4.40E-02
632	1.93E-01		4.60E-02		1.18E-01		3.94E-02
636	1.74E-01		4.16E-02		1.07E-01		3.54E-02
640	1.56E-01		3.82E-02		9.66E-02		3.23E-02
644	1.41E-01		3.47E-02		8.64E-02		2.89E-02
648	1.30E-01		3.25E-02		7.91E-02		2.69E-02
652	1.20E-01		3.28E-02		7.38E-02		2.50E-02
656	1.11E-01		3.40E-02		6.92E-02		2.37E-02
660	1.03E-01		2.84E-02		6.29E-02		2.13E-02
664	9.36E-02		2.71E-02		5.83E-02		2.00E-02
668	9.33E-02		4.45E-02		5.99E-02		2.02E-02
672	8.75E-02		5.90E-02		6.18E-02		2.12E-02
676	8.06E-02		3.71E-02		5.44E-02		1.82E-02
680	7.17E-02		2.22E-02		4.56E-02		1.55E-02
684	6.20E-02		1.77E-02		3.90E-02		1.38E-02
688	5.53E-02		1.59E-02		3.36E-02		1.23E-02
692	4.71E-02		1.36E-02		3.45E-02		1.12E-02
696	4.24E-02		1.17E-02		2.76E-02		1.03E-02
700	4.23E-02		1.12E-02		2.53E-02		9.65E-03
704	3.94E-02		1.06E-02		2.44E-02		8.64E-03
708	3.64E-02		9.64E-03		2.30E-02		7.85E-03
712	3.42E-02		9.79E-03		2.19E-02		7.40E-03
716	3.38E-02		8.73E-03		2.00E-02		6.94E-03
720	2.99E-02		8.18E-03		2.07E-02		6.53E-03
724	2.68E-02		7.40E-03		1.92E-02		6.06E-03
728	2.32E-02		6.51E-03		1.81E-02		5.36E-03
732	2.10E-02		6.50E-03		1.69E-02		4.95E-03
736	1.98E-02		5.04E-03		1.57E-02		4.17E-03
740	1.44E-02		3.54E-03		1.35E-02		4.43E-03
744	1.29E-02		3.62E-03		1.59E-02		4.15E-03
748	1.22E-02		2.65E-03		1.39E-02		3.75E-03

752	8.58E-03		3.96E-03		8.92E-03		3.90E-03
756	7.57E-03		3.93E-03		7.28E-03		3.17E-03
760	9.77E-03		3.95E-03		5.49E-03		3.06E-03
764	1.27E-02		8.97E-03		9.85E-03		4.21E-03
768	1.87E-02		1.50E-02		1.89E-02		5.92E-03
772	1.73E-02		8.31E-03		1.03E-02		4.91E-03
776	4.40E-03		2.07E-03		9.04E-03		4.24E-03
780	2.21E-03		3.91E-04		3.26E-03		1.33E-03

Table 6 (cont.). Spectral radiance ($W/sr*m^2$) at the central position in the VIS region for the set of old lamps.

OLD LAMPS	Central					
λ (nm)	TRAY					
	15	16	17	18	19	20
380		1.62E-41		1.62E-41		0.00E+00
384		1.20E-41		1.20E-41		0.00E+00
388		1.13E-41		1.13E-41		0.00E+00
392		9.15E-42		9.15E-42		0.00E+00
396		7.18E-42		1.72E-05		0.00E+00
400		6.07E-42		1.00E-02		0.00E+00
404		5.33E-42		5.57E-02		0.00E+00
408		5.07E-03		1.73E-01		8.60E-03
412		1.30E-02		2.81E-01		2.74E-02
416		2.13E-02		1.80E-01		4.14E-02
420		2.38E-02		9.36E-02		5.60E-02
424		3.60E-02		9.40E-02		7.04E-02
428		4.97E-02		1.15E-01		8.93E-02
432		6.25E-02		2.23E-01		1.10E-01
436		7.90E-02		4.12E-01		1.37E-01
440		8.39E-02		3.52E-01		1.45E-01
444		7.40E-02		2.64E-01		1.34E-01
448		1.16E-01		5.16E-01		2.03E-01
452		1.49E-01		1.40E+00		2.51E-01
456		9.06E-02		1.02E+00		1.58E-01
460		6.14E-02		2.72E-01		1.19E-01
464		1.65E-01		1.24E-01		2.78E-01
468		2.61E-01		1.14E-01		4.43E-01
472		1.62E-01		1.11E-01		2.69E-01
476		8.89E-02		8.03E-02		1.41E-01
480		3.97E-02		7.23E-02		6.78E-02
484		2.76E-02		7.01E-02		4.28E-02
488		3.99E-02		7.66E-02		6.29E-02
492		1.07E-01		8.99E-02		1.73E-01
496		5.11E-01		1.35E-01		8.23E-01
500		7.47E-01		1.60E-01		1.20E+00
504		2.37E-01		1.05E-01		3.84E-01
508		6.54E-02		9.05E-02		1.00E-01
512		1.17E-01		1.05E-01		1.78E-01
516		1.94E-01		1.30E-01		3.01E-01
520		1.11E-01		1.52E-01		1.74E-01
524		5.33E-02		1.45E-01		7.71E-02
528		5.19E-02		1.87E-01		7.68E-02
532		6.13E-02		1.02E+00		9.56E-02
536		8.45E-02		2.57E+00		1.31E-01
540		9.21E-02		2.11E+00		1.40E-01
544		1.13E-01		8.93E-01		1.70E-01
548		2.39E-01		6.22E-01		3.53E-01
552		5.04E-01		2.62E-01		7.21E-01
556		9.82E-01		1.39E-01		1.37E+00

560		1.63E+00		1.33E-01		2.26E+00
564		2.33E+00		1.96E-01		3.27E+00
568		3.95E+00		4.26E-01		5.62E+00
572		3.75E+00		4.15E-01		5.31E+00
576		2.94E+00		3.99E-01		4.08E+00
580		3.35E+00		4.33E-01		4.61E+00
584		3.61E+00		4.57E-01		4.93E+00
588		2.06E+00		1.43E+00		2.79E+00
592		1.88E+00		2.15E+00		2.54E+00
596		3.51E+00		1.63E+00		4.73E+00
600		4.01E+00		9.70E-01		5.43E+00
604		3.42E+00		6.23E-01		4.63E+00
608		2.76E+00		4.65E-01		3.74E+00
612		2.48E+00		4.08E-01		3.36E+00
616		2.47E+00		3.48E-01		3.38E+00
620		2.00E+00		2.70E-01		2.72E+00
624		1.45E+00		2.08E-01		1.96E+00
628		1.25E+00		1.83E-01		1.68E+00
632		1.13E+00		1.65E-01		1.51E+00
636		1.02E+00		1.53E-01		1.37E+00
640		9.28E-01		1.39E-01		1.24E+00
644		8.40E-01		1.24E-01		1.13E+00
648		7.81E-01		1.24E-01		1.03E+00
652		7.22E-01		1.45E-01		9.54E-01
656		6.73E-01		1.80E-01		8.88E-01
660		6.29E-01		1.31E-01		8.24E-01
664		5.90E-01		1.11E-01		7.65E-01
668		5.72E-01		2.72E-01		7.43E-01
672		5.57E-01		3.96E-01		7.32E-01
676		5.21E-01		2.16E-01		6.67E-01
680		4.59E-01		9.94E-02		5.94E-01
684		4.08E-01		9.03E-02		5.21E-01
688		3.58E-01		7.76E-02		4.60E-01
692		3.23E-01		6.13E-02		4.24E-01
696		2.99E-01		3.81E-02		3.89E-01
700		2.85E-01		4.68E-02		3.69E-01
704		2.63E-01		4.63E-02		3.44E-01
708		2.35E-01		4.83E-02		3.22E-01
712		2.29E-01		4.51E-02		3.00E-01
716		2.18E-01		4.62E-02		2.81E-01
720		2.10E-01		4.05E-02		2.68E-01
724		1.93E-01		3.24E-02		2.52E-01
728		1.94E-01		3.26E-02		2.33E-01
732		1.70E-01		2.83E-02		2.21E-01
736		1.59E-01		2.66E-02		2.12E-01
740		1.42E-01		5.81E-03		1.93E-01
744		1.24E-01		2.60E-02		1.64E-01
748		1.25E-01		8.57E-03		1.49E-01

752		1.18E-01		1.14E-02		1.55E-01
756		1.09E-01		2.08E-02		1.15E-01
760		1.05E-01		8.21E-03		1.21E-01
764		1.44E-01		3.88E-02		1.82E-01
768		2.02E-01		6.47E-02		2.35E-01
772		1.52E-01		2.14E-02		1.98E-01
776		6.50E-02		1.06E-02		9.82E-02
780		5.88E-02		5.24E-04		4.60E-02

Table 6 (cont.). Spectral radiance (W/sr*m^2) at the central position in the VIS region for the set of old lamps.

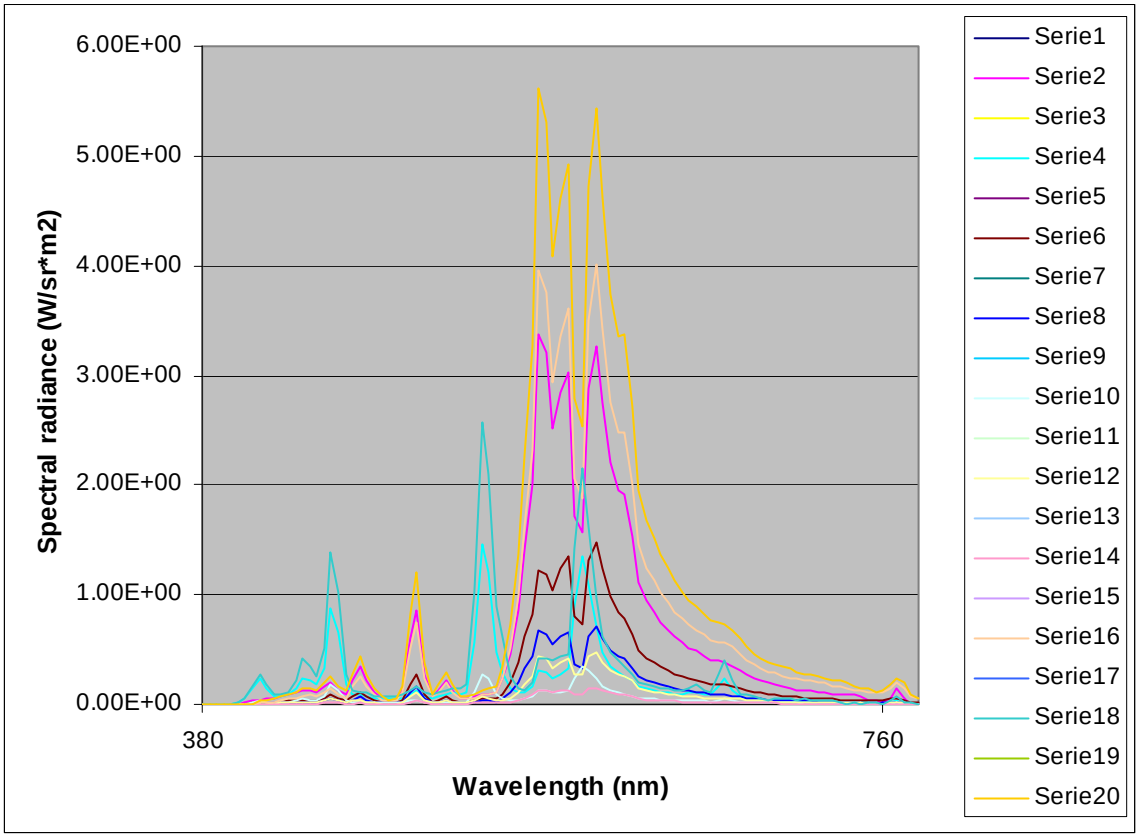


Figure 4. Spectral radiance (W/sr*m^2) at the central position in the VIS region for the set of old lamps (Table 6).

OLD LAMPS Window side							
λ (nm)	TRAY						
	1	2	3	4	5	6	7
380		0.00E+00		2.80E-04		0.00E+00	
384		0.00E+00		0.00E+00		0.00E+00	
388		0.00E+00		0.00E+00		0.00E+00	
392		0.00E+00		0.00E+00		0.00E+00	
396		4.39E-07		0.00E+00		0.00E+00	
400		2.06E-04		6.77E-05		7.31E-05	
404		1.05E-03		8.02E-04		5.97E-04	
408		3.61E-03		2.47E-03		1.53E-03	
412		5.98E-03		3.89E-03		2.79E-03	
416		4.60E-03		3.20E-03		2.41E-03	
420		3.29E-03		2.61E-03		2.05E-03	
424		3.55E-03		2.91E-03		2.17E-03	
428		4.54E-03		3.66E-03		2.77E-03	
432		5.94E-03		4.95E-03		3.68E-03	
436		8.78E-03		6.80E-03		5.18E-03	
440		8.52E-03		6.83E-03		5.16E-03	
444		7.43E-03		6.14E-03		4.55E-03	
448		1.30E-02		1.03E-02		7.57E-03	
452		2.85E-02		2.12E-02		1.53E-02	
456		2.10E-02		1.54E-02		1.11E-02	
460		7.69E-03		6.11E-03		4.45E-03	
464		8.16E-03		7.80E-03		5.98E-03	
468		1.13E-02		1.11E-02		8.76E-03	
472		7.71E-03		7.36E-03		5.77E-03	
476		5.09E-03		4.36E-03		3.39E-03	
480		3.03E-03		2.58E-03		1.97E-03	
484		2.60E-03		2.03E-03		1.51E-03	
488		2.98E-03		2.31E-03		1.96E-03	
492		4.96E-03		4.31E-03		3.70E-03	
496		1.68E-02		1.63E-02		1.44E-02	
500		2.33E-02		2.31E-02		2.06E-02	
504		8.87E-03		8.19E-03		7.10E-03	
508		3.61E-03		2.83E-03		2.62E-03	
512		5.01E-03		4.10E-03		3.89E-03	
516		7.24E-03		6.16E-03		5.93E-03	
520		5.43E-03		4.28E-03		4.18E-03	
524		3.81E-03		2.63E-03		2.67E-03	
528		4.33E-03		2.83E-03		2.86E-03	
532		1.57E-02		8.33E-03		8.80E-03	
536		3.80E-02		1.91E-02		2.04E-02	
540		3.21E-02		1.62E-02		1.76E-02	
544		1.41E-02		7.77E-03		8.70E-03	
548		1.23E-02		8.28E-03		9.46E-03	
552		1.42E-02		1.20E-02		1.40E-02	
556		2.27E-02		2.10E-02		2.50E-02	

560		3.56E-02		3.37E-02		4.05E-02	
564		4.88E-02		4.60E-02		5.56E-02	
568		7.86E-02		7.35E-02		8.84E-02	
572		7.50E-02		7.00E-02		8.50E-02	
576		6.15E-02		5.70E-02		7.05E-02	
580		7.04E-02		6.53E-02		8.10E-02	
584		7.62E-02		7.06E-02		8.73E-02	
588		6.11E-02		4.77E-02		6.01E-02	
592		6.92E-02		4.84E-02		6.25E-02	
596		9.20E-02		7.44E-02		9.49E-02	
600		9.12E-02		7.88E-02		1.01E-01	
604		7.40E-02		6.54E-02		8.38E-02	
608		5.84E-02		5.17E-02		6.73E-02	
612		5.10E-02		4.52E-02		5.93E-02	
616		4.85E-02		4.34E-02		5.66E-02	
620		3.92E-02		3.50E-02		4.60E-02	
624		2.92E-02		2.59E-02		3.42E-02	
628		2.52E-02		2.20E-02		2.93E-02	
632		2.25E-02		1.98E-02		2.62E-02	
636		2.03E-02		1.78E-02		2.37E-02	
640		1.83E-02		1.62E-02		2.14E-02	
644		1.67E-02		1.44E-02		1.95E-02	
648		1.52E-02		1.33E-02		1.80E-02	
652		1.44E-02		1.24E-02		1.69E-02	
656		1.40E-02		1.17E-02		1.61E-02	
660		1.26E-02		1.05E-02		1.47E-02	
664		1.18E-02		9.82E-03		1.38E-02	
668		1.35E-02		1.03E-02		1.45E-02	
672		1.49E-02		1.05E-02		1.52E-02	
676		1.16E-02		9.11E-03		1.30E-02	
680		9.13E-03		7.55E-03		1.06E-02	
684		7.84E-03		6.67E-03		9.36E-03	
688		7.01E-03		5.77E-03		8.19E-03	
692		6.31E-03		5.14E-03		7.55E-03	
696		5.66E-03		4.65E-03		7.16E-03	
700		5.30E-03		4.47E-03		7.02E-03	
704		4.90E-03		4.06E-03		6.04E-03	
708		4.59E-03		3.77E-03		5.60E-03	
712		4.52E-03		3.68E-03		5.50E-03	
716		4.26E-03		3.37E-03		5.23E-03	
720		3.82E-03		3.04E-03		5.43E-03	
724		4.08E-03		3.10E-03		4.29E-03	
728		3.65E-03		2.75E-03		3.86E-03	
732		3.46E-03		2.58E-03		3.53E-03	
736		3.38E-03		2.01E-03		2.80E-03	
740		2.75E-03		1.78E-03		2.74E-03	
744		2.83E-03		1.98E-03		2.30E-03	
748		2.48E-03		1.59E-03		2.22E-03	

752		2.20E-03		1.66E-03		2.55E-03	
756		2.04E-03		1.85E-03		2.18E-03	
760		1.70E-03		2.19E-03		1.98E-03	
764		3.18E-03		2.70E-03		2.83E-03	
768		4.12E-03		3.35E-03		3.39E-03	
772		3.96E-03		2.34E-03		4.67E-03	
776		2.81E-03		9.64E-04		2.10E-03	
780		1.42E-03		8.18E-05		3.54E-04	

Table 7. Spectral radiance ($W/sr*m^2$) at the window side in the VIS region for the set of old lamps.

OLD LAMPS Window side							
λ (nm)	TRAY						
	8	9	10	11	12	13	14
380	0.00E+00		0.00E+00		0.00E+00		0.00E+00
384	0.00E+00		0.00E+00		0.00E+00		0.00E+00
388	0.00E+00		0.00E+00		0.00E+00		0.00E+00
392	0.00E+00		0.00E+00		0.00E+00		0.00E+00
396	4.38E-07		4.22E-07		0.00E+00		5.01E-07
400	1.89E-04		2.00E-04		4.53E-05		2.06E-04
404	7.66E-04		8.78E-04		4.51E-04		7.54E-04
408	2.30E-03		2.64E-03		1.32E-03		2.41E-03
412	3.73E-03		4.44E-03		2.26E-03		4.09E-03
416	3.03E-03		3.36E-03		2.06E-03		3.21E-03
420	2.39E-03		2.45E-03		1.81E-03		2.46E-03
424	2.70E-03		2.66E-03		2.09E-03		2.74E-03
428	3.28E-03		3.42E-03		2.66E-03		3.52E-03
432	4.62E-03		4.94E-03		3.45E-03		4.82E-03
436	6.96E-03		7.58E-03		4.97E-03		7.26E-03
440	6.86E-03		7.32E-03		5.02E-03		7.19E-03
444	6.07E-03		6.49E-03		4.54E-03		6.42E-03
448	1.08E-02		1.17E-02		7.68E-03		1.12E-02
452	2.38E-02		2.72E-02		1.52E-02		2.42E-02
456	1.77E-02		2.01E-02		1.09E-02		1.76E-02
460	6.42E-03		6.81E-03		4.61E-03		6.44E-03
464	6.80E-03		6.92E-03		6.46E-03		7.30E-03
468	9.42E-03		9.41E-03		9.50E-03		1.02E-02
472	6.56E-03		6.58E-03		6.17E-03		6.87E-03
476	4.04E-03		4.15E-03		3.57E-03		4.20E-03
480	2.47E-03		2.66E-03		1.94E-03		2.58E-03
484	2.08E-03		2.26E-03		1.36E-03		2.05E-03
488	2.39E-03		2.58E-03		1.86E-03		2.45E-03
492	4.06E-03		4.22E-03		3.71E-03		4.31E-03
496	1.39E-02		1.38E-02		1.51E-02		1.53E-02
500	1.96E-02		1.94E-02		2.17E-02		2.16E-02
504	7.03E-03		7.20E-03		7.35E-03		7.59E-03
508	2.87E-03		3.06E-03		2.46E-03		3.23E-03
512	4.09E-03		4.18E-03		3.74E-03		4.18E-03
516	5.97E-03		6.02E-03		5.76E-03		6.14E-03
520	4.54E-03		4.75E-03		3.89E-03		4.52E-03
524	3.15E-03		3.35E-03		2.26E-03		3.05E-03
528	3.57E-03		3.85E-03		2.48E-03		3.31E-03
532	1.30E-02		1.48E-02		6.78E-03		1.22E-02
536	3.14E-02		3.63E-02		1.50E-02		2.91E-02
540	2.67E-02		3.07E-02		1.27E-02		2.42E-02
544	1.16E-02		1.31E-02		6.59E-03		1.08E-02
548	1.00E-02		1.06E-02		7.97E-03		1.00E-02
552	1.17E-02		1.11E-02		1.25E-02		1.21E-02
556	1.93E-02		1.74E-02		2.27E-02		2.01E-02

560	3.06E-02		2.74E-02		3.70E-02		3.18E-02
564	4.14E-02		3.75E-02		5.10E-02		4.34E-02
568	6.60E-02		6.12E-02		8.16E-02		6.94E-02
572	6.31E-02		5.83E-02		7.82E-02		6.64E-02
576	5.20E-02		4.74E-02		6.39E-02		5.43E-02
580	5.92E-02		5.40E-02		7.36E-02		6.17E-02
584	6.39E-02		5.95E-02		7.97E-02		6.60E-02
588	5.18E-02		5.32E-02		5.19E-02		5.10E-02
592	5.92E-02		6.26E-02		5.14E-02		5.57E-02
596	7.86E-02		7.79E-02		8.25E-02		7.57E-02
600	7.76E-02		7.38E-02		8.93E-02		7.67E-02
604	6.33E-02		5.89E-02		7.46E-02		6.31E-02
608	5.04E-02		4.63E-02		5.96E-02		5.05E-02
612	4.39E-02		4.03E-02		5.24E-02		4.42E-02
616	4.16E-02		3.82E-02		5.03E-02		4.21E-02
620	3.37E-02		3.09E-02		4.08E-02		3.40E-02
624	2.53E-02		2.29E-02		3.01E-02		2.52E-02
628	2.19E-02		1.97E-02		2.58E-02		2.17E-02
632	1.95E-02		1.76E-02		2.32E-02		1.94E-02
636	1.79E-02		1.59E-02		2.08E-02		1.76E-02
640	1.62E-02		1.46E-02		1.89E-02		1.59E-02
644	1.45E-02		1.32E-02		1.72E-02		1.45E-02
648	1.35E-02		1.22E-02		1.56E-02		1.32E-02
652	1.27E-02		1.16E-02		1.46E-02		1.25E-02
656	1.21E-02		1.16E-02		1.40E-02		1.20E-02
660	1.09E-02		1.00E-02		1.26E-02		1.08E-02
664	1.03E-02		9.36E-03		1.17E-02		9.99E-03
668	1.18E-02		1.12E-02		1.20E-02		1.11E-02
672	1.30E-02		1.28E-02		1.23E-02		1.23E-02
676	1.00E-02		9.62E-03		1.07E-02		9.83E-03
680	7.78E-03		7.41E-03		9.03E-03		7.76E-03
684	6.76E-03		6.21E-03		7.83E-03		6.70E-03
688	6.12E-03		5.45E-03		7.04E-03		6.07E-03
692	5.53E-03		4.96E-03		6.82E-03		5.41E-03
696	4.97E-03		4.40E-03		6.20E-03		4.56E-03
700	4.47E-03		4.08E-03		5.48E-03		4.55E-03
704	4.05E-03		3.95E-03		5.05E-03		4.32E-03
708	4.02E-03		3.72E-03		4.65E-03		3.97E-03
712	3.65E-03		3.39E-03		4.36E-03		3.83E-03
716	3.41E-03		3.13E-03		3.91E-03		3.56E-03
720	3.37E-03		2.90E-03		3.90E-03		3.30E-03
724	3.07E-03		2.71E-03		3.75E-03		2.93E-03
728	2.40E-03		2.52E-03		3.43E-03		2.76E-03
732	2.80E-03		2.50E-03		3.15E-03		2.49E-03
736	2.72E-03		2.44E-03		2.83E-03		2.00E-03
740	2.19E-03		2.03E-03		2.31E-03		2.19E-03
744	2.11E-03		1.86E-03		2.43E-03		2.00E-03
748	2.03E-03		1.67E-03		2.12E-03		1.64E-03

752	1.67E-03		1.55E-03		2.00E-03		1.68E-03
756	2.21E-03		1.13E-03		1.66E-03		1.63E-03
760	2.50E-03		1.42E-03		1.98E-03		1.74E-03
764	2.90E-03		3.09E-03		3.74E-03		2.65E-03
768	4.32E-03		4.64E-03		4.94E-03		4.08E-03
772	2.80E-03		3.81E-03		3.32E-03		3.21E-03
776	2.10E-03		2.23E-03		1.59E-03		1.81E-03
780	1.40E-03		2.31E-03		9.83E-04		1.32E-03

Table 7 (cont.). Spectral radiance ($W/sr*m^2$) at the window side in the VIS region for the set of old lamps.

OLD LAMPS Window side						
λ (nm)	TRAY					
	15	16	17	18	19	20
380		4.96E-04		0.00E+00		0.00E+00
384		0.00E+00		0.00E+00		0.00E+00
388		0.00E+00		0.00E+00		0.00E+00
392		0.00E+00		0.00E+00		0.00E+00
396		2.72E-05		7.03E-07		0.00E+00
400		3.30E-04		2.37E-04		9.65E-06
404		1.04E-03		5.96E-04		1.21E-04
408		3.62E-03		1.93E-03		4.86E-04
412		5.78E-03		3.15E-03		9.21E-04
416		4.26E-03		2.50E-03		8.84E-04
420		2.85E-03		1.99E-03		8.10E-04
424		3.08E-03		2.33E-03		9.25E-04
428		3.93E-03		2.84E-03		1.38E-03
432		5.64E-03		4.08E-03		1.52E-03
436		8.83E-03		5.93E-03		2.11E-03
440		8.53E-03		5.82E-03		2.06E-03
444		7.41E-03		5.22E-03		1.80E-03
448		1.31E-02		8.93E-03		2.93E-03
452		3.07E-02		1.87E-02		5.21E-03
456		2.26E-02		1.36E-02		3.80E-03
460		7.66E-03		5.32E-03		1.77E-03
464		7.10E-03		6.42E-03		2.72E-03
468		9.46E-03		9.10E-03		4.07E-03
472		6.72E-03		6.14E-03		2.62E-03
476		4.30E-03		3.50E-03		1.29E-03
480		2.94E-03		2.20E-03		7.41E-04
484		2.52E-03		1.73E-03		5.60E-04
488		2.76E-03		2.04E-03		7.88E-04
492		4.32E-03		3.55E-03		1.60E-03
496		1.35E-02		1.32E-02		6.67E-03
500		1.87E-02		1.88E-02		9.61E-03
504		7.15E-03		6.60E-03		3.26E-03
508		3.27E-03		2.44E-03		1.11E-03
512		4.20E-03		3.40E-03		1.71E-03
516		5.98E-03		5.25E-03		2.64E-03
520		4.82E-03		3.58E-03		1.75E-03
524		3.57E-03		2.23E-03		8.85E-04
528		4.13E-03		2.43E-03		1.14E-03
532		1.67E-02		7.31E-03		2.91E-03
536		4.07E-02		1.67E-02		6.43E-03
540		3.37E-02		1.39E-02		5.55E-03
544		1.42E-02		6.74E-03		3.09E-03
548		1.13E-02		7.29E-03		4.05E-03
552		1.09E-02		1.03E-02		6.58E-03
556		1.60E-02		1.77E-02		1.19E-02

560		2.44E-02		2.82E-02		1.93E-02
564		3.29E-02		3.79E-02		2.63E-02
568		5.24E-02		5.94E-02		4.16E-02
572		5.01E-02		5.70E-02		4.02E-02
576		4.12E-02		4.72E-02		3.33E-02
580		4.63E-02		5.35E-02		3.82E-02
584		4.94E-02		5.57E-02		4.04E-02
588		4.73E-02		3.66E-02		2.53E-02
592		5.77E-02		3.70E-02		2.49E-02
596		6.75E-02		5.78E-02		4.10E-02
600		6.29E-02		6.33E-02		4.55E-02
604		5.04E-02		5.38E-02		3.86E-02
608		3.99E-02		4.34E-02		3.11E-02
612		3.46E-02		3.81E-02		2.74E-02
616		3.24E-02		3.65E-02		2.63E-02
620		2.62E-02		2.97E-02		2.13E-02
624		1.97E-02		2.23E-02		1.59E-02
628		1.70E-02		1.91E-02		1.37E-02
632		1.53E-02		1.72E-02		1.22E-02
636		1.39E-02		1.55E-02		1.11E-02
640		1.27E-02		1.40E-02		1.00E-02
644		1.16E-02		1.26E-02		9.00E-03
648		1.06E-02		1.16E-02		8.25E-03
652		1.00E-02		1.09E-02		7.73E-03
656		9.74E-03		1.03E-02		7.28E-03
660		8.81E-03		9.24E-03		6.58E-03
664		8.15E-03		8.69E-03		6.12E-03
668		1.02E-02		8.99E-03		6.26E-03
672		1.22E-02		9.34E-03		6.38E-03
676		8.90E-03		7.82E-03		5.50E-03
680		6.34E-03		6.59E-03		4.74E-03
684		5.53E-03		5.77E-03		4.15E-03
688		5.20E-03		5.21E-03		3.68E-03
692		4.41E-03		4.67E-03		3.36E-03
696		3.89E-03		4.37E-03		3.18E-03
700		3.70E-03		4.08E-03		2.92E-03
704		3.59E-03		3.83E-03		2.72E-03
708		3.10E-03		3.47E-03		2.58E-03
712		2.55E-03		3.35E-03		2.38E-03
716		2.72E-03		3.04E-03		2.20E-03
720		2.64E-03		2.90E-03		2.14E-03
724		2.40E-03		2.48E-03		1.97E-03
728		2.41E-03		2.32E-03		1.81E-03
732		2.69E-03		2.04E-03		1.58E-03
736		2.41E-03		1.94E-03		1.51E-03
740		2.14E-03		1.78E-03		1.37E-03
744		1.85E-03		1.67E-03		1.23E-03
748		1.75E-03		1.74E-03		1.12E-03

752		1.47E-03		1.78E-03		8.57E-04
756		1.38E-03		1.62E-03		5.58E-04
760		1.52E-03		1.70E-03		5.73E-04
764		2.64E-03		2.76E-03		1.01E-03
768		4.07E-03		3.54E-03		1.66E-03
772		3.38E-03		2.73E-03		1.30E-03
776		1.91E-03		3.47E-03		8.75E-04
780		1.17E-03		1.93E-03		1.72E-04

Table 7 (cont.). Spectral radiance (W/sr*m^2) at the window side in the VIS region for the set of old lamps.

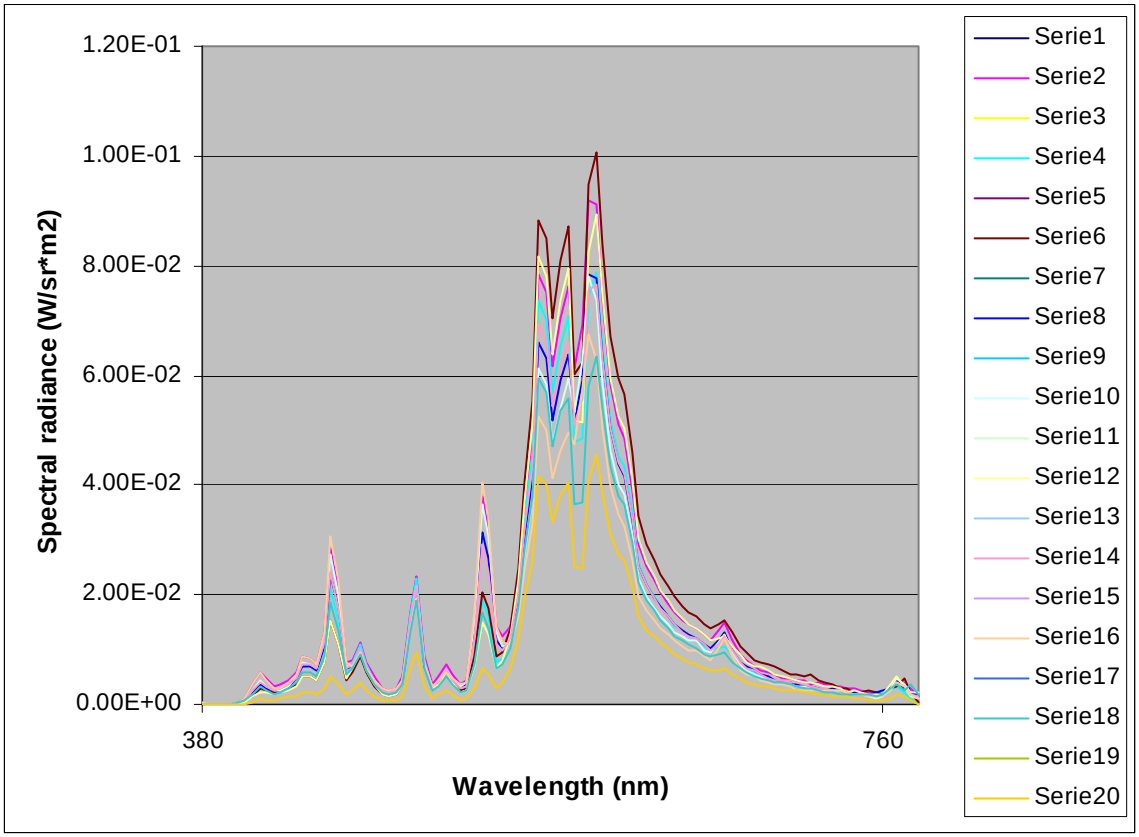


Figure 5. Spectral radiance (W/sr*m^2) at the window side in the VIS region for the set of old lamps (Table 7).

OLD LAMPS Pipe side							
λ (nm)	TRAY						
	1	2	3	4	5	6	7
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
396	0.00E+00	0.00E+00	0.00E+00	8.68E-06	0.00E+00	0.00E+00	0.00E+00
400	0.00E+00	2.59E-04	1.68E-03	5.57E-03	7.46E-04	1.05E-04	4.23E-05
404	4.92E-04	3.75E-03	1.76E-02	3.08E-02	7.08E-03	1.48E-03	4.89E-04
408	3.03E-03	1.10E-02	5.59E-02	8.71E-02	1.61E-02	5.76E-03	1.59E-03
412	5.18E-03	1.69E-02	8.97E-02	1.40E-01	2.52E-02	1.15E-02	2.76E-03
416	5.71E-03	2.12E-02	5.91E-02	8.66E-02	2.90E-02	1.54E-02	2.60E-03
420	6.45E-03	2.44E-02	3.14E-02	4.39E-02	3.29E-02	1.80E-02	2.39E-03
424	8.92E-03	2.93E-02	3.05E-02	4.41E-02	3.98E-02	2.15E-02	2.68E-03
428	8.61E-03	3.52E-02	3.64E-02	5.29E-02	4.74E-02	2.93E-02	3.28E-03
432	1.07E-02	4.45E-02	5.34E-02	8.54E-02	5.57E-02	3.15E-02	4.29E-03
436	1.30E-02	5.06E-02	8.70E-02	1.51E-01	6.66E-02	3.81E-02	5.69E-03
440	1.35E-02	5.39E-02	8.05E-02	1.32E-01	6.98E-02	3.94E-02	5.76E-03
444	1.21E-02	4.70E-02	6.78E-02	1.04E-01	6.56E-02	3.51E-02	5.14E-03
448	1.87E-02	6.99E-02	1.27E-01	2.07E-01	9.02E-02	5.03E-02	8.34E-03
452	2.72E-02	9.87E-02	3.25E-01	5.49E-01	1.30E-01	7.23E-02	1.54E-02
456	1.78E-02	6.51E-02	2.42E-01	4.04E-01	8.33E-02	4.78E-02	1.10E-02
460	1.11E-02	4.09E-02	7.09E-02	1.12E-01	5.50E-02	2.99E-02	4.77E-03
464	2.29E-02	8.54E-02	4.07E-02	5.38E-02	1.17E-01	6.42E-02	7.52E-03
468	3.56E-02	1.33E-01	4.24E-02	5.29E-02	1.83E-01	1.00E-01	1.12E-02
472	2.21E-02	8.30E-02	3.28E-02	4.66E-02	1.14E-01	6.45E-02	7.27E-03
476	1.26E-02	4.45E-02	2.58E-02	3.65E-02	6.10E-02	3.60E-02	4.35E-03
480	6.68E-03	2.17E-02	2.10E-02	3.02E-02	2.65E-02	1.72E-02	2.33E-03
484	4.49E-03	1.56E-02	1.96E-02	3.03E-02	1.94E-02	1.17E-02	1.84E-03
488	5.32E-03	1.94E-02	2.18E-02	3.43E-02	2.64E-02	1.52E-02	2.22E-03
492	1.32E-02	4.94E-02	2.81E-02	4.14E-02	6.58E-02	3.75E-02	4.70E-03
496	5.94E-02	2.26E-01	5.46E-02	6.61E-02	2.98E-01	1.70E-01	1.95E-02
500	8.66E-02	3.28E-01	6.98E-02	8.10E-02	4.36E-01	2.46E-01	2.78E-02
504	2.83E-02	1.05E-01	3.55E-02	4.81E-02	1.42E-01	7.98E-02	9.38E-03
508	7.88E-03	3.20E-02	2.52E-02	3.90E-02	3.89E-02	2.36E-02	3.11E-03
512	1.30E-02	5.19E-02	3.07E-02	4.85E-02	6.53E-02	3.79E-02	4.80E-03
516	2.17E-02	8.35E-02	3.90E-02	5.91E-02	1.06E-01	6.18E-02	7.66E-03
520	1.37E-02	5.04E-02	4.00E-02	6.41E-02	6.38E-02	3.68E-02	5.01E-03
524	6.41E-03	2.57E-02	3.65E-02	5.88E-02	3.40E-02	2.14E-02	2.91E-03
528	6.88E-03	2.51E-02	4.37E-02	7.30E-02	3.08E-02	1.84E-02	3.19E-03
532	1.13E-02	4.25E-02	2.05E-01	3.84E-01	4.93E-02	3.00E-02	9.15E-03
536	1.89E-02	7.46E-02	5.15E-01	9.75E-01	8.54E-02	5.21E-02	2.13E-02
540	1.76E-02	6.97E-02	4.30E-01	8.07E-01	8.10E-02	4.93E-02	1.85E-02
544	1.55E-02	5.85E-02	1.70E-01	3.30E-01	6.91E-02	4.20E-02	9.71E-03
548	2.69E-02	1.03E-01	1.09E-01	2.21E-01	1.22E-01	7.76E-02	1.17E-02
552	5.22E-02	2.04E-01	6.61E-02	1.05E-01	2.42E-01	1.53E-01	1.87E-02
556	9.79E-02	3.89E-01	6.72E-02	7.29E-02	4.62E-01	2.92E-01	3.44E-02

560	1.61E-01	6.39E-01	9.14E-02	8.43E-02	7.60E-01	4.84E-01	5.64E-02
564	2.24E-01	8.87E-01	1.29E-01	1.16E-01	1.07E+00	6.73E-01	7.84E-02
568	3.59E-01	1.43E+00	2.27E-01	2.32E-01	1.73E+00	1.09E+00	1.26E-01
572	3.44E-01	1.37E+00	2.17E-01	2.20E-01	1.65E+00	1.04E+00	1.21E-01
576	2.81E-01	1.13E+00	1.77E-01	1.90E-01	1.34E+00	8.52E-01	9.91E-02
580	3.23E-01	1.31E+00	1.99E-01	2.14E-01	1.54E+00	9.89E-01	1.15E-01
584	3.48E-01	1.43E+00	2.40E-01	2.52E-01	1.68E+00	1.08E+00	1.26E-01
588	2.09E-01	8.56E-01	4.34E-01	6.45E-01	1.03E+00	6.51E-01	8.51E-02
592	1.93E-01	7.92E-01	6.10E-01	9.44E-01	9.61E-01	6.06E-01	8.63E-02
596	3.38E-01	1.38E+00	5.39E-01	7.45E-01	1.63E+00	1.06E+00	1.35E-01
600	3.78E-01	1.53E+00	3.87E-01	4.75E-01	1.79E+00	1.17E+00	1.43E-01
604	3.19E-01	1.28E+00	2.76E-01	3.19E-01	1.49E+00	9.81E-01	1.18E-01
608	2.52E-01	1.03E+00	2.10E-01	2.41E-01	1.19E+00	7.82E-01	9.39E-02
612	2.22E-01	8.98E-01	1.80E-01	2.06E-01	1.04E+00	6.84E-01	8.25E-02
616	2.13E-01	8.64E-01	1.64E-01	1.84E-01	9.91E-01	6.56E-01	7.92E-02
620	1.73E-01	7.00E-01	1.32E-01	1.43E-01	7.97E-01	5.27E-01	6.39E-02
624	1.26E-01	5.16E-01	9.90E-02	1.12E-01	5.83E-01	3.87E-01	4.75E-02
628	1.07E-01	4.39E-01	8.59E-02	9.77E-02	4.95E-01	3.32E-01	4.08E-02
632	9.58E-02	3.90E-01	7.86E-02	8.60E-02	4.41E-01	2.95E-01	3.64E-02
636	8.65E-02	3.51E-01	7.03E-02	7.92E-02	3.95E-01	2.66E-01	3.29E-02
640	7.84E-02	3.15E-01	6.39E-02	7.15E-02	3.54E-01	2.41E-01	2.98E-02
644	7.14E-02	2.85E-01	5.75E-02	6.54E-02	3.19E-01	2.17E-01	2.70E-02
648	6.45E-02	2.61E-01	5.42E-02	6.28E-02	2.89E-01	2.01E-01	2.50E-02
652	5.95E-02	2.43E-01	5.65E-02	6.95E-02	2.66E-01	1.86E-01	2.33E-02
656	5.48E-02	2.27E-01	5.87E-02	7.92E-02	2.42E-01	1.73E-01	2.20E-02
660	5.08E-02	2.08E-01	4.90E-02	6.17E-02	2.25E-01	1.59E-01	1.99E-02
664	4.75E-02	1.95E-01	4.76E-02	5.85E-02	2.08E-01	1.44E-01	1.87E-02
668	4.60E-02	1.90E-01	7.77E-02	1.15E-01	2.04E-01	1.41E-01	1.93E-02
672	4.49E-02	1.87E-01	1.03E-01	1.67E-01	2.01E-01	1.41E-01	1.99E-02
676	4.07E-02	1.68E-01	6.32E-02	9.78E-02	1.78E-01	1.27E-01	1.69E-02
680	3.60E-02	1.47E-01	3.49E-02	4.93E-02	1.56E-01	1.09E-01	1.43E-02
684	3.12E-02	1.24E-01	3.03E-02	4.08E-02	1.35E-01	9.55E-02	1.25E-02
688	2.54E-02	1.10E-01	2.69E-02	3.67E-02	1.19E-01	8.47E-02	1.12E-02
692	2.44E-02	9.81E-02	2.37E-02	2.15E-02	1.09E-01	7.76E-02	1.01E-02
696	2.31E-02	9.34E-02	2.13E-02	2.80E-02	9.68E-02	7.19E-02	9.52E-03
700	2.13E-02	8.84E-02	2.08E-02	2.51E-02	9.21E-02	6.92E-02	9.11E-03
704	1.99E-02	8.17E-02	1.93E-02	2.72E-02	8.60E-02	6.37E-02	8.42E-03
708	1.88E-02	8.06E-02	1.78E-02	2.27E-02	7.68E-02	5.79E-02	7.87E-03
712	1.76E-02	7.11E-02	1.02E-02	2.17E-02	6.90E-02	5.44E-02	7.31E-03
716	1.65E-02	6.30E-02	1.58E-02	1.91E-02	6.56E-02	4.98E-02	7.03E-03
720	1.58E-02	5.80E-02	1.62E-02	1.80E-02	6.25E-02	4.82E-02	6.29E-03
724	1.31E-02	5.40E-02	1.42E-02	1.63E-02	5.47E-02	4.49E-02	5.76E-03
728	1.27E-02	4.99E-02	1.42E-02	1.88E-02	5.83E-02	3.96E-02	5.60E-03
732	1.15E-02	4.48E-02	1.24E-02	1.69E-02	5.29E-02	3.46E-02	5.23E-03
736	8.69E-03	4.30E-02	1.38E-02	1.19E-02	4.12E-02	3.42E-02	4.41E-03
740	1.11E-02	3.43E-02	8.53E-03	8.54E-03	3.77E-02	2.74E-02	4.19E-03
744	1.01E-02	3.03E-02	7.75E-03	1.84E-02	3.24E-02	2.52E-02	3.38E-03
748	8.62E-03	3.05E-02	3.42E-03	1.06E-02	2.87E-02	2.30E-02	3.17E-03

752	5.84E-03	1.69E-02	2.63E-03	1.36E-02	3.34E-02	2.23E-02	2.92E-03
756	6.45E-03	1.95E-02	5.58E-04	5.35E-03	2.28E-02	2.78E-02	1.49E-03
760	4.79E-03	1.41E-02	6.87E-03	1.94E-03	1.47E-02	1.92E-02	9.76E-04
764	4.30E-03	2.71E-02	1.62E-02	1.68E-02	3.22E-02	2.85E-02	4.08E-03
768	1.12E-02	4.64E-02	2.07E-02	2.86E-02	4.26E-02	5.00E-02	5.85E-03
772	8.14E-03	4.69E-02	1.34E-02	9.77E-03	3.26E-02	3.09E-02	4.23E-03
776	1.96E-03	2.21E-02	1.49E-02	5.08E-03	4.85E-03	1.40E-02	1.94E-03
780	6.96E-05	7.80E-03	1.71E-02	2.65E-02	3.39E-03	1.27E-03	2.75E-04

Table 5. Spectral radiance ($W/sr*m^2$) at the pipe side in the VIS region for the set of old lamps.

OLD LAMPS Pipe side							
λ (nm)	TRAY						
	8	9	10	11	12	13	14
380	0.00E+00	0.00E+00	0.00E+00	1.62E-41	0.00E+00	5.04E-03	0.00E+00
384	0.00E+00	0.00E+00	0.00E+00	1.20E-41	0.00E+00	0.00E+00	0.00E+00
388	0.00E+00	0.00E+00	0.00E+00	1.13E-41	0.00E+00	0.00E+00	0.00E+00
392	0.00E+00	1.13E-02	0.00E+00	9.15E-42	0.00E+00	3.56E-03	0.00E+00
396	2.05E-08	1.40E-03	5.80E-06	7.18E-42	0.00E+00	4.43E-04	0.00E+00
400	1.05E-04	0.00E+00	2.30E-03	4.44E-03	3.43E-04	6.14E-04	2.43E-05
404	1.29E-03	3.21E-03	8.19E-03	3.94E-02	2.91E-03	7.29E-03	3.88E-04
408	4.71E-03	1.52E-02	2.82E-02	1.15E-01	7.49E-03	1.77E-02	1.70E-03
412	8.54E-03	2.66E-02	4.76E-02	1.97E-01	1.37E-02	2.79E-02	2.45E-03
416	1.06E-02	3.85E-02	3.35E-02	1.35E-01	1.30E-02	4.05E-02	2.28E-03
420	1.38E-02	3.75E-02	2.02E-02	7.78E-02	1.27E-02	4.77E-02	2.67E-03
424	1.74E-02	5.41E-02	2.06E-02	7.81E-02	1.47E-02	5.69E-02	3.00E-03
428	1.96E-02	6.73E-02	2.68E-02	9.65E-02	1.73E-02	6.55E-02	3.46E-03
432	2.34E-02	7.97E-02	3.96E-02	1.73E-01	2.20E-02	7.68E-02	4.63E-03
436	2.81E-02	9.11E-02	6.47E-02	3.16E-01	3.05E-02	9.40E-02	6.03E-03
440	2.87E-02	9.31E-02	5.98E-02	2.71E-01	3.00E-02	1.00E-01	5.91E-03
444	2.52E-02	8.83E-02	5.05E-02	2.06E-01	2.67E-02	9.16E-02	5.62E-03
448	4.38E-02	1.26E-01	9.77E-02	4.15E-01	4.35E-02	1.30E-01	9.03E-03
452	5.02E-02	1.54E-01	2.52E-01	1.12E+00	7.91E-02	1.62E-01	1.65E-02
456	3.29E-02	9.98E-02	1.90E-01	8.38E-01	5.64E-02	1.01E-01	1.15E-02
460	2.14E-02	7.55E-02	5.70E-02	2.36E-01	2.58E-02	7.44E-02	5.16E-03
464	4.88E-02	1.71E-01	3.41E-02	1.11E-01	4.02E-02	1.68E-01	8.31E-03
468	7.71E-02	2.62E-01	3.82E-02	1.10E-01	5.98E-02	2.67E-01	1.26E-02
472	4.94E-02	1.64E-01	3.07E-02	9.32E-02	3.84E-02	1.65E-01	8.18E-03
476	2.63E-02	8.40E-02	2.24E-02	7.31E-02	2.02E-02	8.71E-02	4.26E-03
480	1.14E-02	4.10E-02	1.83E-02	6.22E-02	1.15E-02	4.06E-02	2.19E-03
484	6.99E-03	2.62E-02	1.66E-02	6.14E-02	8.60E-03	2.47E-02	1.75E-03
488	1.19E-02	3.97E-02	1.78E-02	6.47E-02	1.07E-02	3.72E-02	2.37E-03
492	2.91E-02	1.08E-01	2.31E-02	7.62E-02	2.41E-02	9.63E-02	5.22E-03
496	1.34E-01	4.47E-01	5.12E-02	1.22E-01	1.00E-01	4.54E-01	2.15E-02
500	1.94E-01	6.45E-01	6.72E-02	1.49E-01	1.45E-01	6.61E-01	3.09E-02
504	6.46E-02	2.09E-01	3.24E-02	9.40E-02	4.90E-02	2.08E-01	1.02E-02
508	1.80E-02	5.97E-02	2.07E-02	7.89E-02	1.54E-02	5.48E-02	3.42E-03
512	2.97E-02	9.72E-02	2.51E-02	9.25E-02	2.41E-02	9.39E-02	5.49E-03
516	4.82E-02	1.57E-01	3.30E-02	1.18E-01	3.84E-02	1.58E-01	8.61E-03
520	2.76E-02	9.27E-02	3.27E-02	1.33E-01	2.57E-02	9.08E-02	5.53E-03
524	1.43E-02	4.21E-02	2.89E-02	1.27E-01	1.39E-02	3.77E-02	3.18E-03
528	1.38E-02	4.12E-02	3.62E-02	1.62E-01	1.52E-02	4.11E-02	3.39E-03
532	1.98E-02	5.47E-02	1.70E-01	8.27E-01	4.31E-02	5.29E-02	9.58E-03
536	3.01E-02	8.55E-02	4.26E-01	2.11E+00	9.71E-02	7.50E-02	2.14E-02
540	3.02E-02	8.71E-02	3.58E-01	1.77E+00	8.43E-02	7.71E-02	1.86E-02
544	3.02E-02	9.05E-02	1.42E-01	7.31E-01	4.48E-02	8.51E-02	1.02E-02
548	5.99E-02	1.80E-01	9.26E-02	4.91E-01	5.42E-02	1.72E-01	1.30E-02
552	1.23E-01	3.57E-01	6.21E-02	2.16E-01	8.72E-02	3.61E-01	2.09E-02
556	2.39E-01	6.76E-01	6.82E-02	1.26E-01	1.61E-01	7.02E-01	3.85E-02

560	3.90E-01	1.10E+00	9.77E-02	1.27E-01	2.65E-01	1.16E+00	6.31E-02
564	5.37E-01	1.54E+00	1.36E-01	1.97E-01	3.74E-01	1.63E+00	8.73E-02
568	8.34E-01	2.52E+00	2.35E-01	4.18E-01	6.08E-01	2.67E+00	1.40E-01
572	8.03E-01	2.40E+00	2.24E-01	4.00E-01	5.78E-01	2.52E+00	1.34E-01
576	6.61E-01	1.90E+00	1.84E-01	3.45E-01	4.65E-01	2.01E+00	1.10E-01
580	7.49E-01	2.13E+00	2.05E-01	3.72E-01	5.32E-01	2.32E+00	1.28E-01
584	7.85E-01	2.24E+00	2.33E-01	4.26E-01	5.85E-01	2.57E+00	1.39E-01
588	4.52E-01	1.25E+00	3.69E-01	1.25E+00	3.99E-01	1.56E+00	9.12E-02
592	4.13E-01	1.13E+00	5.22E-01	1.92E+00	4.02E-01	1.43E+00	9.18E-02
596	7.51E-01	2.08E+00	4.96E-01	1.55E+00	6.22E-01	2.48E+00	1.46E-01
600	8.67E-01	2.39E+00	3.78E-01	9.72E-01	6.56E-01	2.71E+00	1.57E-01
604	7.45E-01	2.04E+00	2.78E-01	6.32E-01	5.39E-01	2.23E+00	1.30E-01
608	6.00E-01	1.65E+00	2.14E-01	4.65E-01	4.25E-01	1.76E+00	1.04E-01
612	5.27E-01	1.48E+00	1.82E-01	3.93E-01	3.72E-01	1.55E+00	9.13E-02
616	5.09E-01	1.46E+00	1.66E-01	3.40E-01	3.58E-01	1.51E+00	8.79E-02
620	4.18E-01	1.18E+00	1.31E-01	2.67E-01	2.89E-01	1.22E+00	7.11E-02
624	3.11E-01	8.58E-01	1.00E-01	2.05E-01	2.12E-01	8.97E-01	5.23E-02
628	2.68E-01	7.35E-01	8.63E-02	1.76E-01	1.80E-01	7.60E-01	4.55E-02
632	2.42E-01	6.55E-01	7.69E-02	1.61E-01	1.60E-01	6.76E-01	4.07E-02
636	2.21E-01	5.86E-01	6.93E-02	1.47E-01	1.45E-01	6.03E-01	3.67E-02
640	1.97E-01	5.27E-01	6.33E-02	1.34E-01	1.31E-01	5.41E-01	3.33E-02
644	1.81E-01	4.71E-01	5.91E-02	1.41E-01	1.18E-01	4.80E-01	2.98E-02
648	1.63E-01	4.28E-01	5.59E-02	1.19E-01	1.07E-01	4.38E-01	2.74E-02
652	1.50E-01	3.97E-01	5.49E-02	1.42E-01	9.91E-02	4.03E-01	2.57E-02
656	1.39E-01	3.70E-01	5.66E-02	1.67E-01	9.21E-02	3.75E-01	2.42E-02
660	1.27E-01	3.51E-01	4.83E-02	1.26E-01	8.16E-02	3.47E-01	2.21E-02
664	1.21E-01	3.14E-01	4.57E-02	1.16E-01	7.85E-02	3.22E-01	2.04E-02
668	1.19E-01	3.07E-01	7.14E-02	2.34E-01	8.06E-02	3.14E-01	2.07E-02
672	1.11E-01	2.99E-01	9.19E-02	3.32E-01	8.25E-02	3.05E-01	2.14E-02
676	1.03E-01	2.72E-01	5.84E-02	1.85E-01	7.09E-02	2.75E-01	1.87E-02
680	8.79E-02	2.37E-01	3.57E-02	8.39E-02	6.02E-02	2.40E-01	1.59E-02
684	7.80E-02	2.00E-01	2.97E-02	6.78E-02	5.31E-02	2.08E-01	1.40E-02
688	6.33E-02	1.86E-01	2.55E-02	8.40E-02	4.83E-02	1.84E-01	1.24E-02
692	6.53E-02	1.67E-01	2.20E-02	5.43E-02	4.31E-02	1.69E-01	1.06E-02
696	5.74E-02	1.50E-01	1.57E-02	4.24E-02	3.83E-02	1.54E-01	1.03E-02
700	5.43E-02	1.42E-01	1.75E-02	3.85E-02	3.55E-02	1.44E-01	9.74E-03
704	4.87E-02	1.40E-01	1.73E-02	4.75E-02	3.42E-02	1.34E-01	9.21E-03
708	4.66E-02	1.27E-01	1.73E-02	3.00E-02	3.16E-02	1.25E-01	8.58E-03
712	4.29E-02	1.11E-01	1.61E-02	1.73E-02	3.23E-02	1.14E-01	8.05E-03
716	4.00E-02	9.97E-02	1.56E-02	3.64E-02	2.64E-02	1.05E-01	7.31E-03
720	3.86E-02	9.70E-02	1.39E-02	3.91E-02	2.53E-02	1.01E-01	7.78E-03
724	3.67E-02	8.41E-02	1.34E-02	3.55E-02	2.08E-02	9.31E-02	6.43E-03
728	3.69E-02	7.83E-02	1.28E-02	4.23E-02	1.93E-02	8.50E-02	6.04E-03
732	3.32E-02	8.06E-02	1.34E-02	3.26E-02	2.00E-02	7.90E-02	5.54E-03
736	3.24E-02	6.13E-02	1.09E-02	2.72E-02	2.12E-02	6.42E-02	4.71E-03
740	2.44E-02	6.08E-02	1.05E-02	2.48E-02	1.62E-02	6.10E-02	4.22E-03
744	1.90E-02	4.62E-02	7.93E-03	1.59E-02	1.34E-02	5.34E-02	4.25E-03
748	1.84E-02	3.62E-02	8.32E-03	1.85E-02	1.38E-02	4.39E-02	4.34E-03

752	1.14E-02	3.61E-02	5.23E-03	2.90E-03	1.05E-02	3.84E-02	4.47E-03
756	8.65E-03	4.14E-02	4.73E-03	1.70E-41	1.15E-02	2.46E-02	3.61E-03
760	7.72E-03	5.24E-02	5.16E-03	1.88E-41	1.67E-02	2.22E-02	3.78E-03
764	2.24E-02	4.13E-02	9.29E-03	2.46E-02	1.52E-02	3.57E-02	4.22E-03
768	2.00E-02	6.48E-02	2.15E-02	2.09E-02	1.90E-02	6.78E-02	7.70E-03
772	1.56E-02	3.84E-02	1.50E-02	2.17E-02	1.68E-02	5.05E-02	5.14E-03
776	0.00E+00	1.51E-02	6.80E-03	2.90E-41	6.89E-03	1.80E-02	2.43E-03
780	0.00E+00	3.03E-03	1.45E-03	3.60E-03	1.94E-03	2.29E-03	1.48E-03

Table 8 (cont.). Spectral radiance ($W/sr*m^2$) at the pipe side in the VIS region for the set of old lamps.

OLD LAMPS Pipe side						
λ (nm)	TRAY					
	15	16	17	18	19	20
380	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-41
384	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-41
388	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-41
392	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.15E-42
396	0.00E+00	0.00E+00	1.63E-06	0.00E+00	0.00E+00	7.18E-42
400	0.00E+00	3.44E-04	1.43E-03	3.86E-03	1.20E-04	6.07E-42
404	7.60E-04	3.95E-03	1.04E-02	4.11E-02	2.08E-03	5.33E-42
408	4.53E-03	1.07E-02	3.51E-02	1.33E-01	7.71E-03	4.67E-42
412	7.85E-03	1.58E-02	5.75E-02	2.15E-01	1.13E-02	7.16E-03
416	9.54E-03	1.90E-02	3.82E-02	1.41E-01	9.13E-03	7.69E-03
420	1.21E-02	2.31E-02	2.10E-02	7.40E-02	7.69E-03	1.11E-02
424	1.49E-02	2.79E-02	2.05E-02	7.41E-02	8.14E-03	2.09E-02
428	1.72E-02	3.34E-02	2.60E-02	9.45E-02	1.01E-02	2.39E-02
432	2.05E-02	4.14E-02	4.11E-02	1.57E-01	1.42E-02	3.44E-02
436	2.48E-02	5.09E-02	6.72E-02	2.76E-01	2.09E-02	5.44E-02
440	2.64E-02	5.35E-02	6.22E-02	2.47E-01	2.04E-02	5.94E-02
444	2.70E-02	4.79E-02	5.21E-02	1.97E-01	1.74E-02	4.57E-02
448	3.55E-02	7.15E-02	9.71E-02	3.82E-01	2.93E-02	7.54E-02
452	4.77E-02	1.04E-01	2.52E-01	1.03E+00	6.15E-02	1.16E-01
456	3.05E-02	6.63E-02	1.91E-01	7.59E-01	4.43E-02	7.51E-02
460	2.00E-02	4.09E-02	5.48E-02	2.06E-01	1.67E-02	4.43E-02
464	4.37E-02	8.46E-02	3.05E-02	9.21E-02	2.09E-02	9.90E-02
468	6.88E-02	1.31E-01	3.20E-02	8.91E-02	3.01E-02	1.60E-01
472	4.33E-02	8.26E-02	2.57E-02	7.51E-02	2.02E-02	1.04E-01
476	2.20E-02	4.16E-02	1.91E-02	6.21E-02	1.17E-02	5.83E-02
480	1.00E-02	2.14E-02	1.59E-02	5.18E-02	7.14E-03	2.84E-02
484	7.05E-03	1.47E-02	1.40E-02	5.25E-02	5.90E-03	1.95E-02
488	1.00E-02	2.11E-02	1.51E-02	5.55E-02	6.82E-03	2.90E-02
492	2.51E-02	4.96E-02	2.06E-02	6.26E-02	1.27E-02	6.64E-02
496	1.15E-01	2.28E-01	4.16E-02	9.84E-02	4.78E-02	3.24E-01
500	1.67E-01	3.32E-01	5.36E-02	1.17E-01	6.82E-02	4.71E-01
504	5.46E-02	1.07E-01	2.70E-02	7.33E-02	2.47E-02	1.54E-01
508	1.56E-02	3.32E-02	1.85E-02	6.28E-02	9.87E-03	5.29E-02
512	2.57E-02	5.32E-02	2.25E-02	7.31E-02	1.37E-02	8.78E-02
516	4.09E-02	8.58E-02	2.96E-02	8.96E-02	2.05E-02	1.38E-01
520	2.45E-02	5.33E-02	2.98E-02	1.02E-01	1.49E-02	8.83E-02
524	1.26E-02	2.83E-02	2.58E-02	9.70E-02	9.35E-03	5.44E-02
528	1.26E-02	2.87E-02	3.23E-02	1.23E-01	1.06E-02	5.48E-02
532	1.79E-02	4.68E-02	1.56E-01	6.61E-01	3.77E-02	7.92E-02
536	2.89E-02	8.20E-02	3.92E-01	1.68E+00	8.83E-02	1.22E-01
540	2.75E-02	7.55E-02	3.25E-01	1.38E+00	7.36E-02	1.18E-01
544	2.58E-02	6.34E-02	1.29E-01	5.41E-01	3.57E-02	1.26E-01
548	4.88E-02	1.14E-01	8.47E-02	3.47E-01	3.74E-02	2.40E-01
552	9.84E-02	2.25E-01	5.23E-02	1.55E-01	4.95E-02	5.01E-01
556	1.89E-01	4.33E-01	5.42E-02	1.00E-01	8.54E-02	9.84E-01

560	3.11E-01	7.12E-01	7.50E-02	1.09E-01	1.37E-01	1.64E+00
564	4.31E-01	9.75E-01	1.04E-01	1.52E-01	1.87E-01	2.21E+00
568	6.77E-01	1.54E+00	1.81E-01	3.15E-01	2.94E-01	3.43E+00
572	6.45E-01	1.48E+00	1.73E-01	3.01E-01	2.84E-01	3.35E+00
576	5.24E-01	1.22E+00	1.43E-01	2.59E-01	2.40E-01	2.90E+00
580	5.94E-01	1.41E+00	1.62E-01	2.82E-01	2.78E-01	3.43E+00
584	6.29E-01	1.52E+00	1.90E-01	3.39E-01	2.97E-01	3.70E+00
588	3.67E-01	8.96E-01	3.45E-01	1.04E+00	2.12E-01	2.12E+00
592	3.40E-01	8.34E-01	4.81E-01	1.54E+00	2.21E-01	1.98E+00
596	6.13E-01	1.49E+00	4.18E-01	1.17E+00	3.21E-01	3.68E+00
600	7.01E-01	1.68E+00	3.01E-01	7.10E-01	3.38E-01	4.23E+00
604	5.96E-01	1.42E+00	2.15E-01	4.67E-01	2.82E-01	3.63E+00
608	4.77E-01	1.13E+00	1.66E-01	3.49E-01	2.24E-01	2.94E+00
612	4.16E-01	9.95E-01	1.44E-01	2.97E-01	1.97E-01	2.59E+00
616	3.97E-01	9.53E-01	1.30E-01	2.58E-01	1.87E-01	2.51E+00
620	3.21E-01	7.74E-01	1.05E-01	2.02E-01	1.53E-01	2.06E+00
624	2.38E-01	5.77E-01	7.97E-02	1.56E-01	1.16E-01	1.57E+00
628	2.04E-01	4.98E-01	6.82E-02	1.37E-01	9.95E-02	1.37E+00
632	1.82E-01	4.43E-01	6.15E-02	1.20E-01	8.89E-02	1.23E+00
636	1.65E-01	4.00E-01	5.56E-02	1.09E-01	7.96E-02	1.13E+00
640	1.49E-01	3.60E-01	5.01E-02	1.01E-01	7.18E-02	1.02E+00
644	1.36E-01	3.28E-01	4.52E-02	9.01E-02	6.45E-02	9.28E-01
648	1.24E-01	3.01E-01	4.27E-02	8.28E-02	5.92E-02	8.58E-01
652	1.14E-01	2.77E-01	4.39E-02	9.53E-02	5.52E-02	8.01E-01
656	1.05E-01	2.62E-01	4.58E-02	1.10E-01	5.20E-02	7.48E-01
660	9.48E-02	2.37E-01	3.90E-02	8.90E-02	4.72E-02	6.91E-01
664	8.91E-02	2.20E-01	3.79E-02	8.59E-02	4.49E-02	6.53E-01
668	8.38E-02	2.17E-01	6.28E-02	1.83E-01	4.86E-02	6.39E-01
672	8.18E-02	2.15E-01	8.42E-02	2.60E-01	5.23E-02	6.30E-01
676	7.56E-02	1.96E-01	5.22E-02	1.39E-01	4.19E-02	5.80E-01
680	6.43E-02	1.71E-01	3.16E-02	6.74E-02	3.45E-02	5.13E-01
684	5.71E-02	1.50E-01	2.53E-02	5.83E-02	2.98E-02	4.52E-01
688	5.09E-02	1.33E-01	2.26E-02	4.79E-02	2.63E-02	4.10E-01
692	4.60E-02	1.22E-01	1.82E-02	3.50E-02	2.40E-02	3.76E-01
696	4.53E-02	1.11E-01	1.73E-02	3.16E-02	2.20E-02	3.56E-01
700	4.45E-02	1.02E-01	1.53E-02	3.00E-02	2.16E-02	3.28E-01
704	3.86E-02	9.61E-02	1.45E-02	2.71E-02	1.95E-02	3.09E-01
708	3.42E-02	9.02E-02	1.37E-02	2.57E-02	1.80E-02	2.94E-01
712	3.23E-02	8.19E-02	1.42E-02	2.69E-02	1.69E-02	2.76E-01
716	2.85E-02	7.38E-02	1.39E-02	2.51E-02	1.53E-02	2.62E-01
720	2.60E-02	7.18E-02	1.26E-02	2.73E-02	1.49E-02	2.51E-01
724	2.34E-02	6.68E-02	1.19E-02	2.31E-02	1.44E-02	2.42E-01
728	2.52E-02	5.97E-02	1.00E-02	2.13E-02	1.32E-02	2.21E-01
732	2.28E-02	5.82E-02	8.38E-03	2.12E-02	1.64E-02	2.09E-01
736	1.83E-02	5.65E-02	6.94E-03	2.13E-02	1.43E-02	1.95E-01
740	1.37E-02	4.72E-02	6.85E-03	1.62E-02	1.13E-02	1.82E-01
744	1.41E-02	4.39E-02	5.32E-03	1.29E-02	1.03E-02	1.53E-01
748	1.20E-02	3.79E-02	2.70E-03	5.58E-03	9.62E-03	1.36E-01

752	1.13E-02	3.47E-02	2.09E-03	1.15E-02	8.75E-03	1.54E-01
756	6.63E-03	4.13E-02	3.38E-03	5.20E-03	6.69E-03	1.42E-01
760	2.36E-03	3.82E-02	5.60E-03	4.46E-03	7.32E-03	1.27E-01
764	1.34E-02	4.87E-02	1.07E-02	2.60E-02	1.18E-02	1.68E-01
768	2.51E-02	7.14E-02	1.62E-02	4.15E-02	1.35E-02	3.06E-01
772	2.29E-02	5.13E-02	1.15E-02	2.27E-02	1.02E-02	2.01E-01
776	8.54E-03	1.97E-02	4.21E-03	3.73E-03	6.11E-03	1.25E-01
780	9.07E-04	1.42E-02	2.60E-03	0.00E+00	1.85E-03	8.63E-02

Table 8 (cont.). Spectral radiance (W/sr*m^2) at the pipe side in the VIS region for the set of old lamps.

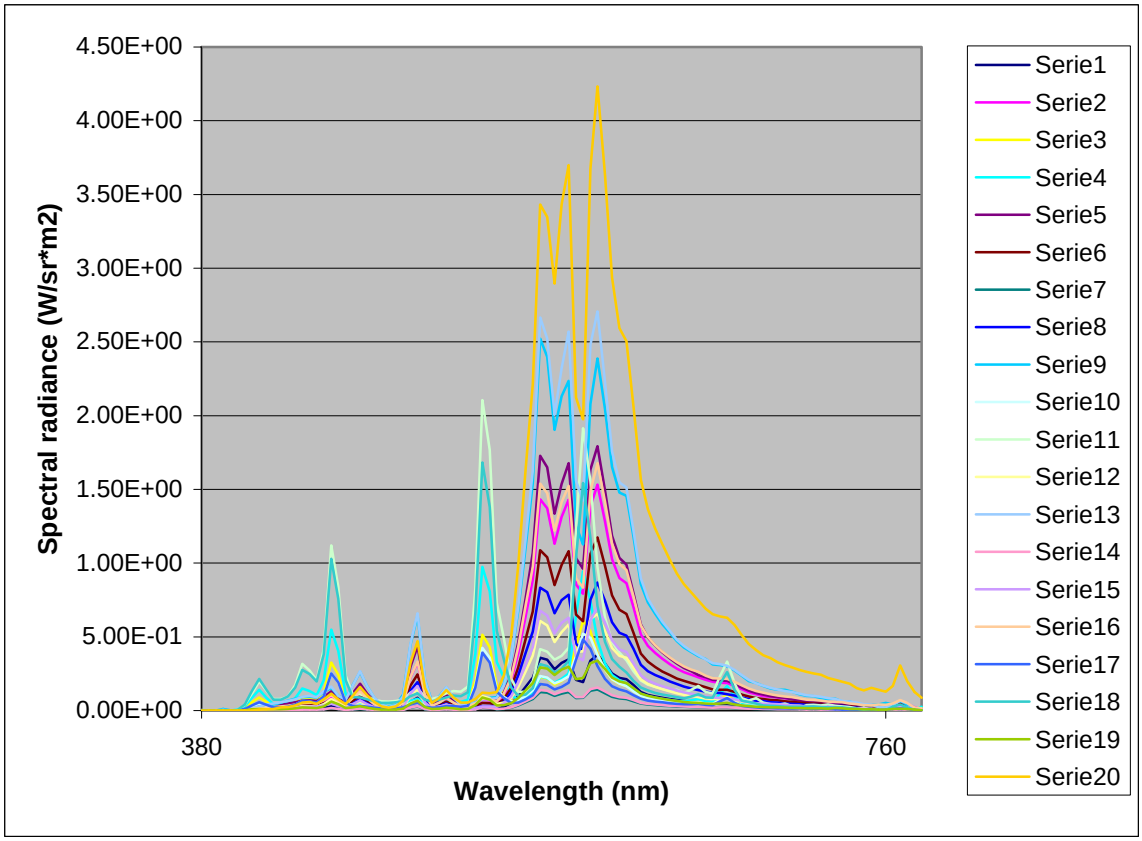


Figure 6. Spectral radiance (W/sr*m^2) at the window side in the VIS region for the set of old lamps (Table 8).

Finally, table 9 reports the measurements of integrated irradiance in the visible region (380 – 780 nm) at three light levels that have been performed to calibrate the external and internal Melissa sensors.

Measurements taken with the IL-1700 sensor (W/cm^2) as well as with the external Melissa sensor (Micromol) are given.

Light level	TE#4 (VIS) (W/cm^2)	External sensor (Micromol)
1	1.19E-02	530
2	6.77E-03	292.9
3	4.17E-03	189.2

4) ACCURACY.

The tele-spectracolorimeter PhotoResearch SpectraColorimeter, model PR-655, serial nº 65082002 with the fiber accessory FP-655, has a radiometric accuracy of 2% (±1 digit) and a spectral accuracy of ±2 nm, according to the technical specifications of this instrument.

The radiometer International Light, model IL-1700, serial nº 2338 has a radiometric accuracy of 3%.

5) TRACEABILITY.

The tele-spectracolorimeter PhotoResearch SpectraColorimeter, model PR-655, serial nº 65082002 with the fiber accessory FP-655 was calibrated using equipment with traceability of the National Institute of Standards (NBS) of United States.

The radiometer International Light, model IL-1700, serial nº 2338 was calibrated using equipment with traceability of the National Institute of Standards (NBS) of United States.

Terrassa, May 6th, 2010.

Meritxell Vilaseca Ricart