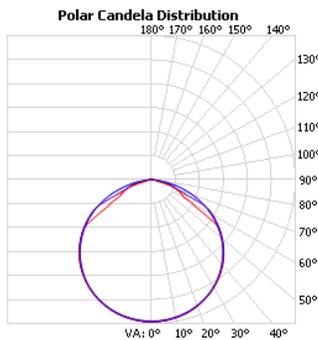


The Crucial Role of Optics

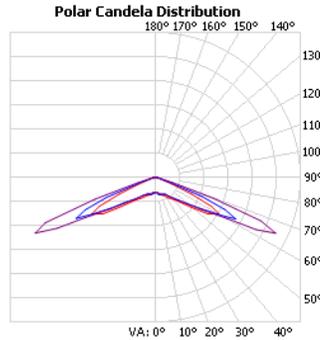
By Bill Little

Optics play an important role in proper lighting and light distribution in any given environment. In the field of agriculture, like many commercial fields, uniformity is equally as important as output, and often even more critical. Many manufacturers simply put a clear cover over the bare LEDs and allow the raw lambertian distribution to provide the light. However, this often results in spotty, uneven light in an environment. It can work reasonably well at times, especially in mid to high ceilings, but in lower ceilings it results in poor light distribution.

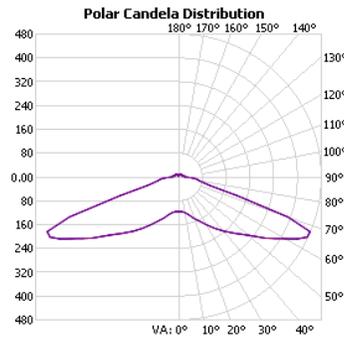
Lambertian (bare LEDs “120 deg”)



LumenPros T5 Square Wide (T5SW)



LumenPros RSR Technology



As you can see above, while all three graphs are theoretically wide angles, the intensity varies greatly at angle. A general rule of thumb for intensity is that intensity is relative to the square of the distance. Therefore, in any downward facing layout, such as a barn, distribution center or factory, the SHORTEST distance for the light to travel is straight down, and therefore should have the lowest intensity.

Note that this is opposite in the Lambertian, where the highest intensity is straight down, results in hot spots in an application. The two IES Type 5 optics illustrated are designed for uniform light distribution, but at different heights.

This particular Type 5 Medium is designed for mid height ceilings, and a spacing that is roughly 2 - 2.2 times the mounting height.

This Particular Type 5 Square Wide is designed for lower ceilings, and a spacing that is roughly 4 times the mounting height. It can be used at higher ceilings at wider spacings as needed as well.

All approaches result in similar averages, however, the critical difference is the uniformity, and equally important, the reduction in peak intensity, or hot spots.

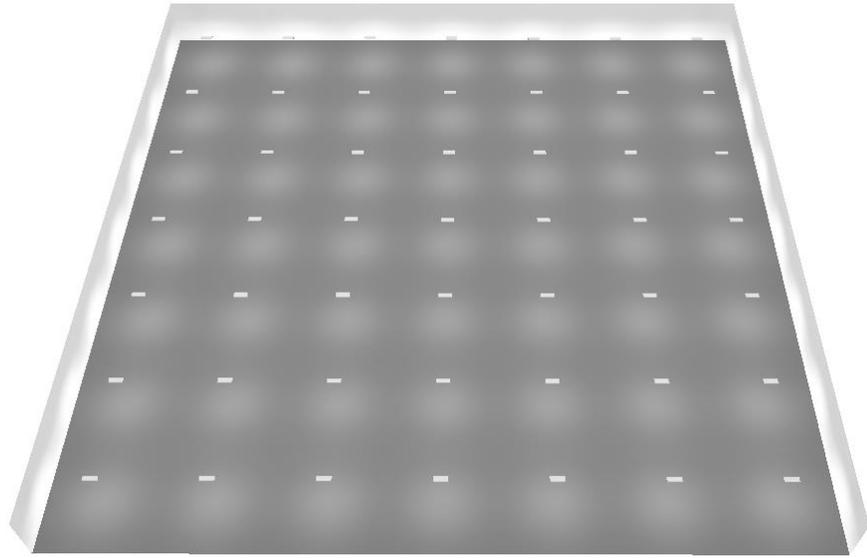
See the comparison below contrasting 150 watt LED fixtures with Lambertian and T5SW light distributions patterns at a common mounting height of 12 feet, and assuming the lumens are the same between fixtures. Note that while they have roughly the same average (20fc), the T5SW has a nearly 40% lower contrast ratio (max vs min). This means a more uniform and comfortable environment for both animals and humans.

Typical Lambertian

36	25	16	22	36	27	16	21	36	28	16	20	35	29	17	19	35	30	17	19	34	31	17	18	32
18	16	13	15	19	17	14	15	19	17	14	15	19	18	14	15	19	18	14	14	19	18	14	14	18
18	16	13	15	19	17	14	15	19	17	14	15	19	17	14	15	19	18	14	14	18	18	14	14	17
35	25	16	22	35	27	17	21	35	28	17	20	34	29	17	20	34	30	18	19	33	31	18	18	31
37	27	17	23	38	29	17	22	38	30	17	21	37	31	18	21	36	32	18	20	35	33	18	19	34
19	16	14	16	20	18	14	16	20	18	14	15	20	18	14	15	20	19	14	15	20	19	14	14	18
18	16	13	15	19	17	14	15	19	17	14	15	19	17	14	15	19	18	14	15	18	18	14	14	17
33	25	16	21	34	26	16	21	34	27	17	20	33	28	17	19	33	29	17	19	32	30	17	18	30
38	27	17	23	39	29	17	22	39	30	18	22	38	32	18	21	37	33	18	20	36	34	18	19	34
20	17	14	16	21	18	14	16	21	19	14	16	21	19	15	16	21	19	15	15	20	20	15	15	19
17	15	13	15	19	17	14	15	19	17	14	15	18	17	14	15	18	17	14	14	18	18	14	14	17
32	24	16	21	33	25	16	20	32	26	17	20	32	27	17	19	31	28	17	18	31	29	17	18	29
39	28	17	24	40	30	17	23	40	31	18	22	39	32	18	21	38	33	19	20	37	35	19	19	35
21	17	14	16	22	19	14	16	22	19	15	16	22	20	15	16	21	20	15	15	21	20	15	15	20
17	15	13	15	18	16	14	15	18	17	14	15	18	17	14	15	18	17	14	14	18	17	14	14	17
31	23	15	20	31	25	16	20	31	25	16	19	31	26	18	19	30	27	17	18	30	28	17	17	28
40	28	17	24	41	30	18	23	40	31	18	22	40	33	18	21	39	34	19	20	38	35	19	19	36
22	18	14	17	23	19	15	17	23	20	15	16	22	20	15	16	22	21	15	16	22	21	15	15	21
17	15	13	15	18	16	14	15	18	16	14	15	18	17	14	15	18	17	14	14	18	17	14	14	16
29	22	15	20	30	24	16	19	30	25	16	19	29	25	16	18	29	26	16	18	28	27	16	17	27
41	28	17	24	41	30	18	23	41	32	18	22	40	33	18	21	39	34	19	21	38	38	19	20	36
23	19	14	17	24	20	15	17	23	20	15	17	23	21	15	16	23	21	15	16	23	22	15	15	21
16	15	13	15	18	16	13	15	18	16	14	14	17	16	14	14	17	14	14	17	14	17	14	14	16
27	21	14	19	28	22	15	18	28	23	15	18	28	24	15	17	27	25	16	17	27	25	16	16	25
40	28	16	23	41	30	17	22	40	31	17	21	40	32	17	21	39	34	18	20	38	35	18	19	36

Point by Point

Note the wide variance in intensities



3D Visual Rendering

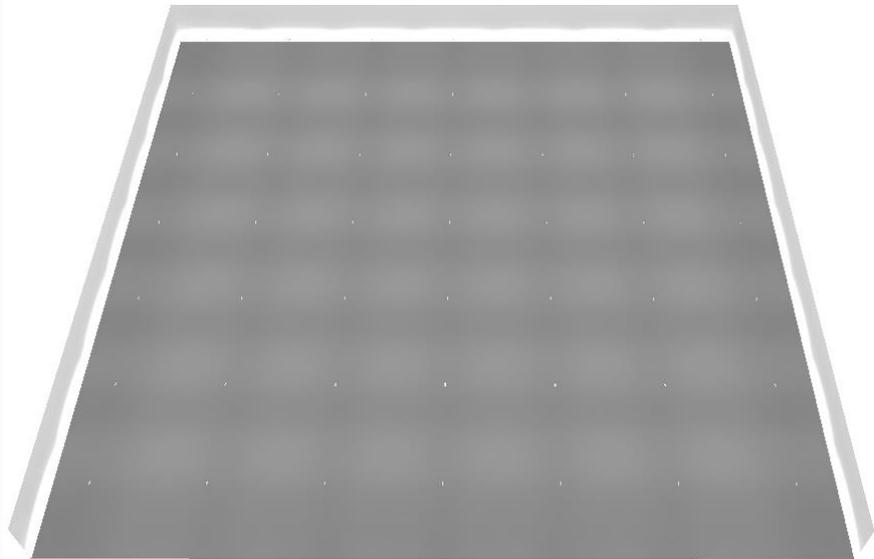
Note the drastic difference in hot spots and dark areas

LumenPros T5SW

14	17	18	18	15	17	18	18	15	16	18	18	16	16	18	18	16	16	18	18	16	16	18	18	15
17	22	25	23	19	22	25	23	19	21	25	24	19	21	25	24	19	21	25	24	20	20	24	24	19
18	22	25	23	19	22	25	24	19	22	25	24	20	22	25	24	20	21	25	24	20	21	25	24	20
14	17	19	18	16	17	19	18	16	17	19	19	16	17	19	18	16	17	19	19	16	17	19	19	16
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17	21	25	23	19	22	25	23	19	21	25	24	19	21	25	24	19	21	24	24	19	20	24	24	19
18	22	26	24	20	22	26	24	20	22	26	24	20	22	25	25	20	21	25	25	20	21	25	25	20
15	18	19	19	16	18	19	19	16	17	19	19	16	17	19	19	16	17	19	19	17	17	19	19	16
14	17	18	18	15	17	18	18	16	17	18	18	16	17	18	18	16	17	18	18	16	16	18	18	15
17	21	25	23	19	21	25	23	19	21	25	23	19	21	25	23	19	21	24	24	19	20	24	24	19
18	22	26	24	19	23	26	24	20	22	26	25	20	22	26	25	20	21	25	25	20	21	25	25	20
15	18	20	19	16	18	20	19	16	18	20	19	17	18	20	19	17	18	20	19	17	18	20	19	16
14	17	18	18	15	17	18	18	15	17	18	18	15	17	18	18	16	16	18	17	16	16	18	18	15
17	21	24	22	19	21	24	23	19	21	24	23	19	21	23	23	19	21	23	23	19	20	23	23	19
18	23	26	24	20	22	26	25	20	22	26	25	20	22	26	25	20	22	26	25	20	21	26	25	20
15	18	20	19	17	18	20	19	17	18	20	19	17	18	20	20	17	18	20	20	17	17	20	20	17
14	17	18	17	15	17	18	18	15	16	18	18	15	16	18	17	15	16	18	17	16	16	18	17	15
17	21	24	22	19	21	23	23	19	20	23	23	19	21	23	23	19	20	23	22	19	20	23	22	19
18	23	26	24	20	22	26	25	20	22	26	25	20	22	26	25	20	22	26	25	20	21	26	25	20
15	19	21	19	17	19	21	20	17	18	21	20	17	18	21	20	17	18	21	20	17	18	20	20	17
13	16	17	17	15	17	18	18	15	16	18	18	15	16	18	17	15	16	18	17	15	16	18	17	15
17	20	23	22	18	20	23	22	18	20	23	22	18	20	22	22	18	20	22	22	19	20	22	22	18
18	22	25	24	20	22	26	25	20	22	26	25	20	22	26	25	20	22	26	25	20	21	26	25	20
15	19	21	20	17	19	21	20	17	19	21	20	17	18	21	20	17	18	21	20	17	18	20	20	17
12	16	16	16	14	16	17	17	14	15	17	17	14	16	17	16	15	15	17	16	15	15	17	16	15

Point by Point

Note the much lower variance in intensities



3D Visual Rendering

Note the much lower difference in hot spots and dark areas

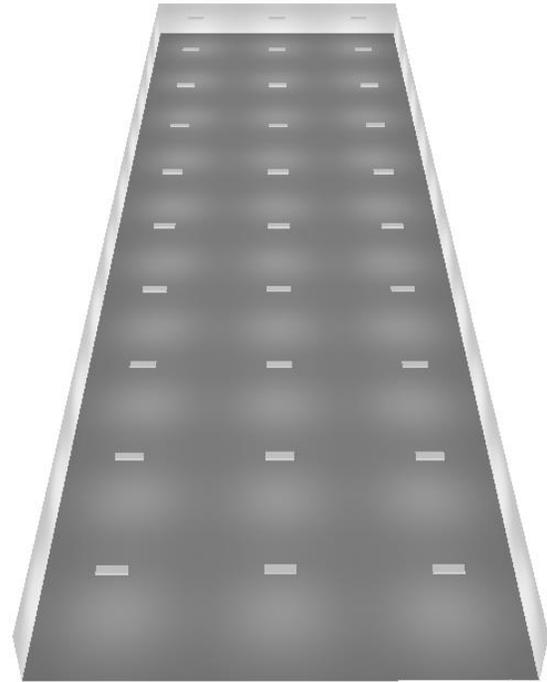
In a similar fashion, looking at common lower ceiling applications such as linear fluorescent and LED jelly jar replacements, we can examine these Lambertian distributions to the LumenPros RSR Technology in the same way assuming lumens are the same, and mounting height is 8 feet. Note that while the Lambertian ,may have a slightly higher average (5-10%), the RSR Technology yields a 68% lower contrast ratio (max vs min). This means dramatically better uniformity and a brighter “feel” to the environment.

Typical Lambertian (LED Tube or LED Jelly Jar)

4.35	3.77	7.07	2.91	7.76	3.19	5.40	5.17	3.36	7.66	2.91	6.70	4.09	4.08	6.66	2.97	7.92	3.07	5.87	4.71	3.47
3.70	3.33	5.48	2.75	5.89	2.94	4.43	4.28	3.06	5.83	2.75	5.25	3.56	3.55	5.22	2.79	6.00	2.85	4.73	3.97	3.11
2.49	2.45	3.03	2.32	3.11	2.35	2.79	2.73	2.39	3.11	2.30	2.99	2.52	2.51	2.99	2.29	3.14	2.36	2.86	2.62	2.33
3.42	3.14	4.78	2.70	5.09	2.82	4.00	3.89	2.93	5.06	2.71	4.62	3.32	3.32	4.61	2.68	5.17	2.78	4.24	3.64	2.96
4.67	4.06	7.59	3.15	8.35	3.44	5.81	5.57	3.63	8.25	3.14	7.21	4.39	4.40	7.16	3.21	8.52	3.32	6.31	5.08	3.75
3.13	2.92	4.22	2.55	4.46	2.67	3.61	3.52	2.76	4.44	2.56	4.10	3.07	3.06	4.09	2.55	4.52	2.63	3.79	3.32	2.77
2.52	2.45	3.09	2.30	3.20	2.33	2.82	2.77	2.38	3.18	2.29	3.05	2.53	2.53	3.04	2.27	3.21	2.34	2.90	2.64	2.34
3.99	3.54	6.10	2.87	6.61	3.08	4.84	4.66	3.22	6.54	2.87	5.82	3.80	3.80	5.79	2.92	6.74	3.00	5.21	4.30	3.29
4.12	3.58	6.58	2.80	7.19	3.05	5.07	4.87	3.22	7.11	2.81	6.25	3.88	3.87	6.21	2.87	7.34	2.95	5.50	4.45	3.31

LED Point by Point

Note the wide variance in intensities



3D Visual Rendering

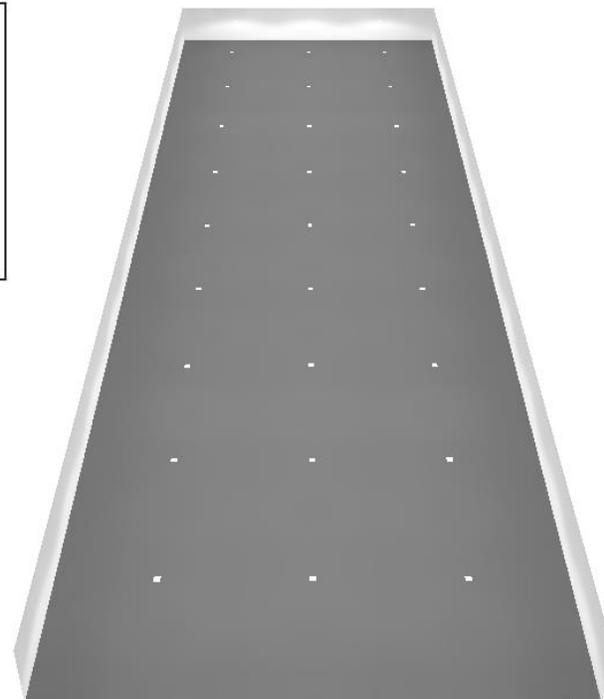
Note the drastic unhealthy hot spots and dark areas

Lumen Pros RSR Technology

2.89	2.80	3.01	2.82	3.43	2.92	3.01	2.99	2.80	3.12	2.79	3.11	2.91	2.92	3.03	2.85	3.45	2.82	3.03	2.88	2.82
3.61	3.52	3.49	3.55	3.85	3.68	3.64	3.64	3.53	3.57	3.53	3.67	3.65	3.64	3.59	3.64	3.89	3.56	3.65	3.57	3.55
3.80	3.75	3.91	3.83	4.19	3.89	3.89	3.92	3.77	3.98	3.76	3.98	3.82	3.88	3.92	3.87	4.23	3.83	3.94	3.81	3.75
4.00	3.89	4.09	3.94	4.38	4.01	4.09	4.09	3.90	4.23	3.91	4.24	4.03	4.03	4.10	3.99	4.45	3.94	4.13	3.96	3.90
4.13	4.06	3.98	4.09	4.35	4.20	4.17	4.17	4.08	4.13	4.07	4.19	4.19	4.19	4.10	4.15	4.32	4.10	4.17	4.09	4.08
3.96	3.87	4.06	3.92	4.36	3.99	4.06	4.06	3.89	4.21	3.89	4.21	4.01	4.00	4.06	3.95	4.44	3.92	4.10	3.94	3.88
3.79	3.73	3.91	3.82	4.18	3.86	3.88	3.91	3.73	3.96	3.75	3.97	3.80	3.86	3.91	3.86	4.22	3.79	3.93	3.79	3.73
3.55	3.45	3.43	3.48	3.81	3.62	3.58	3.57	3.47	3.53	3.44	3.59	3.58	3.57	3.53	3.56	3.87	3.50	3.58	3.50	3.49
2.74	2.66	2.87	2.69	3.10	2.77	2.85	2.84	2.67	2.98	2.66	2.97	2.76	2.77	2.89	2.75	3.12	2.71	2.88	2.73	2.68

LED Point by Point

Note the much lower variance in intensities



3D Visual Rendering

Note the maximized uniformity without hot spots

Uniform illumination typically results in better comfort levels for both animals and humans.

LumenPros engineers each lighting fixture to properly light an application with considerations of light output, quality of light, and optics. LumenPros has developed specific optical technologies such as its T5SW design for mid and high bay applications as well as the innovative RSR Optical Technology for low ceiling applications. As illustrated, optics play a critical role in the engineering of a lighting fixture and application design, and it is important to understand both and purchase products from a company that understands optics and doesn't simply put "LEDs in a box".