Light Measurement Report

Print date: 23/08/2023
Measurement date and time: 23/08/2023 10:35:30 – Measurement no. VFR-230823-0126-MS
Measurement tracking No. and Link: VT230823-009989
Operator: TT

Laboratory and Equipment

Laboratory Owner and Location	Viso Systems, Copenhagen V, Denmark
Goniospectrometer System and Type	LabSpion – Type C, horizontal
Sensor Name, Calibr. Date and Serial No.	LabSensor Model2 – 07/12/2022 – 3532797498
Spectrometer Manufacturer and Model	Ibsen Photonics, Denmark – Freedom VIS (Custom Viso)

Measurement Conditions

Number of C-planes and Resolution	72 planes – 5°
γ (gamma)-Resolution	1°
Test Distance	1,18 m
Input Power, Power and Displ. Factors	14,8 W – PF 0,96 – DPF 0,98
Input RMS Voltage and Current	232 V – 0,066 A
Frequency of Input Power	50,1 Hz
Warm-up Time and Variation	Lamp stabilized in 15 min 3 sec – 2,0%

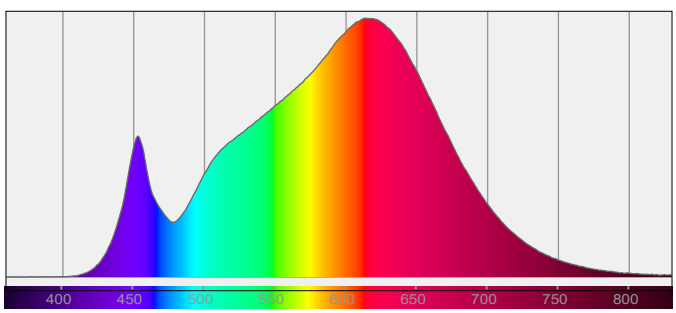
Tested Light Source

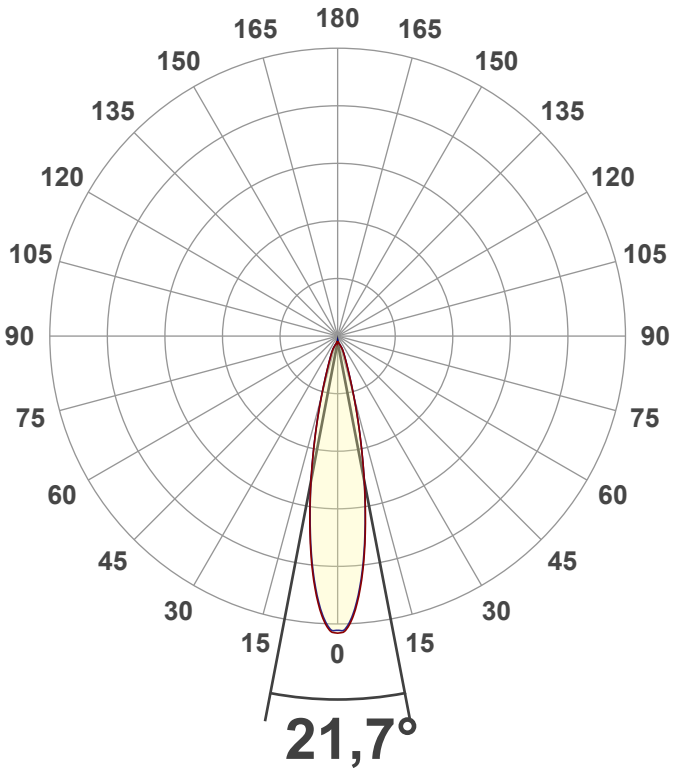
Product Name	MULTITUBE 15 3000K 20D BLACK
Item No. and Manufacturer	0100150030200302 – ELECTRUM
Product Description (line 1)	With driver 350mA

Main Light Measurement Results

Output – Total Lumen (Up% / Down%)	900 lm – 0,25% / 99,75%
Efficiency	61 lm/W
Peak Intensity and Beam Angle	4607 cd – 21,7°
Correlated Color Temperature, Target/Measured	CCT = 3000 K / 3080 K
Color Rendering Index	CRI 91,6
Color Rendering TM30-18	R_f 91,3 – R_g 98,9
Color Shift, CIE duv and MacAdam Steps	Duv 0,0008 – SDCM 2,7
Flicker	SVM 0 – PstLM 0,01



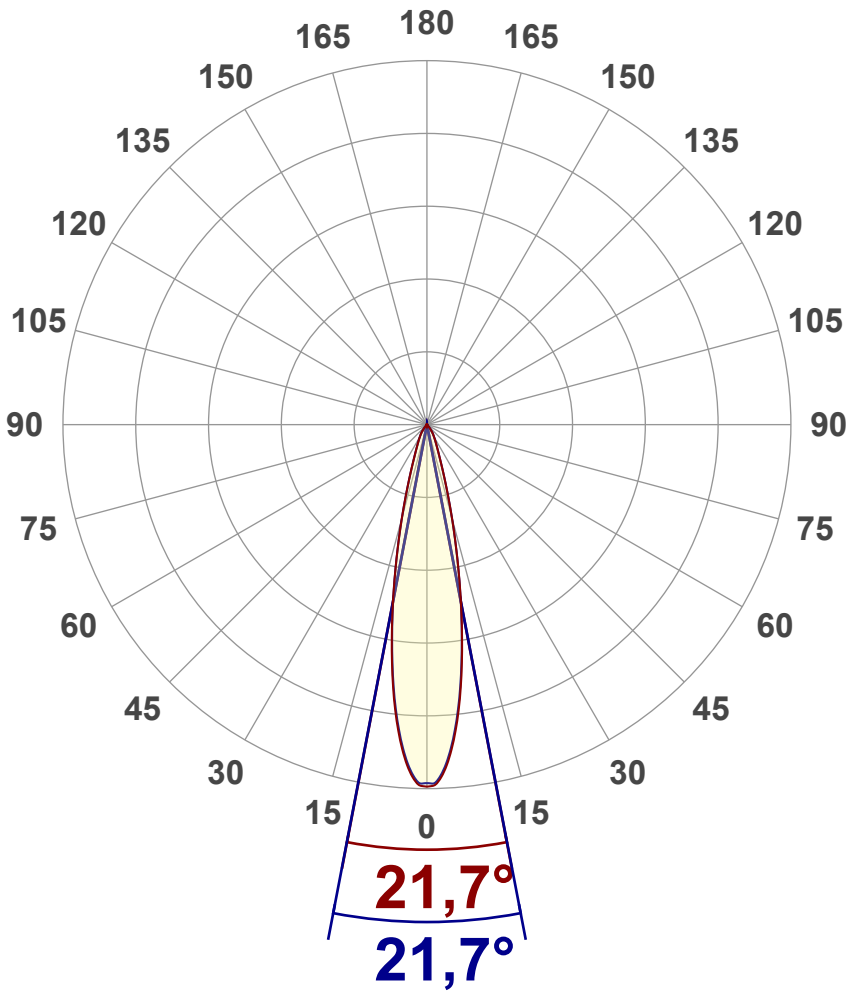




Light Measurement Report

Print date: 23/08/2023
Measurement date and time: 23/08/2023 10:35:30 – Measurement no. VFR-230823-0126-MS
Measurement tracking No. and Link: VT230823-009989
Operator: TT

Luminous Intensity diagram Unit: 0-100% of peak intensity



Main Values

Output (total Lumen)	900 lm
Lumen Up% / Down%	0,25% / 99,75%
Peak Intensity	4607 cd
Beam Angle (50%)	21,7°
Beam Angle (90%)	21,7°
Beam Angle (10%)	21,7°

Cut-off Angle

Average 2,5%	69,4°

Field Angle

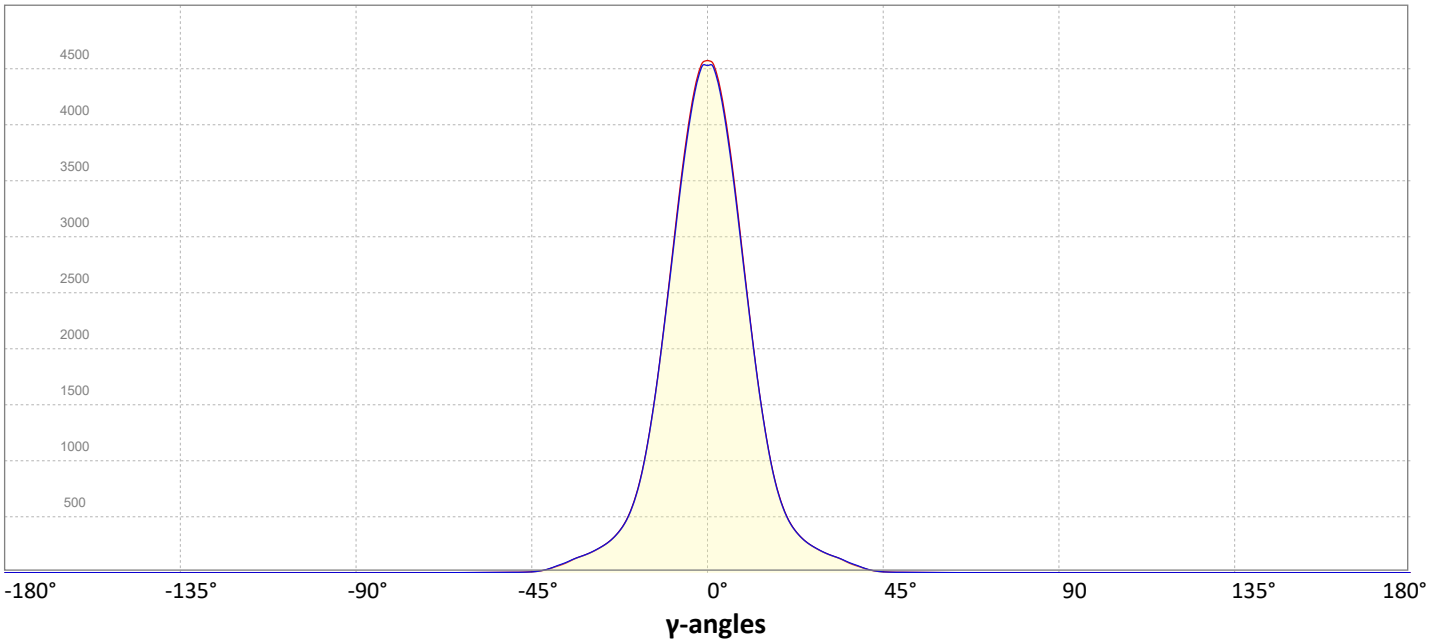
Average 10%	42,1°

Intensity Ratio

In 120° cone	99,5%
In 90° cone	99,0%

C000-C180
C090-C270

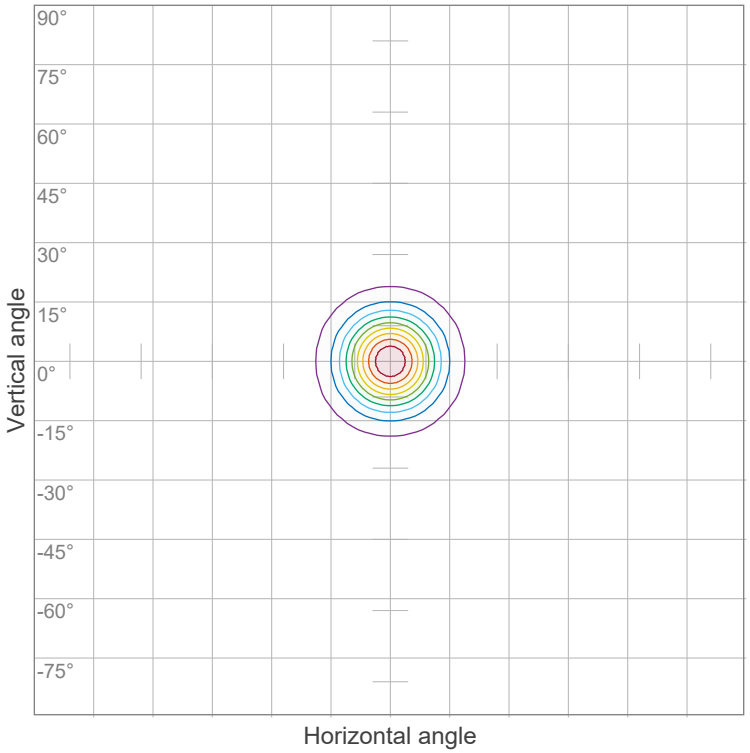
Linear distribution diagram - Intensity (candela) vs γ-angle



Light Measurement Report

Print date: 23/08/2023
Measurement date and time: 23/08/2023 10:35:30 – Measurement no. VFR-230823-0126-MS
Measurement tracking No. and Link: VT230823-009989
Operator: TT

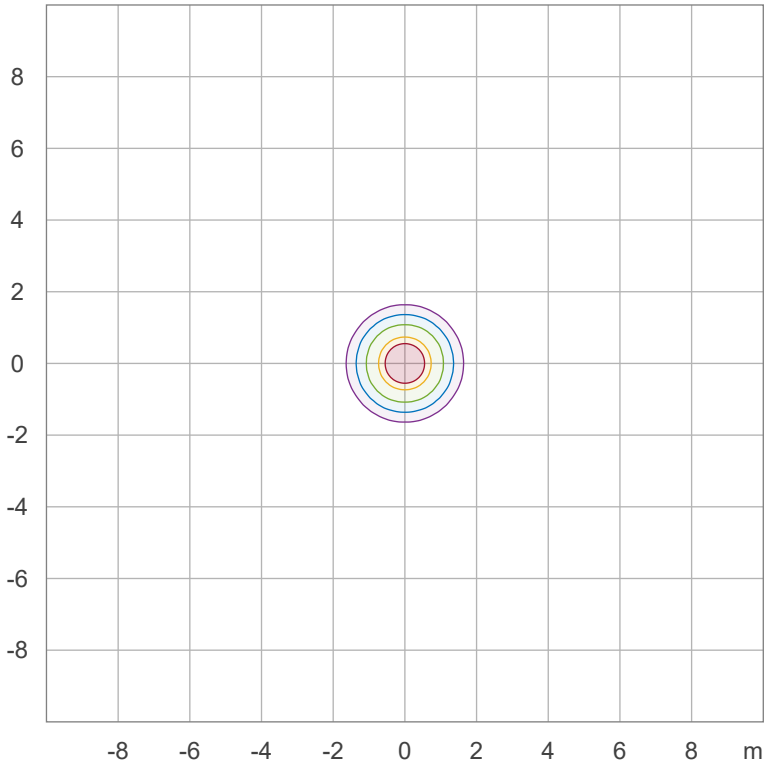
Iso-intensity Diagram (Iso-candela)



90 %	4122,3 cd
80 %	3664,3 cd
70 %	3206,2 cd
60 %	2748,2 cd
50 %	2290,2 cd
40 %	1832,1 cd
30 %	1374,1 cd
20 %	916,1 cd
10 %	458,0 cd

Peak intensity: 4580,3 cd
Number of c-planes: 72

Iso-illuminance Diagram (Iso-lux)



50,0 %	254,3 lx
30,0 %	152,6 lx
10,0 %	50,9 lx
5,0 %	25,4 lx
3,0 %	15,3 lx

Peak illuminance: 508,7 lx
Mounting height: 3,0 m
Number of c-planes: 72

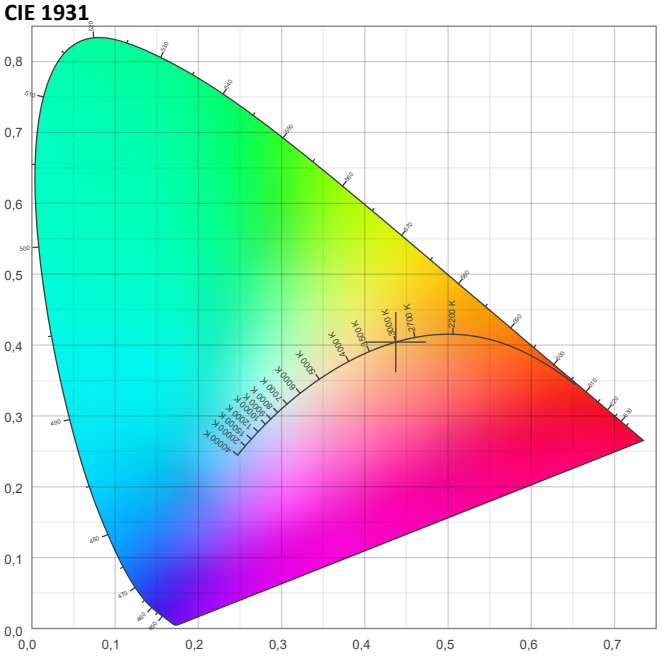
Light Measurement Report

Print date: 23/08/2023
Measurement date and time: 23/08/2023 10:35:30 – Measurement no. VFR-230823-0126-MS
Measurement tracking No. and Link: VT230823-009989
Operator: TT

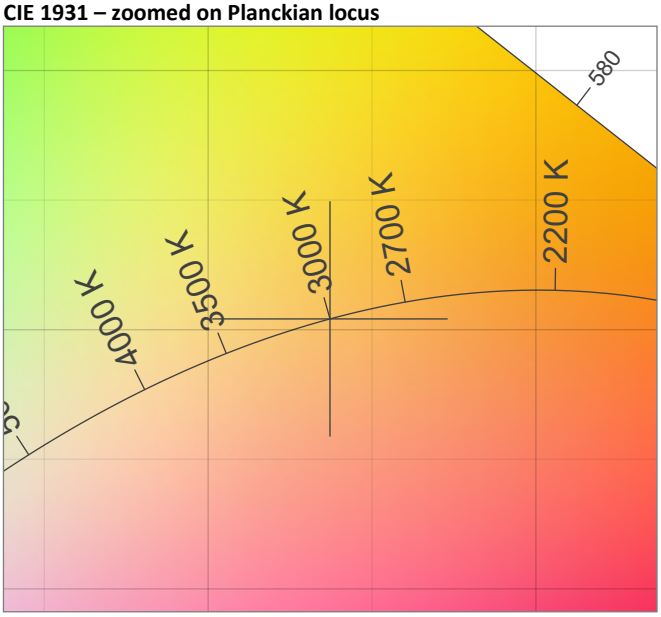
Color details

Correlated Color Temperature, Target	CCT = 3000 K
Correlated Color Temperature, Measured	CCT = 3080 K
Color Rendering Index	CRI 91,6
Color Rendering Index, R9 (red component)	R9 = 52,2
Color Rendering TM30-18	R_f 91,3 – R_g 98,9
Color Quality Scale	CQS = 90,2
MacAdam Steps	SDCM = 2,7
Color coordinates CIE 1931	(x;y) = (0,437;0,404)
Color coordinate CIEs 1960	(u;v) = (0,251;0,348)
Color deviation from BBL	Duv = 0,0008
Color coordinate CIEs 1976 (CIELUV)	(u';v') = (0,251;0,251)

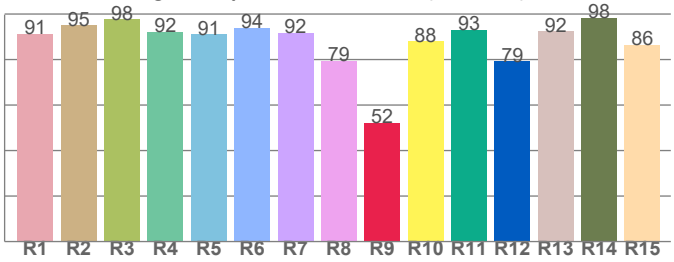
CIE 1931



CIE 1931 – zoomed on Planckian locus



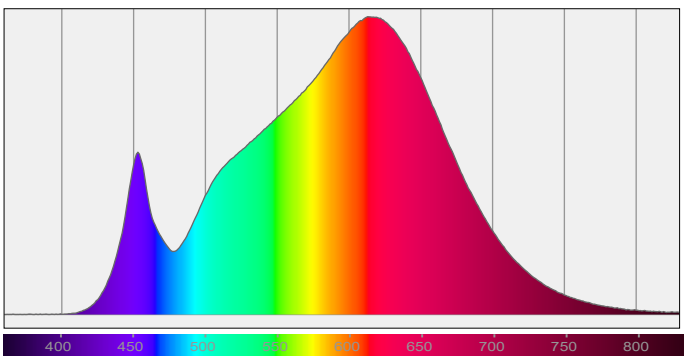
Color Rendering Index per reference color (CIE 1995)



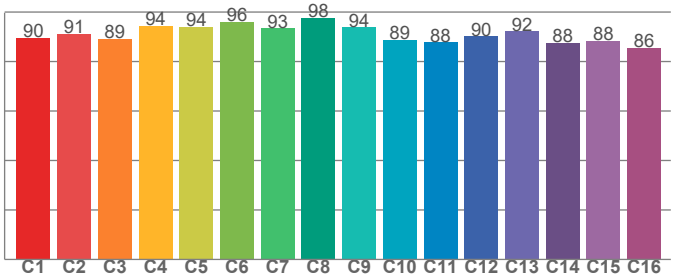
CRI R values, only R1-R8 are used to calculate final CRI value

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
91,4	95,1	97,7	92,1	91,1	94,0	91,7	79,5	52,2	87,9	93,0	79,2	92,3	98,2	86,5

Spectral power distribution (SPD) / W/nm – 0-100%



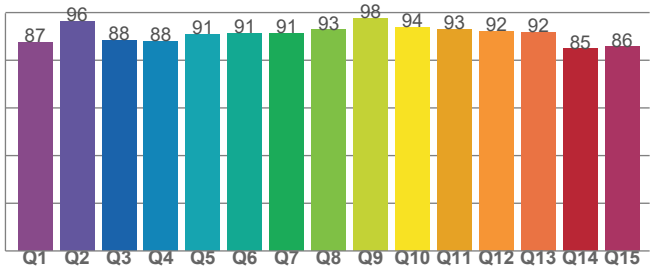
TM30-18 Rf-values per hue bin



TM30 C values, 16 binned values out of total of 99 C values

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
89,6	91,2	89,2	94,4	94,0	96,1	93,4	97,6	93,9	88,8	87,8	90,3	92,2	87,5	88,4	85,6

Color Quality Scale by reference color



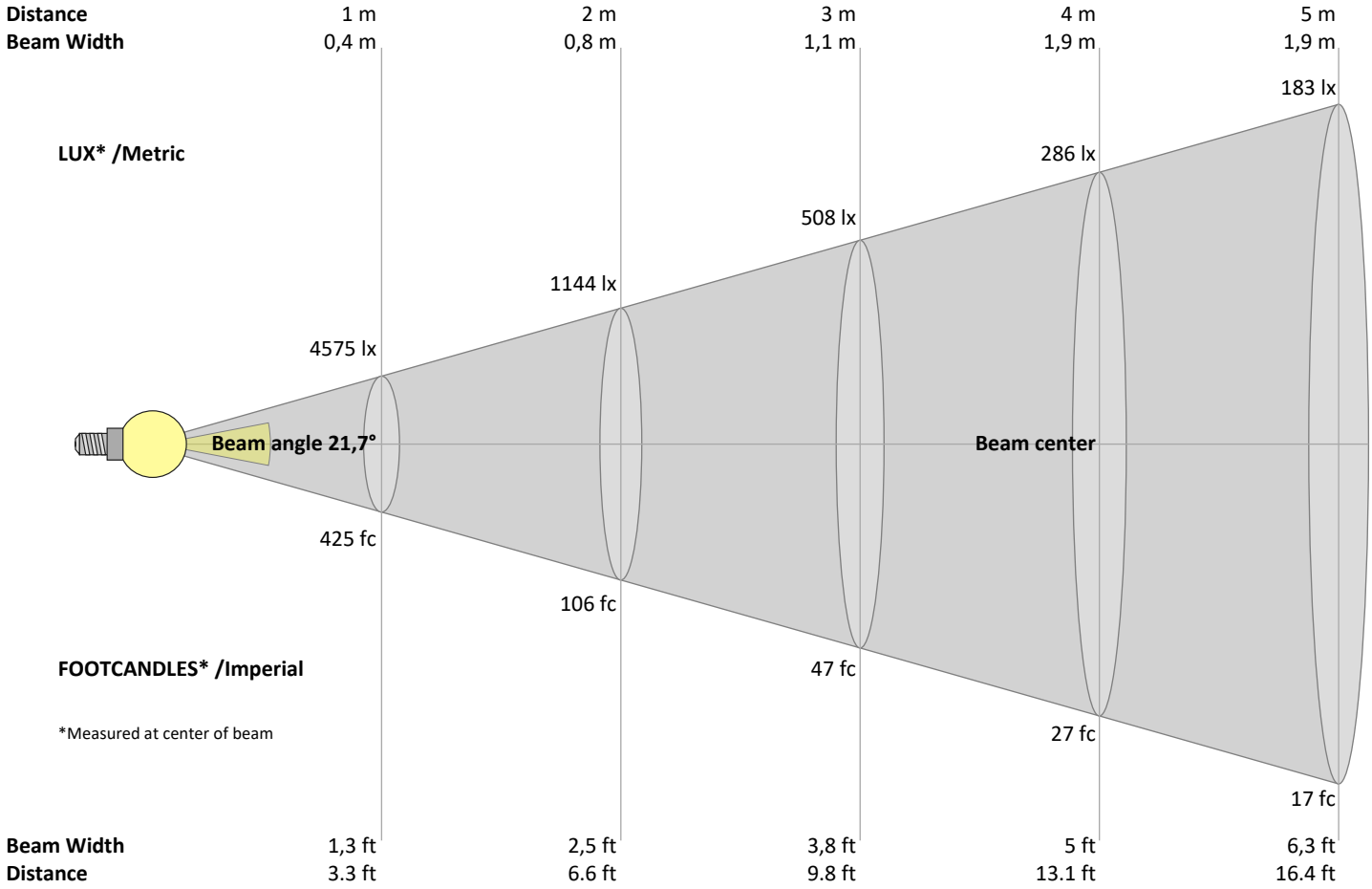
CQS Q values

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
87,4	96,2	88,3	88,0	90,8	91,4	91,3	92,7	97,5	93,7	93,0	92,2	91,6	84,8	85,6

Light Measurement Report

Print date: 23/08/2023
Measurement date and time: 23/08/2023 10:35:30 – Measurement no. VFR-230823-0126-MS
Measurement tracking No. and Link: VT230823-009989
Operator: TT

Beam Details



Beam intensities from 1 – 20 m

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	m
3,3	6,6	9,8	13,1	16,4	19,7	23	26,2	29,5	32,8	36,1	39,4	42,7	45,9	49,2	52,5	55,8	59,1	62,3	65,6	ft
4575	1144	508	286	183	127	93	71	56	46	38	32	27	23	20	18	16	14	13	11	lux
425	106,3	47,2	26,6	17	11,8	8,7	6,6	5,2	4,3	3,5	3	2,5	2,2	1,9	1,7	1,5	1,3	1,2	1,1	fc

Intensities in 0° c-plane

0°	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	32°	34°	36°	38°	γ
4575	4489	4181	3716	3146	2535	1951	1443	1033	732	530	400	316	258	214	179	151	124	91	64	cd
100%	98%	91%	81%	69%	55%	43%	32%	23%	16%	12%	9%	7%	6%	5%	4%	3%	3%	2%	1%	of 0°val

Intensities in 90° c-plane

0°	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	32°	34°	36°	38°	γ
4575	4458	4143	3677	3111	2515	1944	1439	1027	726	525	398	315	257	215	180	151	125	95	69	cd
100%	97%	91%	80%	68%	55%	42%	31%	22%	16%	11%	9%	7%	6%	5%	4%	3%	3%	2%	2%	of 0°val

Intensities in 180° c-plane

0°	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	32°	34°	36°	38°	γ
4575	4489	4181	3716	3146	2535	1951	1443	1033	732	530	400	316	258	214	179	151	124	91	64	cd
100%	98%	91%	81%	69%	55%	43%	32%	23%	16%	12%	9%	7%	6%	5%	4%	3%	3%	2%	1%	of 0°val

Intensities in 270° c-plane

0°	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	32°	34°	36°	38°	γ
4575	4458	4143	3677	3111	2515	1944	1439	1027	726	525	398	315	257	215	180	151	125	95	69	cd
100%	97%	91%	80%	68%	55%	42%	31%	22%	16%	11%	9%	7%	6%	5%	4%	3%	3%	2%	2%	of 0°val

Light Measurement Report

Print date: 23/08/2023
Measurement date and time: 23/08/2023 10:35:30 – Measurement no. VFR-230823-0126-MS
Measurement tracking No. and Link: VT230823-009989
Operator: TT

Light Planning – UGR table

Uncorrected, comprehensive UGR table according to 117-1995

Reflectances											
ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room size H = mounting height above eye level		**Viewed Crosswise** (Viewing direction orthogonal to lamp length axis)					**Viewed Endwise** (Viewing direction parallel to lamp length axis)				
X	**Y**										
2H	2H	12,8	13,2	12,8	13,4	13,6	12,8	13,2	12,9	13,4	13,6
	3H	12,4	13,0	12,8	13,2	13,4	12,5	13,1	12,9	13,3	13,4
	4H	12,4	12,9	12,8	13,2	13,4	12,4	13,0	12,8	13,2	13,4
	6H	12,4	12,8	12,7	13,1	13,5	12,4	12,9	12,7	13,2	13,5
	8H	12,3	12,8	12,7	13,1	13,5	12,4	12,8	12,7	13,1	13,5
	12H	12,3	12,7	12,6	13,1	13,5	12,3	12,8	12,7	13,1	13,5
4H	2H	12,4	12,9	12,8	13,2	13,4	12,4	13,0	12,8	13,2	13,4
	3H	12,3	12,7	12,6	13,1	13,5	12,3	12,8	12,7	13,1	13,5
	4H	12,1	12,5	12,6	13,0	13,5	12,2	12,6	12,6	13,0	13,5
	6H	12,1	12,5	12,6	12,8	13,2	12,1	12,6	12,6	12,9	13,2
	8H	12,0	12,4	12,5	12,8	13,1	12,1	12,5	12,6	12,8	13,2
	12H	12,0	12,3	12,5	12,7	13,2	12,0	12,3	12,5	12,7	13,2
8H	4H	12,0	12,4	12,5	12,8	13,1	12,0	12,5	12,6	12,8	13,2
	6H	11,9	12,2	12,5	12,7	13,2	12,0	12,3	12,5	12,7	13,2
	8H	12,0	12,2	12,5	12,7	13,3	12,0	12,2	12,5	12,7	13,3
	12H	11,9	12,1	12,5	12,6	13,2	12,0	12,1	12,6	12,6	13,2
12H	4H	11,9	12,2	12,4	12,7	13,1	12,0	12,3	12,5	12,7	13,2
	6H	11,9	12,1	12,5	12,7	13,3	12,0	12,2	12,5	12,7	13,3
	8H	11,9	12,1	12,5	12,6	13,2	11,9	12,1	12,5	12,6	13,2

Variations with the observer position for the luminaire spacings, S:		
S = 1.0H	5,6 / -9,5	5,5 / -9,6
S = 1.5H	8,3 / -10,6	8,2 / -10,6
S = 2.0H	10,2 / -11,3	10,2 / -11,3

Coefficients of Utilization

Ceiling reflectance	80			70			50			30			10			0		
Wall reflectance	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
Floor reflectance	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	0
RCR	(RCR: Room Cavity Ratio) Room Values are expressed as percentage of Lumen delivered to the task surface																	
0	119	119	119	119	116	116	116	116	111	111	111	106	106	106	102	102	102	100
1	115	113	111	109	112	111	109	107	106	105	104	103	102	101	99	99	98	96
2	111	107	104	102	109	106	103	100	102	100	98	99	98	96	97	95	94	93
3	107	102	99	96	105	101	98	95	99	96	94	96	94	92	94	92	91	89
4	104	98	94	91	102	97	93	91	95	92	90	93	91	88	92	89	88	86
5	101	94	90	87	99	94	90	87	92	89	86	90	88	85	89	87	85	83
6	97	91	87	84	96	90	86	83	89	86	83	88	85	82	87	84	82	81
7	95	88	84	81	94	87	83	81	86	83	80	85	82	80	84	81	79	78
8	92	85	81	78	91	85	81	78	84	80	78	83	80	77	82	79	77	76
9	89	83	78	76	89	82	78	75	81	78	75	81	77	75	80	77	75	74
10	87	80	76	73	86	80	76	73	79	76	73	79	75	73	78	75	73	72

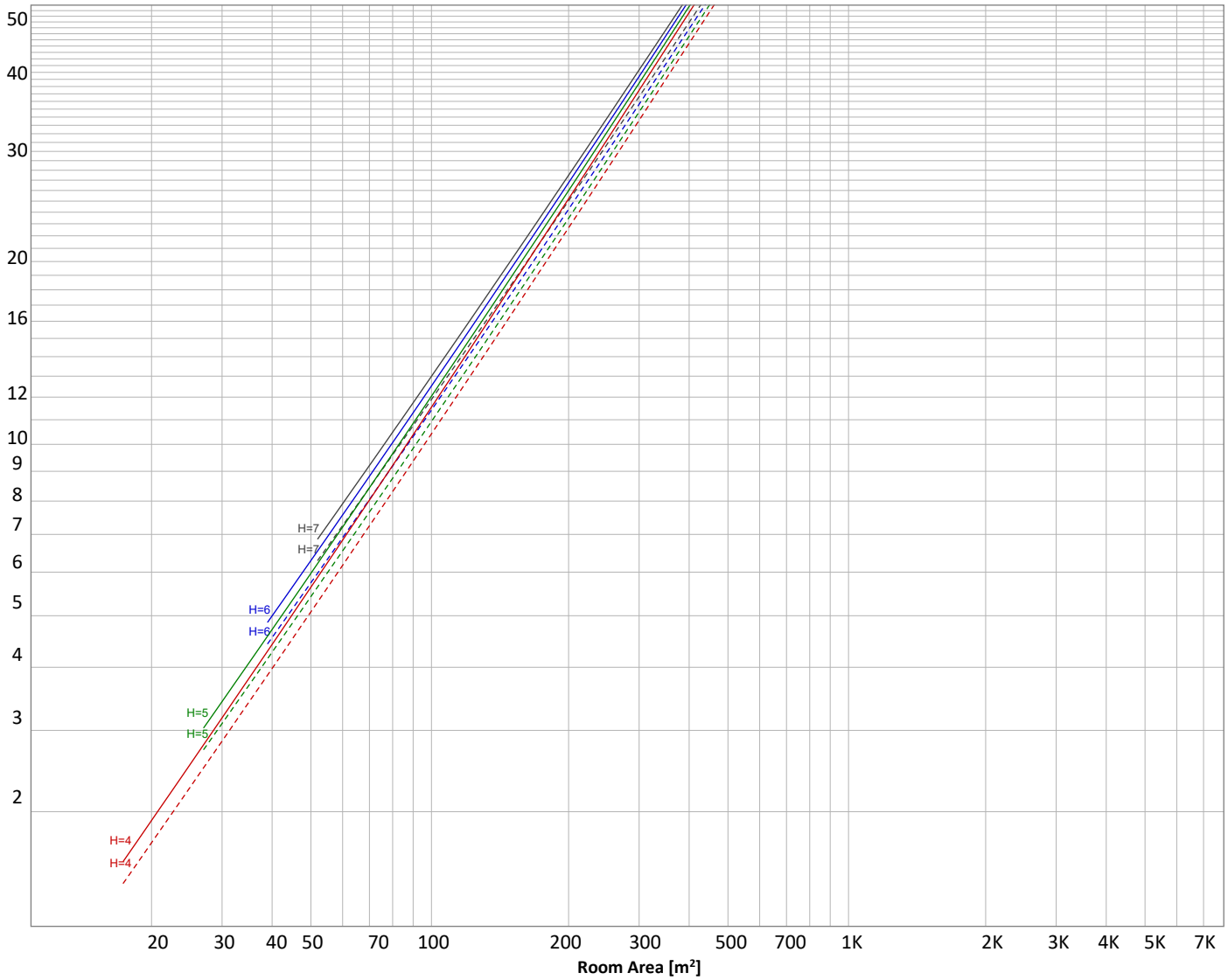
Light Measurement Report

Print date: 23/08/2023
Measurement date and time: 23/08/2023 10:35:30 – Measurement no. VFR-230823-0126-MS
Measurement tracking No. and Link: VT230823-009989
Operator: TT

Luminaire budgetary diagram

Uncorrected, comprehensive UGR table according to 117-1995

LAMPS (number of lamps)



Conditions

H = Room height	Flux = 900 lm		ρ(%)		
H_{down} = Lamp distance from ceiling =	0.00 m	Line type	Ceiling reflectance	Wall reflectance	Floor reflectance
H_{work} = Work area height from floor =	0.00 m	----------	70	50	30
E_{work} = Average lux on work area =	100 lx	————	50	30	20

Zonal Lumen Summary

0°-10°	10°-20°	20°-30°	30°-40°	40°-50°	50°-60°	60°-70°	70°-80°	80°-90°
327 lm	350 lm	139 lm	66,5 lm	10,9 lm	2,67 lm	1,07 lm	0,417 lm	0,331 lm

90°-100°	100°-110°	110°-120°	120°-130°	130°-140°	140°-150°	150°-160°	160°-170°	170°-180°
0,317 lm	0,316 lm	0,287 lm	0,276 lm	0,262 lm	0,286 lm	0,256 lm	0,190 lm	0,052 lm

Light Measurement Report

Print date: 23/08/2023
Measurement date and time: 23/08/2023 10:35:30 – Measurement no. VFR-230823-0126-MS
Measurement tracking No. and Link: VT230823-009989
Operator: TT

Outdoor Light Planning

Lumen per Zone

Zone (γ)	Lumen	% Total
0-10°	327 lm	36,4%
10-20°	350 lm	38,9%
20-30°	139 lm	15,4%
30-40°	67 lm	7,4%
40-50°	11 lm	1,2%
50-60°	3 lm	0,3%
60-70°	1 lm	0,1%
70-80°	0 lm	0,0%
80-90°	0 lm	0,0%
90-100°	0 lm	0,0%
100-110°	0 lm	0,0%
110-120°	0 lm	0,0%
120-130°	0 lm	0,0%
130-140°	0 lm	0,0%
140-150°	0 lm	0,0%
150-160°	0 lm	0,0%
160-170°	0 lm	0,0%
170-180°	0 lm	0,0%
Total	900 lm	100,0%

Intensity peaks

Max intensity	4607 cd
Intensity, 90°	0 cd
Intensity, 0°	4575 cd

Zonal Lumen summary

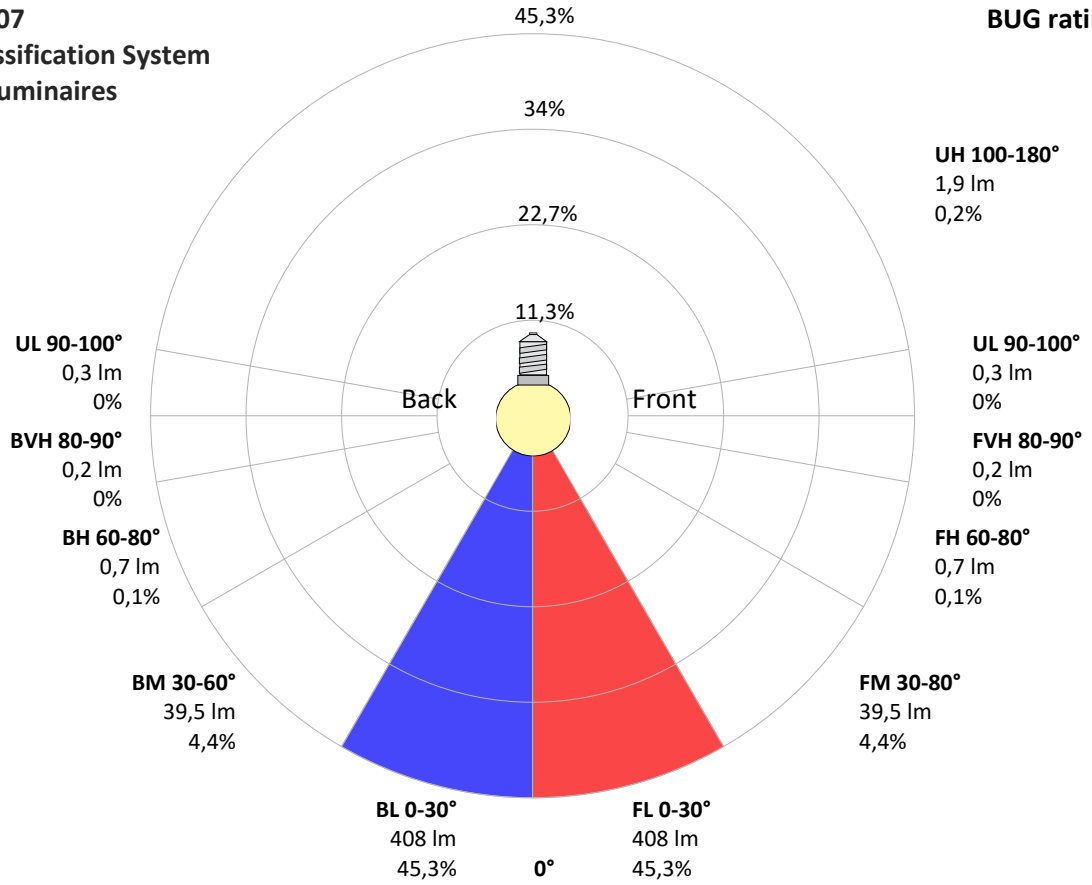
Zone (γ)	Lumen	% Total
0-30°	816 lm	90,7%
0-40°	882 lm	98,0%
0-60°	896 lm	99,5%
60-90°	2 lm	0,2%
70-100°	1 lm	0,1%
90-120°	1 lm	0,1%
0-90°	898 lm	99,8%
90-180°	2 lm	0,2%
0-180°	900 lm	100,0%

BUG rating

	Lumen	% Total
Forward light		
Low(0-30°)	408 lm	45,3%
Medium(30-60°)	40 lm	4,4%
High(60-80°)	1 lm	0,1%
Very high(80-90°)	0 lm	0,0%
Back light		
Low(0-30°)	408 lm	45,3%
Medium(30-60°)	40 lm	4,4%
High(60-80°)	1 lm	0,1%
Very high(80-90°)	0 lm	0,0%
Uplight		
Low(90-100°)	0 lm	0,0%
High(100-180°)	2 lm	0,2%

IESNA TM-15-07
Luminaire Classification System
For Outdoor Luminaires

BUG rating B1 U1 G0



Light Measurement Report

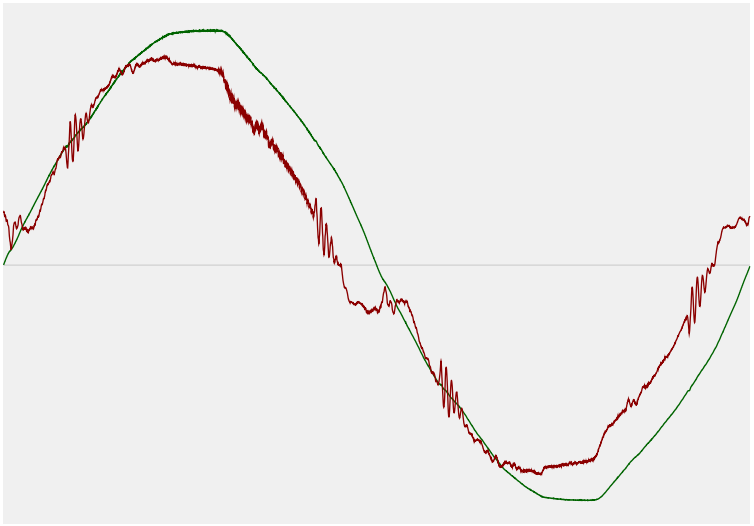
Print date: 23/08/2023
Measurement date and time: 23/08/2023 10:35:30 – Measurement no. VFR-230823-0126-MS
Measurement tracking No. and Link: VT230823-009989
Operator: TT

Power Details

Input Power

Power feed to light source	14,8 W
Frequency of input power	50,1 Hz
RMS Input voltage feed, V_{RMS}	232 V
RMS Input current feed, I_{RMS}	0,066 A
Volt-Ampere or apparent power = V_{RMS}*I_{RMS}	15,33 VA
Displacement factor of AC power feed	0,98
Power factor of AC current feed	0,96
Total harmonic distortion of the current	12,4%
Total harmonic distortion of the voltage	2,65%

Input Power Curve

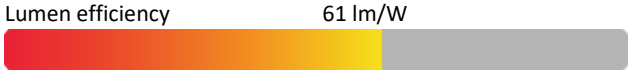


Efficiency

Radiated power efficiency 20,4%



Lumen efficiency 61 lm/W



Stabilization Details

Warmup Conditions

Stable period	15 min
Stable change max	2,0%
Minimum time	15 min

Color Temperature Change

CCT start	3002 K
CCT shift	-2 K
CCT end	3000 K

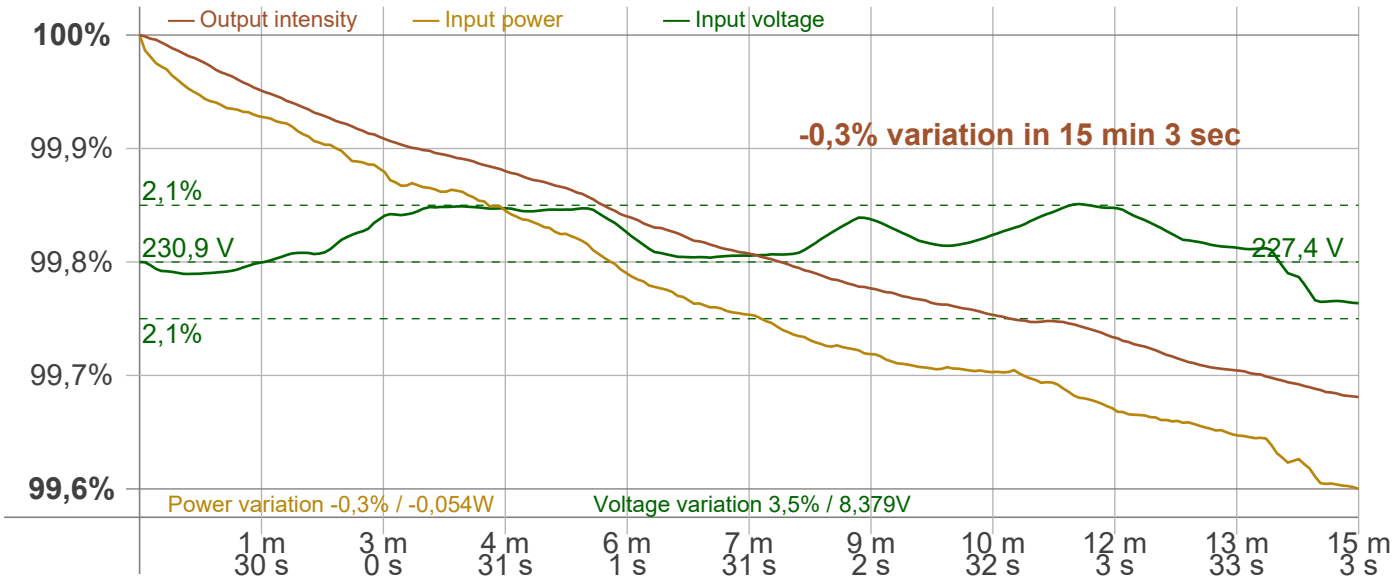
Warmup Result

Total warmup time	Lamp stabilized in 15 min 3 sec
Warmup variation	-0,3%

Output Change

Output start	903 lm
Output change	-3 lm
Output end	900 lm

Stabilization Curve



Light Measurement Report

Print date: 23/08/2023
Measurement date and time: 23/08/2023 10:35:30 – Measurement no. VFR-230823-0126-MS
Measurement tracking No. and Link: VT230823-009989
Operator: TT

Flicker /TLA details

Flicker Meter Type	Viso Systems LabFlicker
Frequency of input power	50,1 Hz
Flicker/TLA sample rate	20000 samples/s

Measurement time

PstLM	180 sec
All other indices	1,2 sec

Flicker indices according to Illuminating Engineering Society (IES)

Flicker frequency	200 Hz
Percent Flicker	0,11 %
Flicker index	0

TLA indices (re IEC TR 61547-1, IEC 61000-3-3 and IEC 61000-4-15)

PstLM value (F < 80 Hz)	0,01
SVM value (80 < F < 2000 Hz)	0

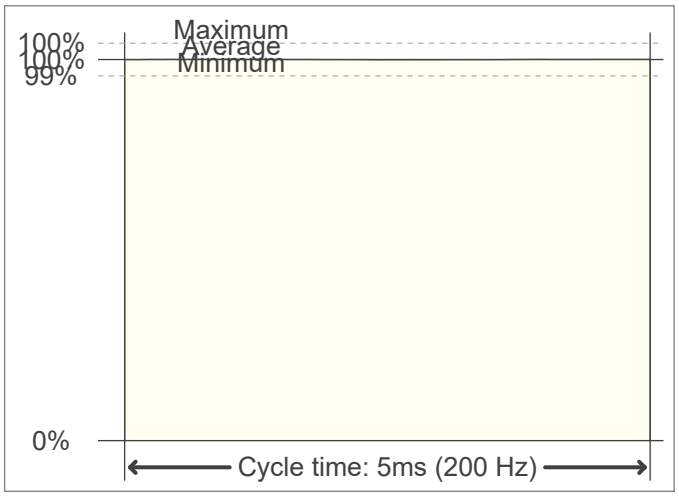
Flicker indices according to California Energy Commission (CEC) 2016b

JA8/10 40 Hz	0,01 %
JA8/10 90 Hz	0,03 %
JA8/10 200 Hz	0,08 %
JA8/10 400 Hz	0,08 %
JA8/10 1000 Hz	0,09 %

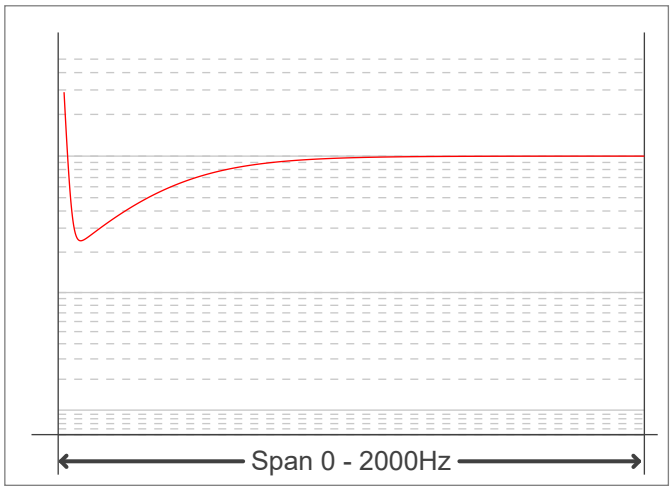
Flicker indices according to Lighting Research Center (2015)

Perception metric, Assist Mp	0,01

Flicker frame (frame of one flicker period in time domain)



Flicker FFT (flicker curve in frequency domain)



IEEE 1789 Frequency/modulation plot

