

Specifying Color Tunable Luminaires: What you need to know



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Trend – Color tuning and White Tuning Luminaires

Three flavors:

- RGB (RGBA, RGBW, etc.), means full color tunable
- Dim-to-warm, ala incandescent
- White tuning, means range of CCTs available

Image from SuperBrightLEDs.com



Sophie's, Chicago

USAI Lighting

Photo: Peter Aaron/Esto



Eaton's
Cooper
Lighting

Applications – Color tuning and White Tuning Luminaires

RGB:

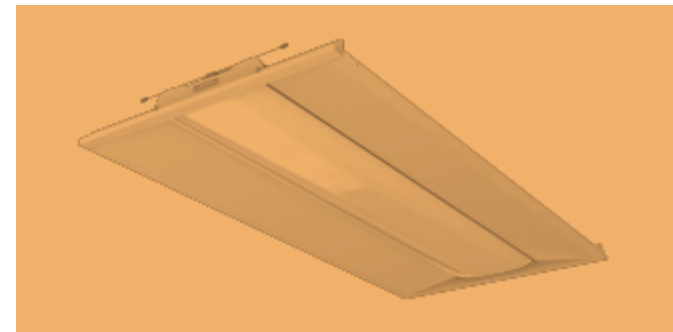
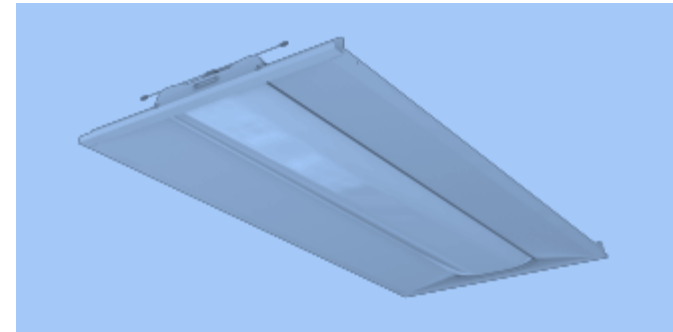
- Tuning one set of LED products in a space to match other sources in the space
- Creative appearance of space (3500K at one work station, pool of reddish light in corridor, wash of purplish light on lobby wall, for example)
- Entertainment (fixed or variable setting for a space with multiple functions and occupancies)

Dim-to-warm:

- Mimicking incandescent, especially when dimmed

White tuning:

- Circadian stimulation or to suppress circadian stimulation, especially if the space has multiple occupancies or uses over the course of 24 hours
- Behavior control (calming, invigorating children in classroom)
- Circadian correction (jet lag)
- Matching color of daylight during day, warmer dimmer light in evening
- Tuning to match finish selections, especially when they change on a seasonal or regular basis
- Tuning for tenant/owner/user preferences
- Tuning to create a mood or condition appropriate for art
- Changing light color to provide apparent cooling or warming to room



Color tuning and White Tuning Luminaires

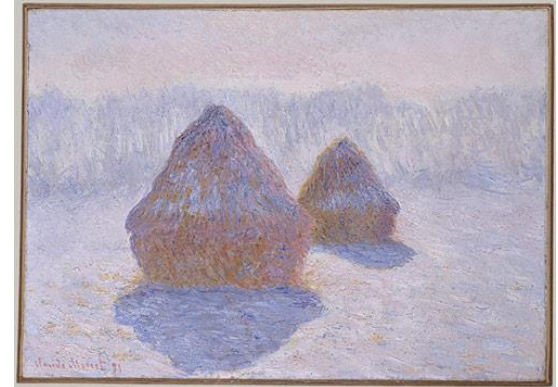
RGB etc. – Full color tuning

Good things

- Matching other light sources in the room, even off black body
- Whiz-bang, eye-catching color effects. Signage and wayfinding
- Entertainment capabilities from a normally-white downlight: 4000K for daytime conference activities, change to 2500 K for an evening wedding or Hallowe'en cocktail party

Complications

- Requires a more complex user interface than a simple slide dimmer. Luminaire powered separately from the dimmer/color control signal. DMX, DALI, or wireless control with high resolution required. Reprogramming may require a trained facility manager or in-house specialist.
- Difficult to completely match spectrum to another source. There are thousands of recipes for create “3000K” from an RGB source, but none of those R,G,B,W recipes R,G,B, W will produce same color rendering unless that is pre-programmed into the user interface and/or the driver.
- RGBW permits almost infinite color selection, but some combinations can oversaturate (“cartoon-like”) or undersaturate (drab/greyed-out) colors.
- 4• Efficacy of system is lower than fixed white LEDs.



Monet's haystacks, painted under different times of day, light conditions

Color tuning and White Tuning Luminaires

Dim to Warm

Good things

- Dims along the black body from 2200 K to 3000 K, just like incandescent.
- Some provide lovely buttery color at the bottom end of the dimming curve (not just amber). Virtually visually indistinguishable from incandescent.

Complications

- Sometimes you want to reduce light output without changing color. (A conference room is an example.) In those applications, it would be helpful to have separate dimming control from color change.
- Efficacy of system is lower than fixed white LEDs.



The Hurricane Club, Paul Gregory, LD

Color tuning and White Tuning Luminaires

White tuning

Good things

- Two sets of LEDs, one warm and one cool. By fading from warm LEDs to cool LED sets, with the intermediate CCTs created by mixing different levels of warm and cool LEDs, a range of colors very close to the black body locus is possible.
- Separate power from control required (0-10V, DMX, DALI, wireless 2-channel). Having a slider for CCT change and another for intensity seems intuitive. User interface is the critical factor.

Complications

- Some products use a separate control slider for the warm LED set and the cool LED set. It's more clumsy to fade from one color (2700 K) to a mixed color (3500 K) and then to a cool color (6500 K), because it required fiddling with two sliders to achieve both the desired CCT and light output.
- Wiring may be more complex.
- Efficacy of system is lower than fixed white LEDs.

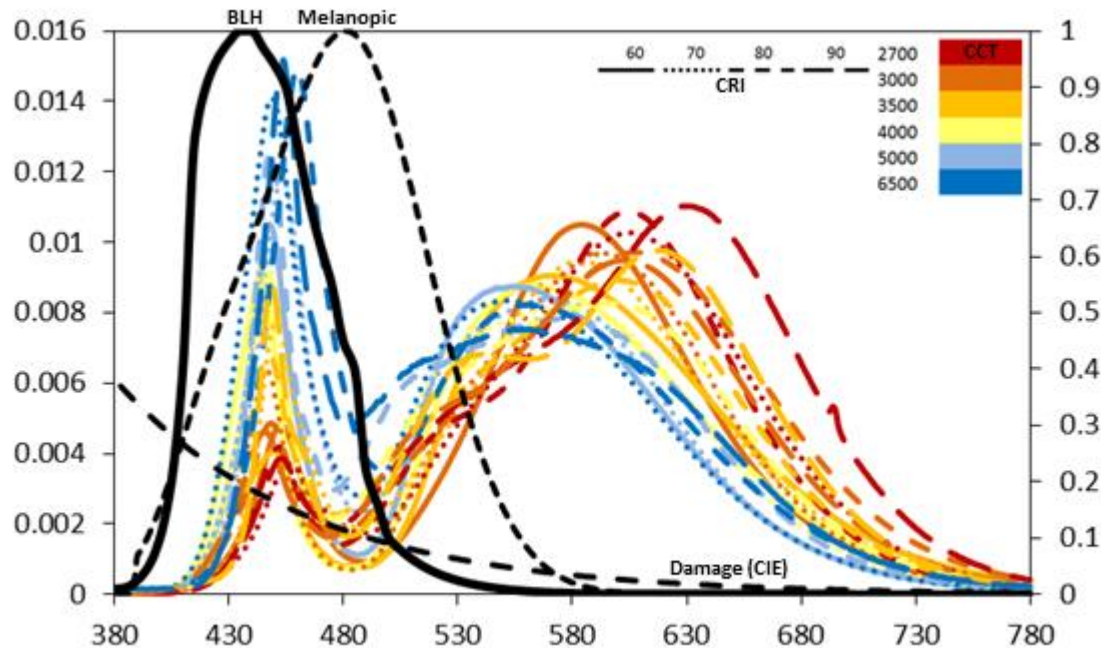


Finelite color controller

Color tuning and White Tuning Luminaires

Health benefits?

- It's too early to know what the benefits/hazards are for most applications. The effect of polychromatic light is still in research.
- The size of the effect compared to static lighting is unclear
- Individual physiology, light history, age, health, will affect the light prescription



Variation in SPD of 15 different LEDs from CALiPER testing

- 2700K – 6500K, range of CRIs
- Compare to one circadian response function (“melanopic”)
- Changing from 2700K to 6500K increases melanopic lumens by 2.5 and vice versa

How to design for health? An example of the difficulty



Lighting for Neonatal unit

- Design to lux or circadian lux? What model?
- Design at multiple times of day?
- Measured at eye or workplane?
- Who gets control of lighting/programming?
- Design for mom, the baby, or nurses?
- How does light spectrum affect tissue color evaluation? (Cyanosis, jaundice, redness)
- How do you know if it's working?

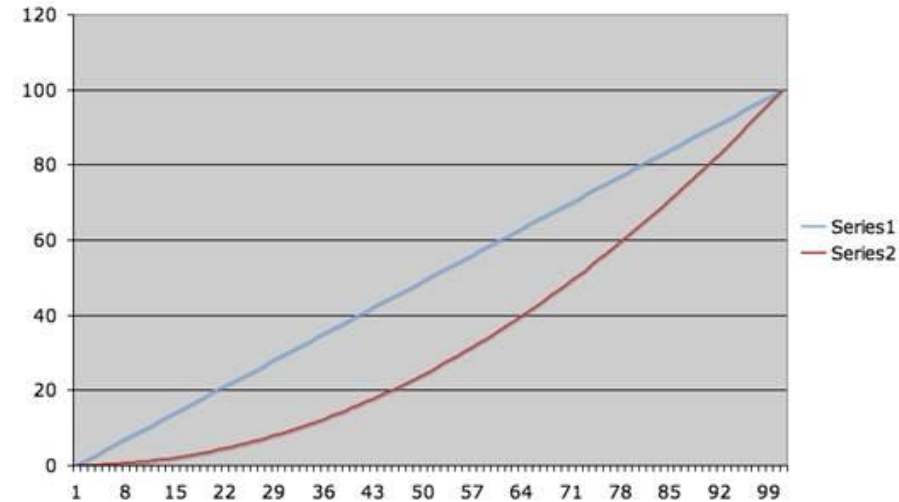


WE DON'T KNOW. NEED more RESEARCH.

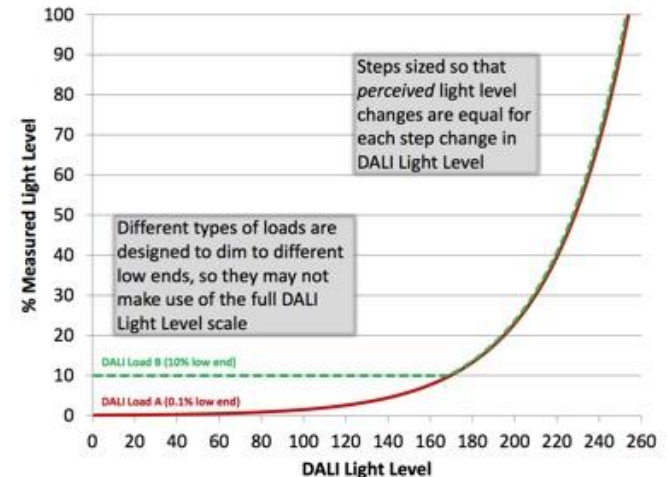
Color tuning and White Tuning Luminaires

Dimming issues

- User interface and intuitiveness of control
- Smoothness of dimming and color change
- Resolution of dimming
- How fast the luminaire reacts to dimming signal
- How low does it go?
- How does it transition to OFF?
- How does it transition from OFF to low levels?
- Dimming curves
- Flicker from system
- Complexity of programming system for owner
- Wiring requirements, construction issues, cost
- Software needed, hack resistance
- Protocol translators
- How color-change controls play with others in room



DALI dimming control performance issues



Trend – Color tuning and White Tuning Luminaires

What information do you need on the product spec sheet?

- Color tuning (RGB), Dim-to-warm, White tuning
- SPD and photopic lumen output at highest CCT, lowest CCT, and in between
- Maximum and minimum watts drawn at max, min, mid CCTs
- Candela curve for distribution info
- Controls protocol (0-10V, DMX, DALI, Zigbee, etc.)
- Compatible controls, and any interfaces between controls and driver
- Cable type and connectors among control, interface, & luminaire
- Driver type, logarithmic or linear dimming curve
- Minimum dimming level, whether it dims to off
- % Flicker and Flicker Frequency at max, min, and mid output level
- Max and min number of luminaires on controller
- How to order the COMPLETE system

- And, perhaps, maximum melanopic lumens at high CCT, low CCT, mid CCT

Color tuning and White Tuning Luminaires

Energy Savings??

- Compared to incandescent....
Yes.
- Compared to highest efficacy LED commercial products.....
No. Not yet.
- The energy codes don't know how to deal with these products.



Image courtesy Finelite Lighting

Now hurl those questions!



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