

## LM-79-08 TEST REPORT

for

### GREEN CREATIVE LTD

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

### LED Lamp

**Model: 15.5PAR38/940FL40/277V**

### Laboratory: Leading Testing Laboratories

**NVLAP CODE: 200960-0**

3rd Floor, Bld. 2, NO. 96 Longchuanwu Rd Qianjiang Economy Dev. Zone, YuhangDist,  
Hangzhou, Zhejiang Province, China 311100

Tel: +86571 86376106

[www.ledtestlab.com](http://www.ledtestlab.com)

Report No.: HZ19050046aq

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

Review by:



Engineer: April Zou

Jul. 05, 2019

Approved by:



Manager: Jim Zhang

Jul. 05, 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: **15.5PAR38/940FL40/277V**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
95.0	1463.3	15.41	0.9918
CCT (K)	CRI	Stabilization Time (Light & Power)	
4027	96.5	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>	: May 29, 2019
<b>Date of Test</b>	: Jul. 01, 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>	: 15.5PAR38/940FL40/277V
<b>Electrical Ratings</b>	: 120-277V, 60Hz, 15.5W
<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	277.0
Voltage frequency (Hz)	60	60
Test Current (A)	0.129	0.063
Power Factor	0.9918	0.9298
Test Power (W)	15.41	16.17
THD A%	10.95	18.07
Luminous Efficacy (lm/W)	95.0	90.7
Total Luminous Flux (lm)	1463.3	1467.3
Color Rendering Index (CRI)	96.5	
R9	97.8	
Correlated Color Temperature (CCT)(K)	4027	
Chromaticity Chroma x	0.3789	
Chromaticity Chroma y	0.3748	
Chromaticity Chroma u	0.2248	
Chromaticity Chroma v	0.3337	
Duv	-0.0005	
Chromaticity Chroma u'	0.2248	
Chromaticity Chroma v'	0.5005	

Special Color Rendering Indices	
R1	97.7
R2	97.8
R3	99.5
R4	95
R5	96
R6	96.1
R7	94.5
R8	95.3
R9	97.8
R10	97.6
R11	97.8
R12	74.8
R13	97.6
R14	99.1

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 25.5 °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)	0.130
Power Factor	0.9923
Power (W)	15.49
Luminous Efficacy (lm/W)	96.0
Total Luminous Flux (lm)	1487.7
Beam Angle ( ° )	38.1 (0°-180°) / 37.4 (90°-270°)
Center Beam Candle Power (cd)	2863
Maximum Beam Candle Power (cd)	2969 (At: C=110.0, Gamma=3.5)
Spacing Criteria	0.63 (0°-180°) / 0.62 (90°-270°)
Zonal Lumens in the 0 °-60 °Zone	97.05%
Zonal Lumens in the 60 °-90 °Zone	2.81%
Zonal Lumens in the 90 °-120 °Zone	0.01%
Zonal Lumens in the 120 °-180 °Zone	0.13%

Table 3: Test data per Goniophotometer Method

### Spectral Power Distribution - Sphere Spectroradiometer Method

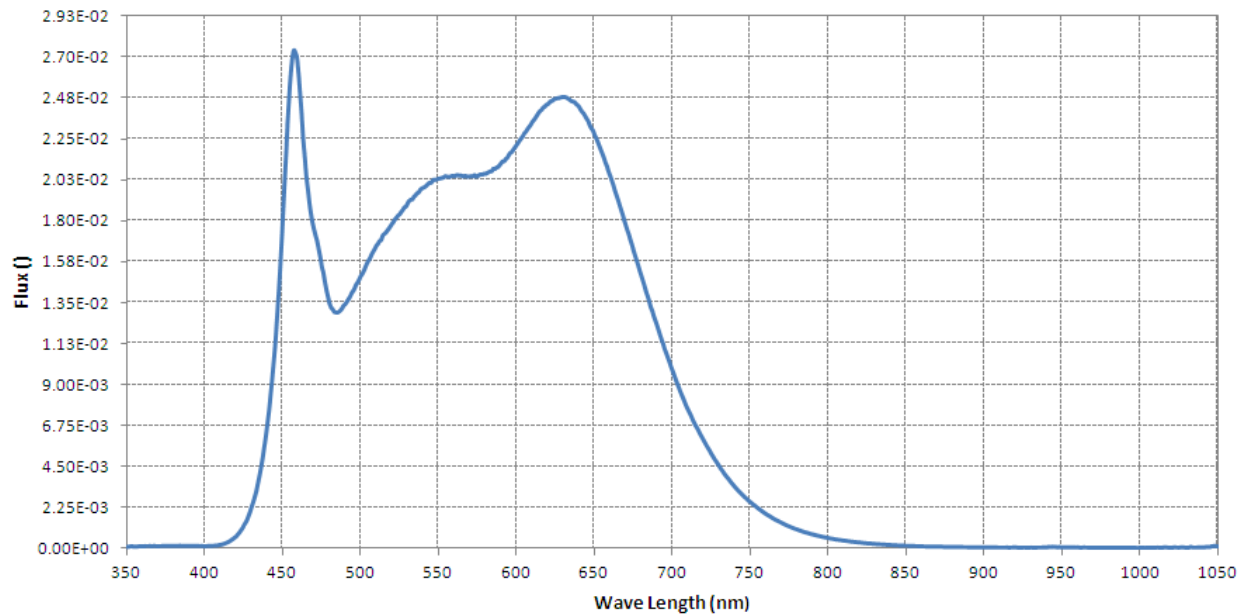


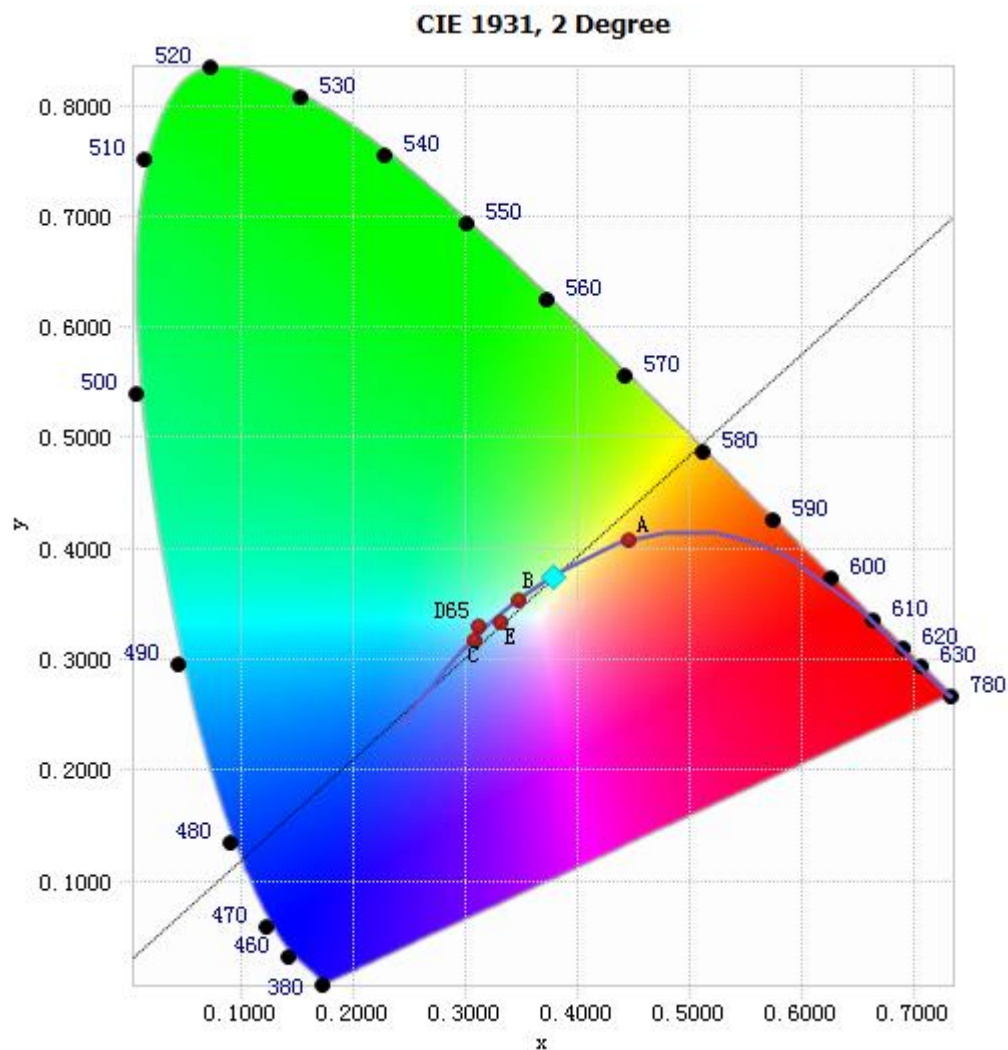
Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	1.19E-04	485	1.29E-02	590	2.12E-02	695	1.09E-02
385	1.01E-04	490	1.34E-02	595	2.16E-02	700	9.76E-03
390	1.08E-04	495	1.41E-02	600	2.22E-02	705	8.60E-03
395	1.06E-04	500	1.50E-02	605	2.28E-02	710	7.60E-03
400	9.78E-05	505	1.58E-02	610	2.34E-02	715	6.71E-03
405	1.20E-04	510	1.66E-02	615	2.40E-02	720	5.90E-03
410	1.73E-04	515	1.73E-02	620	2.44E-02	725	5.16E-03
415	3.29E-04	520	1.78E-02	625	2.47E-02	730	4.50E-03
420	6.26E-04	525	1.84E-02	630	2.48E-02	735	3.89E-03
425	1.24E-03	530	1.89E-02	635	2.46E-02	740	3.35E-03
430	2.27E-03	535	1.94E-02	640	2.43E-02	745	2.91E-03
435	3.96E-03	540	1.98E-02	645	2.36E-02	750	2.52E-03
440	6.78E-03	545	2.01E-02	650	2.27E-02	755	2.17E-03
445	1.11E-02	550	2.03E-02	655	2.17E-02	760	1.86E-03
450	1.81E-02	555	2.04E-02	660	2.05E-02	765	1.60E-03
455	2.60E-02	560	2.04E-02	665	1.91E-02	770	1.38E-03
460	2.61E-02	565	2.05E-02	670	1.77E-02	775	1.18E-03
465	2.05E-02	570	2.04E-02	675	1.64E-02	780	1.01E-03
470	1.75E-02	575	2.05E-02	680	1.50E-02		
475	1.55E-02	580	2.06E-02	685	1.36E-02		
480	1.34E-02	585	2.09E-02	690	1.23E-02		

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



## Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3789, 0.3748)

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

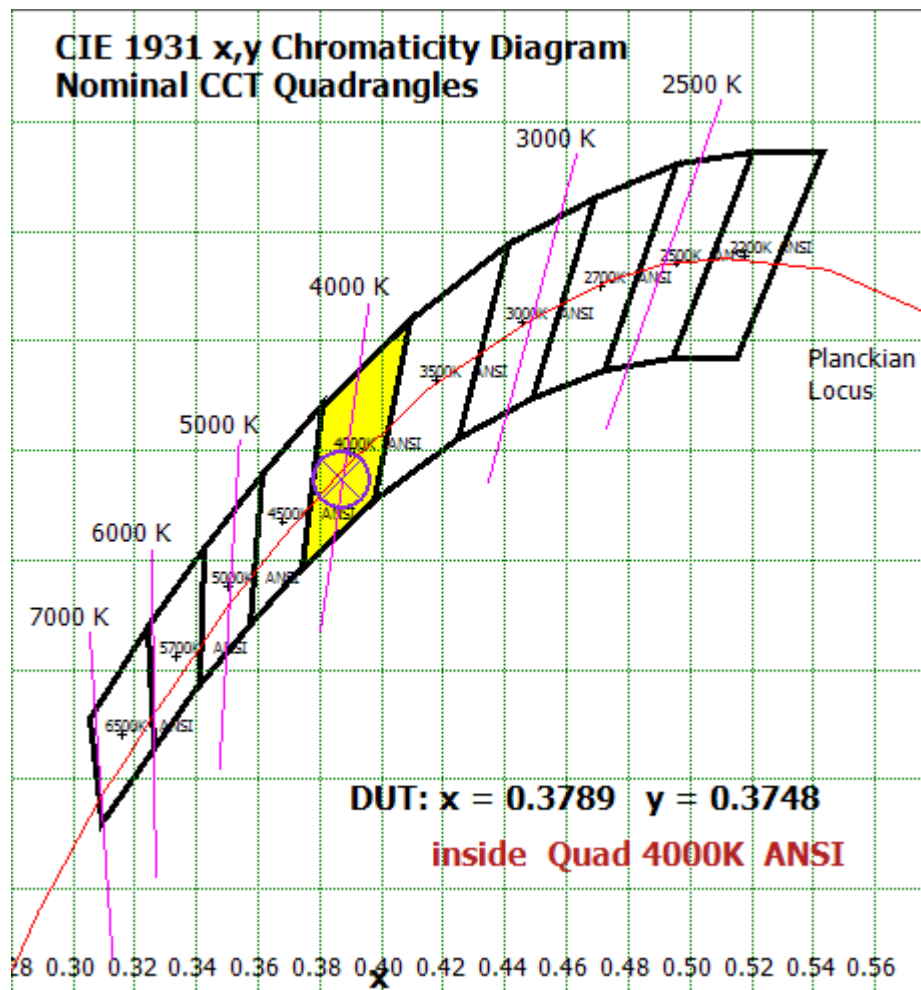
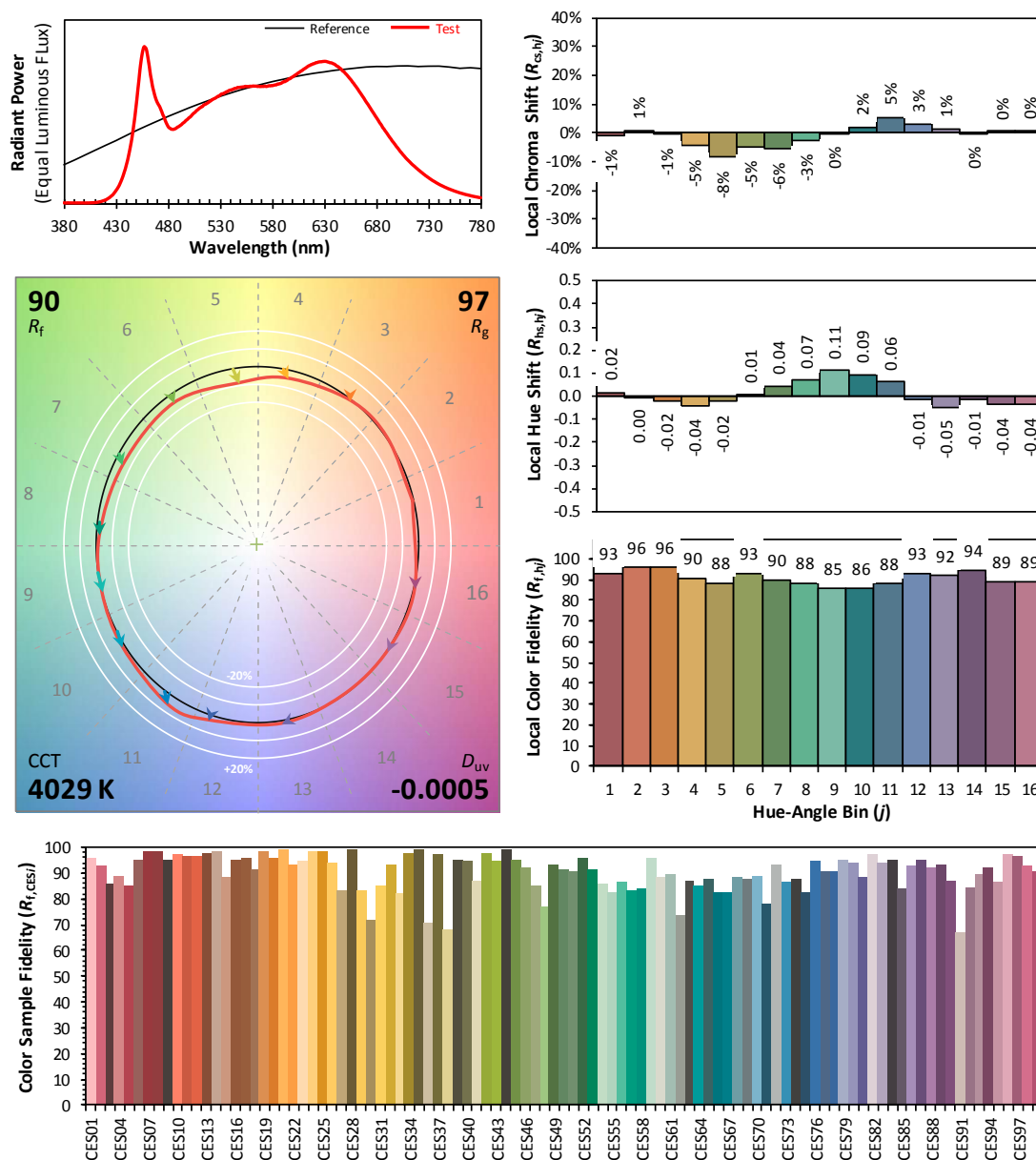


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

## Color Rendition Report – Sphere Spectroradiometer Method



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

$x$  0.3789

$y$  0.3748

$u'$  0.2248

$v'$  0.5005

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	259.094	17.42%
10- 20	531.075	35.70%
20- 30	375.929	25.27%
30- 40	167.995	11.29%
40- 50	70.691	4.75%
50- 60	39.028	2.62%
60- 70	25.31	1.70%
70- 80	13.238	0.89%
80- 90	3.325	0.22%
90-100	0.039	0.00%
100-110	0.016	0.00%
110-120	0.032	0.00%
120-130	0.087	0.01%
130-140	0.253	0.02%
140-150	0.461	0.03%
150-160	0.539	0.04%
160-170	0.416	0.03%
170-180	0.138	0.01%
Total	1487.7	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	1443.812	97.05%
60- 90	41.873	2.81%
0-90	1485.685	99.87%
90- 180	1.981	0.13%
0- 180	1487.7	100%

Table 5: Zonal Lumen

## Illuminance Plots- Goniophotometer Method

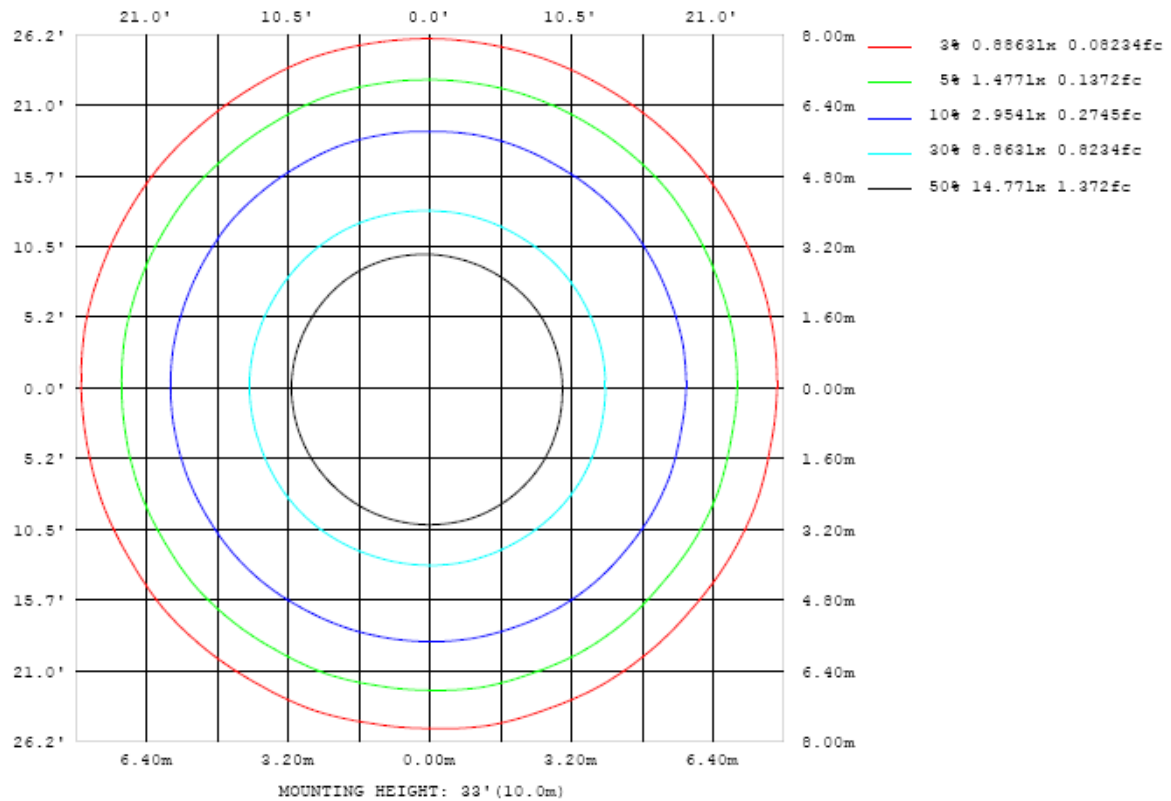


Chart 5: Illuminance Plot (Footcandles)

## Luminous Intensity Distribution Plots- Goniophotometer Method

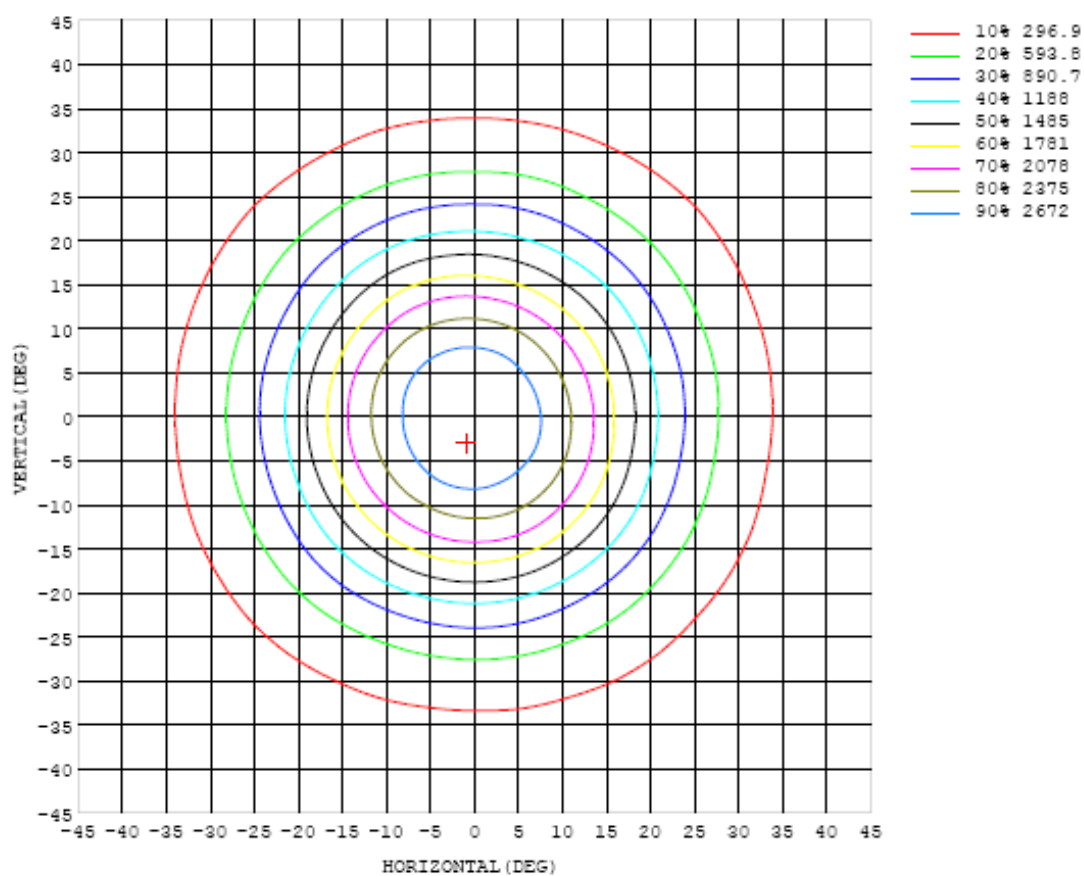


Chart 6: Isocandela Plot

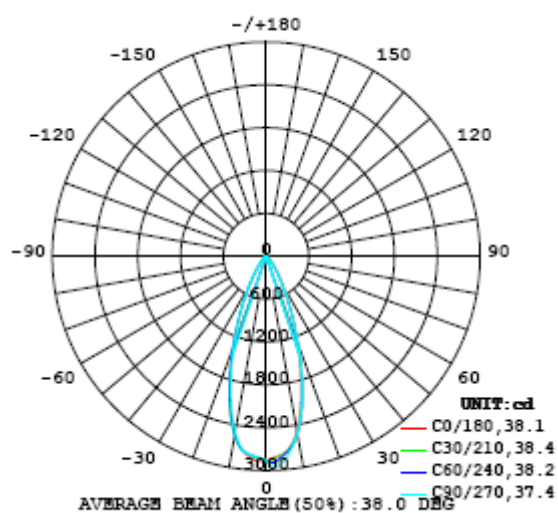


Chart 7: Polar Candela Distribution

## Luminous Intensity Data- Goniophotometer Method

Table--1

UNIT: cd

C (DEG) γ (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
5	2773	2777	2780	2780	2783	2789	2798	2818	2842	2877	2908	2921	2914	2895	2876	2857	2842	2825	2811
10	2473	2489	2501	2508	2518	2522	2526	2526	2525	2522	2521	2522	2521	2525	2527	2528	2529	2534	2534
15	1895	1907	1925	1942	1954	1964	1979	1987	1986	1982	1985	1987	1987	1989	1993	1999	2004	2008	2007
20	1278	1278	1295	1312	1316	1318	1319	1325	1326	1330	1330	1335	1342	1350	1356	1357	1357	1363	1369
25	797	787	793	797	796	793	789	789	795	795	790	790	799	815	822	819	821	830	840
30	459	450	455	453	448	452	452	445	446	445	444	447	451	461	467	468	474	477	481
35	260	253	256	253	247	250	250	246	248	243	243	249	248	255	260	258	262	262	263
40	146	144	146	143	140	140	140	137	138	137	137	140	139	141	144	144	148	148	151
45	87.5	86.4	86.8	85.7	85.5	84.4	84.0	82.9	83.6	83.3	83.6	84.4	84.6	85.2	86.1	87.6	89.9	91.1	92.4
50	57.6	57.3	57.6	57.4	57.3	56.9	57.1	56.8	57.0	56.6	56.5	56.6	57.0	57.4	58.3	58.6	59.1	59.8	60.1
55	42.1	42.2	42.6	42.6	42.7	42.9	43.0	43.1	42.8	42.7	42.5	42.4	42.3	42.7	43.1	43.3	43.3	43.5	43.9
60	32.3	32.4	32.6	32.6	32.6	33.0	33.4	33.4	33.1	32.8	32.5	32.4	32.6	32.9	33.2	33.1	32.9	33.1	33.5
65	24.9	25.0	25.1	25.1	25.1	25.3	25.6	25.7	25.8	25.6	25.4	25.2	25.3	25.4	25.6	25.7	25.7	25.8	26.2
70	18.3	18.4	18.4	18.4	18.4	18.5	18.6	18.8	19.0	18.9	18.9	18.8	19.0	19.0	19.1	19.1	19.1	19.1	19.3
75	12.1	12.1	12.2	12.2	12.2	12.3	12.4	12.5	12.6	12.6	12.7	12.7	12.7	12.8	12.8	12.7	12.8	12.7	12.7
80	6.74	6.75	6.77	6.85	6.87	6.94	7.02	7.09	7.20	7.22	7.30	7.31	7.37	7.38	7.37	7.38	7.35	7.31	7.36
85	2.49	2.52	2.55	2.60	2.64	2.69	2.76	2.81	2.87	2.91	2.96	3.00	3.01	3.02	3.03	3.03	3.01	3.00	3.08
90	0.22	0.23	0.24	0.26	0.28	0.29	0.32	0.33	0.35	0.37	0.38	0.39	0.40	0.40	0.40	0.40	0.40	0.39	0.42
95	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
100	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
105	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
110	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
115	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
120	0.04	0.04	0.04	0.04	0.04	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
125	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.10
130	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.19
135	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.22	0.37
140	0.38	0.37	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.37	0.35	0.59
145	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.52	0.52	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.50	0.82
150	0.70	0.70	0.70	0.70	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.70	0.70	0.66	1.04
155	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.89	0.89	0.89	0.89	0.86	1.22
160	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.06	1.33
165	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.22	1.22	1.23	1.23	1.23	1.23	1.24	1.24	1.22	1.35
170	1.27	1.27	1.27	1.28	1.29	1.29	1.30	1.30	1.30	1.31	1.31	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.29
175	1.29	1.28	1.28	1.28	1.28	1.28	1.28	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.32	1.33	1.34	1.34	1.35
180	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49

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	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863		
5	2800	2795	2790	2787	2785	2783	2784	2783	2781	2782	2783	2782	2778	2772	2768	2771	2771		
10	2545	2555	2554	2550	2544	2532	2519	2509	2495	2485	2478	2470	2462	2456	2455	2461	2469		
15	2006	2003	1995	1986	1981	1971	1953	1930	1913	1895	1885	1877	1875	1876	1880	1881	1885		
20	1370	1364	1355	1353	1354	1350	1336	1317	1303	1293	1284	1279	1282	1286	1285	1279	1280		
25	844	839	838	842	838	835	831	821	815	819	813	801	801	804	798	795	800		
30	484	481	480	484	476	472	475	469	463	467	465	459	464	467	460	456	462		
35	268	266	266	267	263	262	268	265	264	263	264	263	264	266	262	261	262		
40	154	153	152	152	151	152	155	152	151	149	148	147	146	148	147	147	147		
45	93.0	92.9	93.0	92.4	92.2	90.9	90.4	90.2	90.5	90.1	89.9	89.0	87.0	86.6	86.2	87.5	87.3		
50	60.2	60.3	60.2	60.0	60.2	59.5	59.0	58.8	58.2	58.0	57.8	57.7	57.4	57.6	57.7	57.6	57.7		
55	44.1	44.3	44.2	44.2	44.0	43.6	43.5	43.3	42.9	42.6	42.4	42.3	42.1	42.1	42.3	42.1	41.9		
60	33.7	33.9	33.8	33.8	33.8	33.6	33.4	33.0	32.7	32.4	32.4	32.5	32.6	32.5	32.6	32.4	32.3		
65	26.4	26.4	26.2	26.1	26.0	25.8	25.8	25.6	25.3	25.1	25.1	25.3	25.4	25.2	25.0	24.8	24.8		
70	19.5	19.4	19.2	19.0	19.0	18.9	18.9	18.9	18.7	18.6	18.5	18.5	18.6	18.5	18.4	18.3	18.3		
75	12.8	12.7	12.6	12.5	12.4	12.4	12.4	12.3	12.1	12.1	12.0	12.0	12.0	12.0	12.0	11.9	12.0		
80	7.34	7.29	7.21	7.13	7.05	7.00	6.95	6.87	6.79	6.72	6.68	6.67	6.66	6.64	6.66	6.65	6.67		
85	3.04	3.00	2.95	2.89	2.84	2.78	2.73	2.67	2.61	2.57	2.54	2.50	2.49	2.48	2.50	2.50	2.52		
90	0.42	0.40	0.39	0.36	0.34	0.32	0.30	0.28	0.26	0.25	0.24	0.23	0.23	0.23	0.23	0.23	0.23		
95	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		
100	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		
105	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		
110	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		
115	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.03		
120	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06		
125	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11		
130	0.21	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.21		
135	0.41	0.41	0.41	0.42	0.42	0.42	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.40		
140	0.67	0.66	0.67	0.67	0.67	0.68	0.68	0.68	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.70	0.64		
145	0.97	0.95	0.95	0.96	0.96	0.97	0.97	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.99	1.01	0.90		
150	1.26	1.24	1.24	1.24	1.24	1.25	1.25	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28	1.32	1.14		
155	1.51	1.48	1.48	1.48	1.48	1.48	1.49	1.49	1.50	1.50	1.51	1.51	1.51	1.52	1.52	1.56	1.32		
160	1.71	1.68	1.68	1.68	1.68	1.69	1.69	1.70	1.70	1.70	1.71	1.71	1.72	1.72	1.72	1.76	1.43		
165	1.81	1.80	1.80	1.80	1.80	1.81	1.81	1.82	1.82	1.82	1.83	1.83	1.83	1.83	1.83	1.86	1.40		
170	1.69	1.78	1.77	1.76	1.75	1.75	1.75	1.76	1.76	1.77	1.77	1.78	1.78	1.79	1.81	1.74	1.26		
175	1.34	1.47	1.55	1.54	1.54	1.54	1.54	1.55	1.56	1.56	1.57	1.58	1.58	1.59	1.50	1.31	1.30		
180	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49		

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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