

## LM-79-08 TEST REPORT

for

### GREEN CREATIVE LTD

756 North Zhongshan Rd., Unit B301 Zhabei District, Shanghai

### LED Lamp

**Model: 5.5PAR20DIM/840FL40/N**

### Laboratory: Leading Testing Laboratories

**NVLAP CODE: 200960-0**

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Report No.: HZ19070039j

The laboratory that conducted the testing detailed in this report has been accredited for SSL by NVLAP.

Review by:



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Aug. 01, 2019

Approved by:



Manager: Jim Zhang

Aug. 01, 2019

Note: This report does not imply product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

## TEST SUMMARY

Sample Tested: 5.5PAR20DIM/840FL40/N

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
108.0	573.5	5.31	0.7169
CCT (K)	CRI	Stabilization Time (Light & Power)	
3894	81.7	60	

Table 1: Executive Data Summary

Note: The above results are recorded/ derived from measurements made using an Integrating Sphere.

### Test specifications:

<b>Date of Receipt</b>	: Jul. 25, 2019
<b>Date of Test</b>	: Jul. 31, 2019
<b>Test item</b>	: Total Luminous Flux, Luminous Distribution Intensity, Luminous Efficacy, Correlated Color Temperature, Color Rendering Index, Chromaticity Coordinate, Electrical parameters
<b>Reference Standard</b>	: IESNA LM-79-2008 Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products ANSI/IES TM-30-18 IES Method for Evaluating Light Source Color Rendition

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## SAMPLE PHOTO



Figure 1- Overview of the sample

### Equipment Under Test(EUT)

<b>Name</b>	: LED Lamp
<b>Model</b>	: 5.5PAR20DIM/840FL40/N
<b>Electrical Ratings</b>	: 120V, 60Hz, 5.5W
<b>Product Description</b>	: 4000K
<b>Manufacturer</b>	: GREEN CREATIVE LTD
<b>Address</b>	: 756 North Zhongshan Rd., Unit B301 Zhabei District, Shanghai

## TEST RESULTS

Test ambient temperature was 26.0 °C.

Base orientation was base up. Test was conducted without a dimmer in the circuit.

The stabilization time of the sample was 60 minutes, and the total operating time including stabilization was 65 minutes.

### Sphere-Spectroradiometer Method

Parameter	Result
Test Voltage (V)	120.0
Voltage frequency (Hz)	60
Test Current (A)	0.062
Power Factor	0.7169
Test Power (W)	5.31
THD A%	69.03
Luminous Efficacy (lm/W)	108.0
Total Luminous Flux (lm)	573.5
Color Rendering Index (CRI)	81.7
R9	2.2
Correlated Color Temperature (CCT)(K)	3894
Chromaticity Chroma x	0.3868
Chromaticity Chroma y	0.3855
Chromaticity Chroma u	0.2258
Chromaticity Chroma v	0.3376
Duv	0.0023
Chromaticity Chroma u'	0.2258
Chromaticity Chroma v'	0.5063

Special Color Rendering Indices	
R1	79.4
R2	89.3
R3	95.7
R4	78.6
R5	79.1
R6	85
R7	84.9
R8	61.3
R9	2.2
R10	74.2
R11	76.4
R12	60.2
R13	82
R14	97.9

Table 2: Test data per Sphere-Spectroradiometer Method

Note: According to CIE 1976 (u',v') diagram,  $u' = u = 4x/(-2x+12y+3)$ ,  $v' = 3v/2 = 9y/(-2x+12y+3)$ .

### Goniophotometer Method

Test ambient temperature was 25.2 °C.

The photometric distance is 2.47 m.

Luminous data was taken at 0.5 vertical intervals and 10 horizontal intervals.

Parameter	Result
Test Voltage (V)	120.0
Voltage frequency (Hz)	60
Test Current (A)	0.061
Power Factor	0.7228
Power (W)	5.28
Luminous Efficacy (lm/W)	110.0
Total Luminous Flux (lm)	580.7
Beam Angle ( ° )	38.4 (0°-180°) / 37.4 (90°-270°)
Center Beam Candle Power (cd)	1033
Maximum Beam Candle Power (cd)	1039 (At: C=320.0, Gamma=0.5)
Spacing Criteria	0.59 (0°-180°) / 0.63 (90°-270°)
Zonal Lumens in the 0 °-60 °Zone	95.86%
Zonal Lumens in the 60 °-90 °Zone	4.00%
Zonal Lumens in the 90 °-120 °Zone	0.02%
Zonal Lumens in the 120 °-180 °Zone	0.12%

Table 3: Test data per Goniophotometer Method

### Spectral Power Distribution - Sphere Spectroradiometer Method

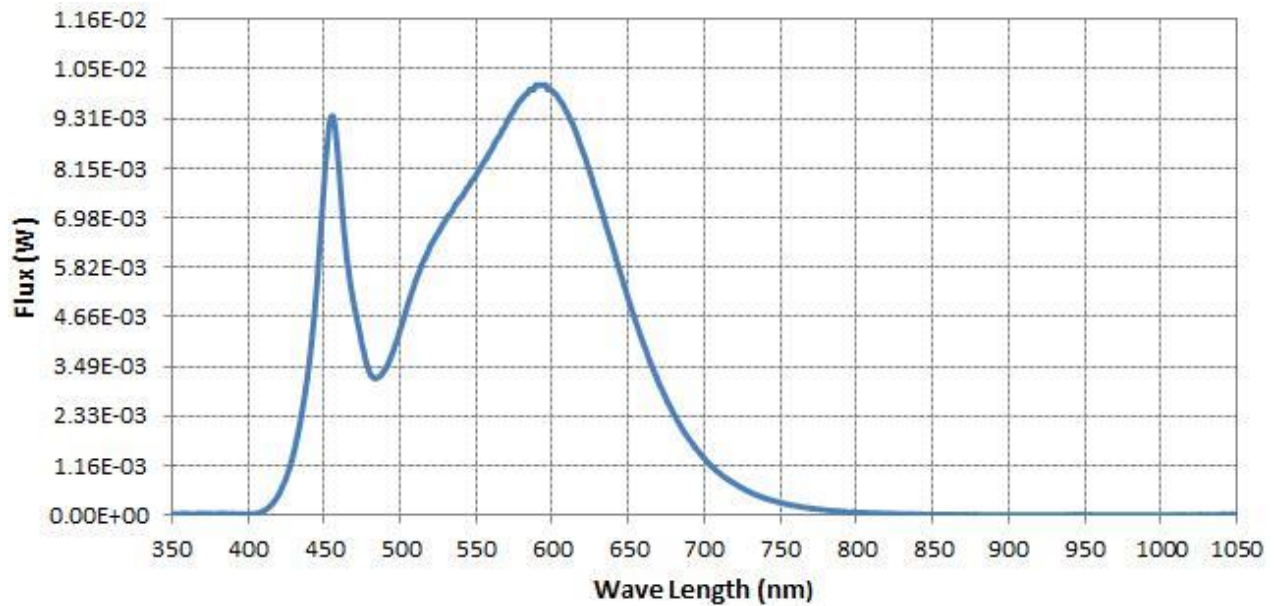


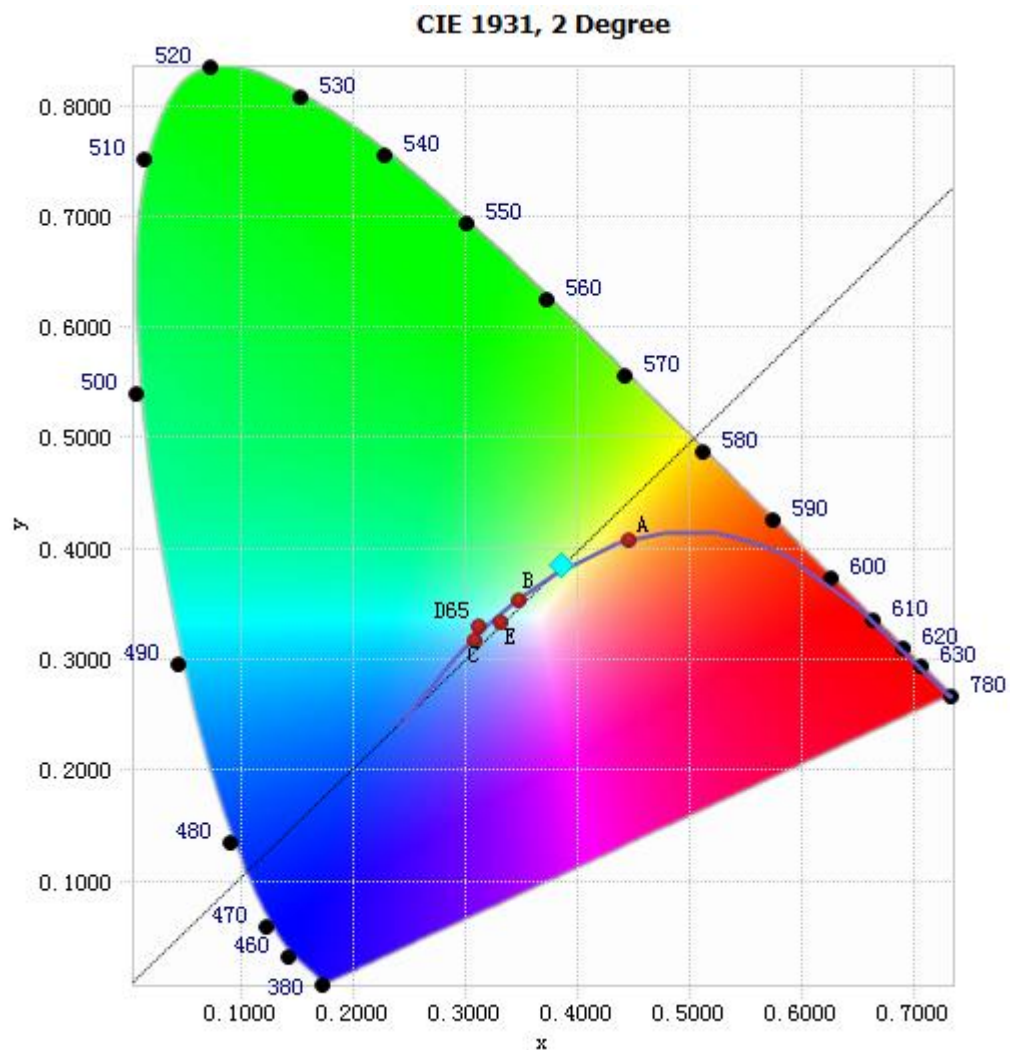
Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	3.93E-05	485	3.22E-03	590	1.01E-02	695	1.54E-03
385	3.74E-05	490	3.41E-03	595	1.01E-02	700	1.33E-03
390	3.40E-05	495	3.81E-03	600	9.96E-03	705	1.14E-03
395	2.70E-05	500	4.35E-03	605	9.75E-03	710	9.86E-04
400	2.30E-05	505	4.93E-03	610	9.43E-03	715	8.48E-04
405	3.70E-05	510	5.48E-03	615	9.05E-03	720	7.38E-04
410	9.59E-05	515	5.95E-03	620	8.55E-03	725	6.33E-04
415	2.27E-04	520	6.34E-03	625	8.02E-03	730	5.43E-04
420	4.74E-04	525	6.63E-03	630	7.45E-03	735	4.65E-04
425	8.66E-04	530	6.93E-03	635	6.83E-03	740	3.97E-04
430	1.45E-03	535	7.19E-03	640	6.26E-03	745	3.46E-04
435	2.30E-03	540	7.46E-03	645	5.66E-03	750	2.95E-04
440	3.49E-03	545	7.72E-03	650	5.07E-03	755	2.56E-04
445	5.26E-03	550	7.99E-03	655	4.53E-03	760	2.22E-04
450	7.74E-03	555	8.29E-03	660	4.01E-03	765	1.89E-04
455	9.38E-03	560	8.58E-03	665	3.54E-03	770	1.63E-04
460	8.09E-03	565	8.89E-03	670	3.11E-03	775	1.41E-04
465	6.04E-03	570	9.22E-03	675	2.72E-03	780	1.20E-04
470	4.90E-03	575	9.51E-03	680	2.37E-03		
475	4.00E-03	580	9.77E-03	685	2.06E-03		
480	3.35E-03	585	9.99E-03	690	1.78E-03		

Table 4: Spectral Power Distribution Numerical Data per Sphere - Spectroradiometer Method



## Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3868, 0.3855)

Chart 2: Chromaticity Diagram per Sphere - Spectroradiometer Method

Note: The location on the diagram of the tristimulus coordinates are indicated by the blue diamond.



### Nominal CCT Quadrangles – Sphere Spectroradiometer Method

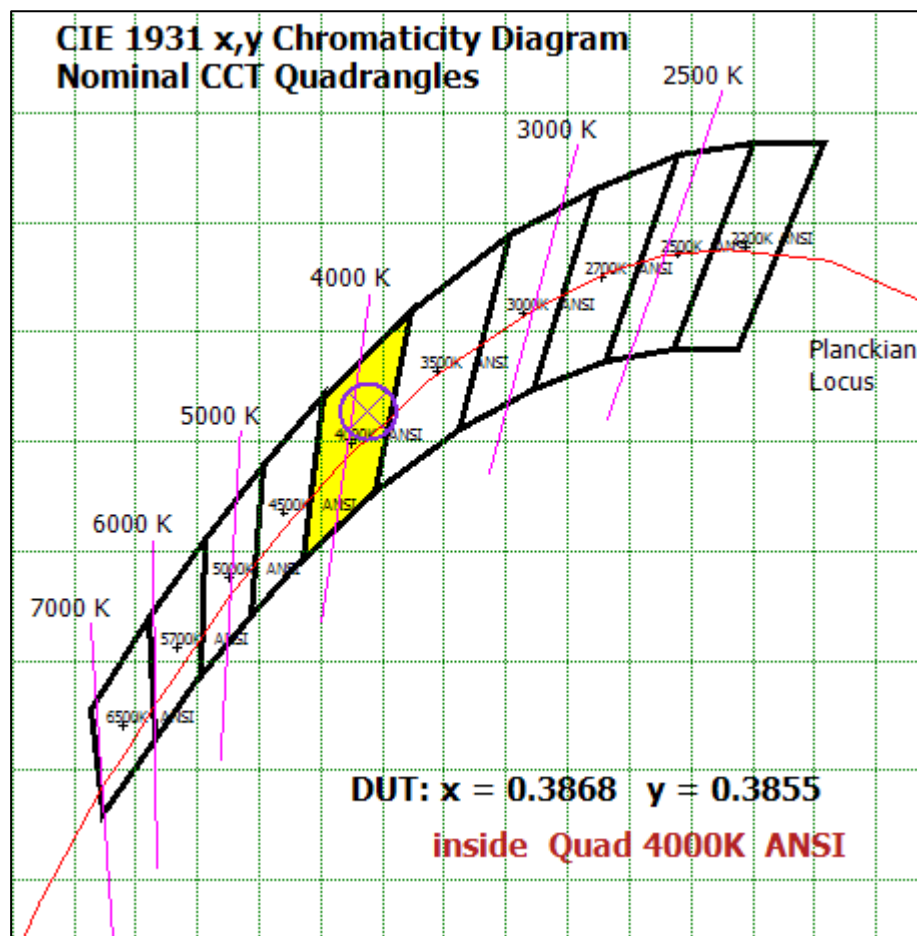
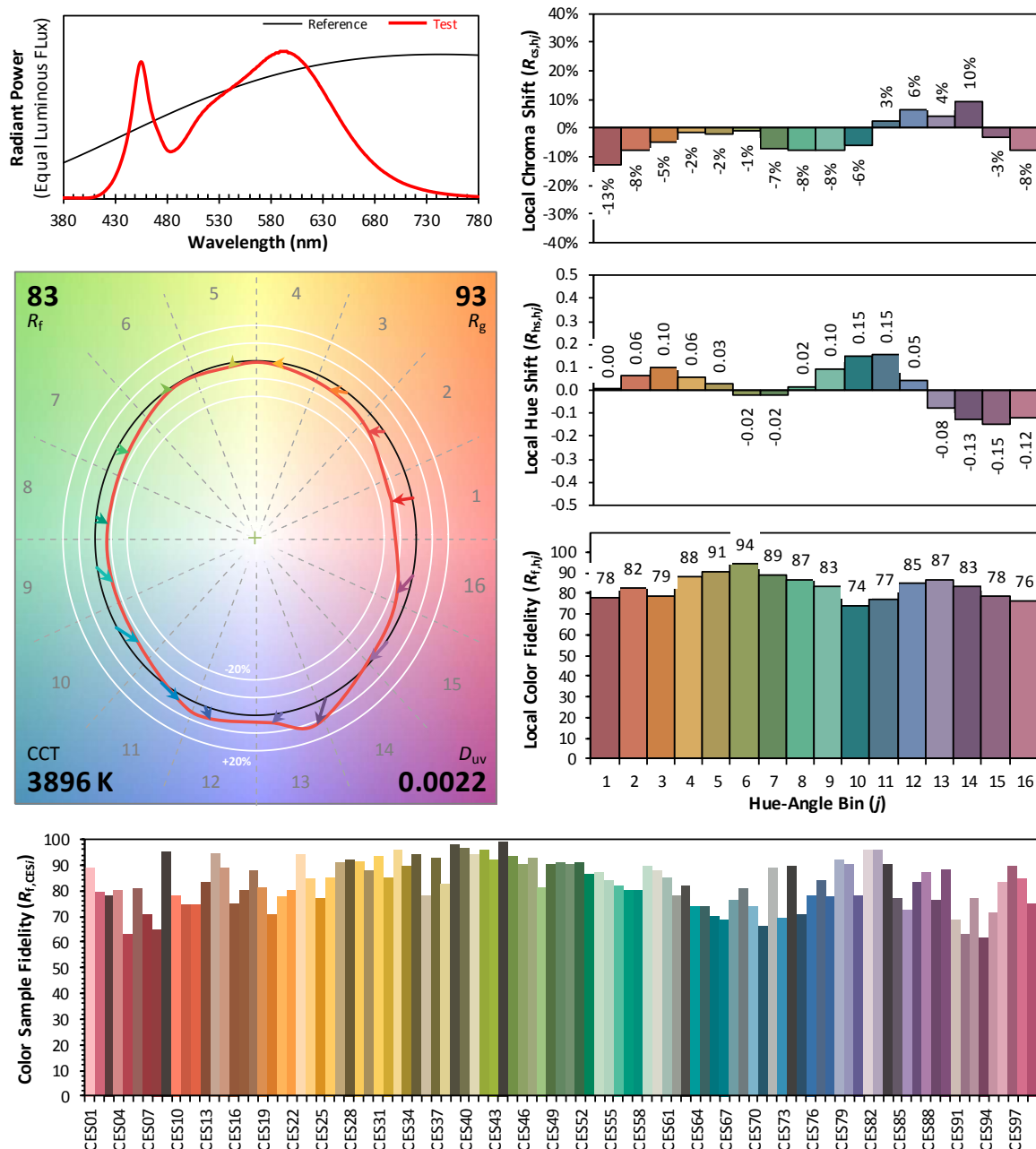


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

## Color Rendition Report – Sphere Spectroradiometer Method



Notes: This is a recommended method for displaying ANSI/IES TM-30-18 information.

$x$  0.3869  
 $y$  0.3855  
 $u'$  0.2258  
 $v'$  0.5063

Chart 4: Full Report Created with the IES TM-30 Calculator

Note: The values in this diagram might be a little different from the values in Table 2 due to rounding.

### Zonal Lumen Tabulation- Goniophotometer Method

$\gamma(^{\circ})$	Lumens	% Total
0- 10	91.001	15.67%
10- 20	187.499	32.29%
20- 30	133.112	22.92%
30- 40	77.38	13.33%
40- 50	44.382	7.64%
50- 60	23.315	4.01%
60- 70	13.989	2.41%
70- 80	7.166	1.23%
80- 90	2.051	0.35%
90-100	0.067	0.01%
100-110	0.008	0.00%
110-120	0.017	0.00%
120-130	0.04	0.01%
130-140	0.099	0.02%
140-150	0.173	0.03%
150-160	0.2	0.03%
160-170	0.153	0.03%
170-180	0.052	0.01%
Total	580.7	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	556.689	95.86%
60- 90	23.206	4.00%
0-90	579.895	99.86%
90- 180	0.809	0.14%
0- 180	580.7	100%

Table 5: Zonal Lumen

## Illuminance Plots- Goniophotometer Method

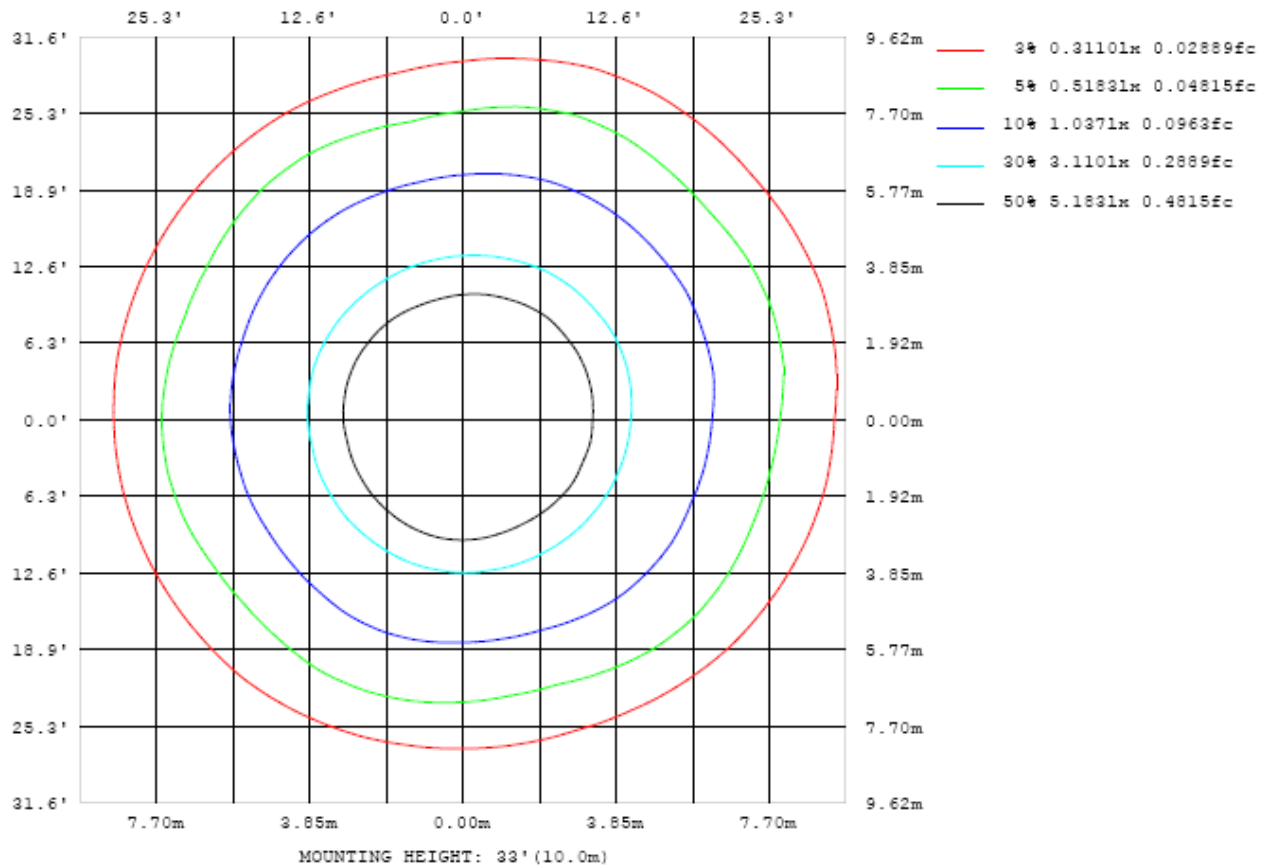


Chart 5: Illuminance Plot (Footcandles)

# Luminous Intensity Distribution Plots- Goniophotometer Method

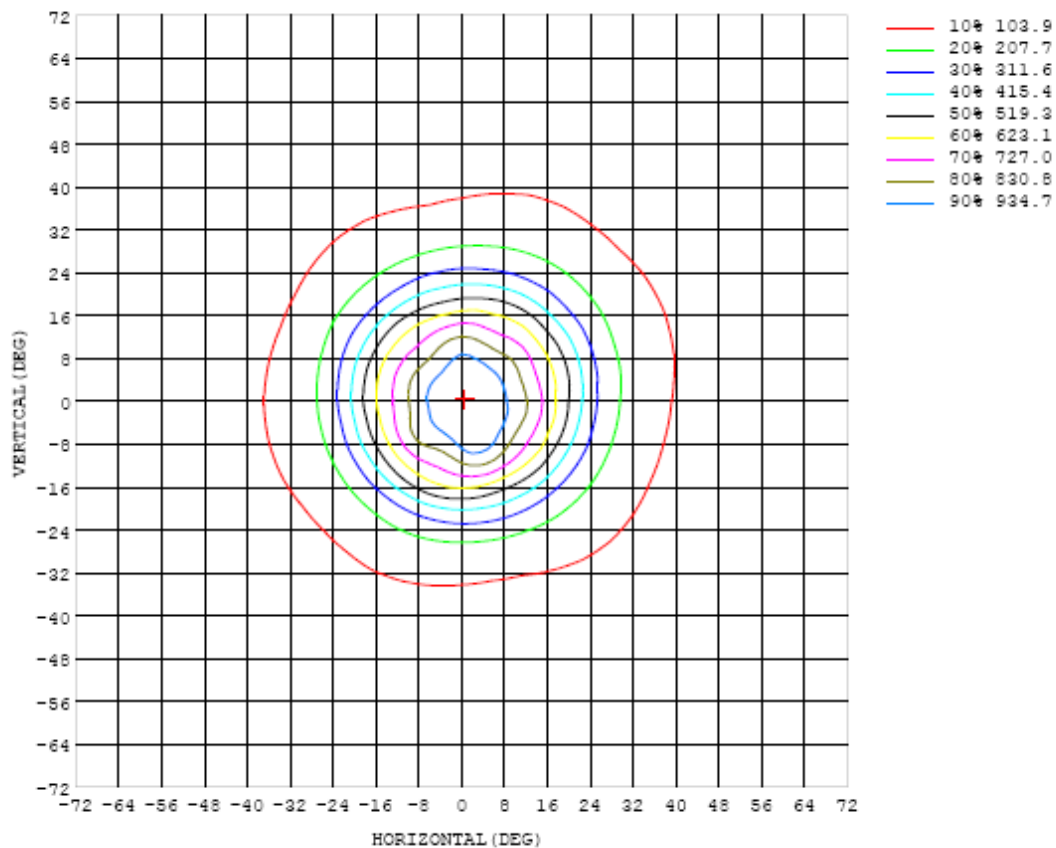


Chart 6: Isocandela Plot

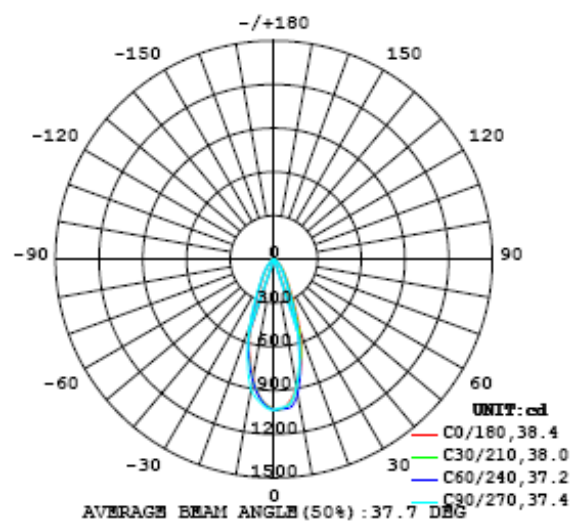


Chart 7: Polar Candela Distribution

## Luminous Intensity Data- Goniophotometer Method

Table--1

UNIT: cd

C (DEG) y (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033
5	1006	1009	1012	1015	1018	1024	1027	1029	1021	1008	992	981	972	965	964	962	962	963	967
10	896	905	899	897	901	922	938	939	927	891	852	831	833	851	864	860	840	825	826
15	728	725	713	708	705	698	691	690	683	676	670	661	655	656	661	655	651	647	656
20	517	510	498	480	471	455	438	431	425	425	425	427	422	421	420	421	428	429	445
25	320	310	302	287	278	266	256	250	244	241	241	242	239	238	238	240	244	247	255
30	201	194	186	183	177	170	159	148	144	146	150	153	154	150	148	150	155	159	165
35	137	131	127	127	124	117	107	96.8	95.4	97.9	102	105	106	102	102	105	111	116	118
40	97.9	93.5	90.0	87.0	83.3	76.5	70.5	66.8	65.9	65.3	66.0	68.4	70.8	72.9	73.5	75.0	78.3	80.8	82.2
45	68.9	68.2	64.5	58.4	51.8	46.7	44.1	43.0	42.2	40.9	39.9	41.1	44.9	49.2	51.4	51.0	49.7	48.9	50.8
50	45.6	46.4	43.3	38.1	33.4	30.6	29.4	28.8	28.3	27.5	27.1	27.7	29.6	32.2	33.7	33.4	31.7	30.5	32.1
55	30.0	30.7	29.2	26.1	23.5	22.1	21.4	21.2	20.8	20.4	20.2	20.3	21.1	22.4	23.3	23.0	22.1	21.8	22.6
60	21.4	22.0	21.1	19.2	17.6	16.9	16.7	16.6	16.3	16.0	15.8	15.8	16.3	17.1	17.6	17.5	16.9	16.7	17.3
65	15.7	16.3	15.7	14.5	13.5	13.1	13.0	13.0	12.9	12.7	12.5	12.5	12.7	13.2	13.5	13.3	12.9	12.7	12.9
70	11.4	11.8	11.4	10.7	10.2	9.94	9.91	9.89	9.81	9.64	9.45	9.33	9.47	9.78	9.91	9.76	9.45	9.31	9.44
75	7.58	7.75	7.52	7.17	6.93	6.84	6.76	6.70	6.62	6.49	6.38	6.29	6.28	6.35	6.39	6.33	6.19	6.17	6.27
80	4.34	4.34	4.22	4.13	4.05	3.99	3.93	3.89	3.84	3.77	3.71	3.64	3.58	3.55	3.51	3.54	3.53	3.60	3.66
85	2.08	2.08	2.06	2.01	1.97	1.92	1.87	1.83	1.80	1.74	1.70	1.66	1.62	1.59	1.56	1.57	1.60	1.70	1.73
90	0.43	0.42	0.40	0.38	0.36	0.34	0.32	0.30	0.28	0.26	0.25	0.24	0.23	0.23	0.22	0.23	0.25	0.29	0.29
95	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02
100	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
105	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
110	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
115	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
120	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
125	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.04	0.04	0.05
130	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.10
135	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.11	0.11	0.17
140	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.17	0.17	0.27
145	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.38
150	0.25	0.25	0.25	0.25	0.26	0.26	0.26	0.27	0.27	0.27	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.48
155	0.32	0.32	0.32	0.32	0.33	0.33	0.33	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.56
160	0.38	0.39	0.39	0.39	0.39	0.40	0.40	0.40	0.40	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.62
165	0.43	0.44	0.44	0.44	0.44	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.46	0.46	0.46	0.46	0.65
170	0.46	0.46	0.46	0.46	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.48	0.48	0.48	0.48	0.63
175	0.48	0.48	0.48	0.48	0.49	0.49	0.49	0.49	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.56
180	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53

Table 6: Luminous Intensity Data

Table--2

UNIT: cd

C (DEG) y (DEG)	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350		
0	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033	1033		
5	969	971	971	969	970	974	982	988	994	996	1002	1007	1010	1011	1012	1008	1008		
10	831	841	839	831	829	841	867	892	906	900	887	875	879	887	887	884	887		
15	661	668	672	673	670	676	684	694	711	713	703	709	724	736	726	717	720		
20	450	460	461	468	469	469	471	472	484	500	520	534	545	540	548	544	536		
25	261	271	279	278	279	281	291	297	306	311	324	334	341	343	348	344	335		
30	168	170	175	178	180	181	181	184	190	198	205	212	216	217	218	212	210		
35	116	114	116	121	125	127	123	122	129	139	145	148	147	147	150	149	147		
40	82.3	81.3	82.0	83.8	85.9	86.9	85.0	83.6	88.7	97.7	106	107	104	103	108	110	107		
45	54.8	57.6	57.6	55.7	53.7	52.8	54.2	56.4	58.9	62.4	68.2	72.5	74.4	74.5	75.1	74.8	71.8		
50	35.5	38.6	39.0	36.7	34.0	33.1	34.8	37.1	38.2	38.7	41.6	46.8	51.8	52.7	50.0	46.0	44.4		
55	24.5	26.5	26.8	25.2	23.6	23.2	24.2	25.4	26.0	26.0	27.2	30.3	34.1	35.1	32.5	29.2	28.7		
60	18.5	19.8	19.9	18.7	17.7	17.6	18.1	18.8	19.1	19.0	19.5	21.2	23.3	23.9	22.3	20.7	20.5		
65	13.8	14.6	14.6	13.8	13.1	13.1	13.5	14.0	14.2	14.0	14.1	15.1	16.6	16.9	15.9	15.0	15.0		
70	9.88	10.3	10.3	9.81	9.45	9.45	9.75	10.1	10.2	10.1	10.1	10.7	11.4	11.7	11.2	10.7	10.8		
75	6.39	6.43	6.39	6.26	6.20	6.27	6.45	6.60	6.69	6.67	6.72	6.95	7.33	7.48	7.33	7.26	7.37		
80	3.67	3.55	3.49	3.47	3.50	3.54	3.60	3.66	3.74	3.81	3.92	4.05	4.14	4.17	4.24	4.34	4.39		
85	1.68	1.60	1.58	1.59	1.61	1.64	1.67	1.71	1.75	1.79	1.84	1.93	1.99	2.05	2.07	2.10	2.12		
90	0.26	0.25	0.24	0.24	0.25	0.26	0.26	0.27	0.29	0.31	0.34	0.37	0.40	0.42	0.44	0.45	0.46		
95	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.04		
100	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01		
105	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
110	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
115	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		
120	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.03		
125	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05		
130	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08		
135	0.17	0.17	0.16	0.16	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15		
140	0.27	0.26	0.26	0.25	0.25	0.25	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.24	0.24	0.24		
145	0.38	0.37	0.37	0.36	0.36	0.35	0.35	0.34	0.34	0.34	0.34	0.33	0.33	0.34	0.34	0.34	0.34		
150	0.48	0.48	0.47	0.46	0.46	0.46	0.45	0.45	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44		
155	0.56	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53		
160	0.62	0.62	0.62	0.62	0.61	0.61	0.61	0.61	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60		
165	0.65	0.65	0.65	0.65	0.65	0.64	0.65	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.65		
170	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.65	0.65	0.65	0.65	0.65	0.65	0.65		
175	0.56	0.56	0.56	0.56	0.56	0.57	0.57	0.57	0.57	0.58	0.58	0.58	0.58	0.58	0.58	0.59	0.58		
180	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53		

Table 7: Luminous Intensity Data



## EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Aug. 14, 2018	Aug. 13, 2019
Digital Power Meter	PF2010A	HZTE028-01	Sep. 12, 2018	Sep. 11, 2019
AC Power Supply	DPS1060	HZTE001-06	Aug. 09, 2018	Aug. 08, 2019
DC Power Supply	WY12010	HZTE004-03	Aug. 09, 2018	Aug. 08, 2019
Temperature recorder	JM624U	HZTE018-08	Aug. 09, 2018	Aug. 08, 2019
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 09, 2018	Aug. 08, 2019
Standard source	D908	HZTE012-01	Aug. 14, 2018	Aug. 13, 2019
Integrate Sphere system	3M	HZTE015-04	Aug. 16, 2018	Aug. 15, 2019
Digital Power Meter	WT210	HZTE008-01	Aug. 02, 2018	Aug. 01, 2019
AC Power Supply	PCR 500L	HZTE001-07	Aug. 09, 2018	Aug. 08, 2019
DC Power Supply	IT6154	HZTE004-04	Aug. 09, 2018	Aug. 08, 2019
Standard source	SCL-1400	HZTE012-02	Aug. 16, 2018	Aug. 15, 2019
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 09, 2018	Aug. 08, 2019
Temperature Meter	TES1310	HZTE017-01	Aug. 09, 2018	Aug. 08, 2019

Table 8: Test Equipment List

## TEST METHODS

### Seasoning of SSL Product

For the purpose of rating new SSL products, SSL products shall be tested with no seasoning. Therefore, no seasoning was performed.

### Sphere-Spectroradiometer Method- Photometric and Electrical Measurements

A Labsphere Model CDS 2100 Spectroradiometer and Two Meter Sphere was used to measure correlated color temperature, chromaticity coordinates, and the color rendering index for each SSL unit. The coating reflectance of each sphere is 98%. The measure geometry is  $4\pi$ . Self-absorption correction is conducted in testing. Bandwidth of spectroradiometer is 350nm-1050nm.

Ambient temperature was measured at a position inside the sphere. Each SSL unit was operated on the client provided driver at the rated input voltage in its designated orientation.

The stabilization time typically ranges from 30 min (small integrated LED lamps) to 2 or more hours for large SSL luminaires). It can be judged that stability is reached when the variation (maximum – minimum) of at least 3 readings of the light output and electrical power over a period of 30 min, taken 15 minutes apart, is less than 0.5 %.

Electrical measurements including voltage, current, and power were measured using the Yokogawa Power Analyzer.

The standard reference of the integrated sphere system is halogen incandescent lamp, the intensity distribution type is omni-directional, and is traceable to the National Institute of Standards and Technology.

The uncertainty of integrating sphere system reported in this document is expanded uncertainty is 2.1% with a coverage factor  $k=2$ .

## **Goniophotometer Method**

### **Photometric and Electrical Measurements**

An EVERFINE Type C Model GO-R5000 Goniophotometer was used to measure the intensity at each angle of distribution for each sample. The photometric distance is 2.475m for near-field measurement or 30m for far-field measurement. Bandwidth of spectroradiometer is 380nm-780nm.

Ambient temperature was measured at the same height of the sample mounted on the Goniophotometer equipment. Each SSL unit was operated on the client provided driver at the rated input voltage in its designated orientation.

The stabilization time typically ranges from 30 min (small integrated LED lamps) to 2 or more hours for large SSL luminaires). It can be judged that stability is reached when the variation (maximum – minimum) of at least 3 readings of the light output and electrical power over a period of 30 min, taken 15 minutes apart, is less than 0.5 %.

Electrical measurements including voltage, current, and power were measured using the Everfine Digital Power Meter.

Some graphics were created with Photometric Plus software.

The standard reference of the Goniophotometer system is halogen incandescent lamp, the intensity distribution type is omni-directional, and is traceable to the National Institute of Metrology P.R. China.

The uncertainty of goniophotometer system reported in this document is expanded uncertainty is 2.3% with a coverage factor  $k=2$ .

### **Color Characteristics Measurements**

The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as values that are spatially average, weighted to intensity, over the angular range where light is intentionally emitted from the SSL product. The color characteristics measurements are using gonio-spectroradiometer.

### **Color Spatial Uniformity**

The characteristics of SSL products may be spatially non-uniform, the chromaticity coordinate shall be measured at two vertical planes ( $C=0^\circ/180^\circ$  and  $C=90^\circ/270^\circ$ ) and at  $10^\circ$  or less intervals for vertical angle until the light output dropped to below 10% of the peak intensity. The averaged weighted chromaticity coordinate

was calculated from these points. The data was then analyzed to check for delta color differences of the  $u'$ ,  $v'$  chromaticity coordinates. The spatial non-uniformity of chromaticity,  $\Delta u'v'$ , is determined as the maximum deviation (distance on the CIE ( $u'$ ,  $v'$ ) diagram) among all measured points from the spatially averaged chromaticity coordinate.

The geometry for the chromaticity measurement using gonio-spectroradiometer is shown as following.



\*\*\* End of Report \*\*\*

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