SunLike SEOUL
Powered by TRI-R

The closest artificial light to the Sun

Seoul Semiconductor

October 2018

V11

Contents

01 Introduction

History of Lighting

Our biological clock is adjusted by natural Sunlight

Sunlike = Artificial light as good as natural light:

1. **Well-being light**
2. **Color under the Sun**
3. **Clear light with less glare**

SunLike SEOUL Powered by TRI-R

History of Lighting

Retrofit

Traditional

Advance

2008 ~ 2015
LED

- ***Cost & Efficiency***
- *lm/$ & lm/W*
- *Commodity*

2016 ~
Lighting source → Solution

- Function → Quality
- Product → Solution
- Control system, IoT …

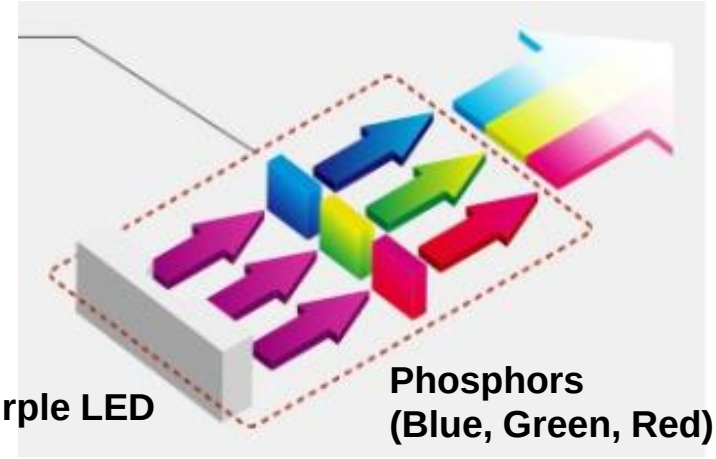
  + lighting = Smart lighting
- Next generation lighting (ex. High value LED, OLED …)

2018 ~
Human centric
Add value & Function

- Health, Comfort
- Circadian rhythm
- Re-creation of natural light
- Acceleration of a light source technology

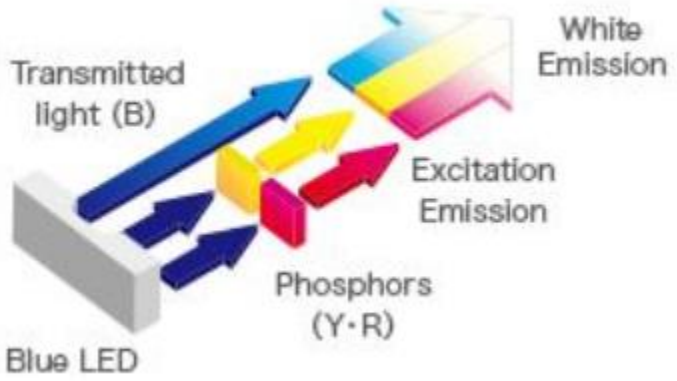
SunLike Core Technology

TRI-R

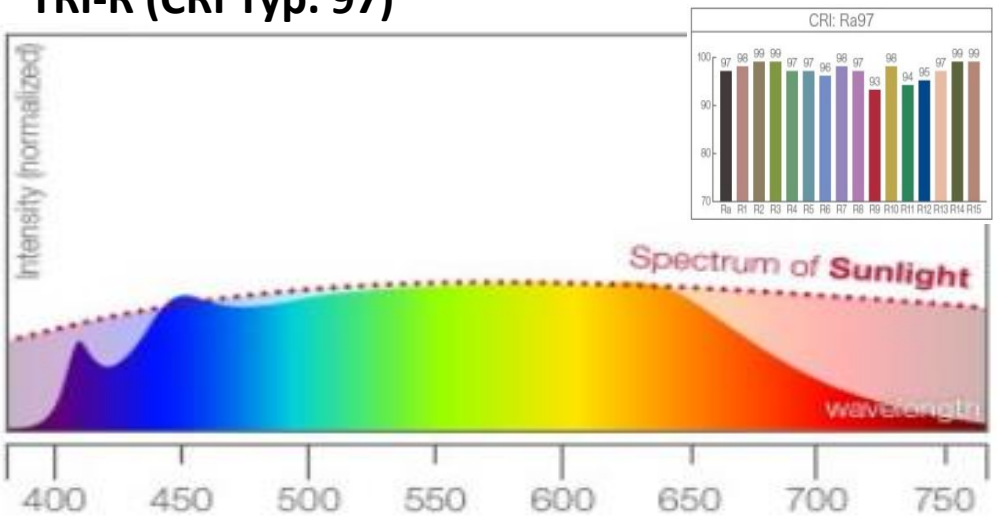


VS.

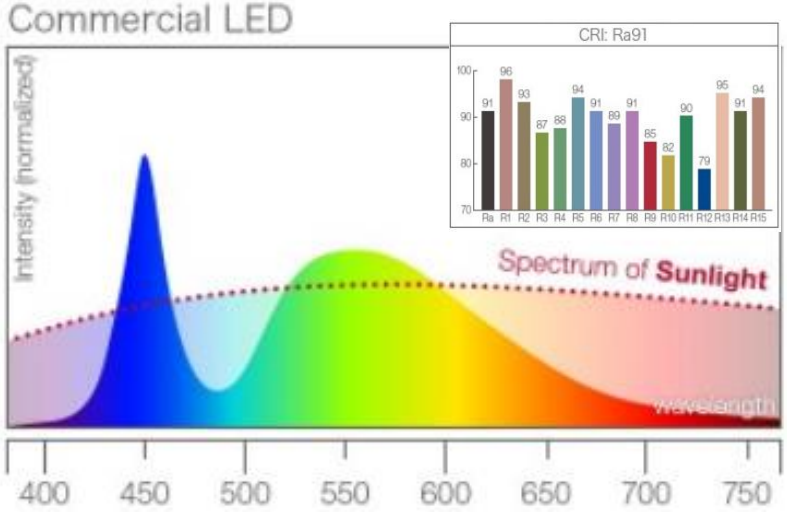
Ordinary LED (B+YR)



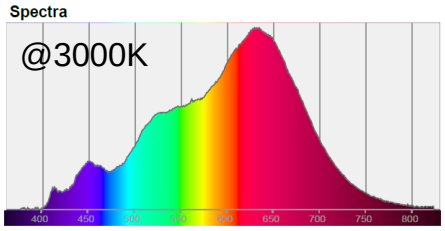
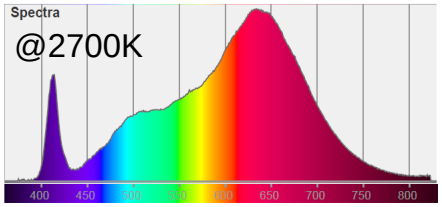
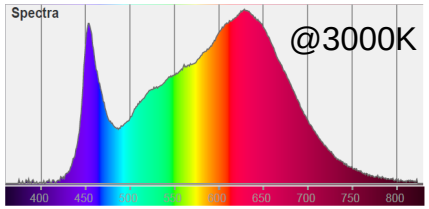
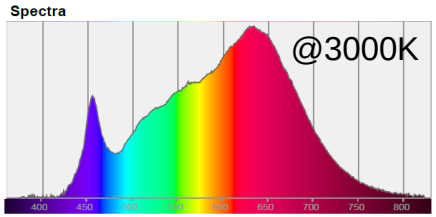
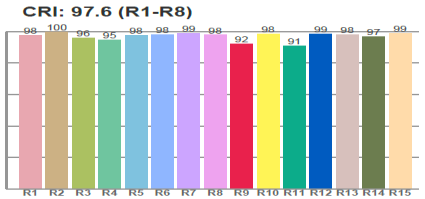
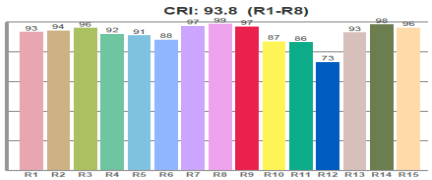
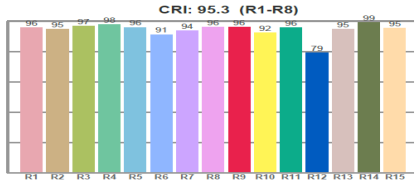
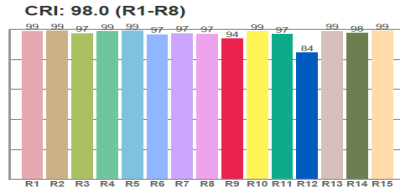
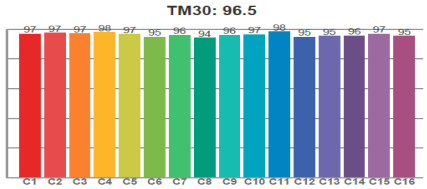
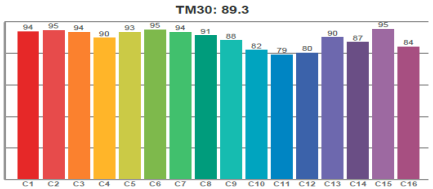
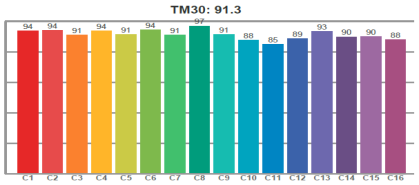
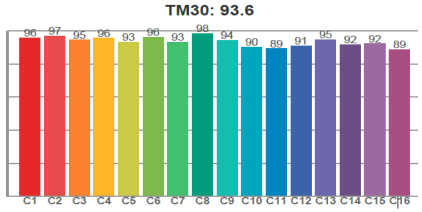
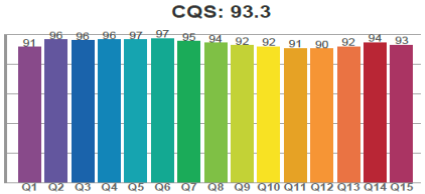
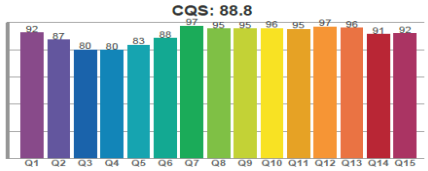
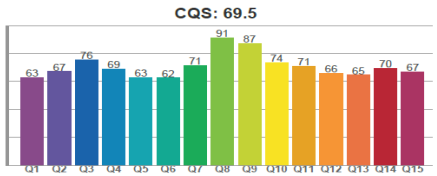
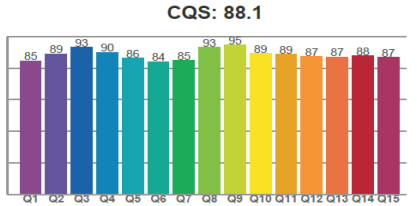
TRI-R (CRI Typ. 97)



Commercial LED



SunLike Core Technology

SunLike SSC	xy	xy	xy
			
Just like Sun Spectrum	Big near UV peak Color distortion Low in Blue and Cyan	Big color distortion going to pinkish Very low CQS	Blue peak base Low CQS
CRI				
TM30				
CQS				

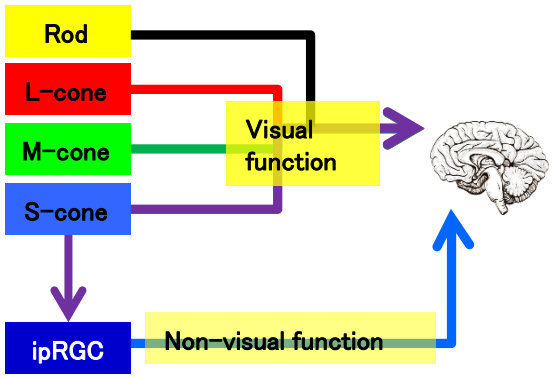
SunLike Core Technology

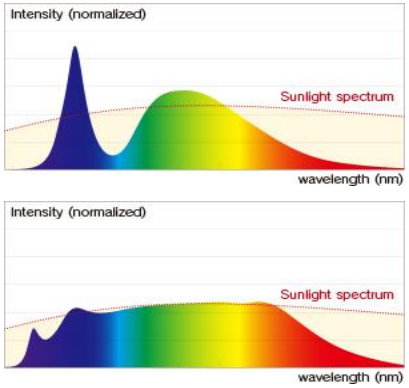
Ordinary LED

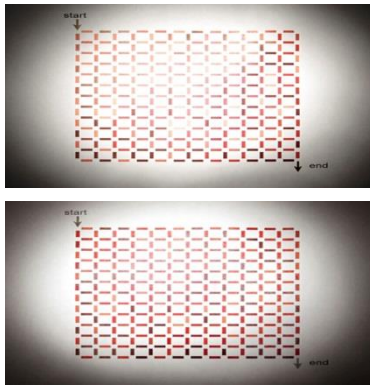
SunLike

Why Sunlike ?

Color Quality → Top class of lighting "Well-being and Clean"







1. Health & Well-being

Healthcare
Quality of sleep

Residential

Children room

Hospital

2. Exact and True Color

Natural light
Sun spectrum

Dressing & fitting rooms

Retail Store

Kitchen

3. Good Visibility

Vividness
Eye protection

Desk lamp

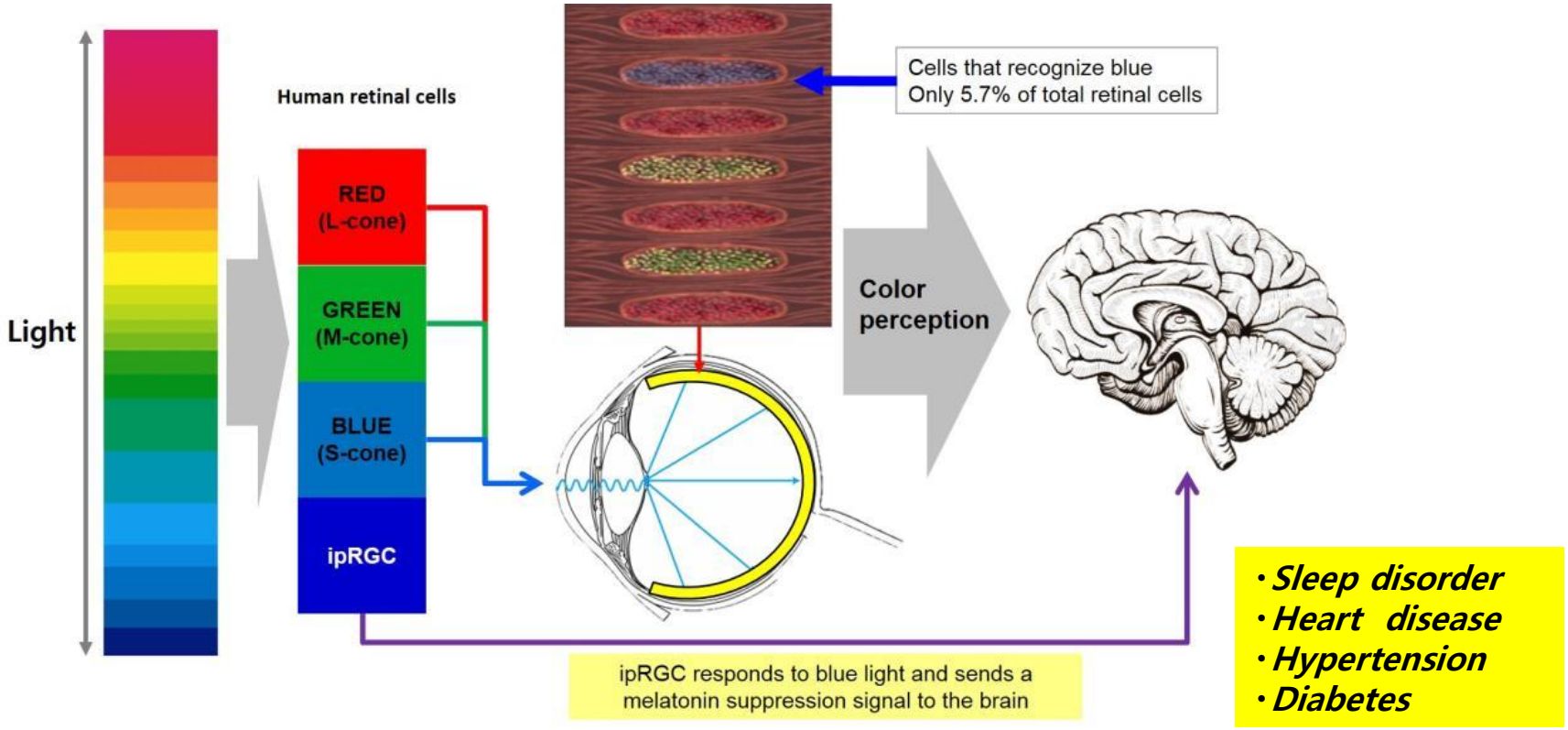
Study room

School, Surgery room

02 Well-being light

Well-being light : Healthy and high quality of sleep

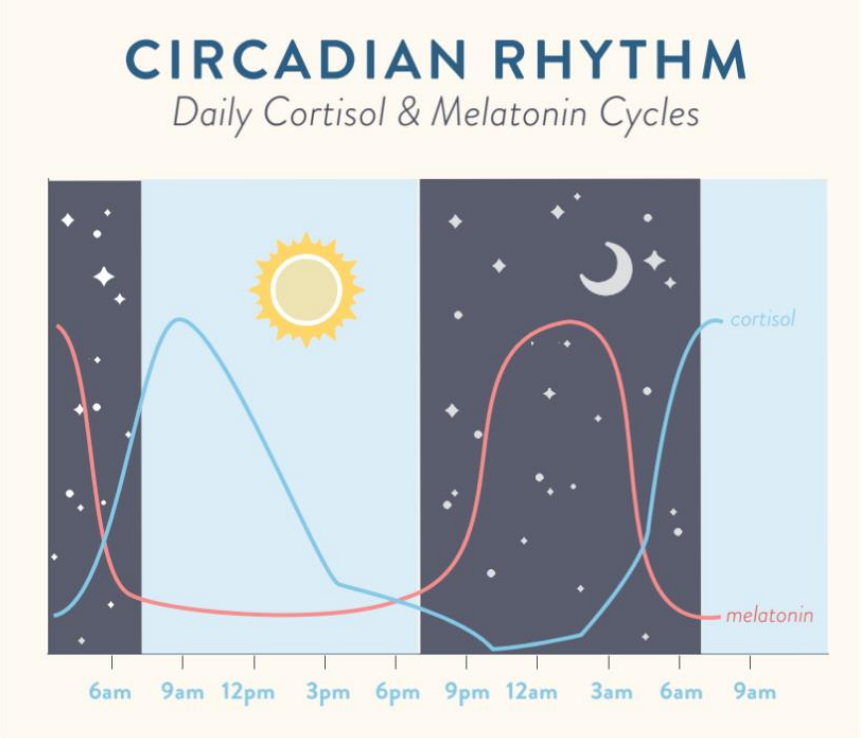
Short wavelength blue light causes glare effect & sleep disorder

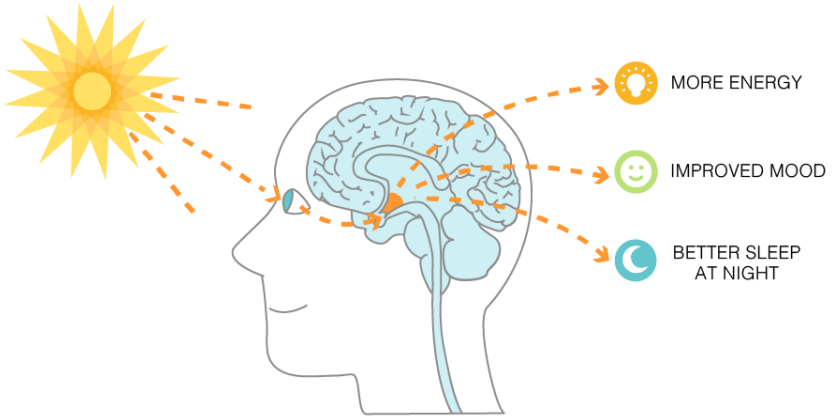


- ❖ Human's S-cone is below 6% → blue Lighting lead dazzling & Damage on retina
- ❖ ipRGC responds to only blue Light → Control circadian rhythms

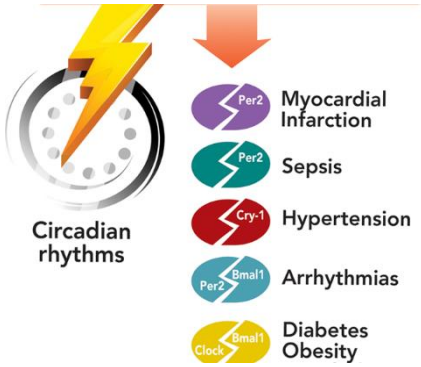
Well-being light : Healthy and high quality of sleep

Short wavelength blue light causes glare effect & sleep disorder



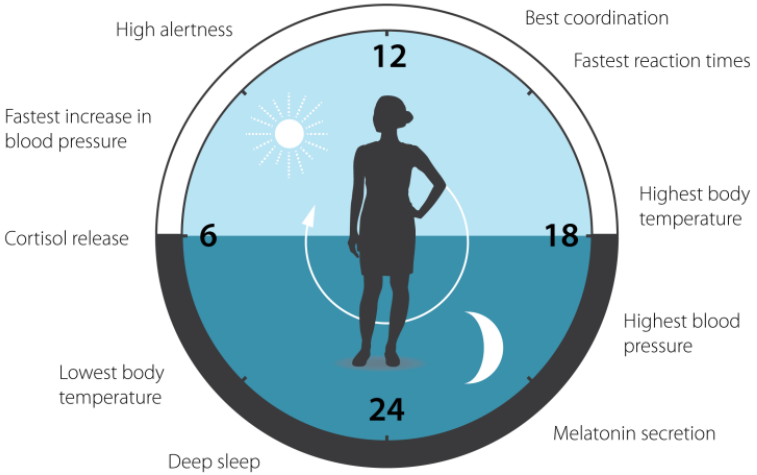


Inadequate Light



Well-being light : Healthy and high quality of sleep

2017 Nobel Prize in Physiology/Medicine



Jeffrey C. Hall, Michael Rosbash and Michael W. Young

Nobelförsamlingen
The Nobel Assembly at Karolinska Institutet

Our biological clock helps to regulate sleep patterns, feeding behavior, hormone release, blood pressure, and body temperature.

Chronic misalignment between our lifestyle and the rhythm is associated with increased risk for various diseases.

Molecular Mechanisms Controlling the Circadian Rhythm:

At night, the *period* gene is active, making *period* mRNA that heads to the cell's cytoplasm to direct production of PER, the period protein.

Ongoing Research on Bio-benefits of Sunlike

SSC is cooperating with several institutions and research centers

Research institute	Expected results	Test methods	Final report date
S* University (South Korea)	Improves sleep quality Improved visual comfort	Clinical test in humans	**Q2 2018**
B University (Swiss)	More alertness during daytime	Clinical test in humans	**Q4 2018**
C University (USA)	Improved alertness → impact in learning and studying Improved sleep induction	Clinical test in humans	**Q3 2019**
D University (USA)	Improved cognitive performance → impact in learning and studying	Clinical test in humans	**Q3 2019**
E University (Japan)	Improved visual comfort	Clinical test in humans	**Q3 2018**
Institute (Singapore)	Less myopia progress	Animal test	**Q2 2019**

Well-being light : Healthy and high quality of sleep

Demand of low blue lighting is increasing for Healthcare / sleep

Dark side on conventional LED Lighting

Harvard Health Publications
HARVARD MEDICAL SCHOOL

Harvard Health Letter

Blue light has a dark side

Exposure to blue light at night, emitted by electronics and energy-efficient lightbulbs, harmful to your health.

Updated: September 2, 2015 Published: May, 2012

Until the advent of artificial lighting, the sun was the major source of lighting, and people spent their evenings in (relative) darkness. Now, in much of the world, evenings are illuminated, and we take our easy access to all those lumens pretty much for granted.

Source: Harvard Health Letter (2015.09)

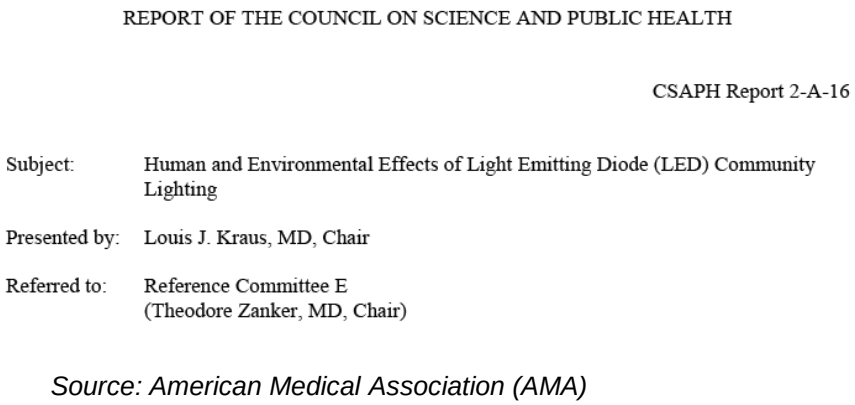
PHYSICS TODAY

Nighttime blue-light LEDs cause health problems, AMA warns

The shift to LEDs for residential street lighting is creating a host of medical and environmental problems, a new report says.

The American Medical Association (AMA) has issued a warning about the human health and environmental impacts of LEDs that emit excessive blue light. A new AMA-approved report backs six-year-old findings of the International Dark-Sky Association (IDA) about the negative consequences of the global movement to LEDs as the preferred outdoor lighting technology.

Source: Physics Today (2016.06)



REPORT OF THE COUNCIL ON SCIENCE AND PUBLIC HEALTH

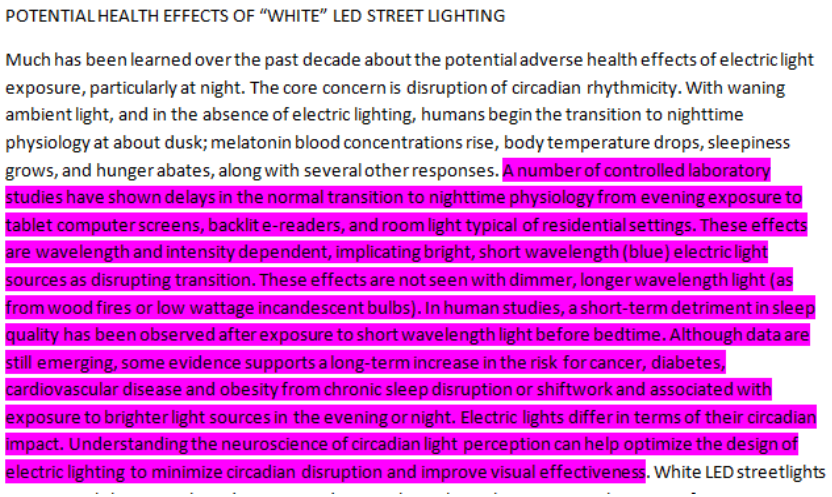
CSAPH Report 2-A-16

Subject: Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting

Presented by: Louis J. Kraus, MD, Chair

Referred to: Reference Committee E (Theodore Zanker, MD, Chair)

Source: American Medical Association (AMA)



POTENTIAL HEALTH EFFECTS OF "WHITE" LED STREET LIGHTING

Much has been learned over the past decade about the potential adverse health effects of electric light exposure, particularly at night. The core concern is disruption of circadian rhythmicity. With waning ambient light, and in the absence of electric lighting, humans begin the transition to nighttime physiology at about dusk; melatonin blood concentrations rise, body temperature drops, sleepiness grows, and hunger abates, along with several other responses. A number of controlled laboratory studies have shown delays in the normal transition to nighttime physiology from evening exposure to tablet computer screens, backlit e-readers, and room light typical of residential settings. These effects are wavelength and intensity dependent, implicating bright, short wavelength (blue) electric light sources as disrupting transition. These effects are not seen with dimmer, longer wavelength light (as from wood fires or low wattage incandescent bulbs). In human studies, a short-term detriment in sleep quality has been observed after exposure to short wavelength light before bedtime. Although data are still emerging, some evidence supports a long-term increase in the risk for cancer, diabetes, cardiovascular disease and obesity from chronic sleep disruption or shiftwork and associated with exposure to brighter light sources in the evening or night. Electric lights differ in terms of their circadian impact. Understanding the neuroscience of circadian light perception can help optimize the design of electric lighting to minimize circadian disruption and improve visual effectiveness. White LED streetlights

#Appendix

Apples introduced "Night Shift" for circadian rhythms (LIVE SCIENCE, March 24th, 2016)

Apple's iOS 9.3 update will include a feature called Night Shift that is designed to help people preserve their circadian rhythms.

A new iPhone feature called "Night Shift" automatically adjusts the screen's colors to warmer hues after sunset, on the premise that this change could help people sleep better.

The company introduced the feature because studies show that exposure to light at nighttime — especially blue light, which dominates the light emitted by electronic devices — can interfere with sleep. That's because exposure to light suppresses the production of melatonin, a hormone that signals to the body that it's time to sleep. And blue light seems to be particularly effective at suppressing melatonin.

"When people are exposed to blue light from TV screens and computers and artificial light," studies show that their sleep is disrupted, said Dr. Alon Avidan, a professor of neurology and director of the Sleep Disorders Center at the University of California, Los Angeles.

"[So] when you reduce the amount of light that's bad for you, and you screen out those blue rays, then theoretically you get better sleep," Avidan told Live Science. "However, we don't have good data to show that that's in fact what's going to take place" if people turn on Apple's new feature, he said.

Doctors Issue Warning About important of circadian rhythm (Nov 23th, 2016)

Disturbing circadian rhythm connected to higher risk of liver cancer in mice; link to humans

A team of researchers says disrupting a regular sleep routine can trigger the development of liver cancer in mice.

Disrupting a regular sleep routine can trigger the development of liver cancer in mice, says a team of researchers from Baylor College of Medicine, the USDA/ARS Children's Nutrition Research Center at Baylor and Texas Children's Hospital, the Dan L Duncan Comprehensive Cancer Center at Baylor and Florida State University.

Doctors Issue Warning About LED Streetlights (June 14th, 2016)

American Medical Association Gives Warning About LED Streetlights

At the 2016 Annual Meeting of the American Medical Association (AMA), the AMA issued new guidance for communities on how to "reduce the harmful human and environmental effects of high-intensity [LED] street lighting."

"Recognizing the detrimental effects of poorly-designed, high-intensity LED lighting, the AMA encourages communities to minimize and control blue-rich environmental lighting by using the lowest emission of blue light possible to reduce glare. The AMA recommends an intensity threshold for optimal LED lighting that minimizes blue-rich light.

The AMA also recommends all LED lighting should be properly shielded to minimize glare and detrimental human health and environmental effects, and consideration should be given to utilize the ability of LED lighting to be dimmed for off-peak time periods."

AMA

#Appendix

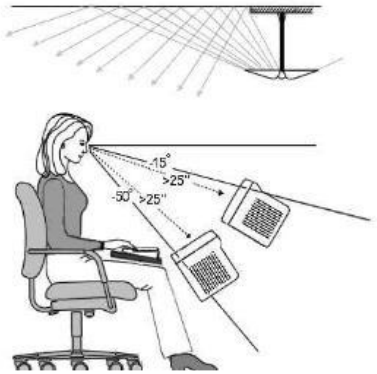
- ***"What kind of light sources should we construct in order to satisfy man's biological as well as visual needs?"***

Wurtman, Richard J. 1968. "Biological Implications of Artificial Illumination." In *National Technical Conference of the Illuminating Engineering Society*, 63: 523-529. Phoenix, Arizona: Illuminating Engineering Society of North America
100 Significant Papers' of the IES (illuminating engineering society)

- ***"…an appropriate federal body (should) give thought to the ultimate necessity of regulating the spectral composition of commercially available light sources."***

Wurtman, Richard J, and RM Neer. **1970**. "Good Light and Bad." *The New England Journal of Medicine* 282: 394-395.

Well-being light : Human Centric Lighting (HCL)



Visual ergonomic and environment

EN-12464
prEN-17037 (Daylight)

HCL

Energy efficiency

ErP 1124 EU
LEED
BREAM

Health and Well-being

WELL
FITWEL

Well-being light : Human Centric Lighting (HCL)

New standards coming into application

The new **WELL standard**

INTERNATIONAL WELL BUILDING INSTITUTE

1. Focused on the health and wellness of building occupants
2. Marries best practices in design and construction with evidence based health and wellness interventions
3. Harnesses the build environment as a vehicle to support human health, well-being and comfort

Well-being light : Human Centric Lighting (HCL)

New standards coming into application

The new **WELL standard**

1. Requires 4 hours of natural daylight at working place of 200 Equivalent melanopic lux at the eye level
2. New efficiency metrics to be used
    1. Lux on the table versus Melanopic Lux in the eye
        1. Sunlike is best LED !

Well-being light : Human Centric Lighting (HCL)

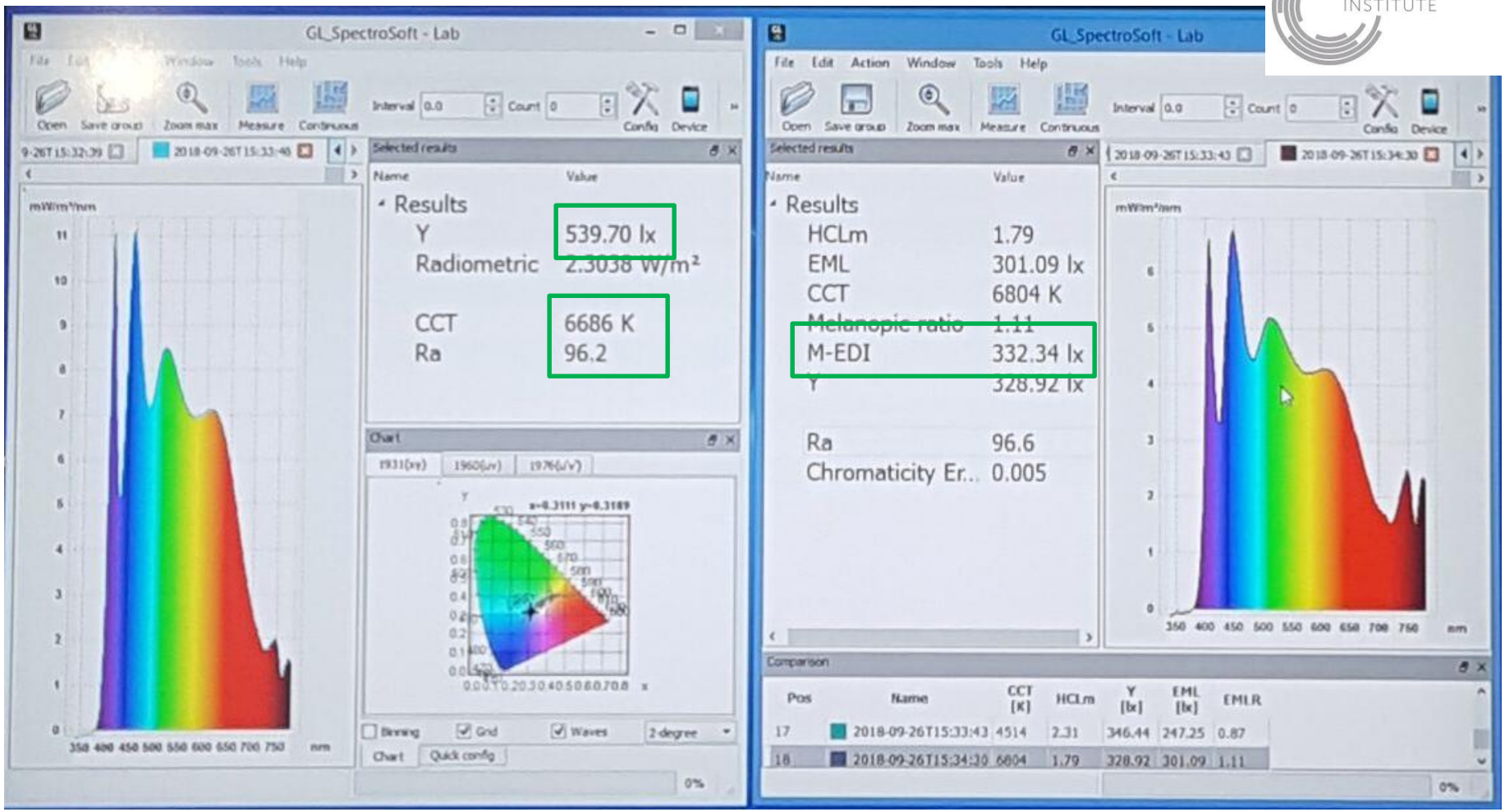
New standards coming into application

INTERNATIONAL WELL BUILDING INSTITUTE

Well-being light : Human Centric Lighting (HCL)

New standards coming into application

INTERNATIONAL WELL BUILDING INSTITUTE



Well-being light : Human Centric Lighting (HCL)

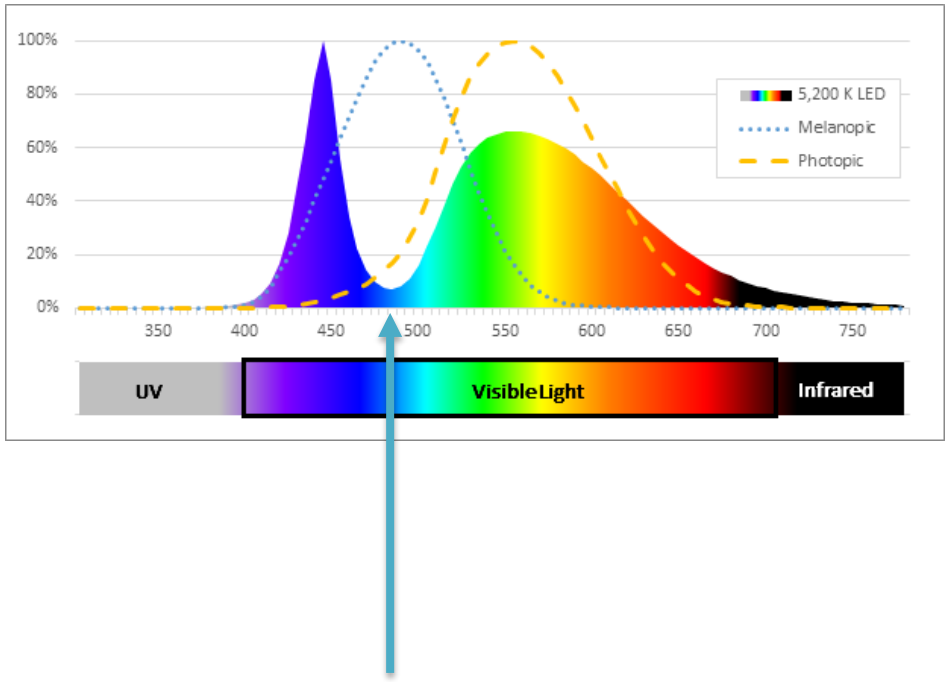
New standards coming into application

		3000K	4000K	6500K
	Ehorizontal (Lux)	547	571	539
Sunlike	Evertical Melanopic (M-EDI)	186	273	332
LED CRI90	Evertical Melanopic (M-EDI)	150	203	240
Sunlike	Ratio	3.24	2.31	1.79
	Inverse ratio	**0.30**	**0.43**	**0.56**
LED CRI90	Ratio	3.70	2.85	2.27
	Inverse ratio	**0.27**	**0.35**	**0.44**

Sunlike efficiency to generate more Ev (M-EDI) for same lux level is 10-22% higher depending CCT and CRI → **needs less lm/W for M-EDI**

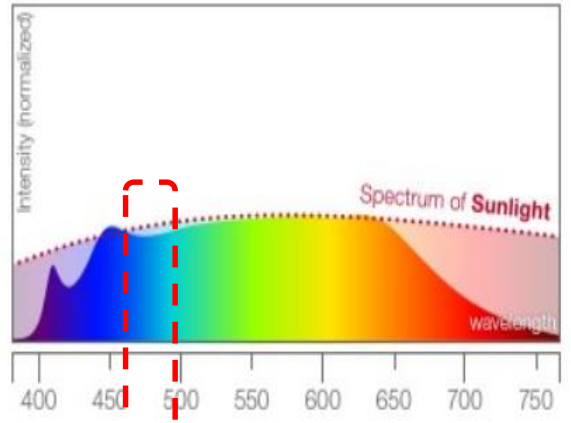
Well-being light : Human Centric Lighting (HCL)

HCL effective lighting with Sunlike

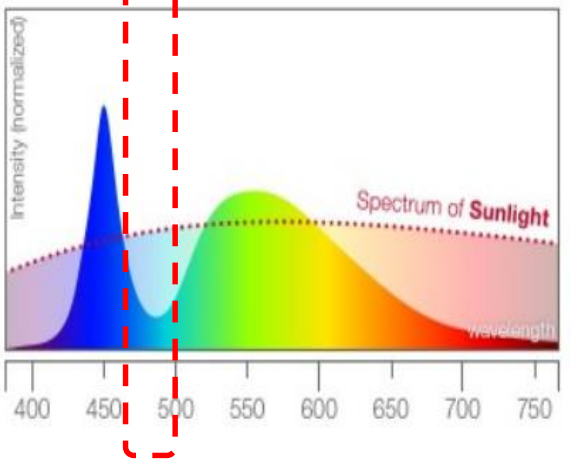


Melanopic response in 480 nm

Sunlike



Conventional LED



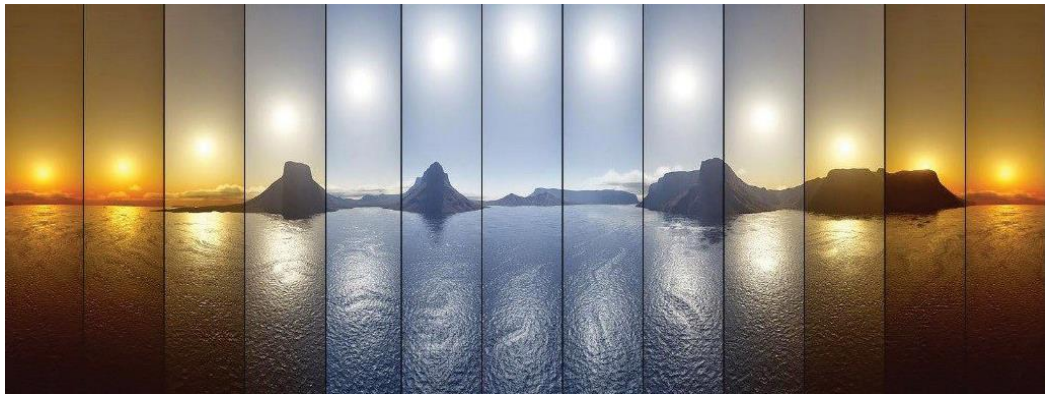
480nm

Well-being light : Human Centric Lighting (HCL)

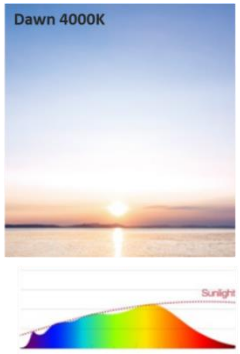
Sunlike can replicate sunlight spectra during the course of the day

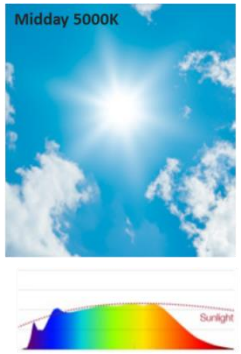
Human Centric Lighting

- Luminaire makers can reproduce the sun at the different times of the day



- Combining 2700K – 4000K and 6500K – Sunlike LEDs in one luminaire

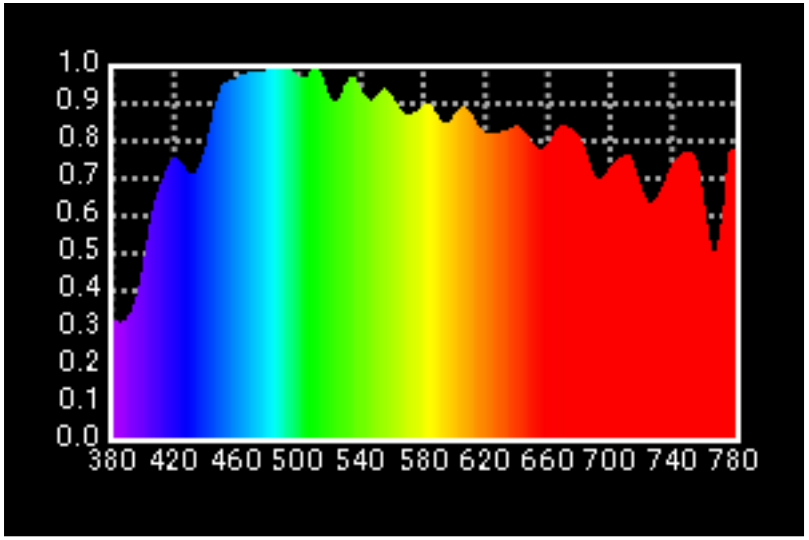




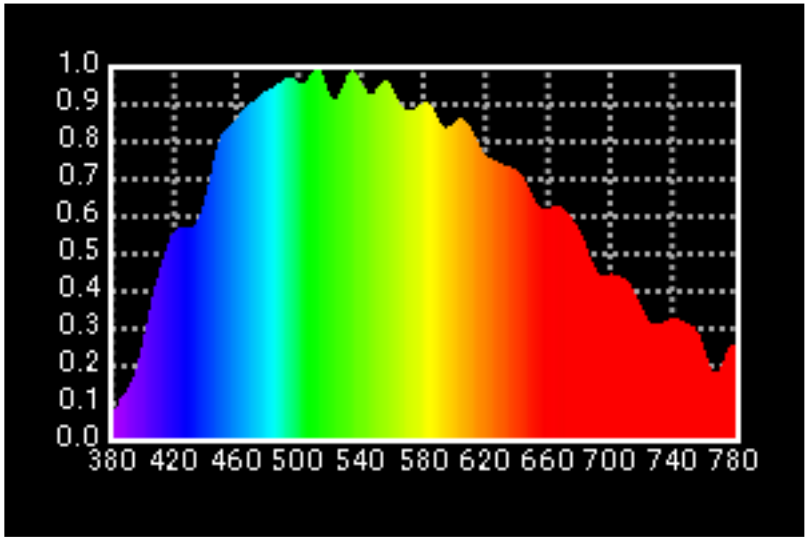
Well-being light : Human Centric Lighting (HCL)

How it looks the real Sun light ?

- Sun outside (clear day)

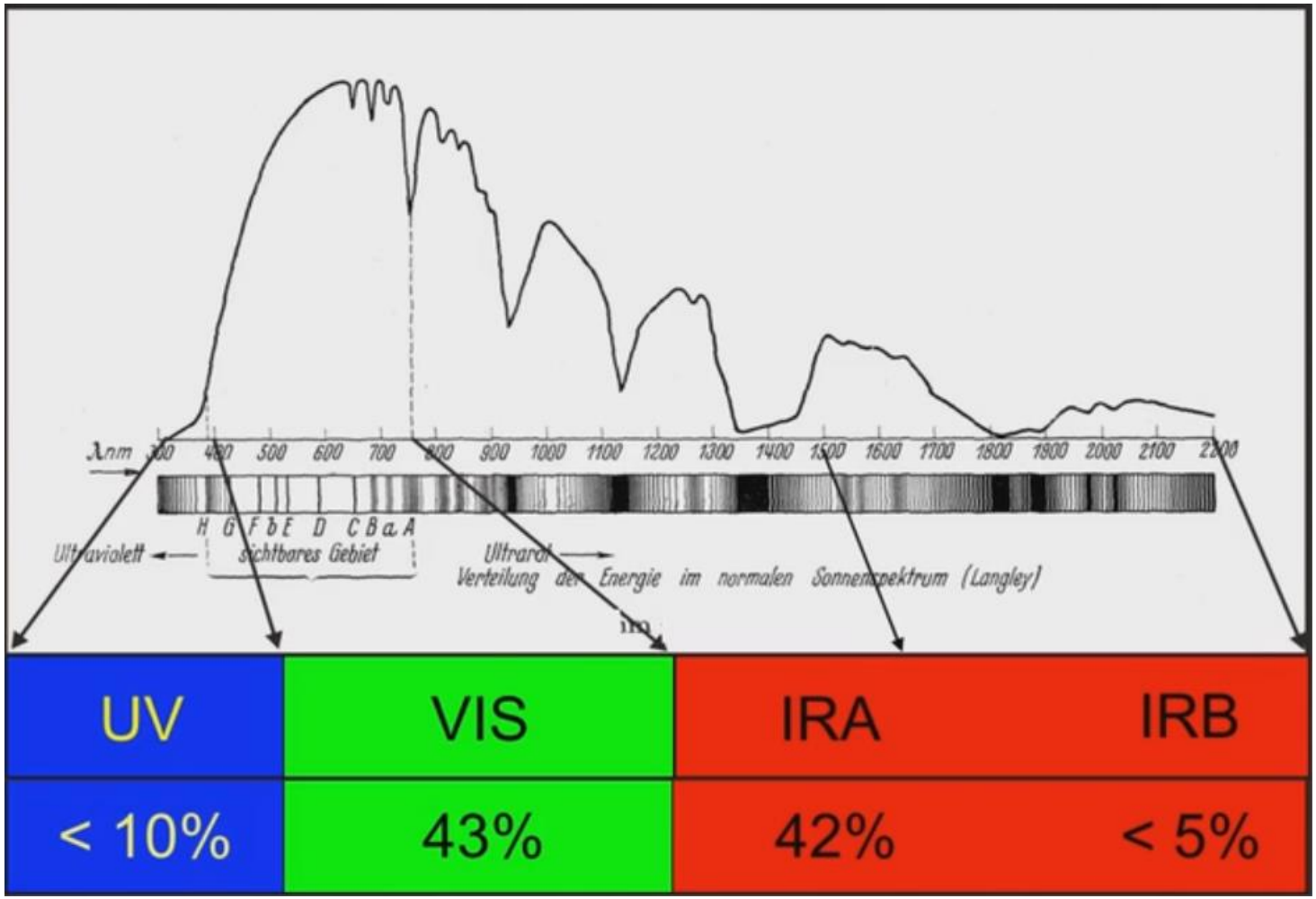


- Sun behind a window (clear day)
  - Less UV by glass supression
  - Less IR



Well-being light : Human Centric Lighting (HCL)

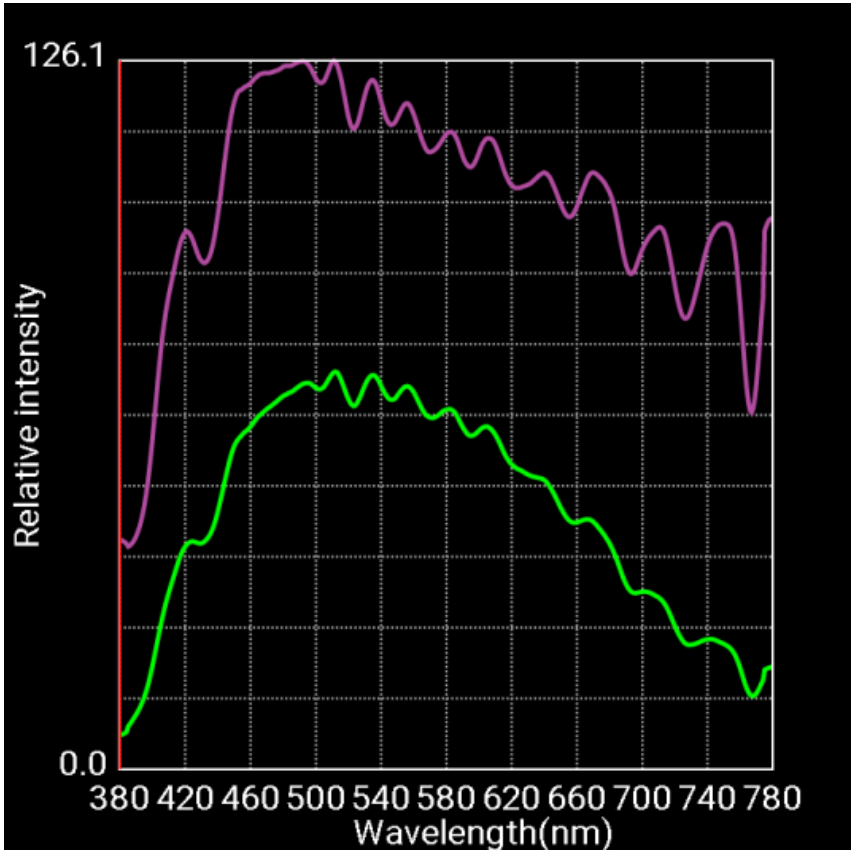
How it looks the real Sun light ?



Well-being light : Human Centric Lighting (HCL)

How it looks the real Sun light ?

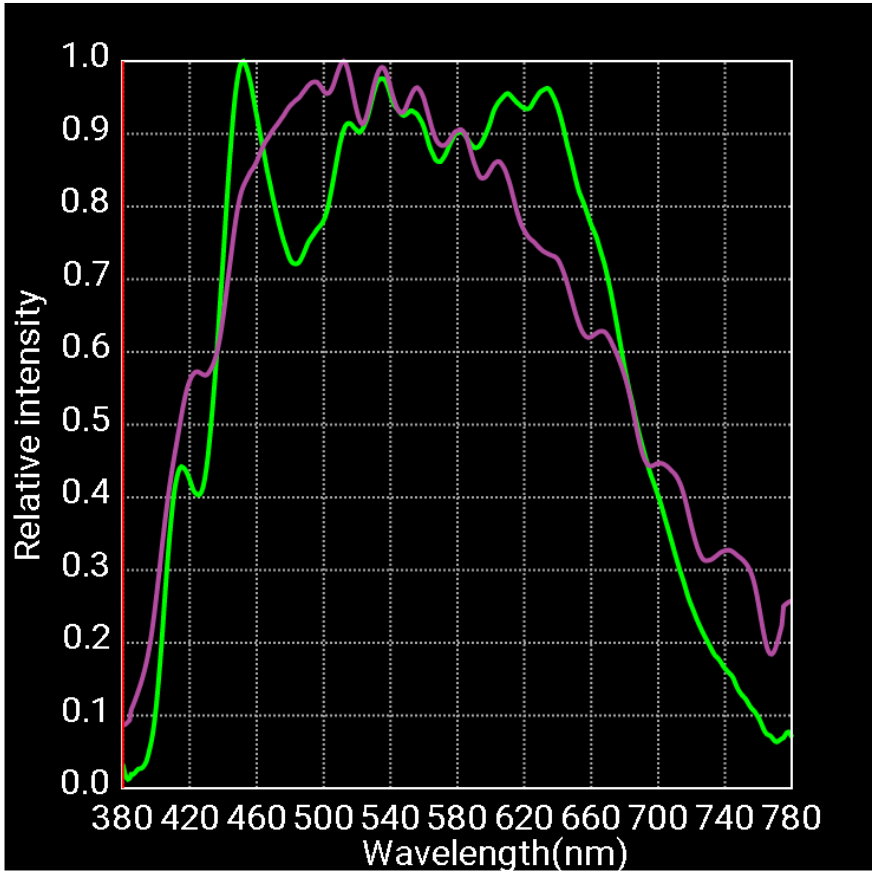
- Comparison Sunlight before and after a window

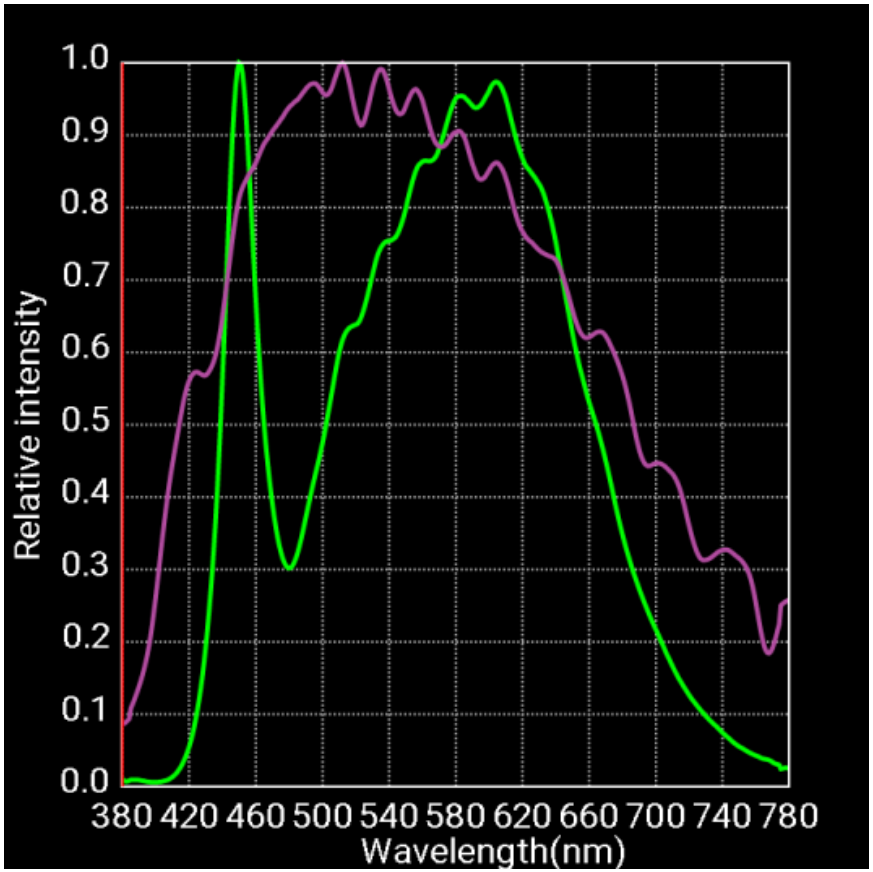


Well-being light : Human Centric Lighting (HCL)

Which technology matches better the Sun spectrum ?

- Comparison Sunlight after a window vs Sunlike vs Blue pump LED

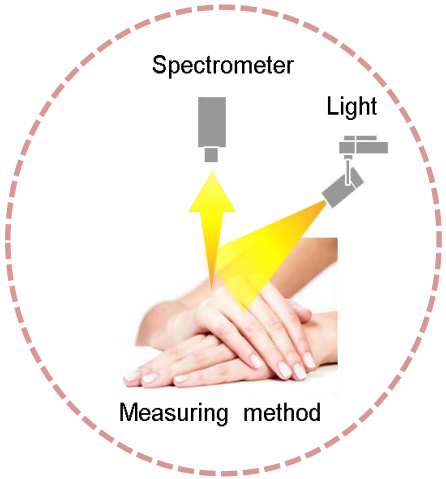


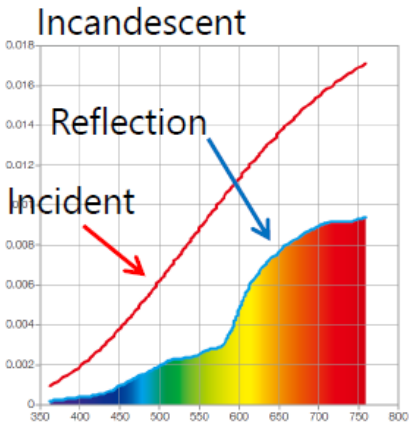


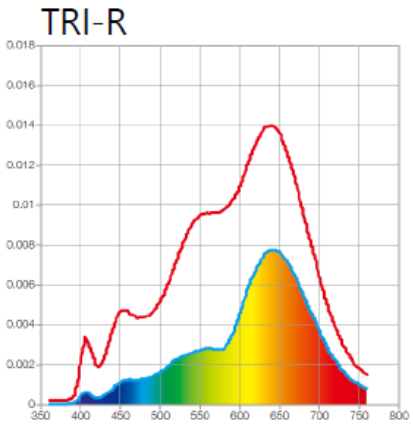
03 Color & Visibility

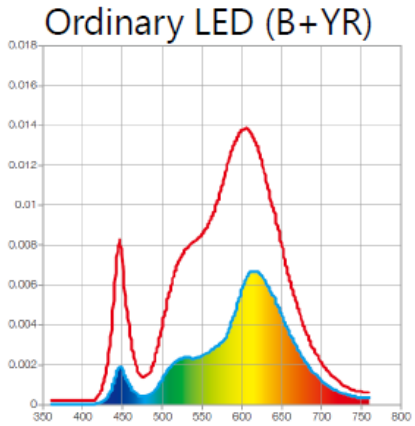
Sun “Like”

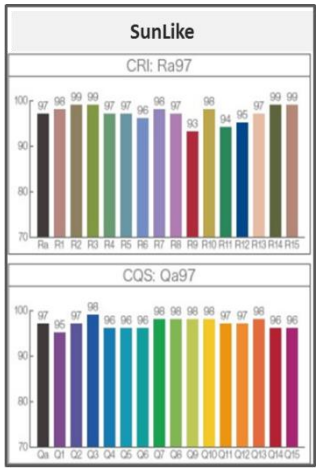
Feel natural and genuine color of the objects

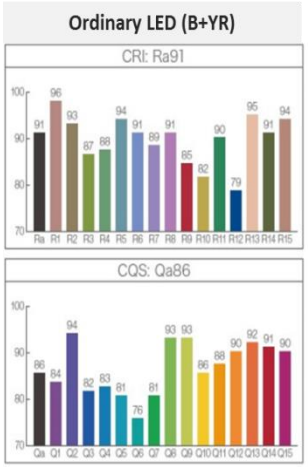


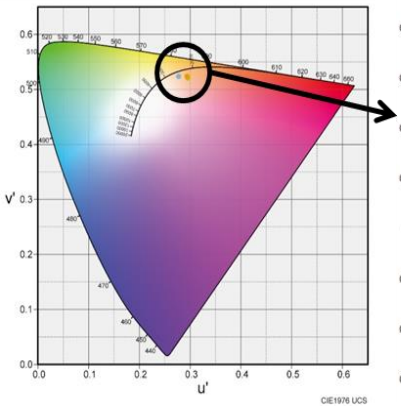


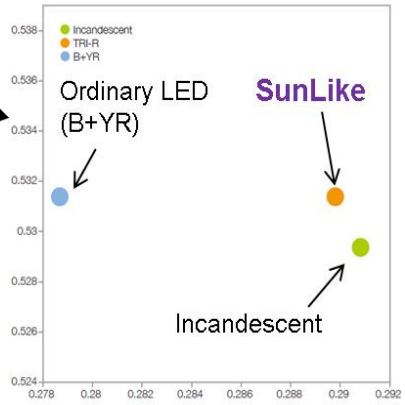


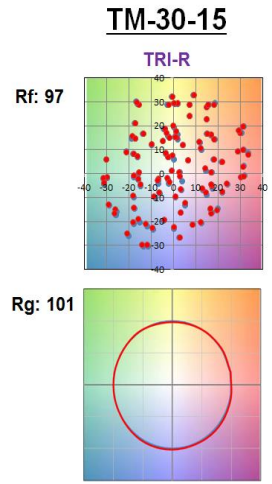








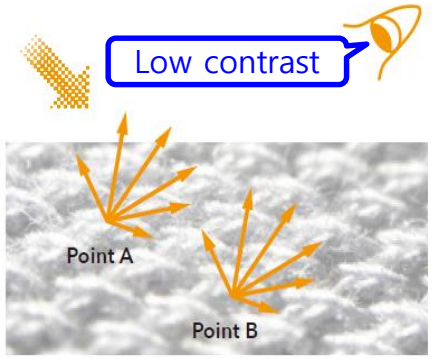


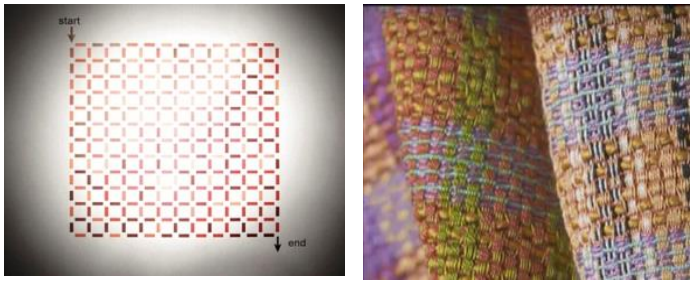


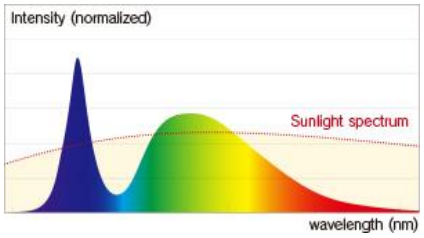
Clear light with less glare

Eye protection – Less glare - All gets vividness

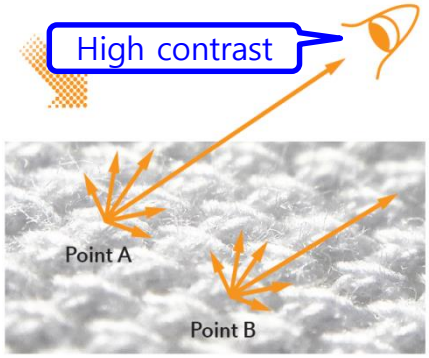
Ordinary LED

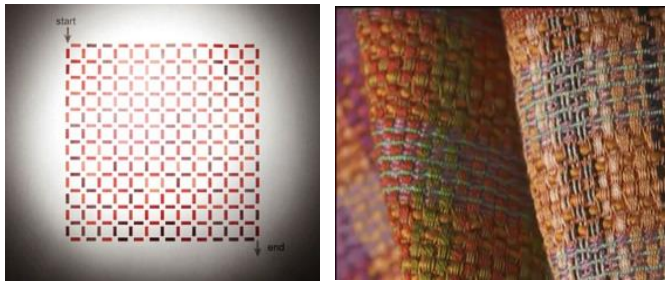


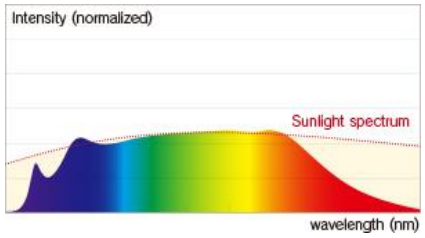




SunLike







Color metrics – CRI vs TM-30

"Gamut" is not a dimension of perception. It is best interpreted with reference to a complementary graphic.

CRI Calculation Engine (1974)		TM-30 Calculation Engine (2015)
CIE 1964 U*V*W*	⇨	CAM02-UCS (CIECAM02)
8 color samples Medium chroma/lightness Spectral sensitivity varies Munsell samples only	⇨	99 color samples Uniform color space coverage Spectral sensitivity neutral Variety of real objects
Fidelity Metric Only	⇨	Fidelity, Gamut, Graphical, Detailed
Ref Illuminant Step Function	⇨	Ref Illuminant Continuous (Uses same reference sources, but blended between 4500 K and 5500 K)
No lower limit for scores	⇨	0 to 100 scale (fidelity)

IES Method for Color Rendition

Color Fidelity

The accurate rendition of color so that they appear as they would under familiar (reference) illuminants

Fidelity Index (R_f)
(0-100)

Color Gamut

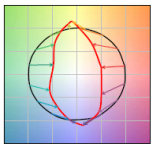
The average level of saturation relative to familiar (reference) illuminants.

Gamut Index (R_g)
~60-140 when $R_f > 60$

Graphics

Visual description of hue and saturation changes.

Color Vector Graphic



CRI95 / Rf=93 / Rg=100

[Original]

CRI80 / Rf=78 / Rg=90

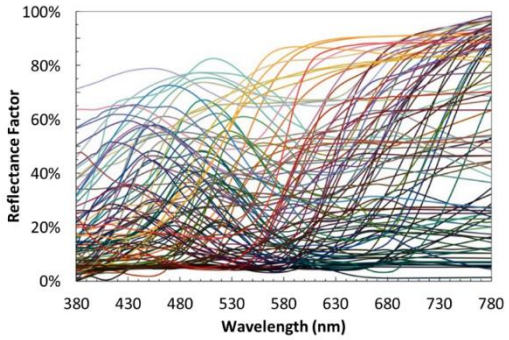
[Desaturated]

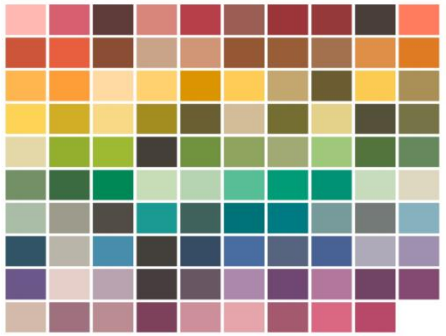
CRI80 / Rf=78 / Rg=110

[Red-Enhanced]

Color metrics – CRI vs TM-30

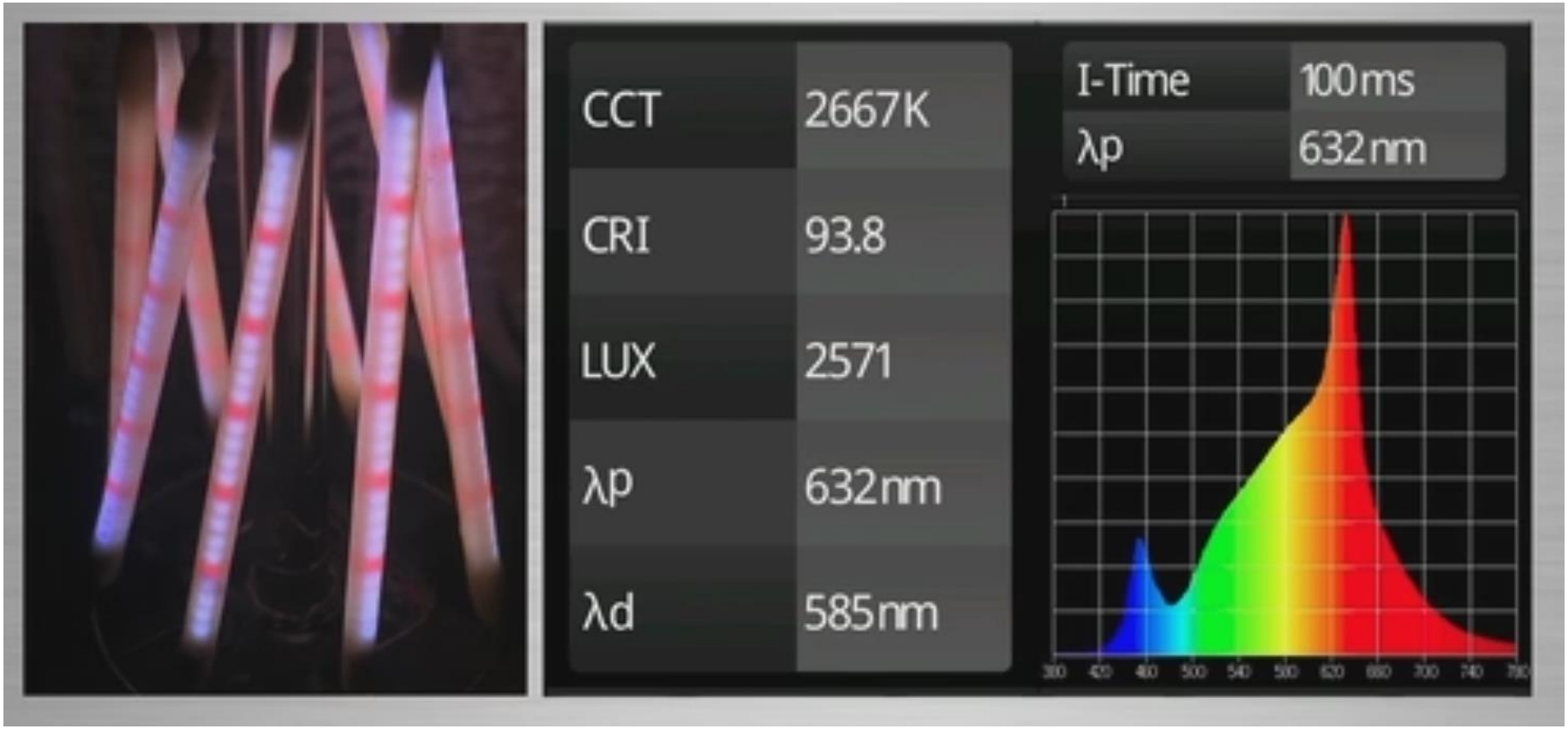
	CIE 13.3-1995 (CRI)	IES TM-30-15
Year of Issuance	1965, 1974 (Revision), 1995	2015
Color Space	CIE 1964 U*V*W*	CAM02-UCS (CIECAM02)
Number of Color Samples	8 general (for R_a) plus 6 special (for R_is)	99
Color Volume Coverage	Limited	Full and equal
Saturated Samples	No	Yes
Sample Types	Munsell samples only (limited pigments)	Variety of real objects
Sample Spectral Uniformity	No	Yes
Reference Illuminants	Blackbody radiation, CIE D series	Blackbody radiation, CIE D series
Reference Transition	Sharp at 5000 K	Blended between 4500 K and 5500 K
Output Measures	General index, R_a (fidelity) 6 special indices, R_i (fidelity)	Fidelity Index, R_f Gamut Index, R_g Color Vector/Saturation Graphics 16 hue-based fidelity indices 16 hue-based chroma indices 1 skin-specific fidelity index 99 individual fidelity values
Score Ranges	Max 100 with no lower limit, variable scaling	0 to 100, consistent scaling





Color metrics – CRI vs TM-30

Color metrics – CRI vs TM-30



Some companies found a way to trick the standard system !
But it doesn't mean the light quality is good

Color metrics – CRI vs TM-30

"Gamut" is not a dimension of perception. It is best interpreted with reference to a complementary graphic.

CRI Calculation Engine (1974)		TM-30 Calculation Engine (2015)
CIE 1964 U*V*W*	⇨	CAM02-UCS (CIECAM02)
8 color samples Medium chroma/lightness Spectral sensitivity varies Munsell samples only	⇨	99 color samples Uniform color space coverage Spectral sensitivity neutral Variety of real objects
Fidelity Metric Only	⇨	Fidelity, Gamut, Graphical, Detailed
Ref Illuminant Step Function	⇨	Ref Illuminant Continuous (Uses same reference sources, but blended between 4500 K and 5500 K)
No lower limit for scores	⇨	0 to 100 scale (fidelity)

IES Method for Color Rendition

Color Fidelity

The accurate rendition of color so that they appear as they would under familiar reference illuminants

Fidelity Index (R_f)
(0-100)

Color Gamut

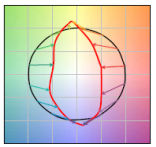
The average level of saturation relative to familiar (reference) illuminants.

Gamut Index (R_g)
~60-140 when $R_f > 60$

Graphics

Visual description of hue and saturation changes.

Color Vector Graphic

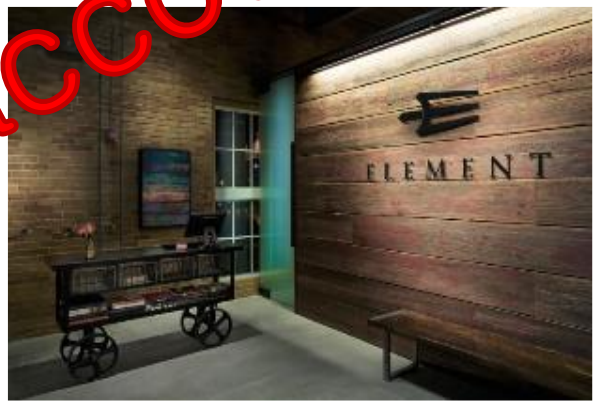


This are only metrics
Not into account the spectrum

CRI95 / Rf=93 / Rg=100

[Original]

CRI80 / Rf=78 / Rg=90



[Desaturated]

CRI80 / Rf=78 / Rg=110

[Red-Enhanced]

New 3528 – CRI95

Interested in matching the standard CRI 95 at lower cost and higher lm/w ?

- ***We have the solution: 3528 – CRI95 - STWHA12D-E1***

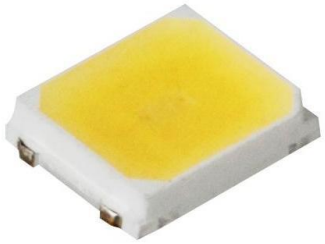
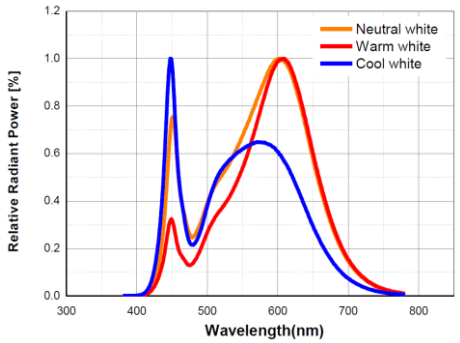


Fig 1. Color Spectrum, T_j = 25°C, I_F=65mA



Part No.		STWHA12D-E1
Size (mm)		3.5 x 2.8
Rated IF (mA)		65
Typ. Vf @Tj=25		2.9
Typ. Flux @Tj=25 @ 65mA	3000K	22.5 lm min.
Typ. Flux @Tj=25 @ 65mA	5000K	26.4 lm min.

Advantages & Benefits

- CRI ≥ 95
- R9 >90
- CCT 2600-5300K
- Higher performance than competitors
- low cost solution for high CRI

04 Applications

Applications

Place to need true, natural color / in long-time exposure of lighting

Residential	Hospitality & Architectural	Retail

- **Dresser**


- **Task lamp**


Par / Bulb / Tube / Linear

- **Interior lighting**

- **Museum / Gallery**

Linear Bar

- **Fashion shop**

- **Beauty salon**

- **Grocery, Food**

MR / Par / Linear

Potential Niche Market

- Medical


- Horticulture

- Broadcasting

Application : Healthy lit, Quality of sleep

Health care lighting for circadian rhythm

SunLike Powered by

Lighting with circadian rhythm

- Sound sleep
- Pleasant & active during the day
- Health/Well-being

Conventional LED with Blue peaks at Night

Disorder of circadian rhythm/
Suppression of Melatonin production

- Sleep disorder
- Cancer, Heart disease
- Diabetes, Obesity

Application : Healthy, Concentration, Circadian

Less glare, Well-being lighting

Design offices & Study rooms

Children's Nurseries

Work places & 24/7 place

Application : Clear, Natural color

Experience genuine color in-and-outside

Fitting room

Dresser

Real colors for clothes

Real colors for make-up

Application : Museums

Experience same colors as artist

Museum

- Natural blue-green gradation
- Texture of white cloth
- Skin with bare flesh feeling and transparent

La Giovinezza Giorgio Kienerk,
1902, Pavia, Musei civici

Sunlike

Ordinary LED CRI90

Application : Museums

Experience same colors as artist

Museum

- **Real color and texture of various building materials**

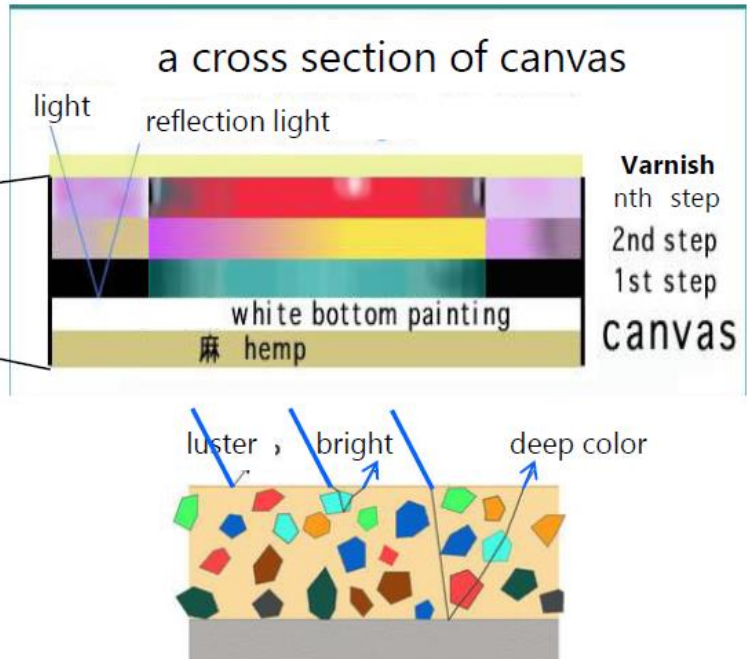
Studio Marco Piva




Application : Museums

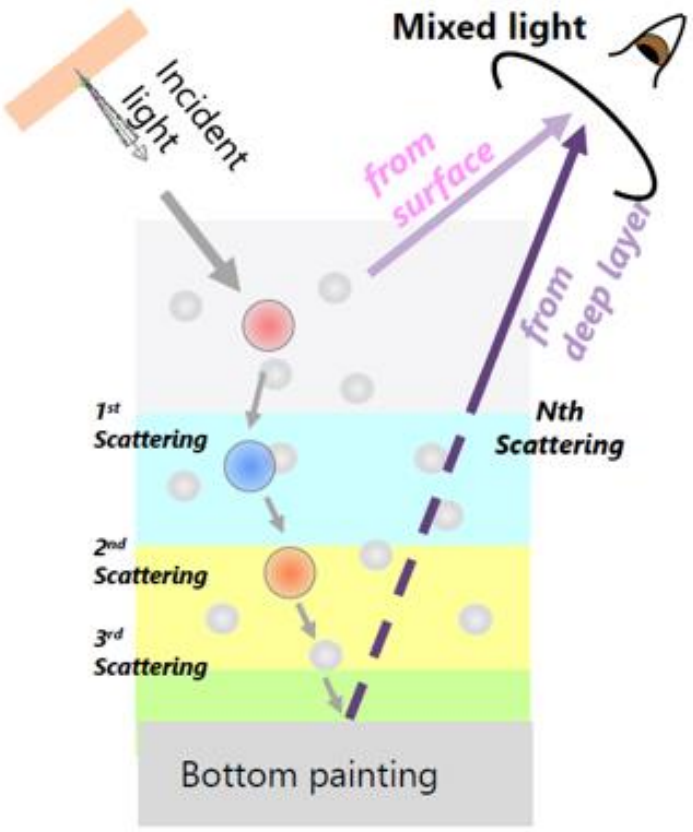
Experience same colors as artist

- If there is lack of color in spectrum of light masterpieces lose their true beauty
- No reflection from deep layers less colors reflected and lose own colors masterpiece



Application : Museums

Experience same colors as artist



Short wavelengths are diffusive towards depth

⇩

Absorption (Attenuation) at every scattering

⇩

Reflection on bottom painting

⇩

Multiple attenuation causes unbalanced colors

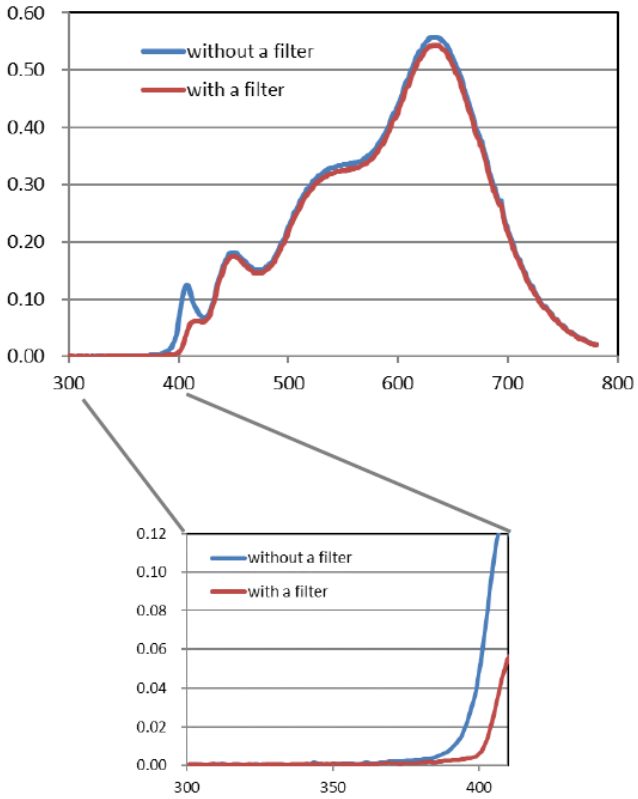
⇩

That's why Sunlight is truly important for color rendering

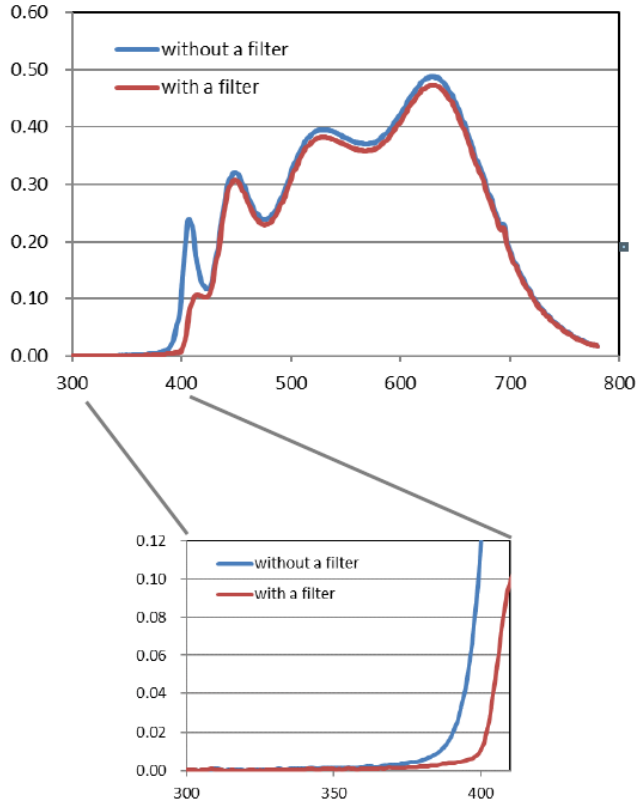
Application : Museums

Use of 400nm cut filter

TRI-R 3000K



TRI-R 4000K



No relevant spectrum change → keep color quality

Application : Museums

Degradation factor for museum lights

	Light source	Tc[K]	Ra	Degradation Coefficient
Fixture Maker's data	FL for Museum (with a filter)	3000K	95	0.008
		4000K	98	0.010
		5000K	99	0.012
	Blue-type LED	2700K	92	0.004
		5000K	85	0.009
SunLike Powered by TRI-R	TRI-R (without a filter)	2700K	97	0.007
		3000K	97	0.009
		4000K	97	0.014
		5000K	97	0.017
	TRI-R (with a filter)	2700K	97	0.005
		3000K	97	0.007
		4000K	97	0.010
		5000K	97	0.013

Sunlike offers similar values as actual Flourescent/LED technology

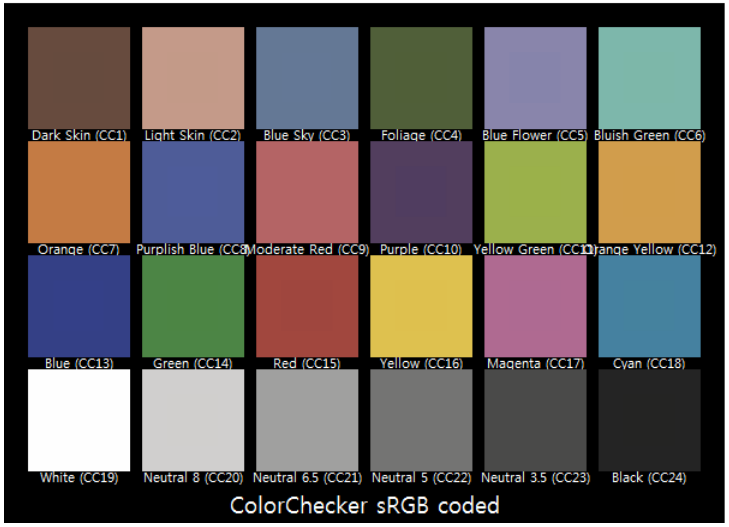
Application : Broadcasting

Better color correction & expression judged by TLCI

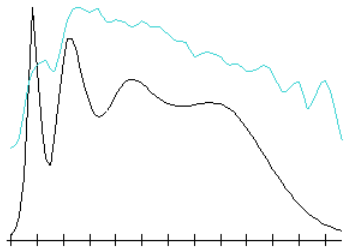
Best for Television & Film production

[Analysis by TLCI]

Direct spectrum input : CCT = D6211 (-0.5)
TLCI-2012 : 98 (D6211)



Sector	Lightness	Chroma	Hue
R	0	0	0
R/Y	0	0	0
Y	0	0	0
Y/G	0	0	0
G	0	0	0
G/C	0	0	+
C	0	0	+
C/B	0	0	+
B	0	0	0
B/M	0	0	+
M	0	0	+
M/R	0	0	+

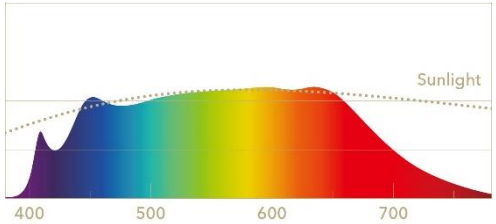


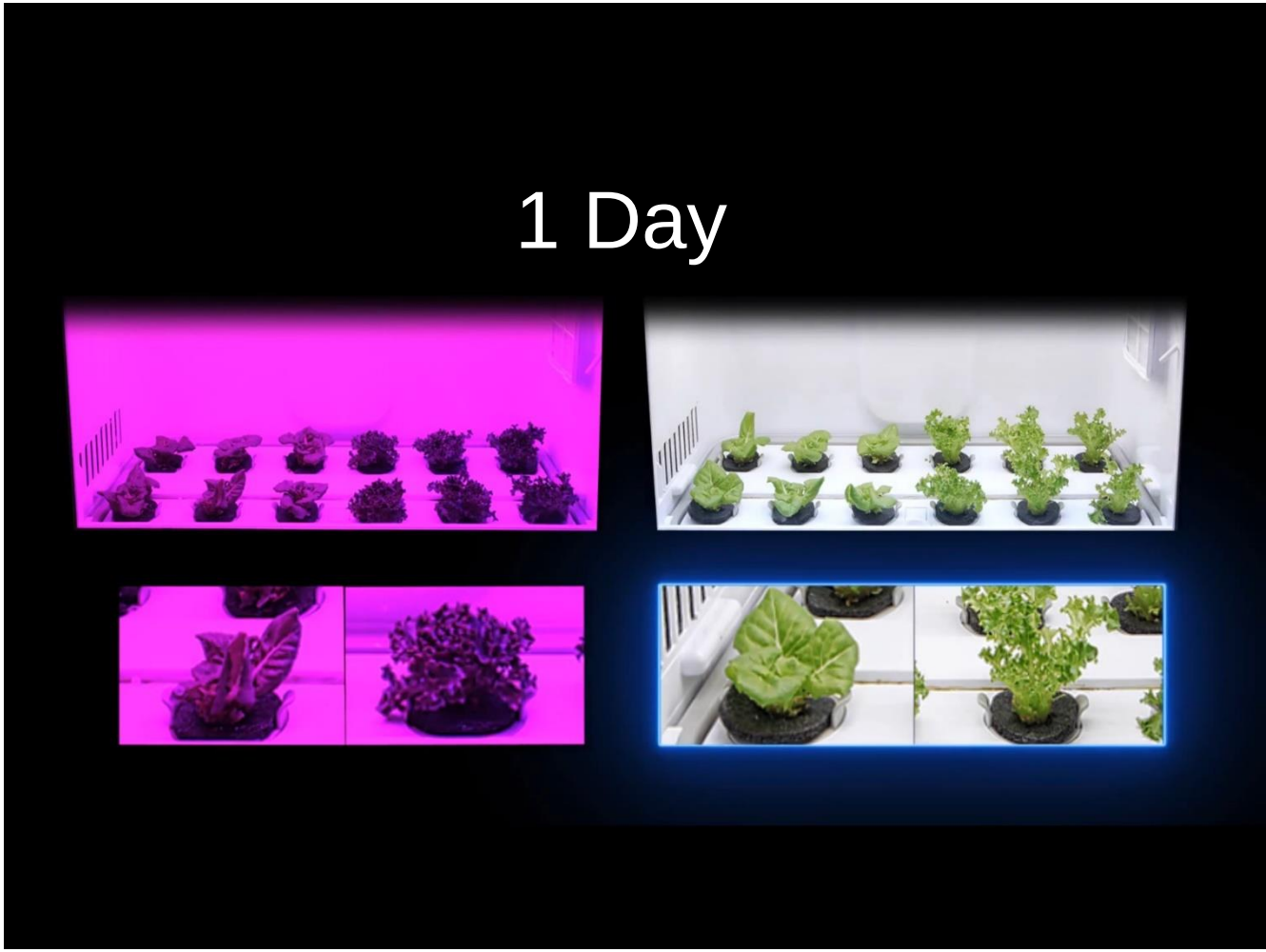
Application : Horticulture

New studies confirm that full spectrum LEDs are better for Plants

Horticulture Plants

With Sunlike any crop is possible



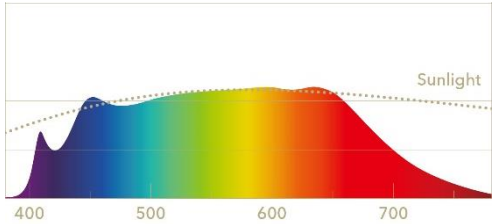


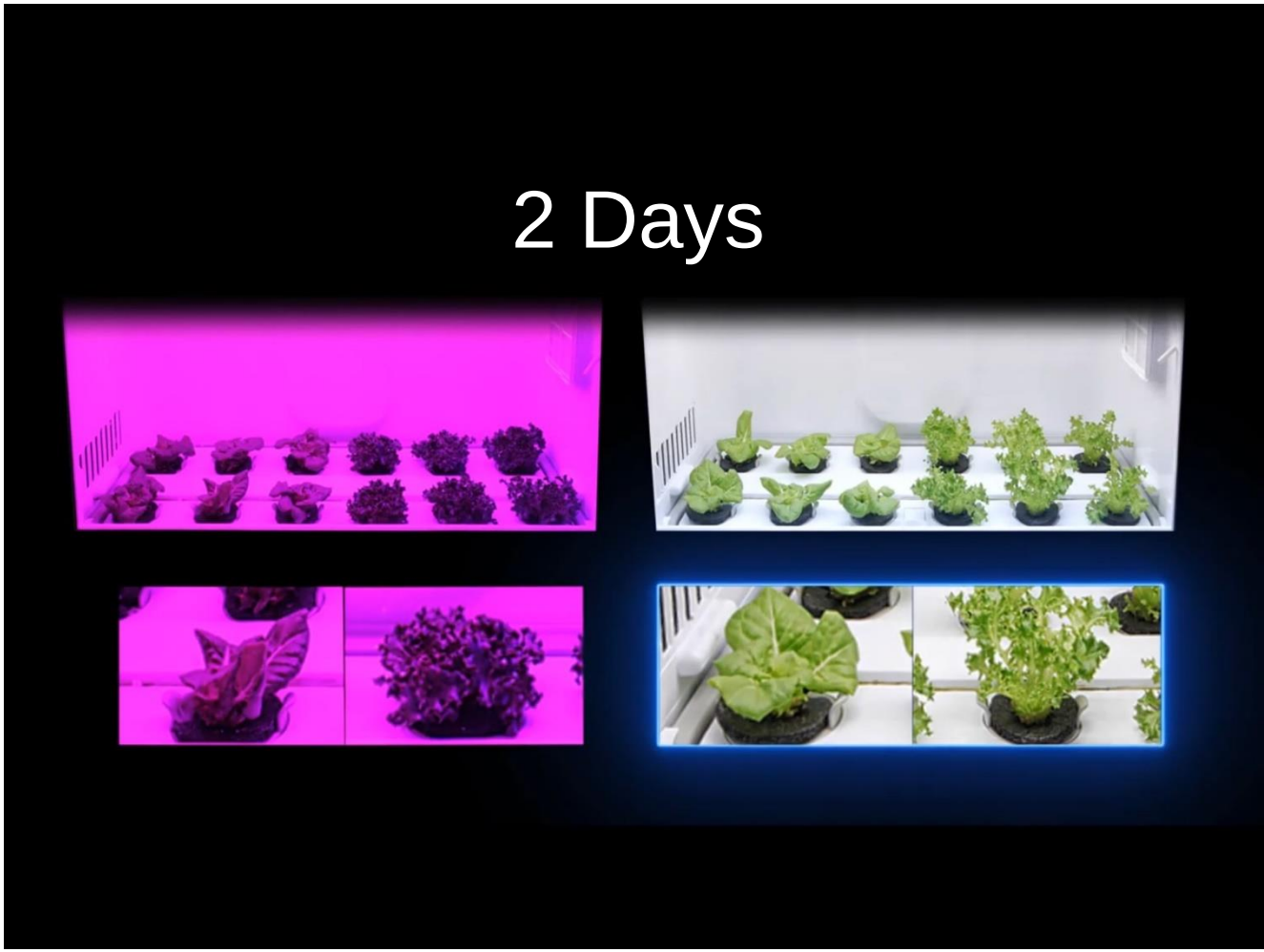
Application : Horticulture

New studies confirm that full spectrum LEDs are better for Plants

Horticulture Plants

With Sunlike any crop is possible



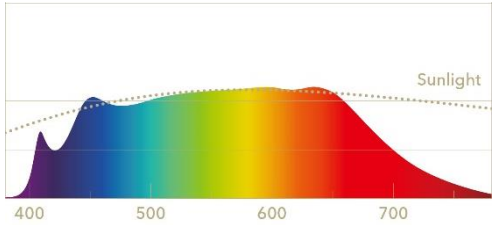


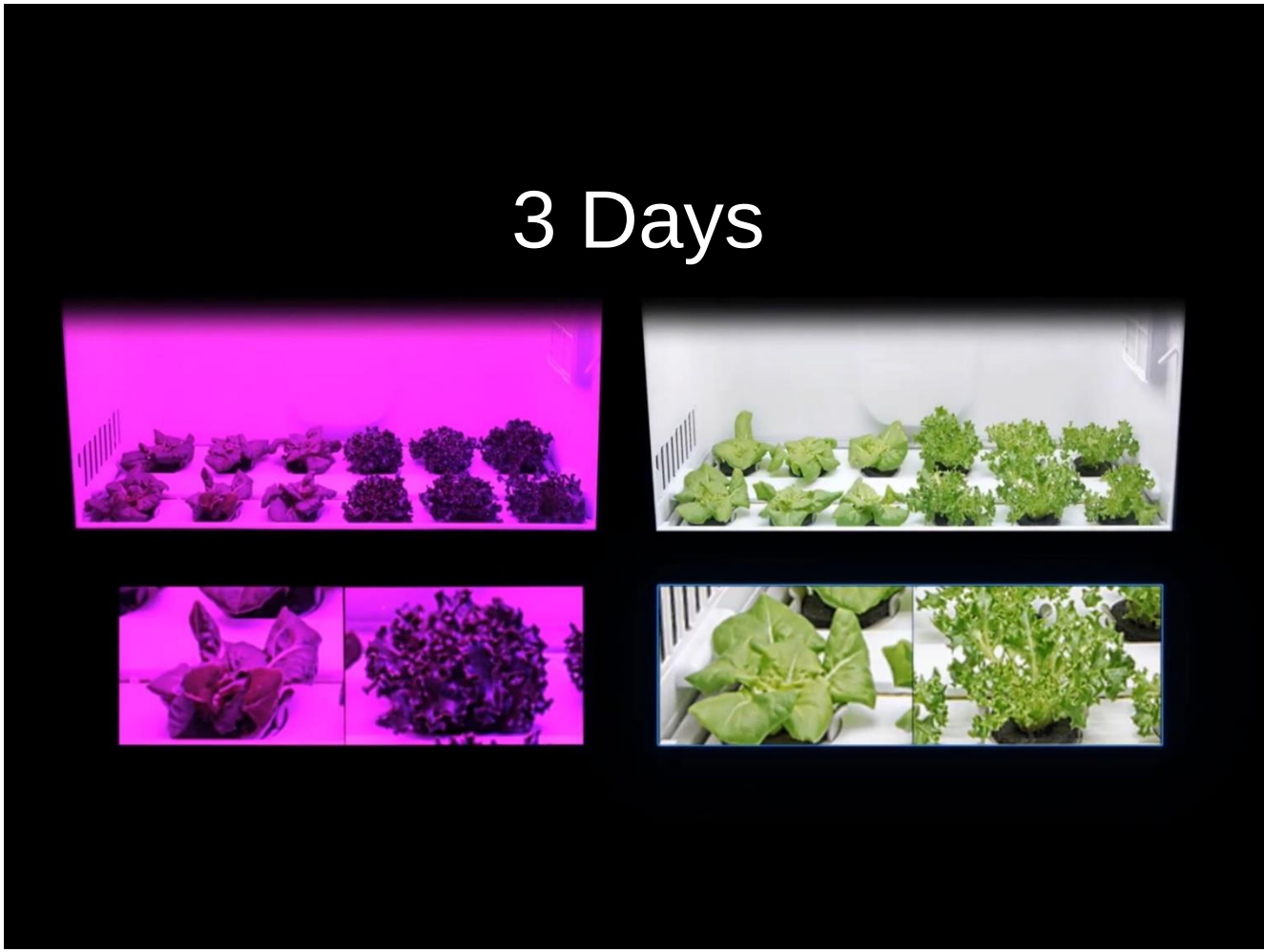
Application : Horticulture

New studies confirm that full spectrum LEDs are better for Plants

Horticulture Plants

With Sunlike any crop is possible



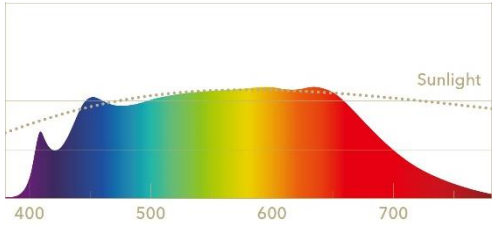


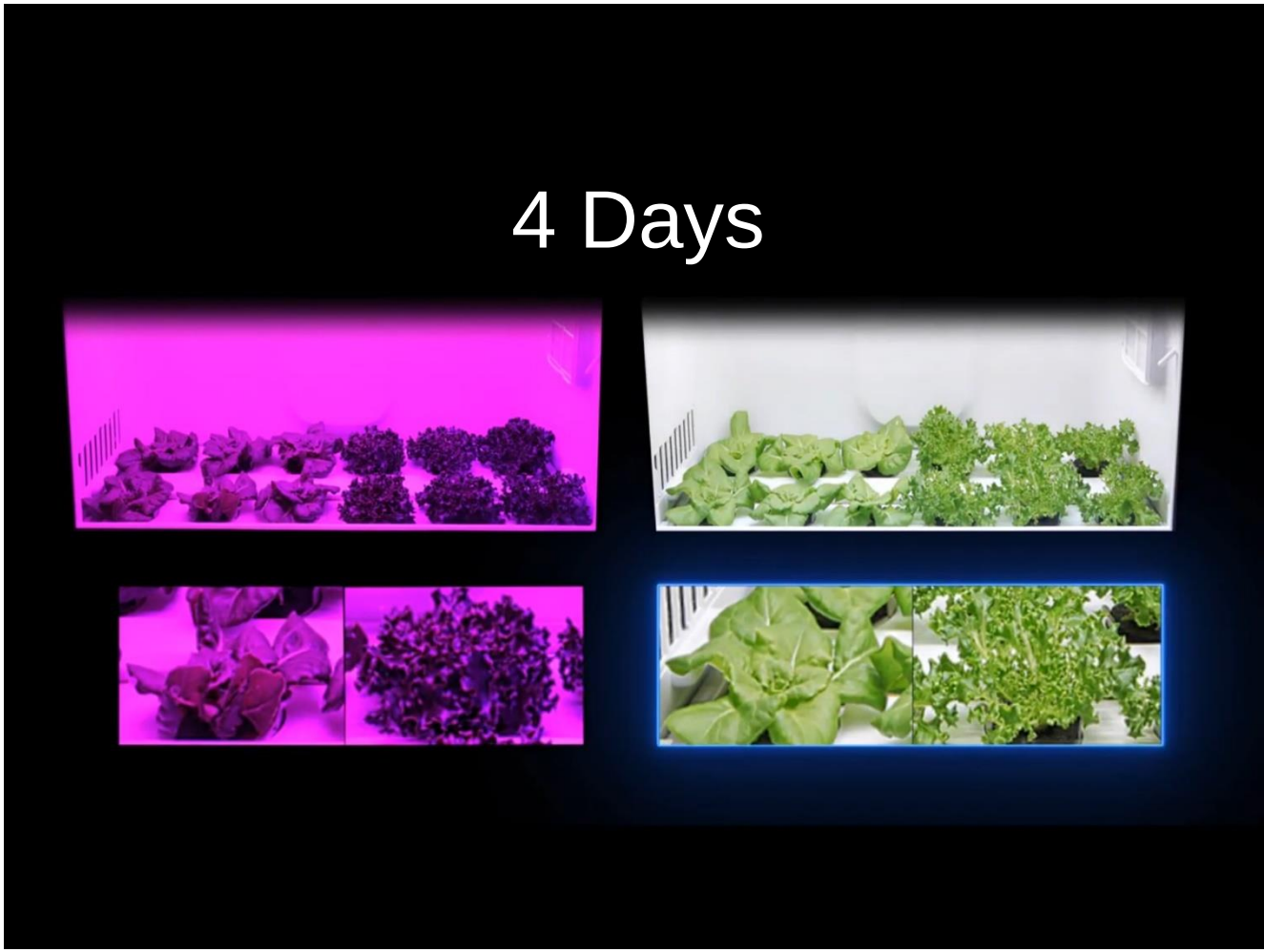
Application : Horticulture

New studies confirm that full spectrum LEDs are better for Plants

Horticulture Plants

With Sunlike any crop is possible



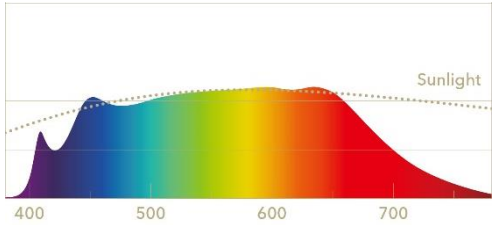


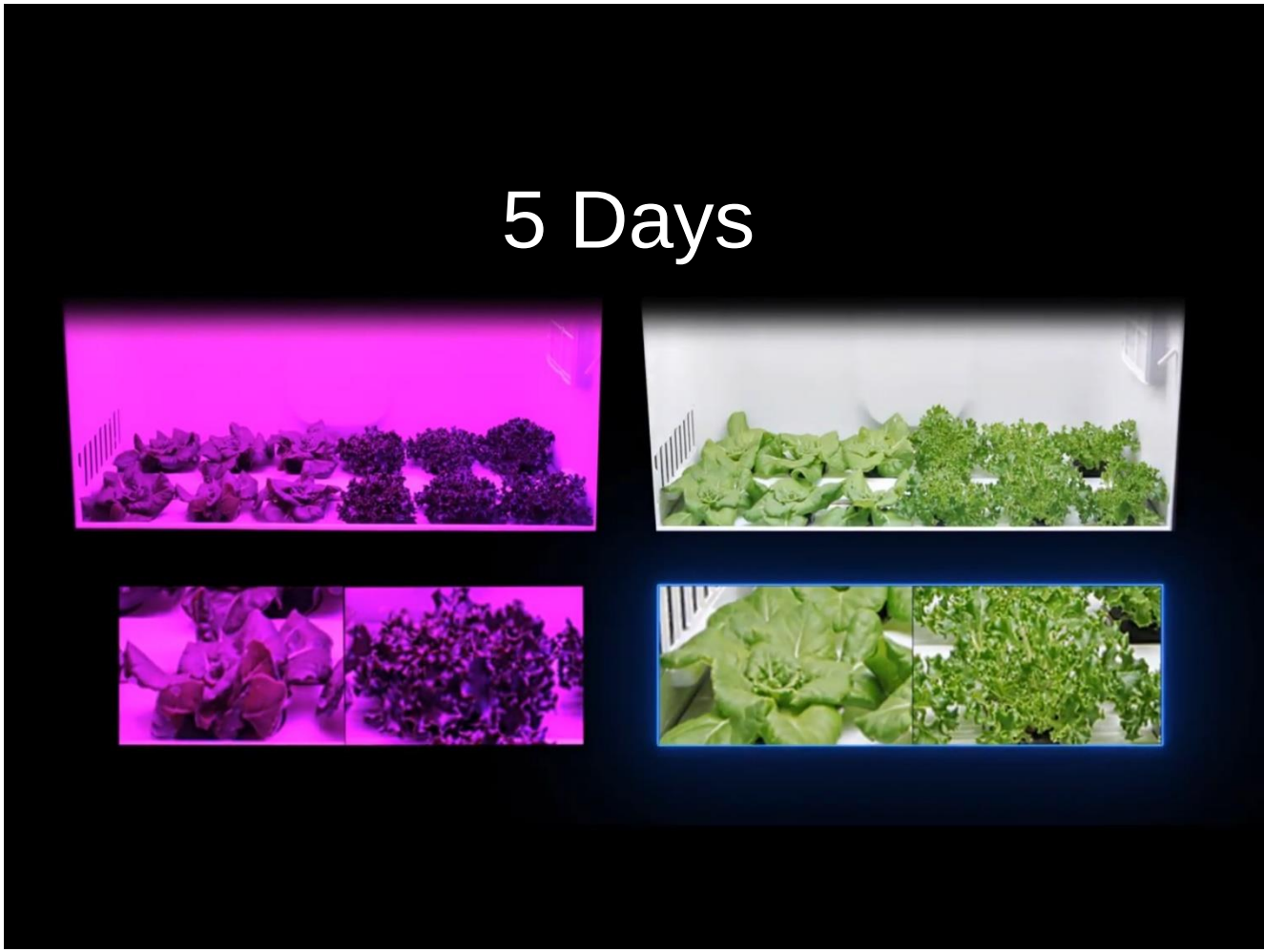
Application : Horticulture

New studies confirm that full spectrum LEDs are better for Plants

Horticulture Plants

With Sunlike any crop is possible



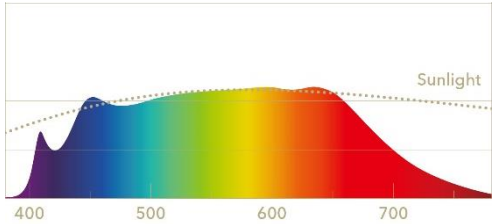


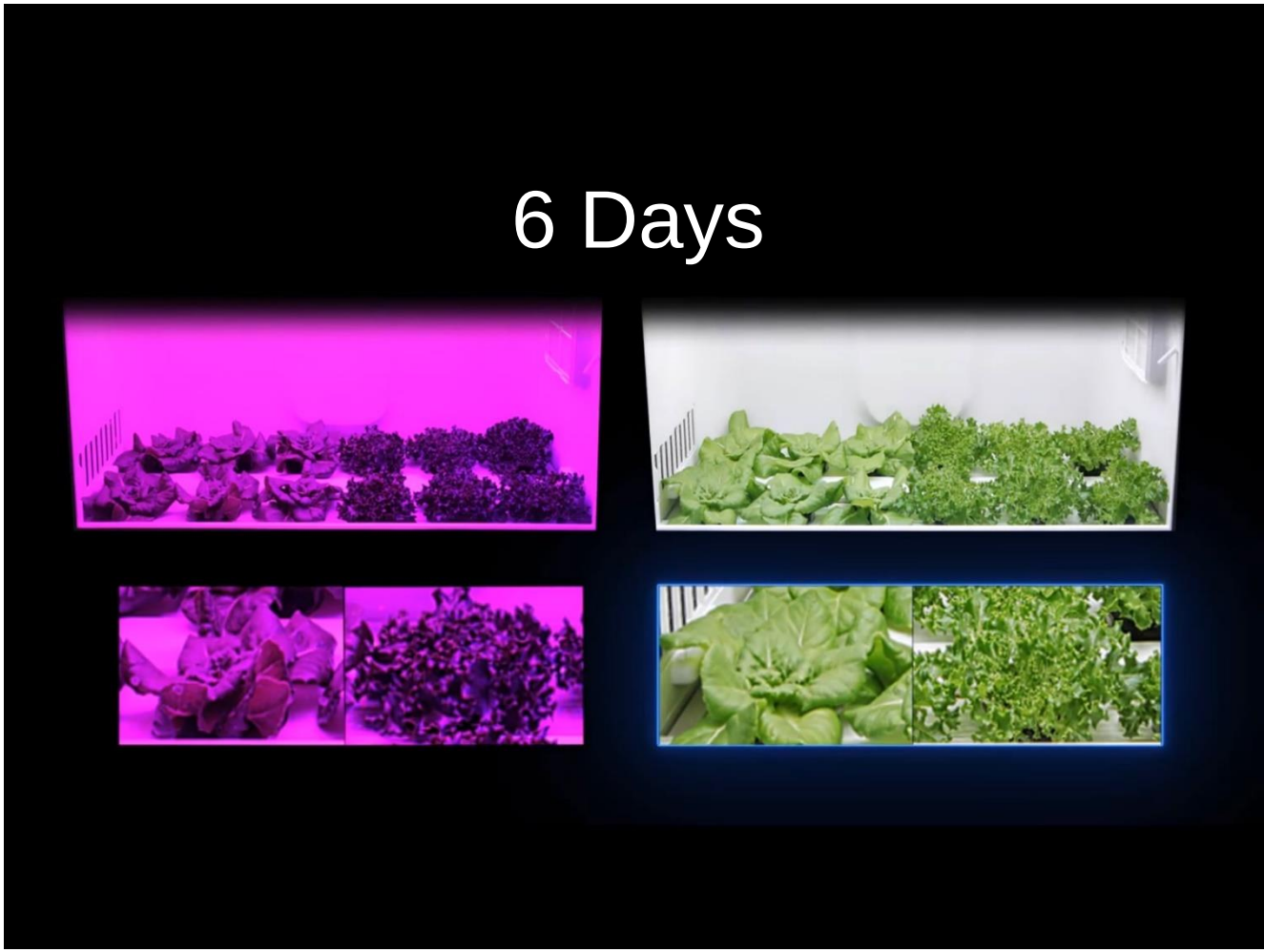
Application : Horticulture

New studies confirm that full spectrum LEDs are better for Plants

Horticulture Plants

With Sunlike any crop is possible



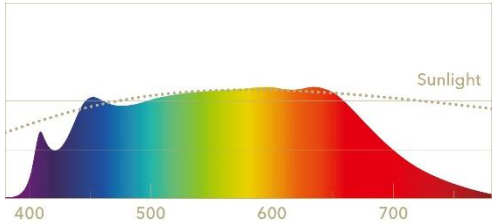


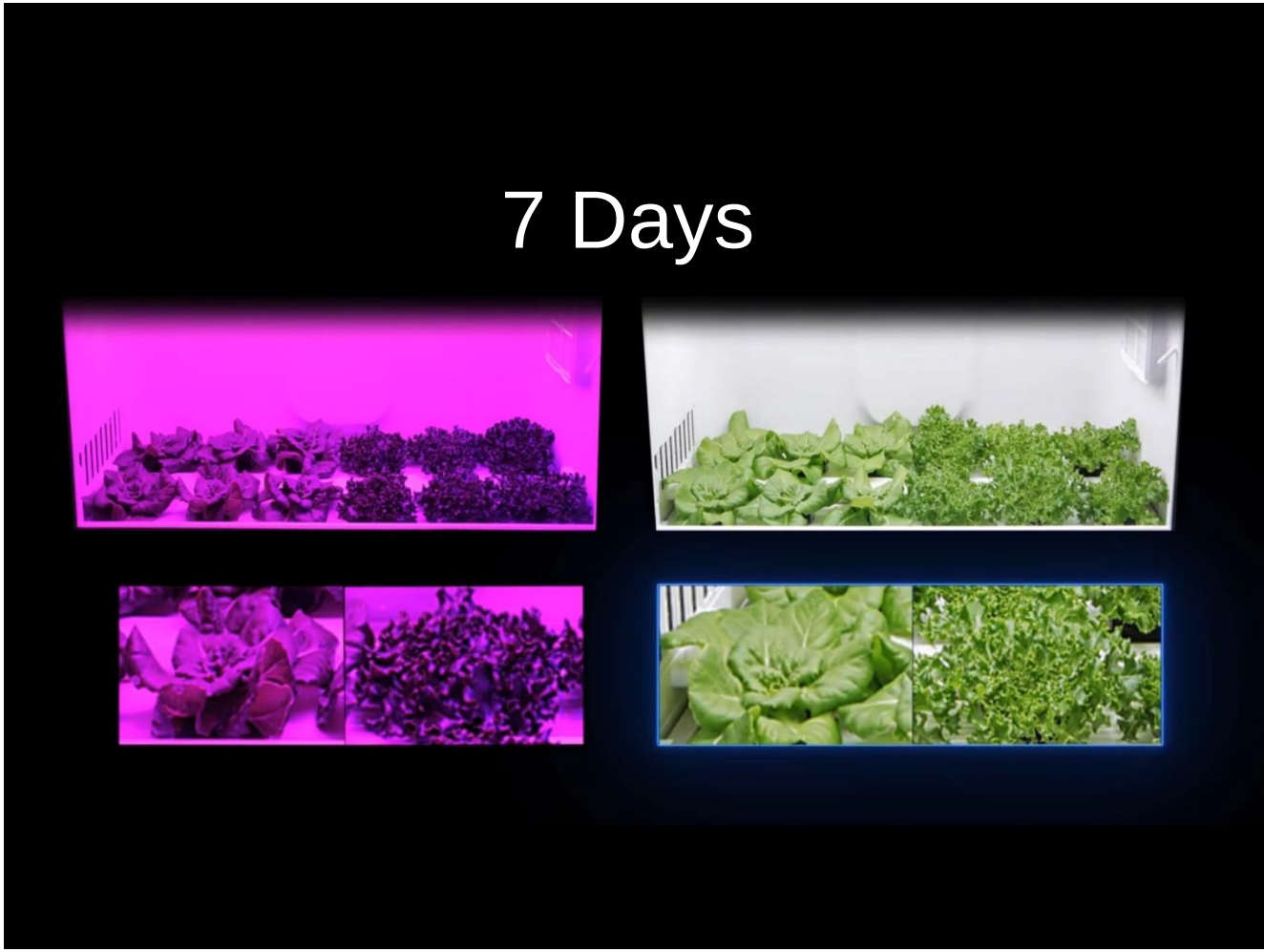
Application : Horticulture

New studies confirm that full spectrum LEDs are better for Plants

Horticulture Plants

With Sunlike any crop is possible



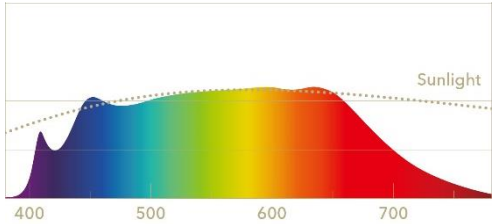


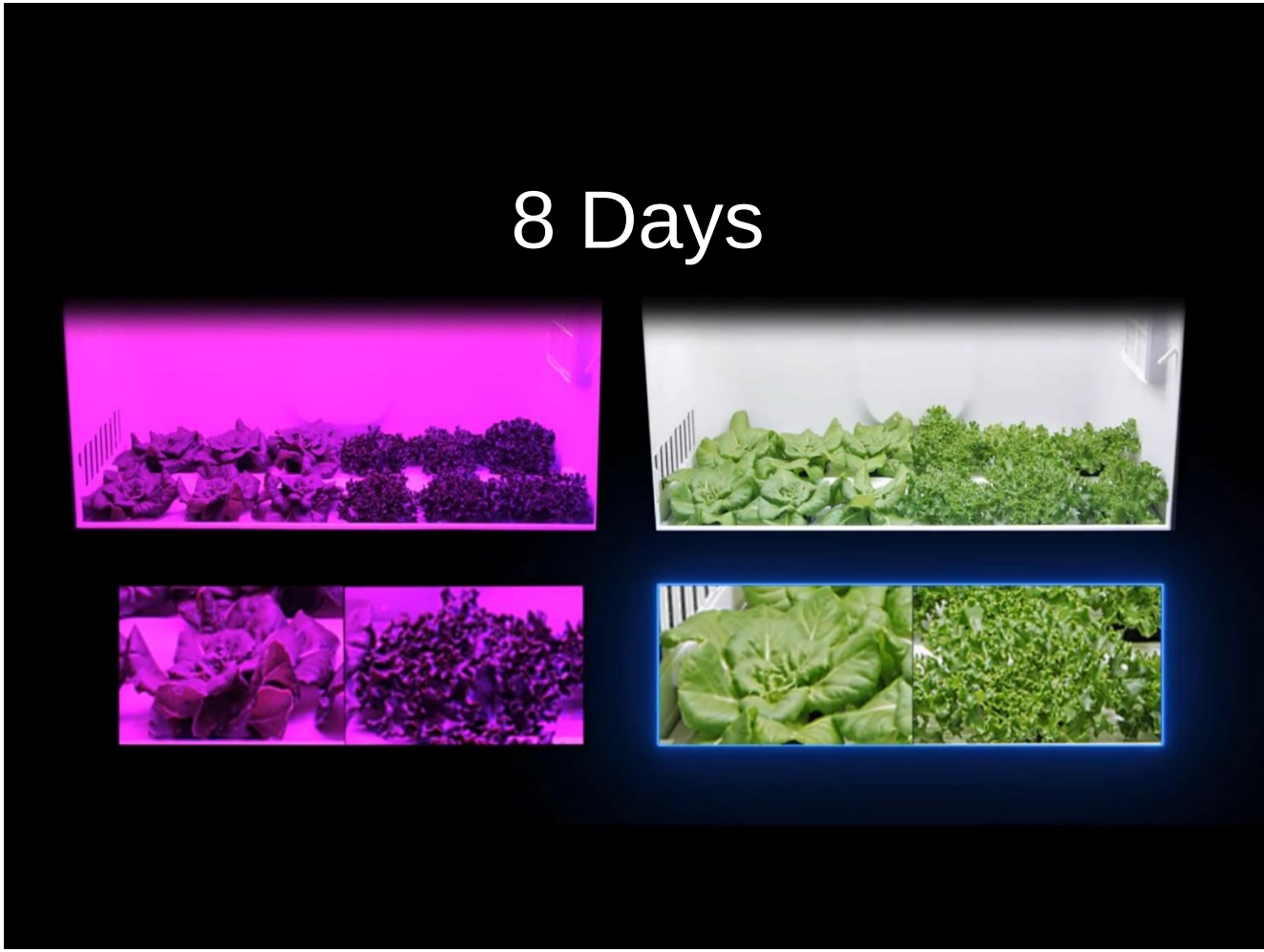
Application : Horticulture

New studies confirm that full spectrum LEDs are better for Plants

Horticulture Plants

With Sunlike any crop is possible



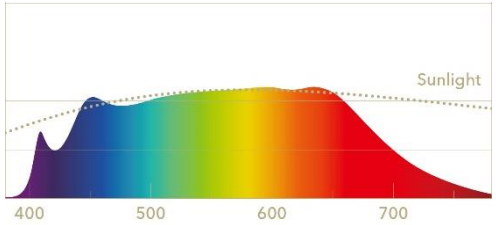


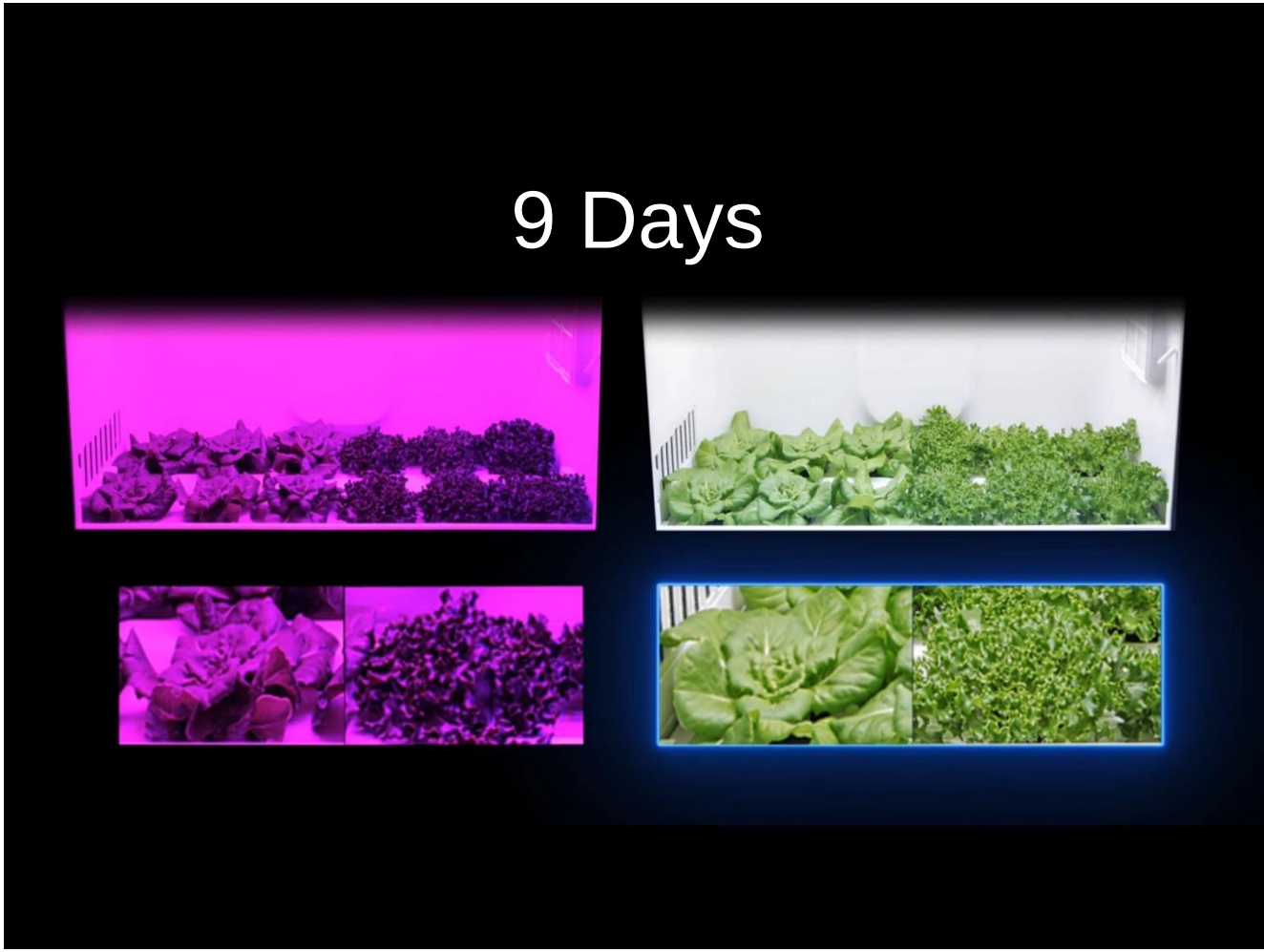
Application : Horticulture

New studies confirm that full spectrum LEDs are better for Plants

Horticulture Plants

With Sunlike any crop is possible





A new world of opportunities

REUTERS

JUNE 26, 2017 / 11:46 PM / A MONTH AGO

Seoul Semi says new 'Sun-like' LEDs could generate $400 million in sales by 2021

Georgina Prodhan and Niamh Melvin

The New York Times

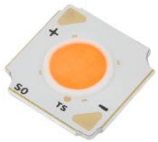
Sunlike: the closest artificial light to the Sun

05 Product line-up

Product Line-up

MJT COB

- ***SunLike 6W MJT COB***

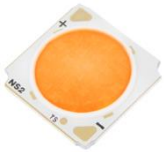


Part No.		SAWS0661A
Size (mm)		13.5x13.5
LES (Φ)		6
Rated IF (A)		0.17 A
Typ. Vf @Tj=85		36.1 V
Typ. Flux @Tj=85	3000K	516 lm
	4000K	550 lm
	5000K	557 lm

- ***SunLike 10W MJT COB***

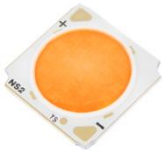
Part No.		SAWS1063A
Size (mm)		13.5x13.5
LES (Φ)		9.8
Rated IF (A)		0.29 A
Typ. Vf @**Tj=85**		34.8 V
Typ. Flux **@Tj=85**	3000K	900 lm
	4000K	955 lm
	5000K	970 lm

- ***SunLike 15W MJT COB***



Part No.		SAWS1564A
Size (mm)		19x19
LES (Φ)		14.5
Rated IF (A)		0.43 A
Typ. Vf @**Tj=85**		35.0 V
Typ. Flux **@Tj=85**	3000K	1,380 lm
	4000K	1,469 lm
	5000K	1,490 lm

- ***SunLike 25W MJT COB***



Part No.		SAWS1566A
Size (mm)		19x19
LES (Φ)		14.5
Rated IF (A)		0.72 A
Typ. Vf @**Tj=85**		35.2 V
Typ. Flux **@Tj=85**	3000K	2,226 lm
	4000K	2,370 lm
	5000K	2,404 lm

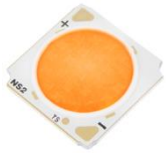
Advantages & Benefits

- Sunlike spectrum
- CRI ≥ 97 & R1~R14 >90
- Rf=97, Rg=102 under TM30-15 (2700K ~ 5000K)
- 3000K~5000K line up. 2700K & 6500K to be available soon
- IEC62471, RG1

Product Line-up

MJT COB

- ***SunLike 40W MJT COB***



Part No.		SAWS226AA
Size (mm)		28x28
LES (Φ)		14.5
Rated IF (A)		1.05 A
Typ. Vf @**Tj=85**		35.4 V
Typ. Flux **@Tj=85**	3000K	3.850 lm

Advantages & Benefits

- Sunlike spectrum
- CRI ≥ 97 & R1~R14 >90
- Rf=97, Rg=102 under TM30-15
- 3000K available
- IEC62471, RG1

Product Line-up

3030

- ***SunLike 3030***

Size (mm)	30 x 30				
CRI (Min.)	96				
CCT	2700	3000	4000	5000	6500
Power (W)	0.2				
Vf (V)	2.96				
If (A)	0.065				
Flux (lm)	19.5	20.2	21.2	21.2	20.2
lm/W	98	101	106	106	101

Advantages & Benefits

- **Sunlike spectrum**
- **CRI ≥ 96**
- Linear application for retail , Architectural Appl.
- 2700K~6500K line up.
- IEC62471, RG0(exempt)

06

Q&A

SunLike SEOUL
Powered by 그루

Q&A

•How does SunLike differ from a conventional white LED technology?

An ordinary LEDs spectrum is very different to sunlight, whereas TRI-R′s is almost the same.. Conventional LED is using a blue LED with phosphor creating various colour temperatures depending on the composition of the Phosphors used. SunLike is really showing almost the full spectrum of the sun – a conventional LED is not doing. SunLike is based on a purple chip and combination of TRI-R phosphors. The composition of the TRI-R phosphors is also influencing the colour temperature.

•How will this technology change what is visible to the human eye?

Objects lit by SunLike appear as they would be in sunlight. SunLike products faithfully reproduces all colours & textures of objects and even the pale intermediate colors are rendered faithfully.

• Is this technology programmed to automatically adjust its spectrum throughout the day in order to follow the circadian rhythm?

We expect multiple sources using this technology to deliver the right spectrum of light at the right time. Using multiple sources one can repli cate the natural spectrum of the sun with artificial light as we progress through the day without the negative effect of blue light at night.

•How does the new technology enable us to see the same contrasts as sunlight?

How light interacts with objects affects the way that they appear to the human eye. The spectrum plays a key part in this. The strong blue light of a normal LED diffuses heavily within a material's fibres, this weakens the contrast the human eye can perceive. TRI-R's spectrum is almost the same as sunlight, which enables us to see the same subtle contrasts. It lets us experience greater depth and perspective.

•Is the new technology environmentally friendly? Does it use toxic materials?
All of our products are RoHS compliant. In addition LED technology is a big step forward as it has the potential to replace older technologie s for near-sunlight; those technologies are far less energy-efficient. Therefore our SunLike products will help to reduce energy consumption in all those application areas.

•The technology of the LEDs has developed further during the last years. In your opinion, what will be the next step?
Focus of the last years was and still is to increase lm/W, decrease costs, and improve quality of light. Now SunLike is another milestone in our company history which will change the LED market. Following concepts such as Acrich, Wicop or nPola. Next steps for us are to continue with our successful approach to serve the market with highly innovative and reliable products protected by our unique patent strategy ensuring that customers are save when buying our products to manufacture their own products and solutions. Highest brightness efficiency further cost reduction as well as perfectly matched solutions are playing a vital role.

07

Test results and comparisons

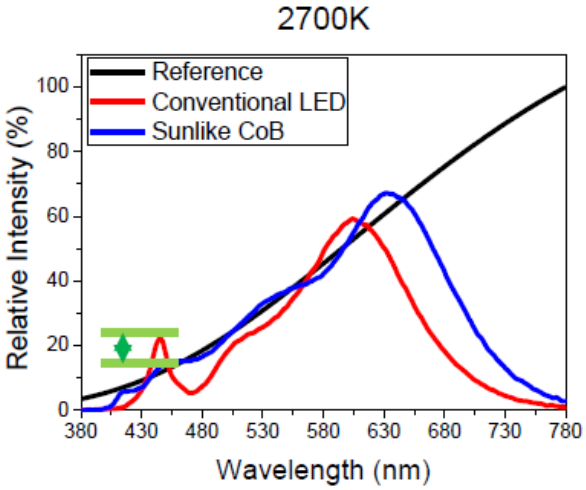
Comparison with existing SSC LED products

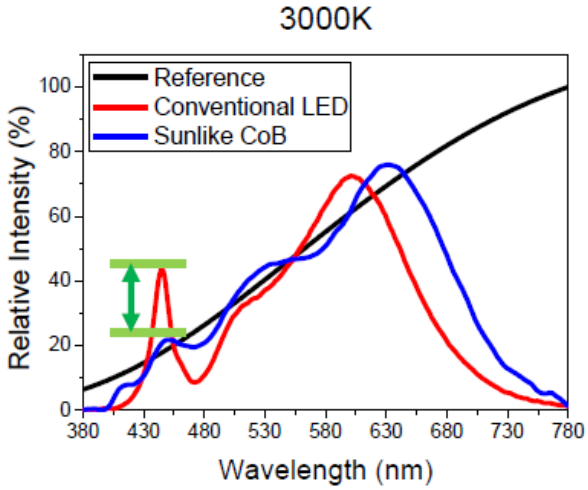
✓Already , SSC products are optimized for CRI and TM30 criteria of R_f R_g

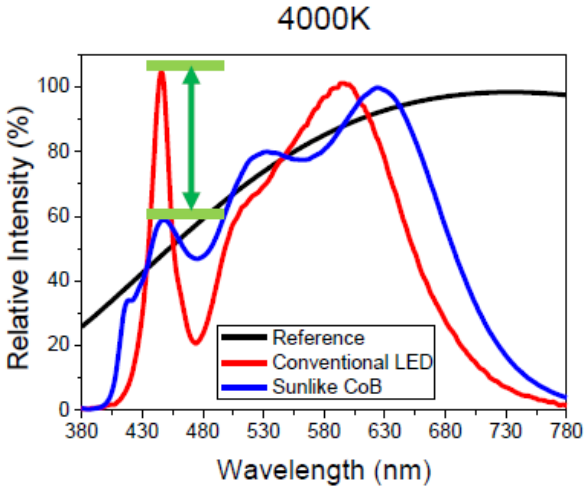
SSC CRI Target	CRI 70			CRI 80			CRI 90			Sun like		
White Target	Cool	Neutral	Warm	Cool	Neutral	Warm	Cool	Neutral	Warm	Cool	Neutral	Warm
CRI	70.3	74.3	71.9	84.0	80.1	83.8	89.4	90.5	91.8	98	98	97
TM30-R_f	67.2	71.2	70.9	82.5	80.2	84.6	86.9	89.4	88.6	97	97	96
TM30-R_g	95.8	97.7	95.6	95.7	96.8	96.9	102.4	101.2	102.4	101	101	102
CIE-x	0.3476	0.3847	0.4549	0.3502	0.3779	0.4639	0.3439	0.3833	0.4575	0.3456	0.3818	0.4595
CIE-y	0.3567	0.3756	0.4138	0.3559	0.3831	0.4133	0.3508	0.3847	0.4073	0.3573	0.3816	0.4107
CCT	4925K	3876K	2796K	4826K	4115K	2666K	5044K	3981K	2707K	5000K	4000K	2706K
D_{uv}	0.0016	-0.0018	0.0016	0.0001	0.0037	0.0007	0.0001	0.0029	-0.0010	0.0027	0.0019	0.0001

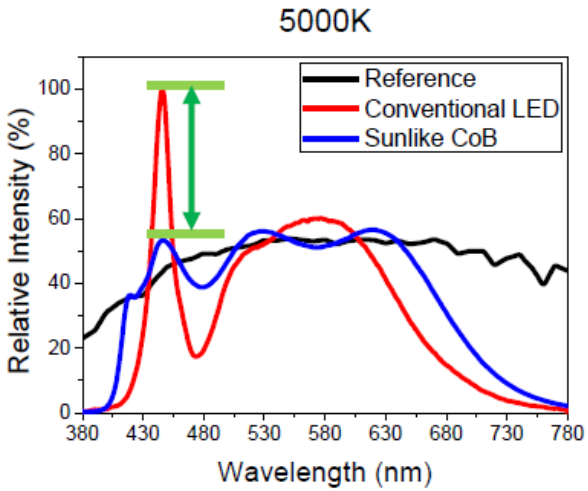
Comparison with existing SSC LED products

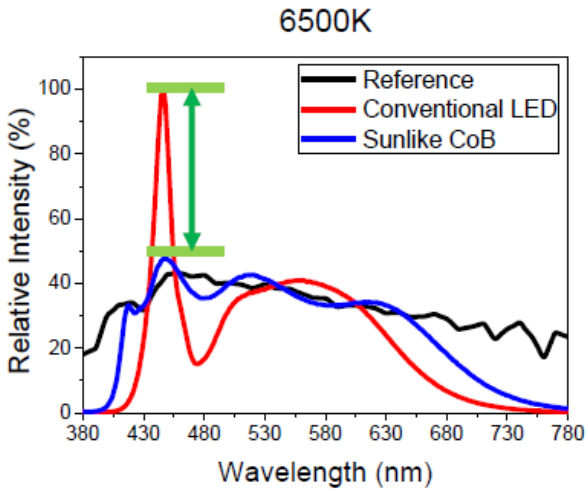
✓ **Sunlike have a closer spectrum to the Sun than any other LED**









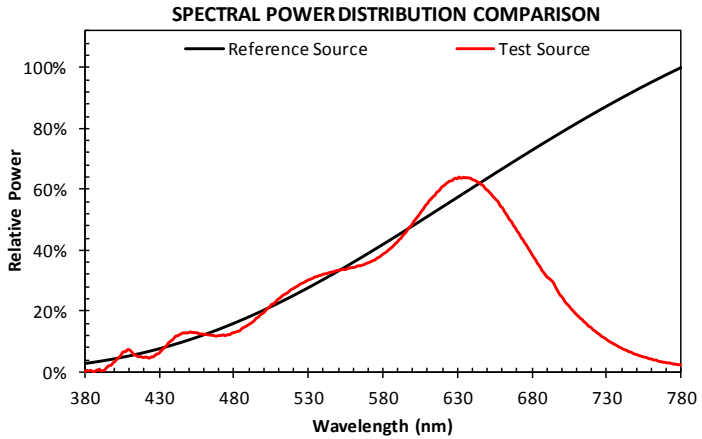


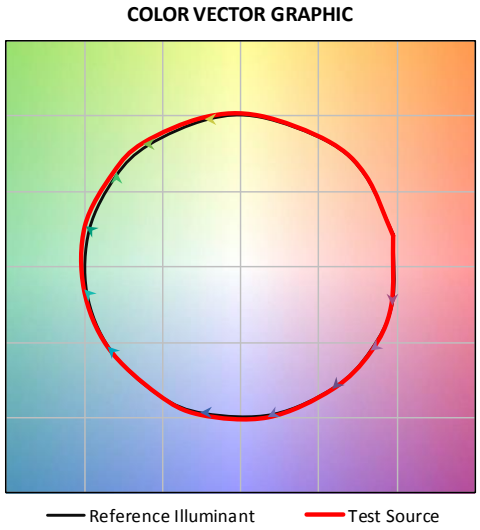
Test results for: Sunlike Warm 2700K

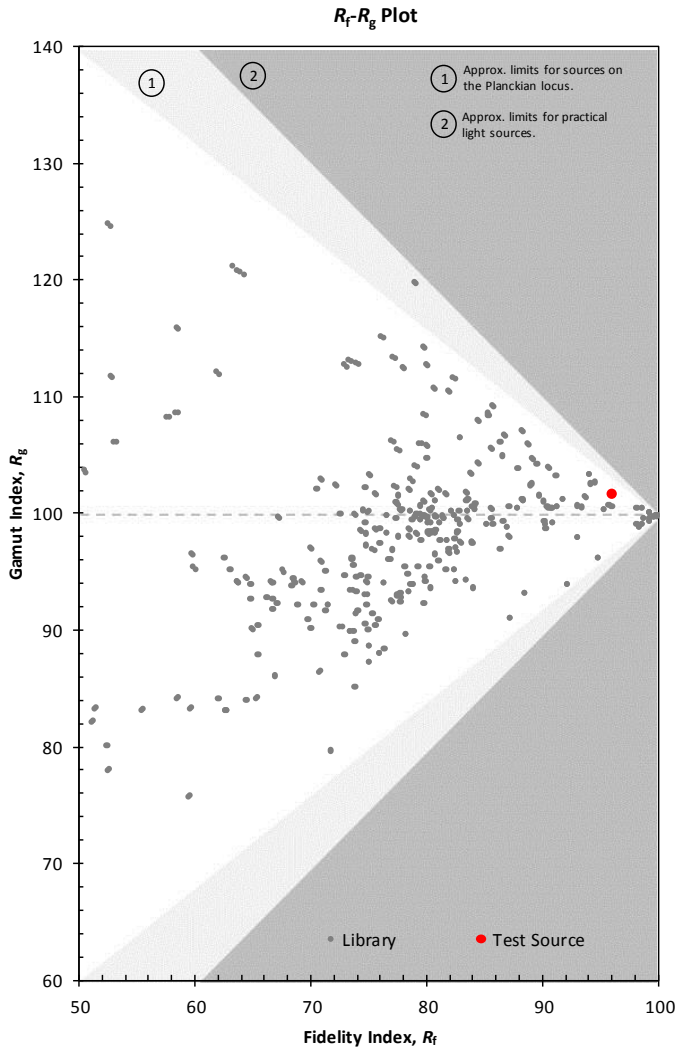
Source:

Test Source

R_f	96
R_g	102
CCT (K)	2706
D_{uv}	0.0001
x	0.4595
y	0.4107
CIE R_a	97



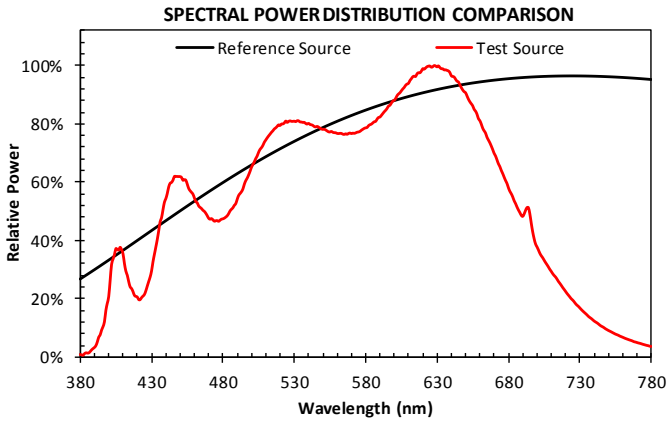


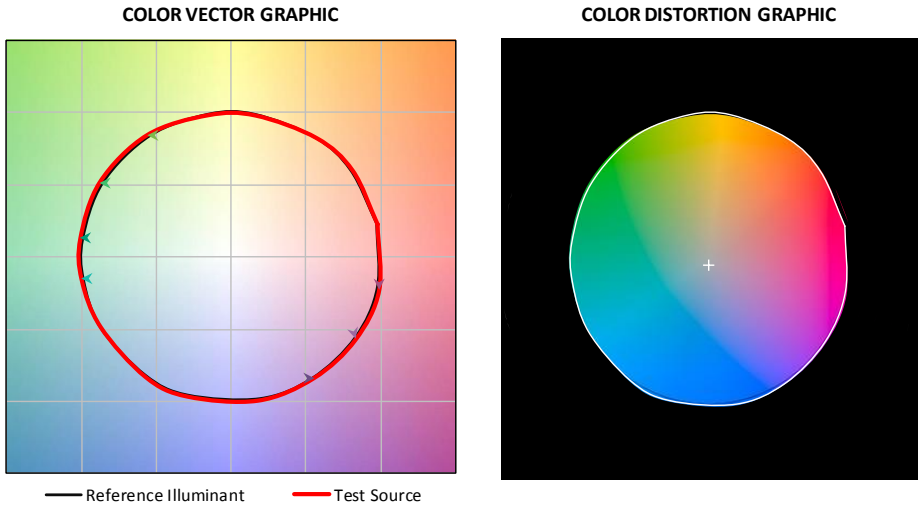


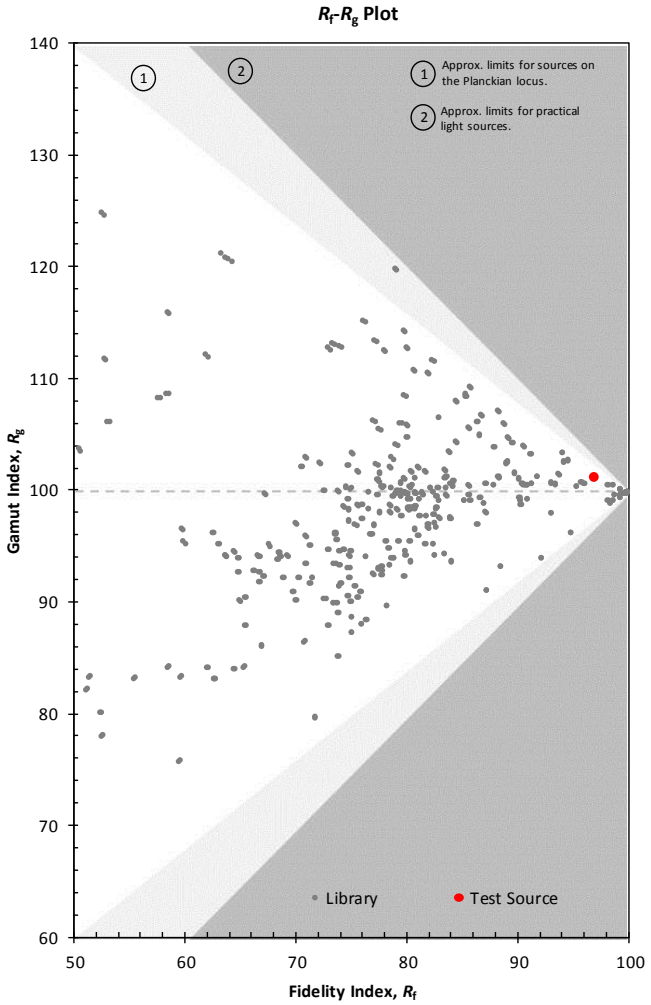
Test results for: Sunlike Neutral 4000K

Source:
Test Source

R_f	97
R_g	101
CCT (K)	4000
D_{uv}	0.0019
x	0.3818
y	0.3816
CIE R_a	98





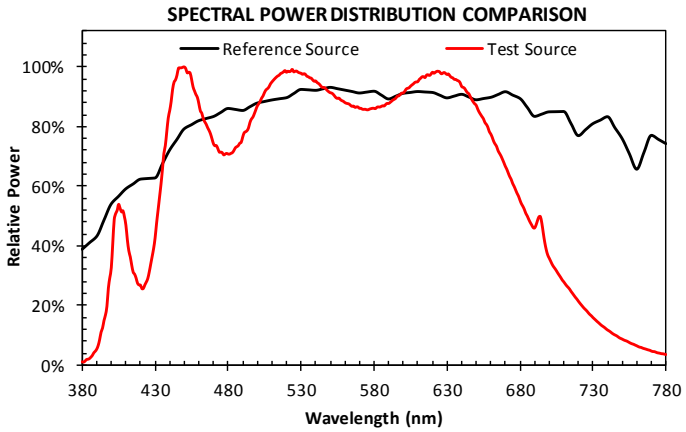


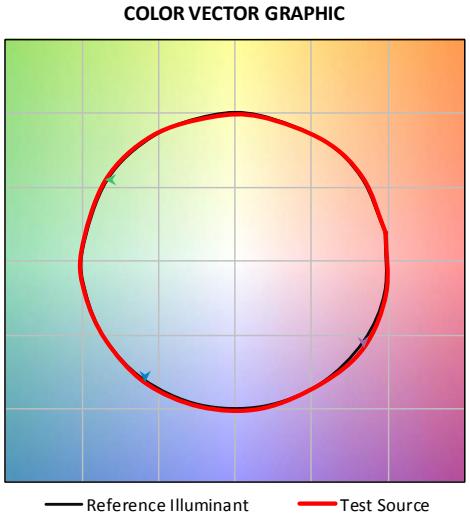
Test results for: Sunlike Cold 5000K

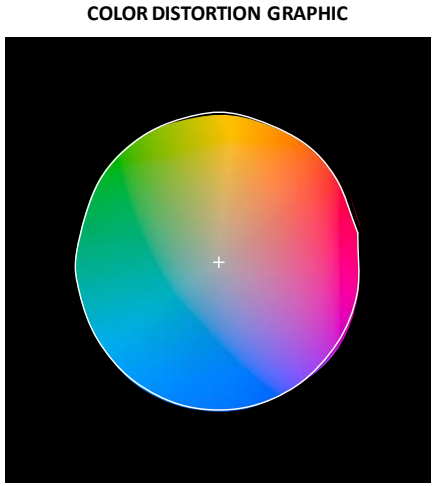
Source:

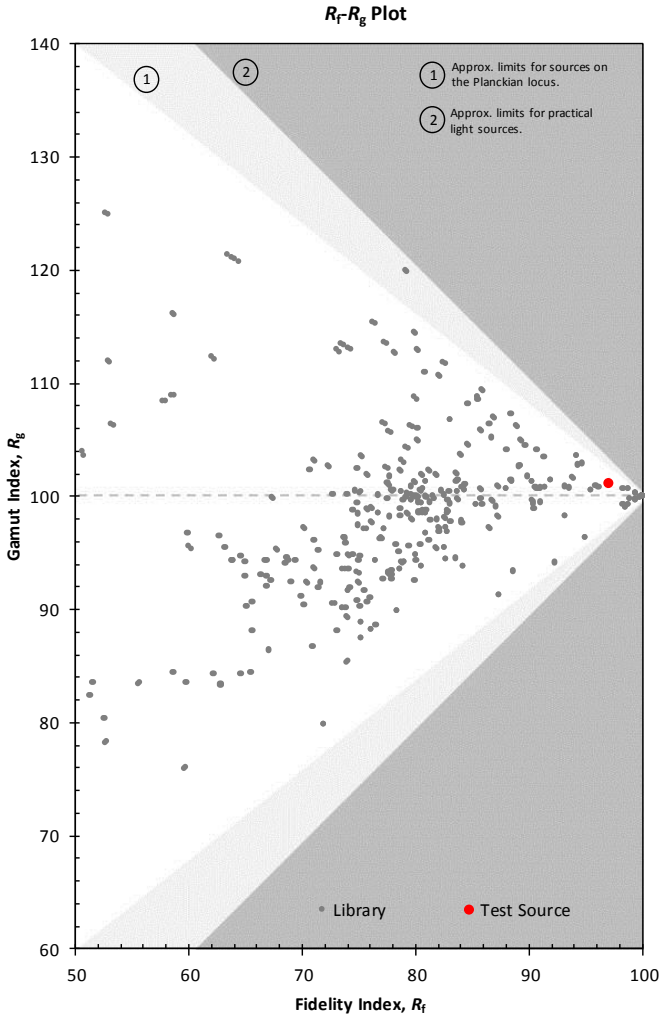
Test Source

R_f	97
R_g	101
CCT (K)	5000
D_{uv}	0.0027
x	0.3456
y	0.3573
CIE R_a	98

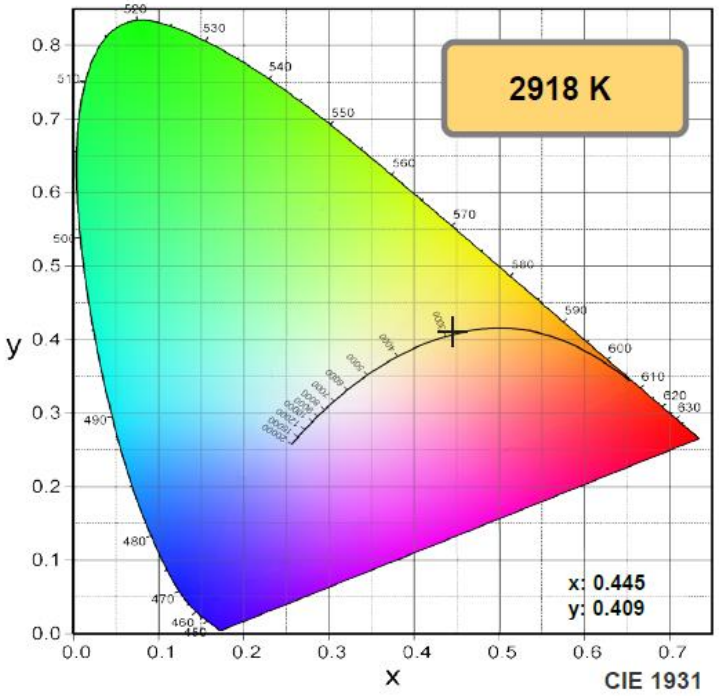


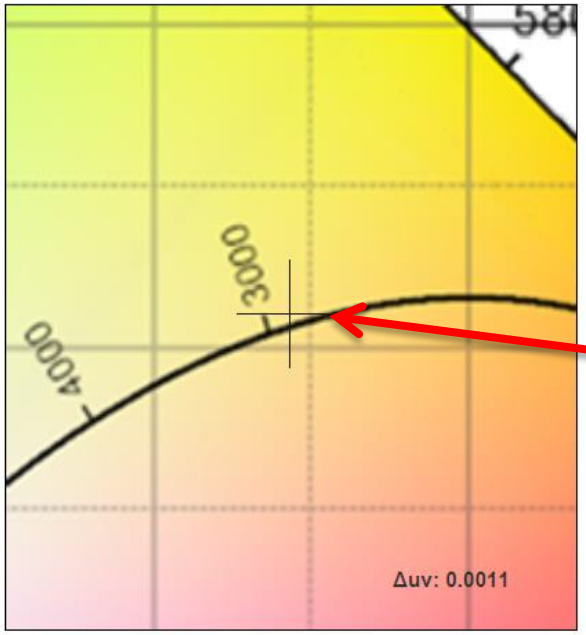






Test results for: Sunlike 3000K





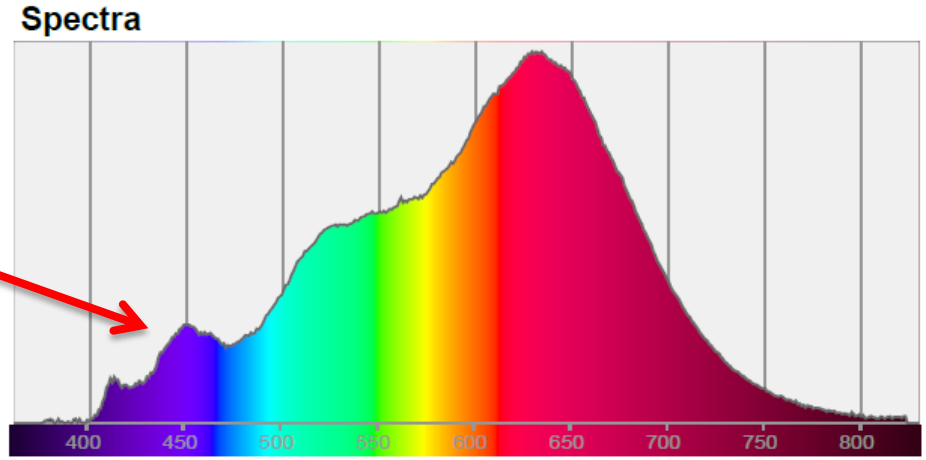
Color point in the BBL

Means real color as the Sun

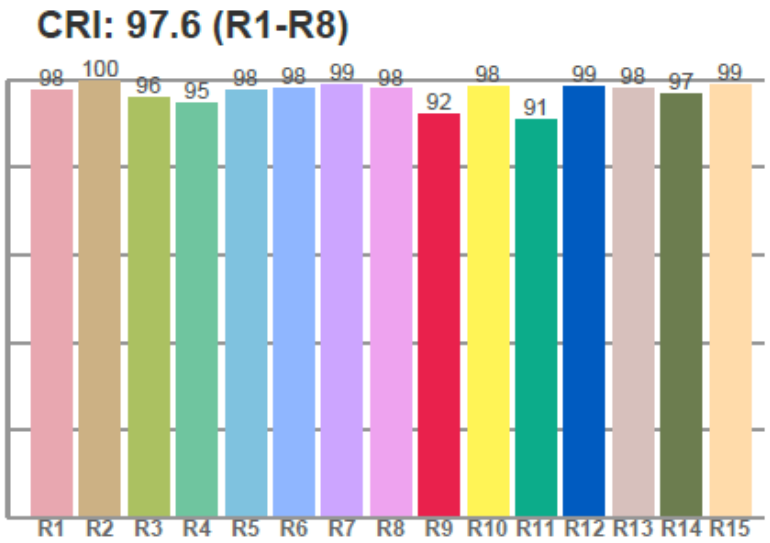
Delta UV < 0.001
NO color deviation

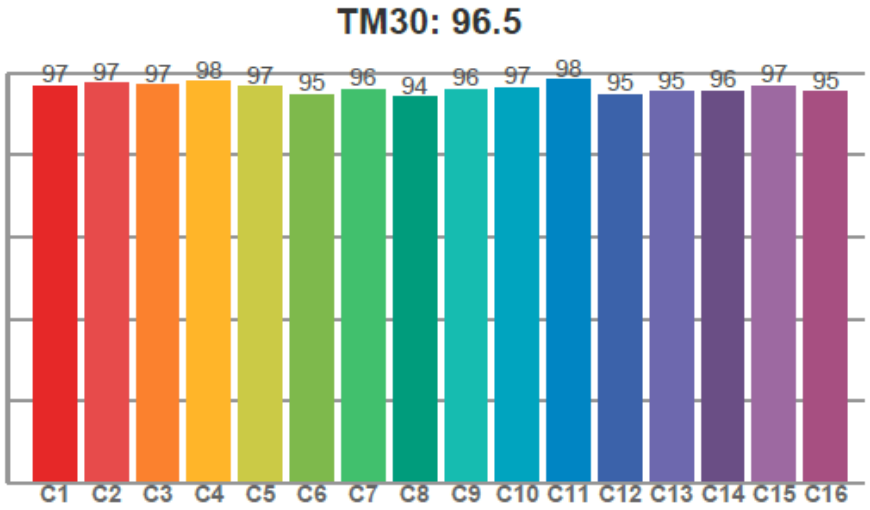
NO UV/Blue peak

NO Color distortion
NO Health disorder

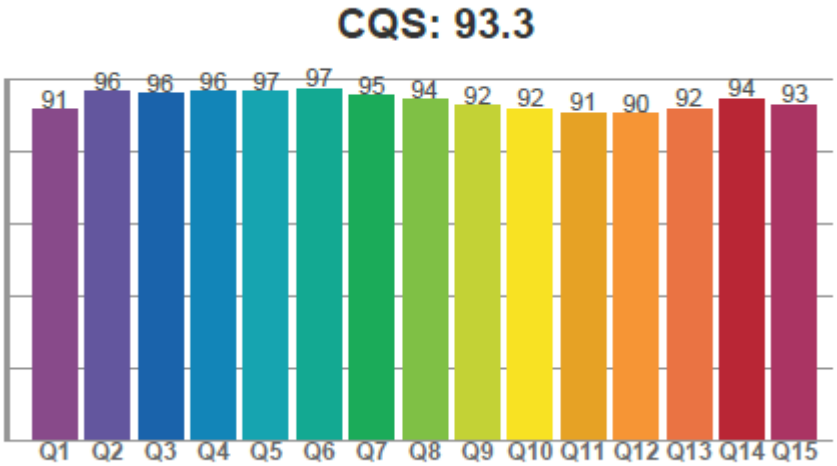


Test results for: Sunlike 3000K

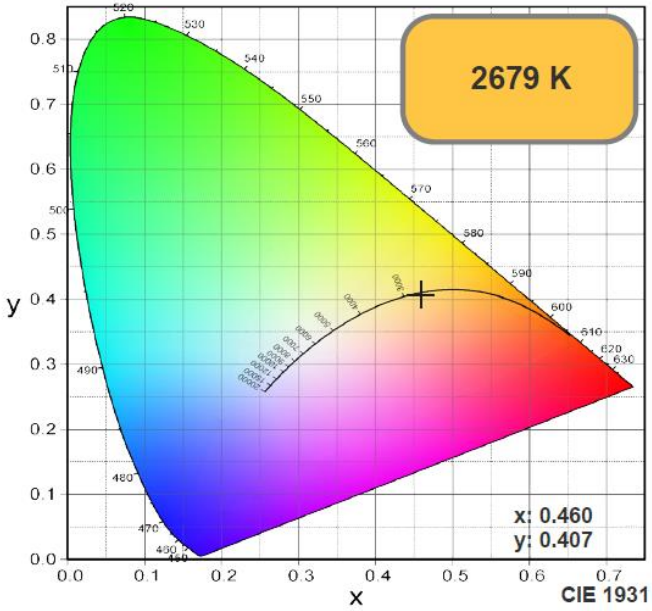


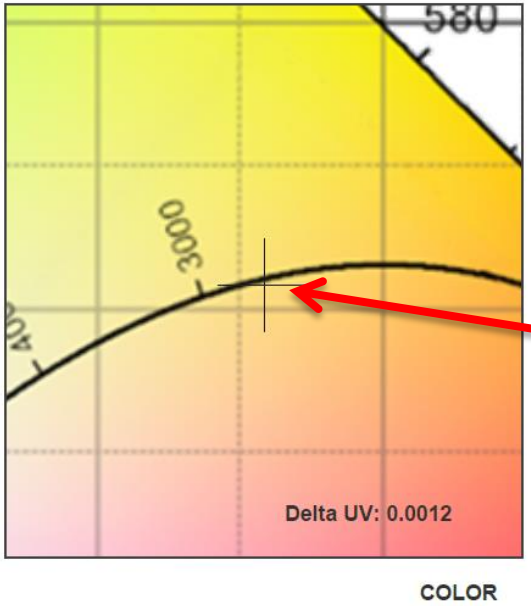


Sunlike offers the highest values in all accepted Color Metrics in the market (TM30, CRI, CQS)



Test results for: S**** bulb 2700K





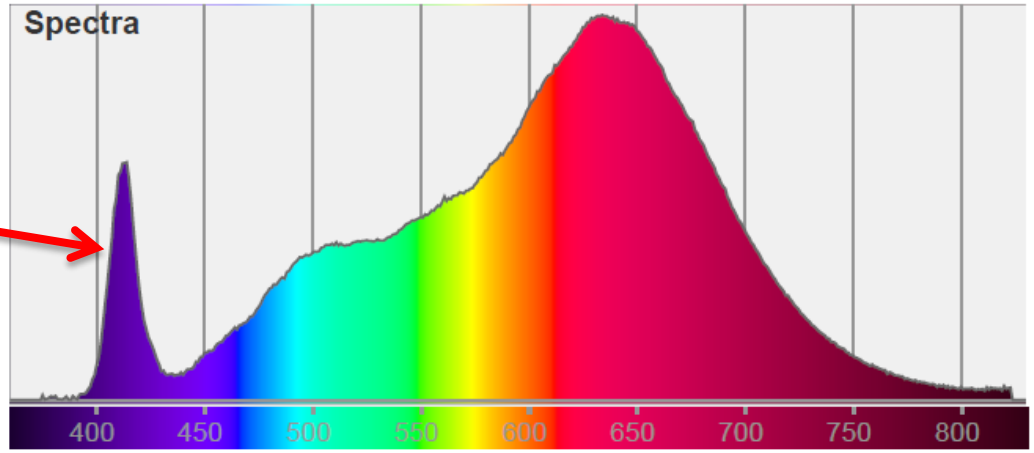
Color point in the BBL

Means real color as the Sun

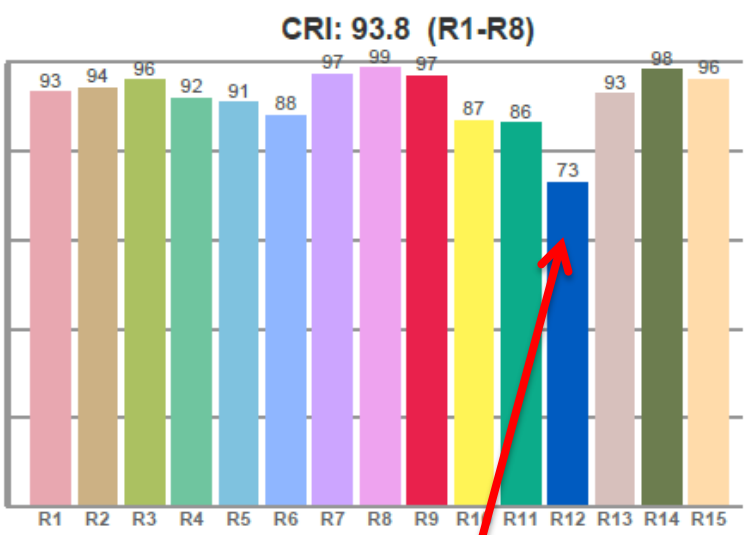
Delta UV < 0.001
NO color deviation

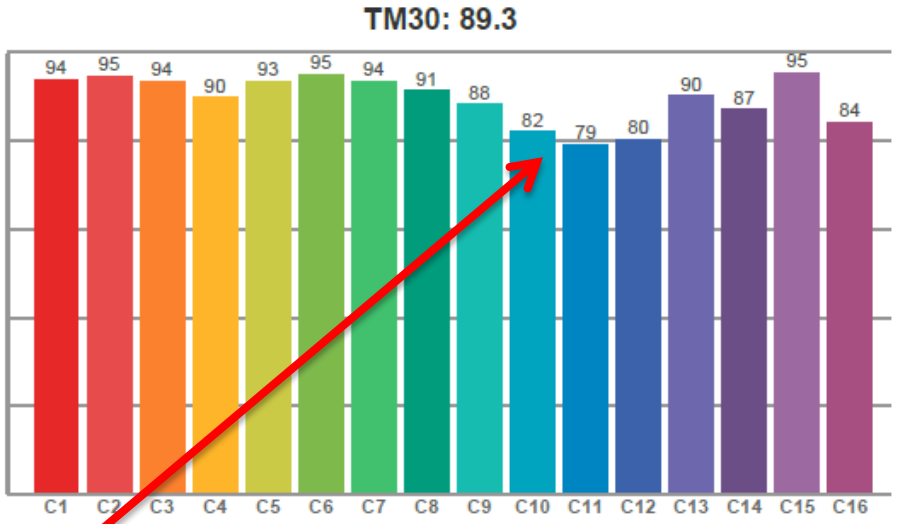
Big near UV peak

Color distortion
Health disorder

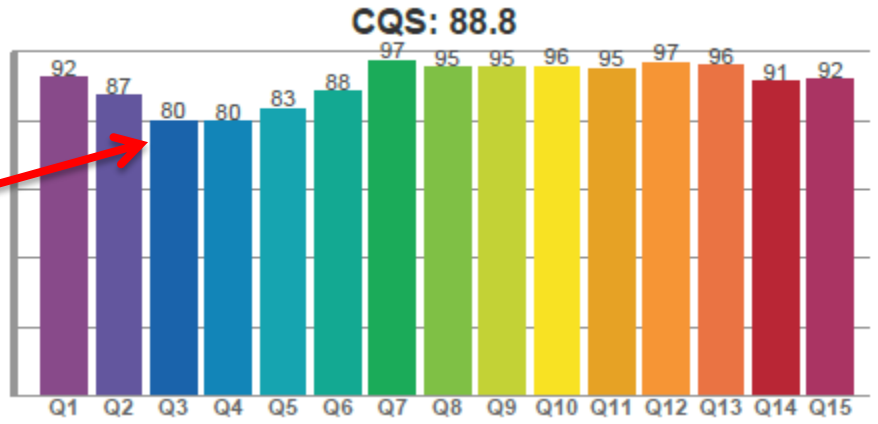


Test results for: S**** bulb 2700K

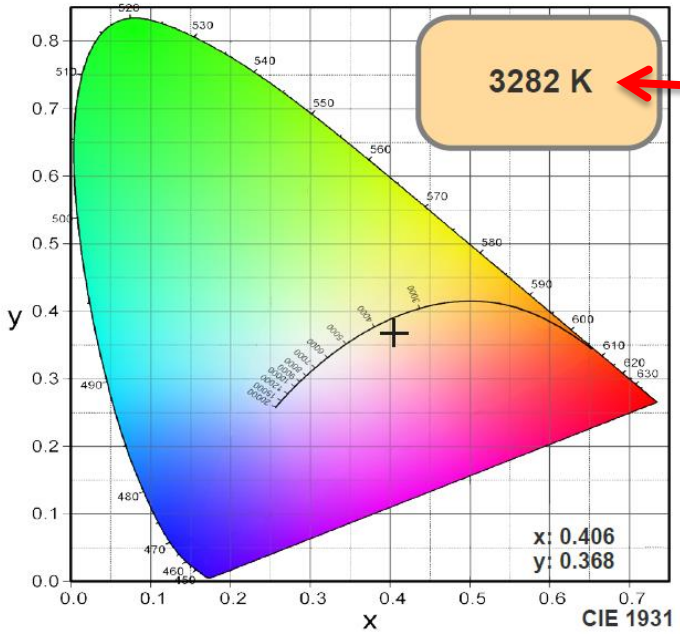


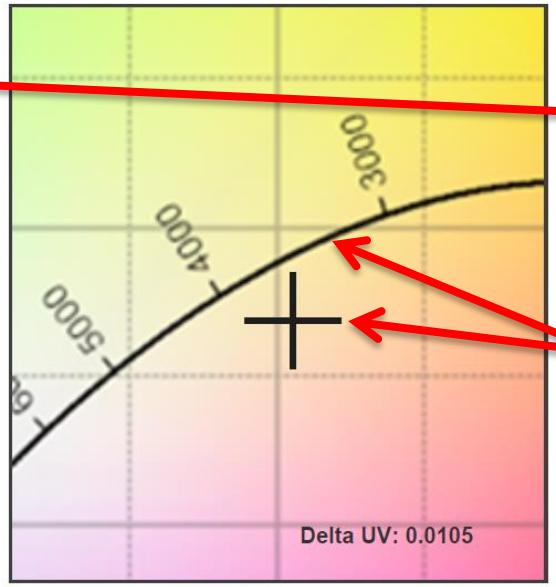


Low values in Blue and Cyan



Test results for: L*** Crispy color 3000K





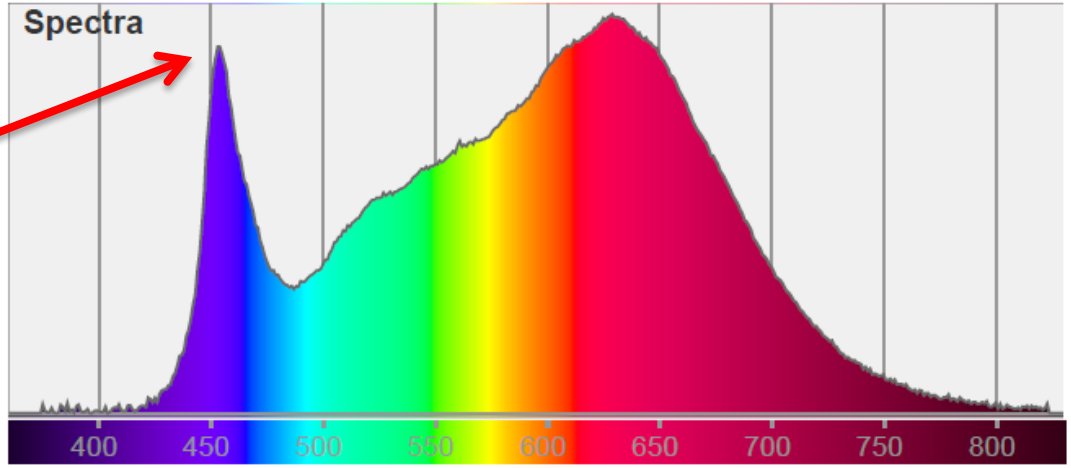
Big color distortion going to pinkish

CCT distortion –3000K to 3280K

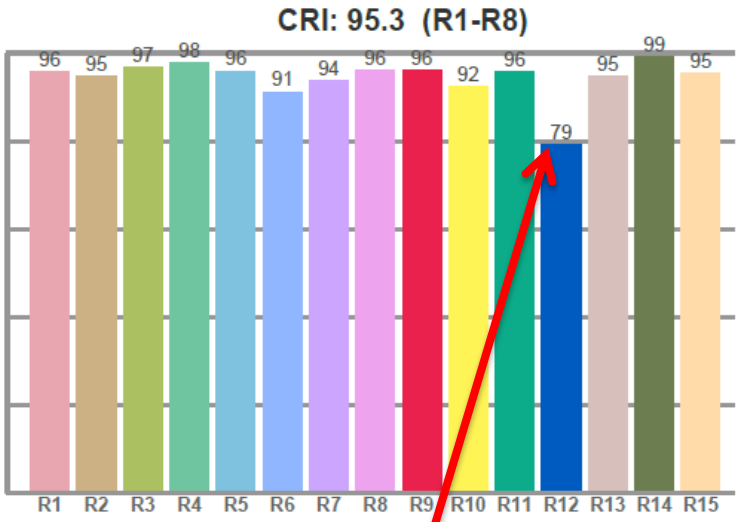
Delta UV very Big
> 0,01 means no real colors as Sun

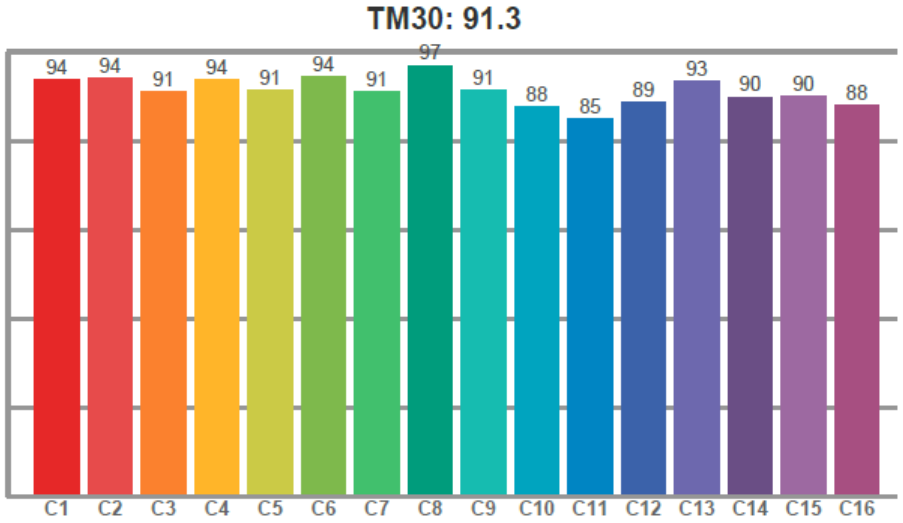
Big blue peak

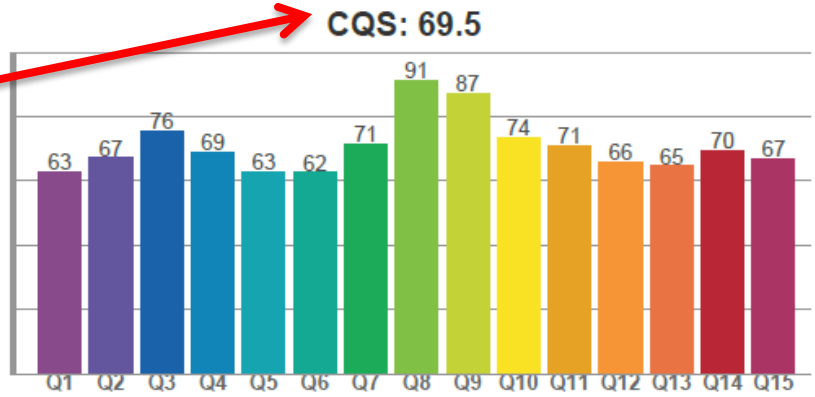
Color distortion
Health disorder



Test results for: L*** Crispy color 3000K



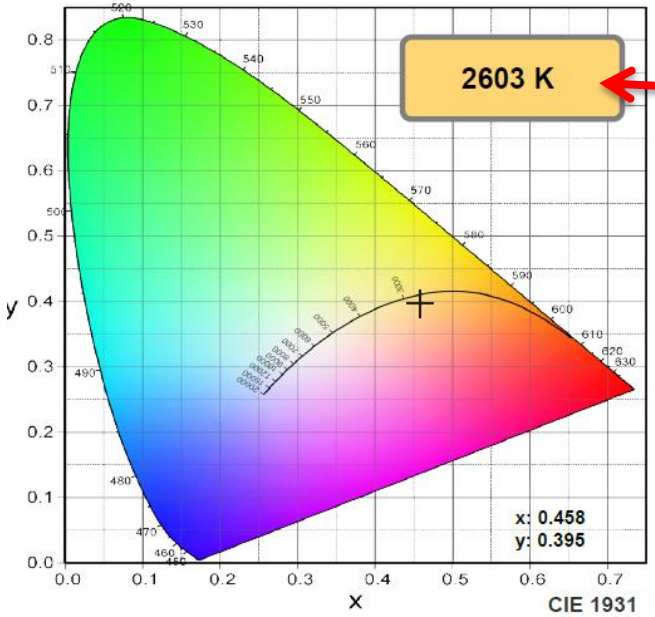


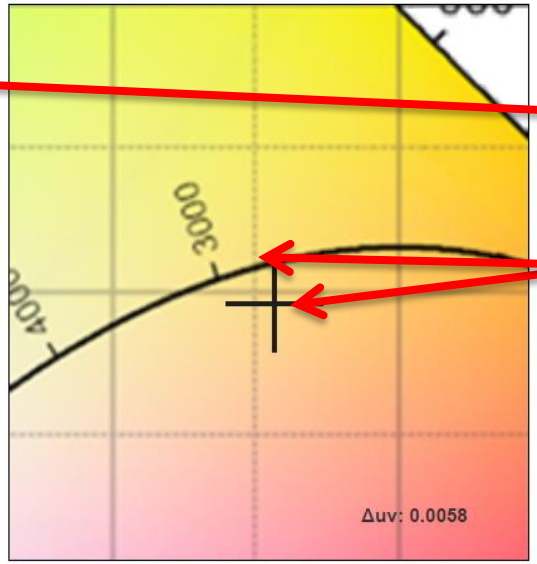


Low values in Blue and Cyan

Very low CQS (Color Quality Scale) meaning this LED is prepared for high CRI/TM30 metrics only, but not really good for color reproduction based on CQS

Test results for: B**** Decor color 2700K



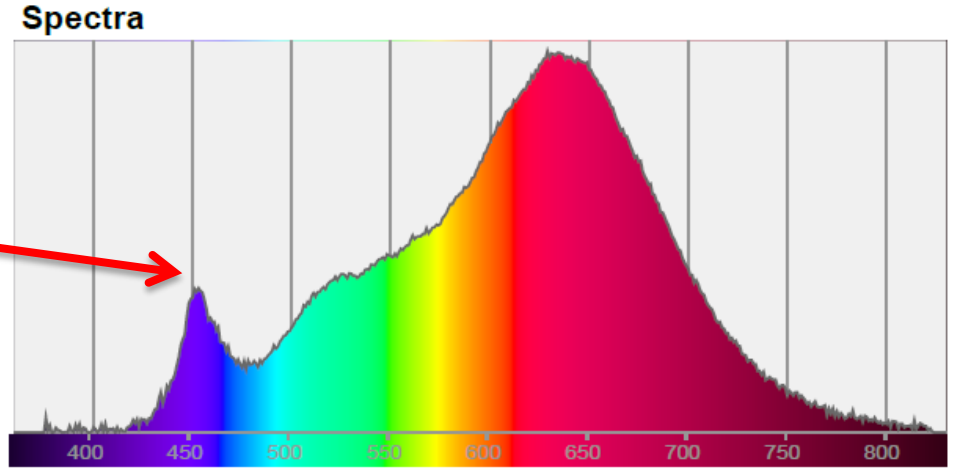


Color distortion going to pinkish

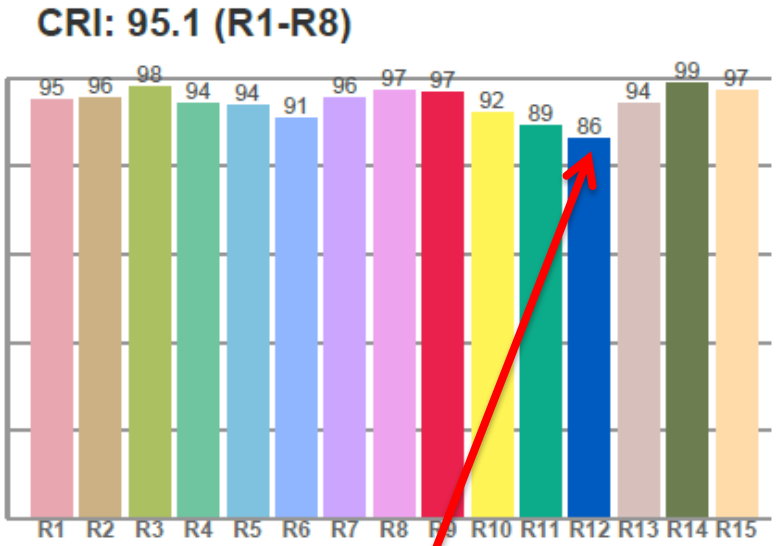
CCT distortion –2700K to 2600K

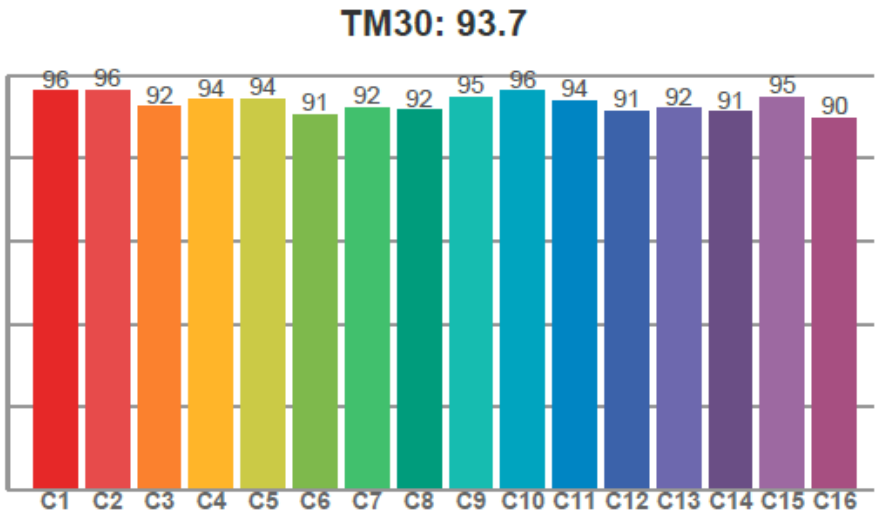
Big blue peak

Color distortion
Health disorder



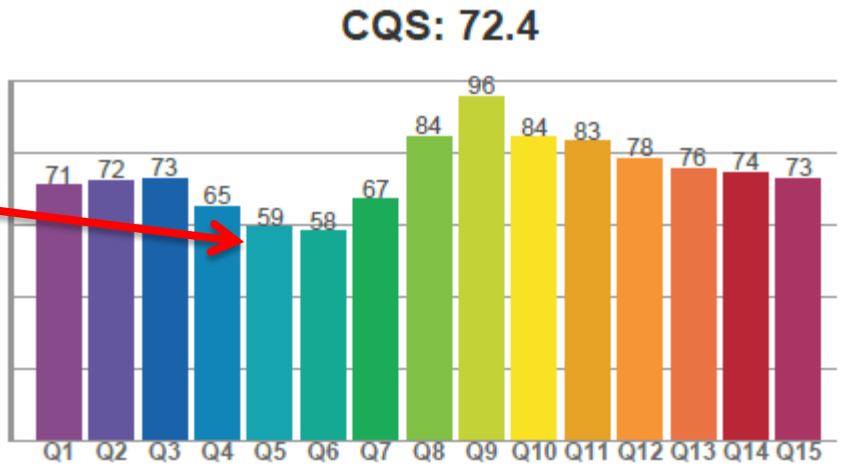
Test results for: B**** Decor color 2700K



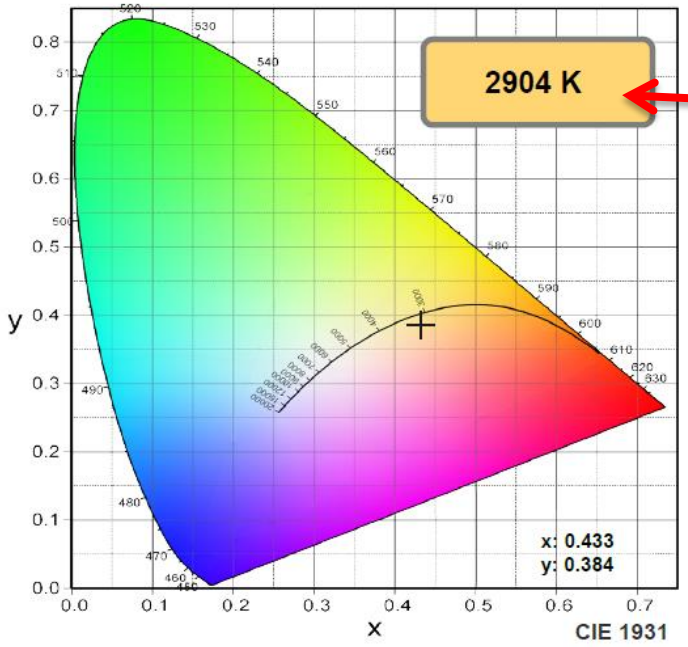


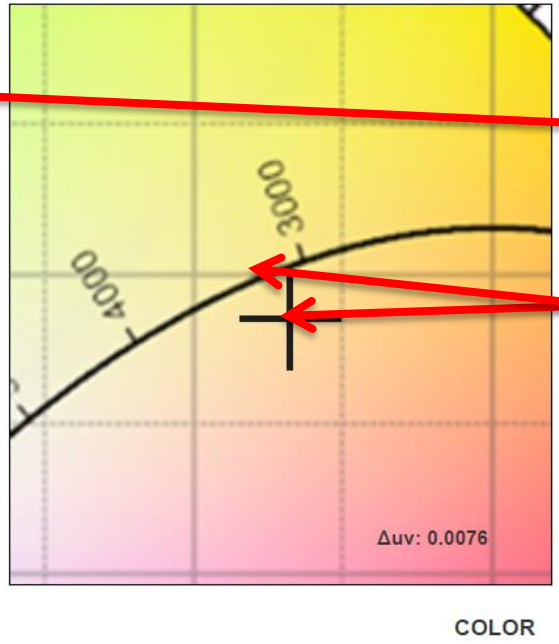
Low values in Blue and Cyan

Very low CQS (Color Quality Scale) meaning this LED is prepared for high CRI/TM30 metrics only, but not really good for color reproduction based on CQS



Test results for: B**** Decor color 3000K



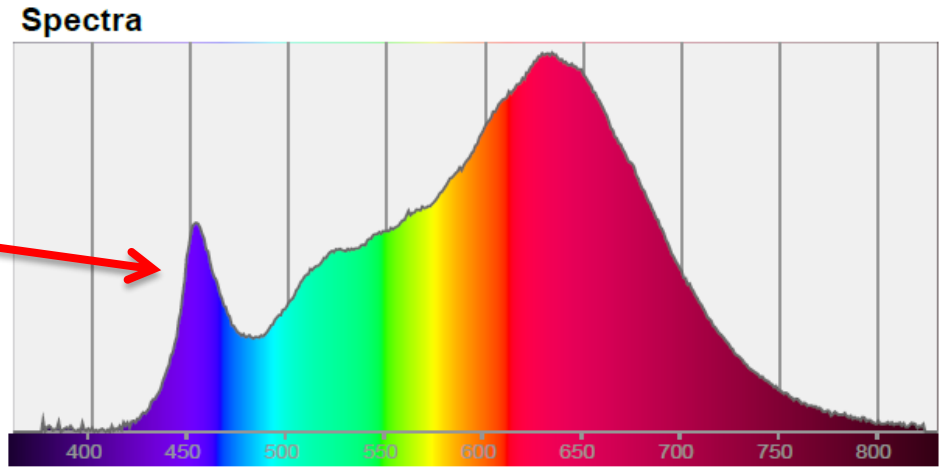


Big color distortion going to pinkish, below black body locus

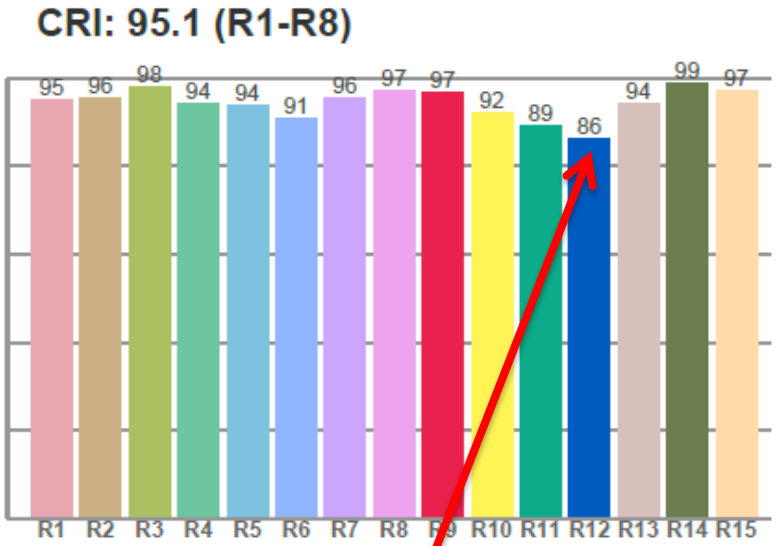
CCT distortion 3000K to 2900K

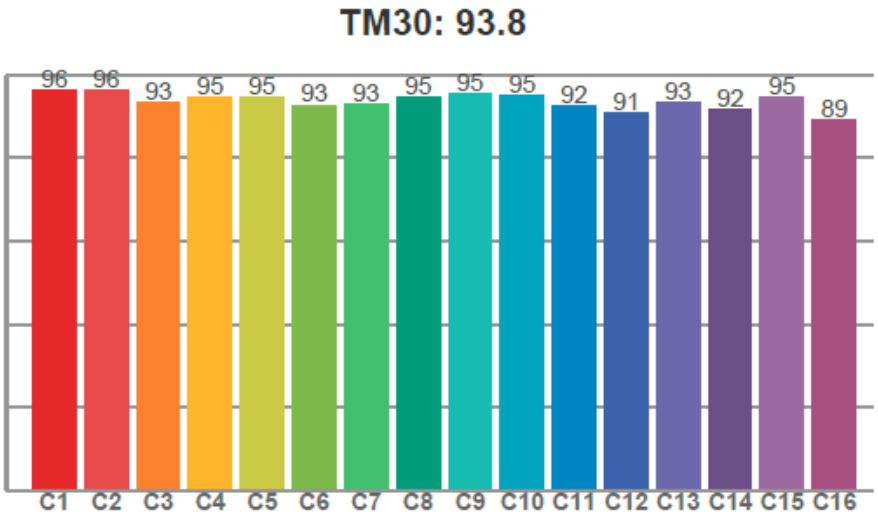
Big blue peak

Color distortion
Health disorder



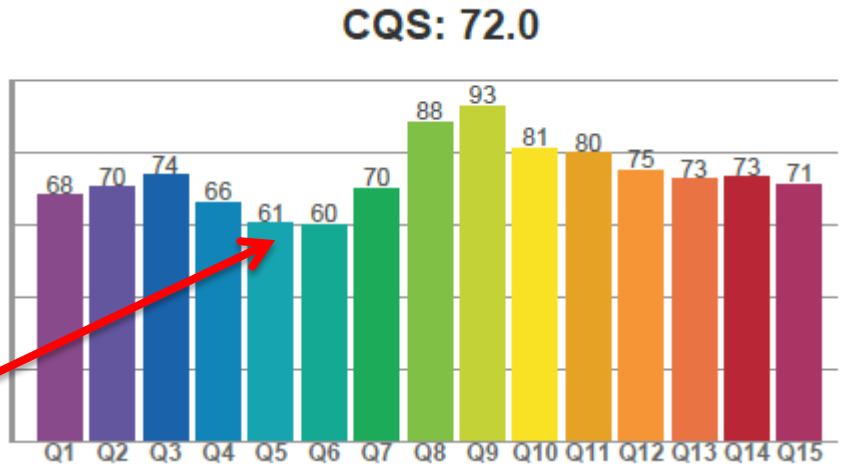
Test results for: B**** Decor color 3000K



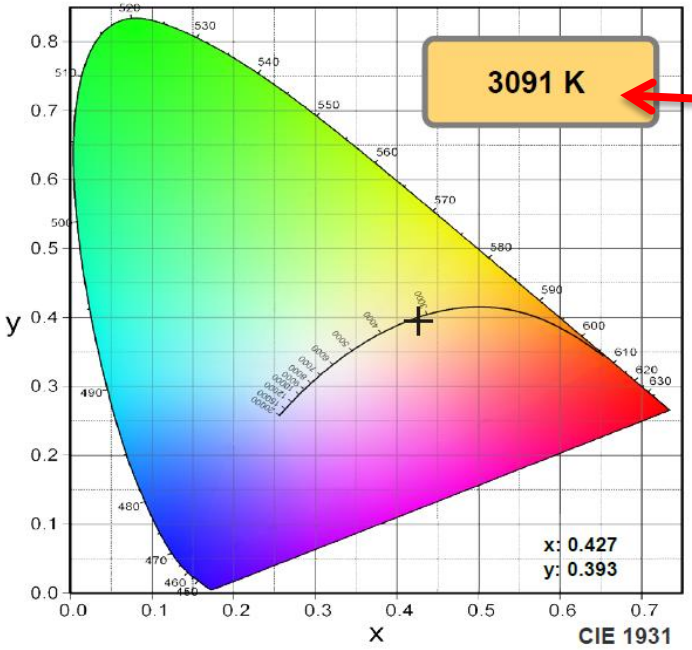


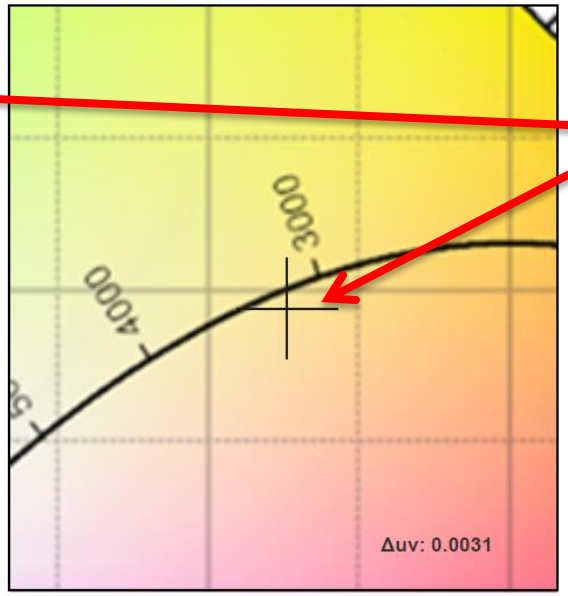
Low values in Blue and Cyan

Very low CQS (Color Quality Scale) meaning this LED is prepared for high CRI/TM30 metrics only, but not really good for color reproduction based on CQS



Test results for: Cit**** color 3000K

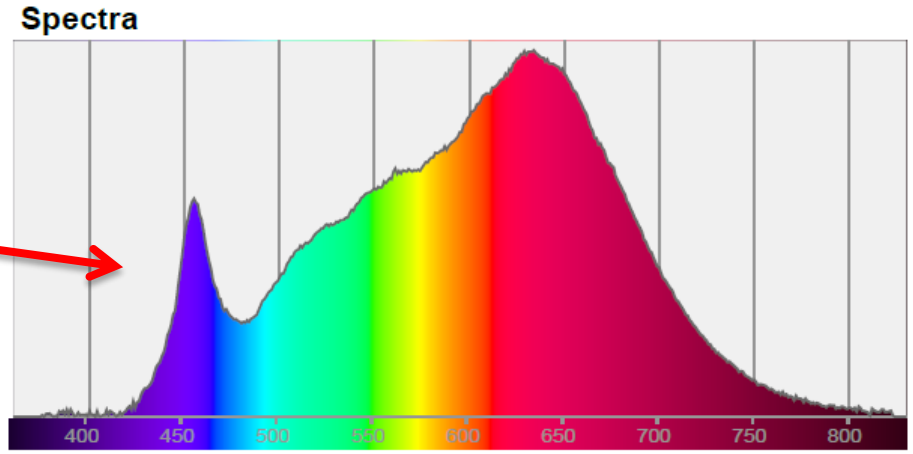




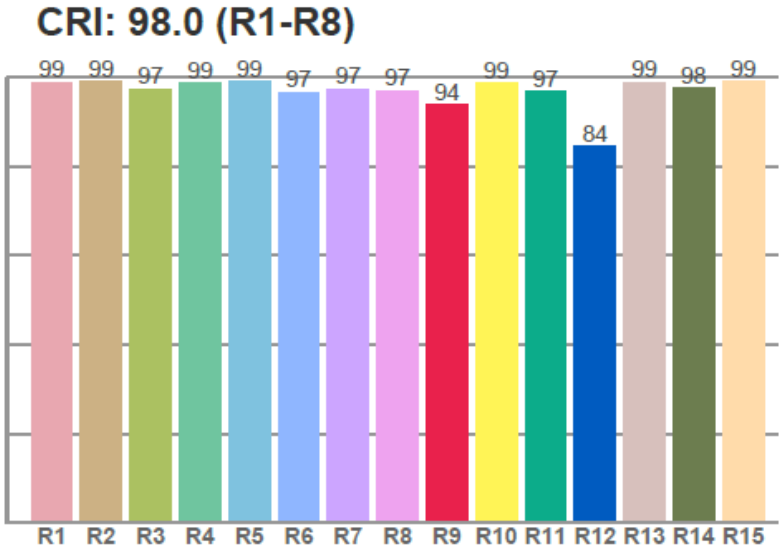
CCT in the right Position

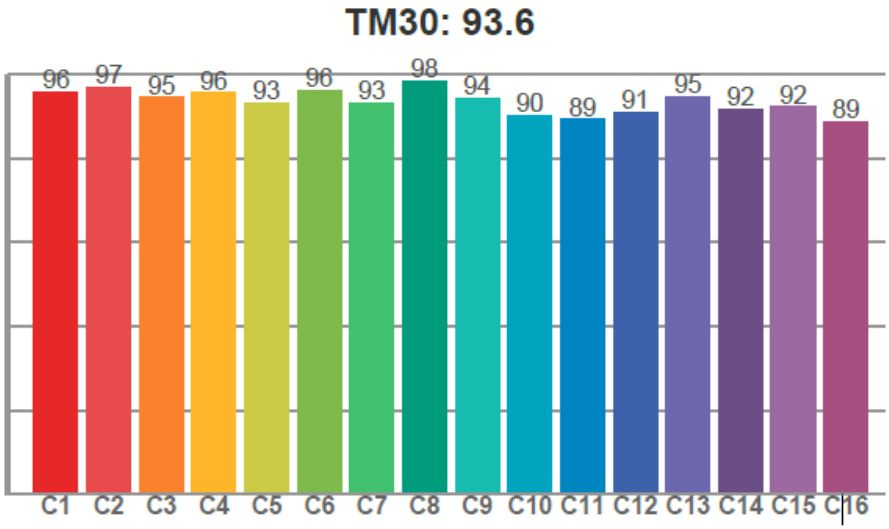
Big blue peak

Color distortion
Health disorder



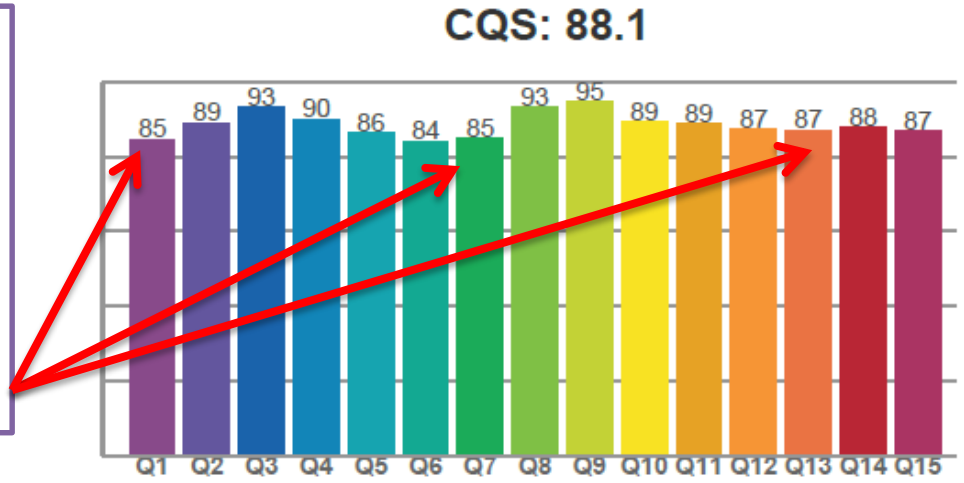
Test results for: Cit**** color 3000K



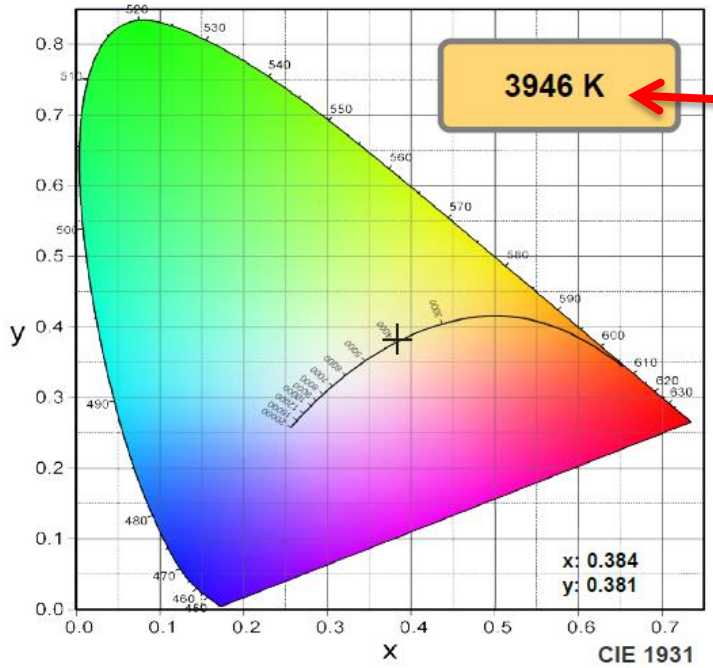


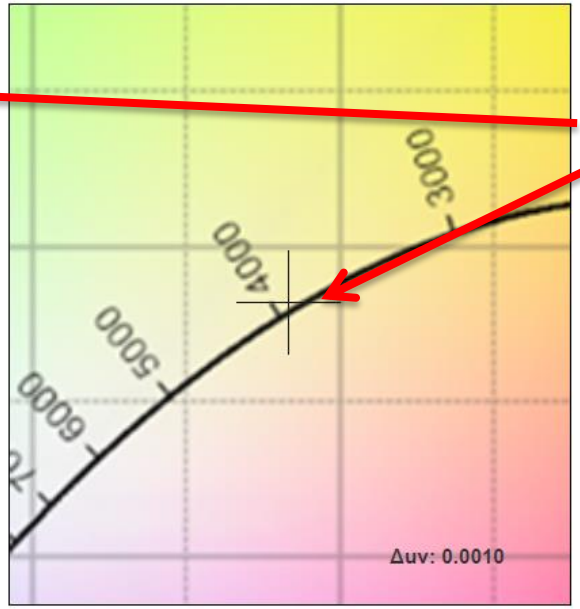
Low values in Violet, Green and Reds

Low CQS (Color Quality Scale) meaning this LED is prepared for high CRI/TM30 metrics only, but not really good for color reproduction based on CQS



Test results for: Cit**** color 4000K

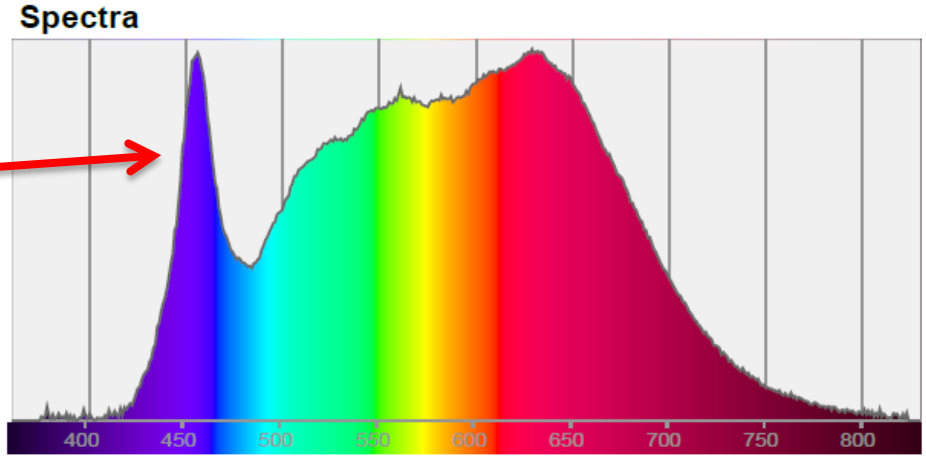




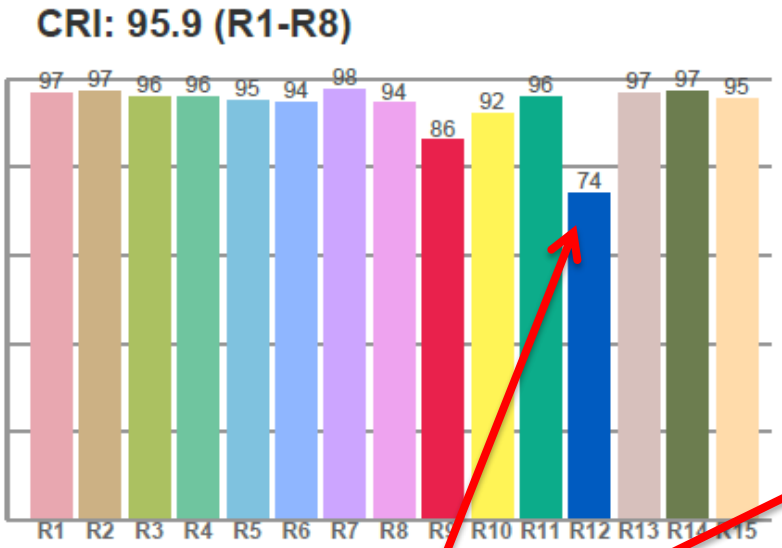
CCT in the right Position

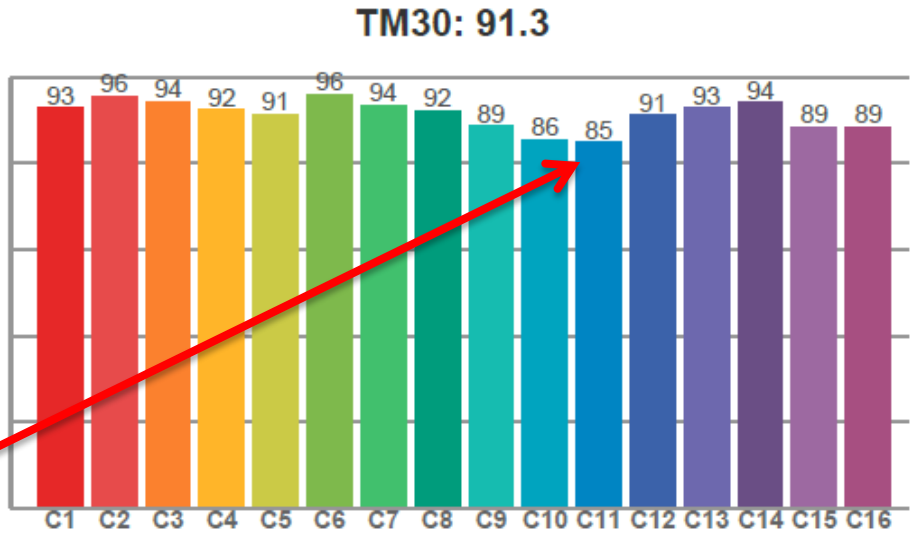
Big blue peak

Color distortion
Health disorder



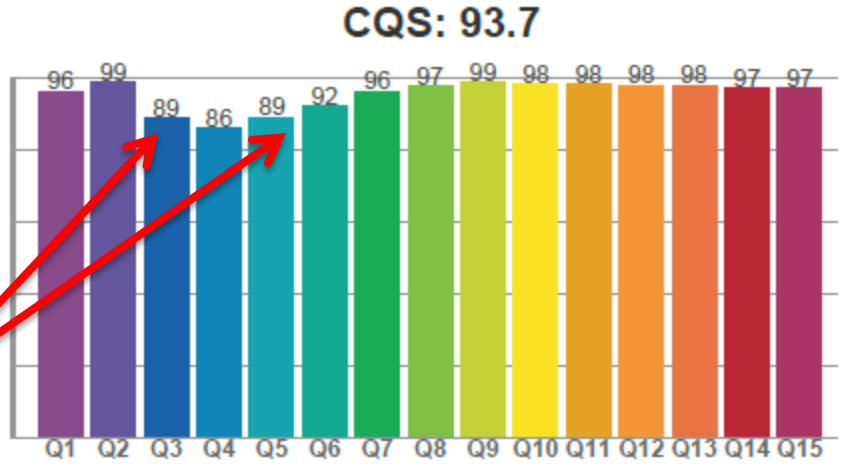
Test results for: Cit**** color 4000K





Low values in Blue and Cyan

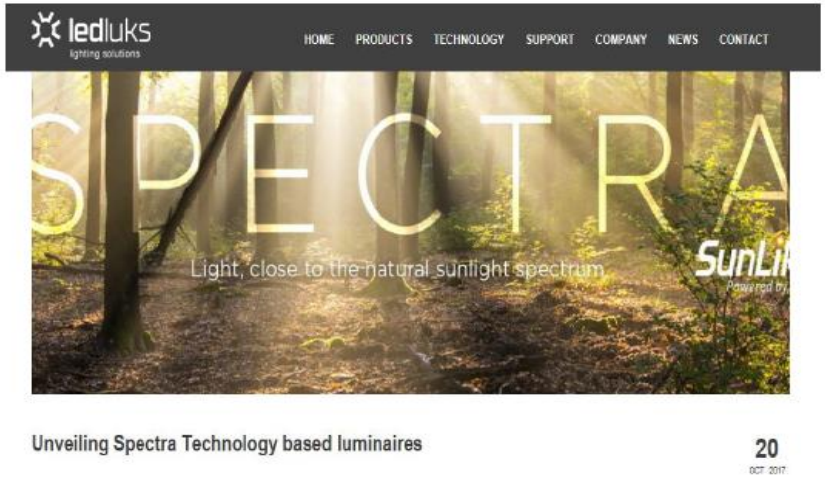
TM30 is quite low meaning not good color representing of the gamut and fidelity



08

Success stories with Sunlike

Success stories

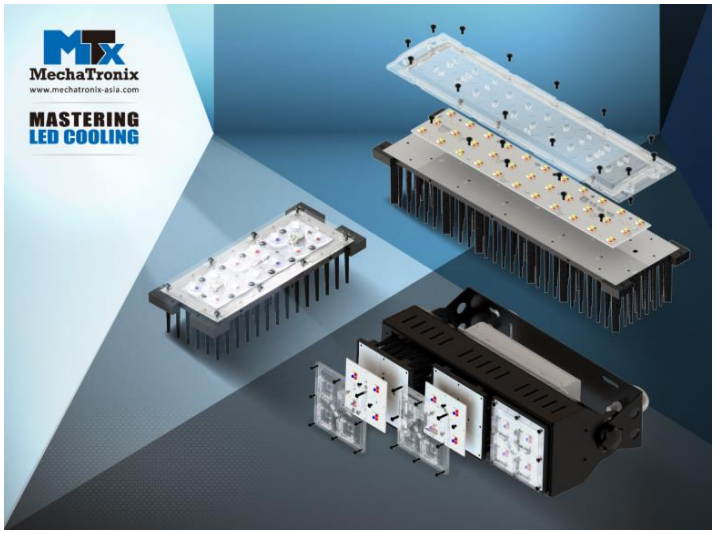


Unveiling Spectra Technology based luminaires

20
OCT 2017

Success stories

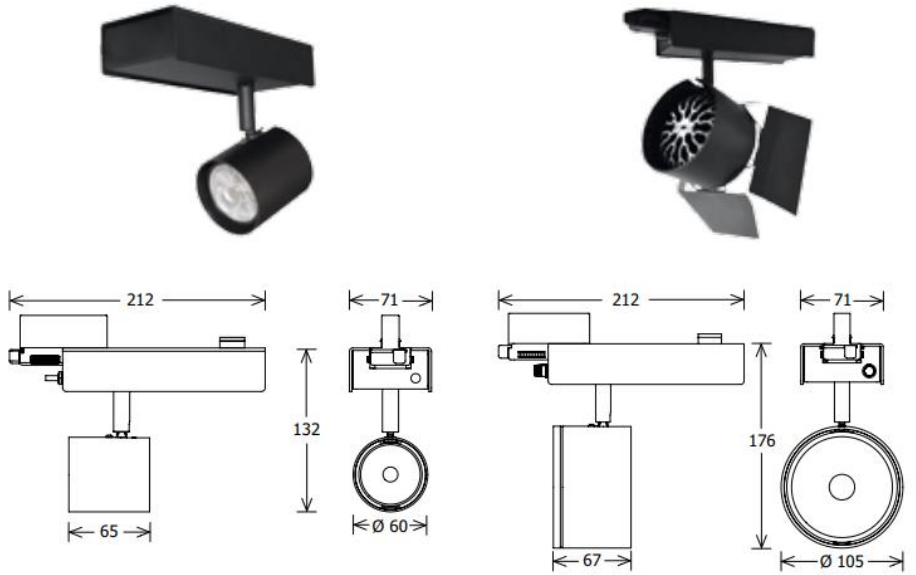
Success stories



Success stories

Lighting Manufacturer LTS Licht & Leuchten, Part of the FargerhultGroup, to Offer Selected Spot- & Downlights with Seoul Semiconductor´s SunLike Series Natural Spectrum LEDs

LTS®
LIGHT & LUMINAIRES



Success stories

FLOS Architectural Spotlights Incorporate Seoul Semiconductor's SunLike Series LEDs

on March 9, 2018 in Uncategorized, LED Lighting Luminaires and Fixtures

Article Type: News, Feature

Seoul Semiconductor, reported that FLOS Architectural a Spanish branch of Italian specialty lighting firm FLOS Inc. utilizes its SunLike LEDs in its UT Spot and other spotlight products. Seoul claims that its SunLike LEDs emit light closest to the spectrum of natural sunlight. FLOS Architectural's UT Spot, UT Pro(tracking power), and Light Supply spotlight products feature remote control of lamp positioning, direction, and focus. And the firm has also specified SunLike LEDs for its Smart Control, scheduled to be released in 2018.

FLOS Architectural's UT spotlight incorporates Seoul Semiconductor's SunLike Series LEDs.

FLOS

Success stories

Seoul Semiconductor: SunLike Series Natural Spectrum LEDs Illuminate Pompeii Ruins

- SunLike LED technology has been adopted by the new Lumen Center Italia for a lighting project of the in the ancient city of Pompeii

- Restored murals in the ruins of Pompeii show more pronounced color and depth when SunLike Series LEDs as a light source

- SunLike Series LEDs implement light that closely matches the spectrum of natural sunlight and represents objects as they would appear in natural light, overcoming the limits of artificial lighting

LUMEN CENTER ITALIA

Success stories

ESSENZIALED®
Led lighting

SunLike SEOUL
Powered by TRI-R

Success stories

Xiaomi Crowdfunds Yeelight Eye Lamp Pro: Safe For Your Eyes

by Jeet 1 month ago 0

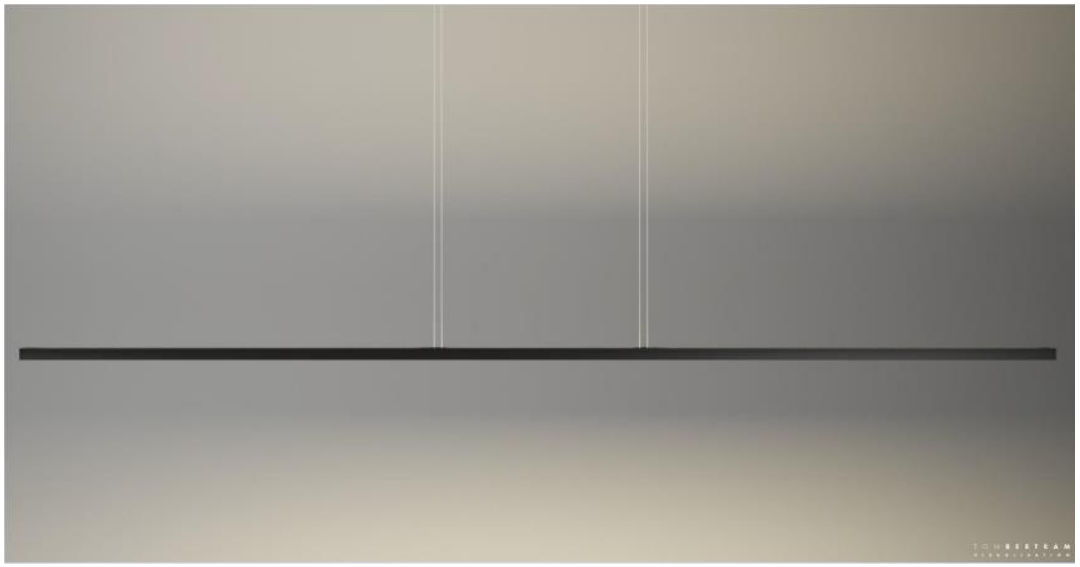
14 4 3 21 SHARES

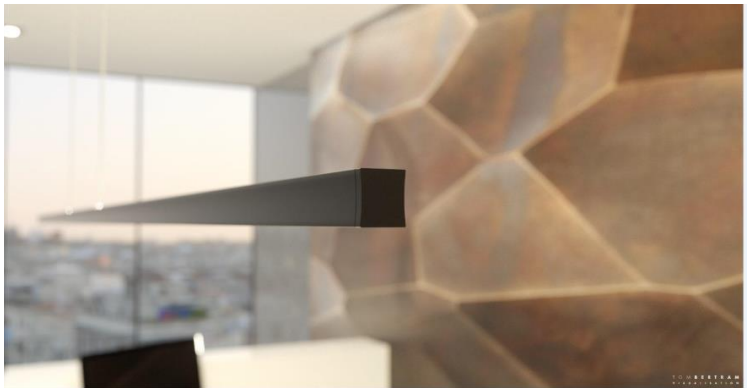
After launching products like Yeelight Moonlight Chandelier and Candlelight Lamp, China-based manufacturer Xiaomi is now gearing up to launch a new product tomorrow under its Yeelight brand — Yeelight Eye Lamp Pro. Ahead of the official launch through crowdfunding, the product has been exposed online along with its features.

Xiaomi

YEELIGHT

Success stories





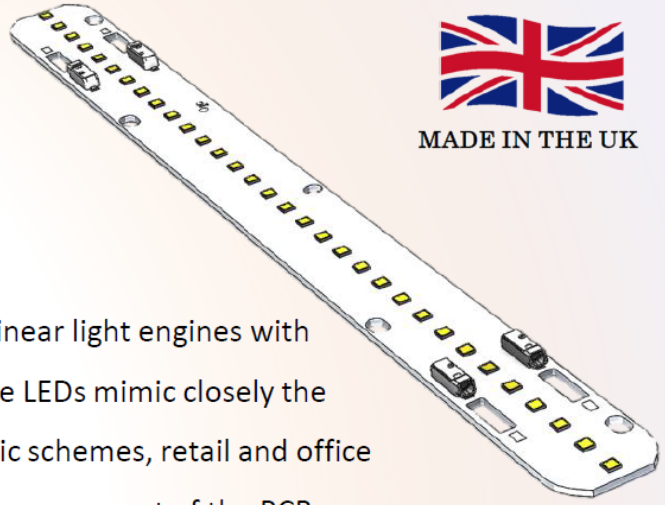
FERRO LIGHT®

Success stories

Pro-LED Linear SunLike

Powered by

Zhaga Format LED Light Engines



MADE IN THE UK

Pro-LED Linear SunLike LED light engines are a range of Zhaga compliant LED linear light engines with ultra high CRI Seoul Semiconductor SunLike LEDs. Using a purple LED chip these LEDs mimic closely the light from the sun. Suited to lighting applications such as hospital and biocentric schemes, retail and office lighting. Reliability and long lifetime are achieved through enhanced thermal management of the PCB.

Benefits

- Ultra high quality light from Seoul Semiconductor Sunlike LEDs
- Suitable for SELV or non-SELV applications
- Push fit wire connectors – front or rear facing
- Insulated metal substrate printed circuit board for superior thermal management

Characteristics

Application

- Compliant with Zhaga Book 7 Geometry – L28W2, L56W2 or L28W6
- Can be screwed in place or supplied with pre-applied thermally conductive Bondline 700 for mechanical attachment
- Option of Unicoat 120 protective coating
- Suitable for interior lighting applications

Success stories

lighting MiMI
미미라이팅주식회사

Living room

Bed room

Kitchen

Desk Lamp

Success stories – Castaldi lighting

Success stories

QUANTULA

Power (W)	Flux (lm)	Efficacy (LPW)	CRI (Ra)	CCT (K)
15	1320	88	97	4000/3000

Success stories

LUMITRONIX®
High-Performance LED-Technologies & Solutions

Success stories

OPPOSITE 2 OUT CIRCADIAN
ES-SYSTEM Light is Life

4899832

Luminaire type	600x600
Mounting type	recessed

OPPOSITE 2 OUT CIRCADIAN
a premium luminaire for recessed installation in coffered ceilings with low glare - UGR 19 - and an unusual, registered design. The CIRCADIAN function is a specialized system that supports the human circadian rhythm of daily activity. The most advanced purple LED module with excellent 95% color rendering, including the red component. A square, thermoformed, convex, multi-layer PMMA diffuser with rounded corners has glare-reducing microprisms, whereas the opalized layer evenly disperses light over the entire surface of the room. The spring-lamella system simplifies assembly. Wireless communication.

OPPOSITE 2 IN CIRCADIAN
ES-SYSTEM Light is Life

4899833

Luminaire type	600x600

OPPOSITE 2 IN CIRCADIAN
a premium luminaire for recessed installation in coffered ceilings with low glare - UGR 19 - and an unusual, registered design. The CIRCADIAN function is a specialized system that supports the human circadian rhythm of daily activity. The most advanced purple LED module with excellent 95% color rendering, including the red component. A square, thermoformed, concave, multi-layer PMMA diffuser with rounded corners has glare-reducing microprisms, whereas the opalized layer evenly disperses light over the entire surface of the room. The spring-lamella system simplifies assembly. Wireless communication.

OPPOSITE 1 OUT CIRCADIAN
ES-SYSTEM Light is Life

4899834

Luminaire type	600x600

OPPOSITE 1 OUT CIRCADIAN
a premium luminaire for recessed installation in coffered ceilings with low glare - UGR 19 - and an unusual, registered design. The CIRCADIAN function is a specialized system that supports the human circadian rhythm of daily activity. The most advanced purple LED module with excellent 95% color rendering, including the red component. A round, thermoformed, concave, multi-layer PMMA diffuser has glare-reducing microprisms, whereas the opalized layer evenly disperses light over the entire surface of the room. The spring-lamella system simplifies assembly. Wireless communication.

OPPOSITE 1 IN CIRCADIAN
ES-SYSTEM Light is Life

4899835

Luminaire type	600x600

OPPOSITE 1 IN CIRCADIAN
a premium luminaire for recessed installation in coffered ceilings with low glare - UGR 19 - and an unusual, registered design. The CIRCADIAN function is a specialized system that supports the human circadian rhythm of daily activity. The most advanced purple LED module with excellent 95% color rendering, including the red component. A round, thermoformed, concave, multi-layer PMMA diffuser has glare-reducing microprisms, whereas the opalized layer evenly disperses light over the entire surface of the room. The spring-lamella system simplifies assembly. Wireless communication.

THANK YOU!

www.seoulsemicon.com