CHRISTIE®

MAINTAINING ROCK-SOLID BRIGHTNESS AND COLOR STABILITY IN A PROJECTION SYSTEM

With Christie LiteLOC color and brightness control

christiedigital.com

WHITE PAPER

What if content could look as good throughout a projector's operational life as it did on day-one? What if we could automatically maintain color balance and brightness over time, and regardless of fluctuations in ambient temperature? And what if this technology came factory-calibrated in your RGB pure laser projector?

High brightness and real-world color

As good as laser phosphor projectors are, sometimes good isn't quite good enough. When you need the ultimate in color accuracy and impact, such as promotional content for a flagship product or specific brand, copyrighted IP characters in themed attractions, or a blockbuster movie premiere, laser phosphor color may not cut it. For high brightness and immaculate color, RGB pure laser illumination gives you the high-end performance you need.

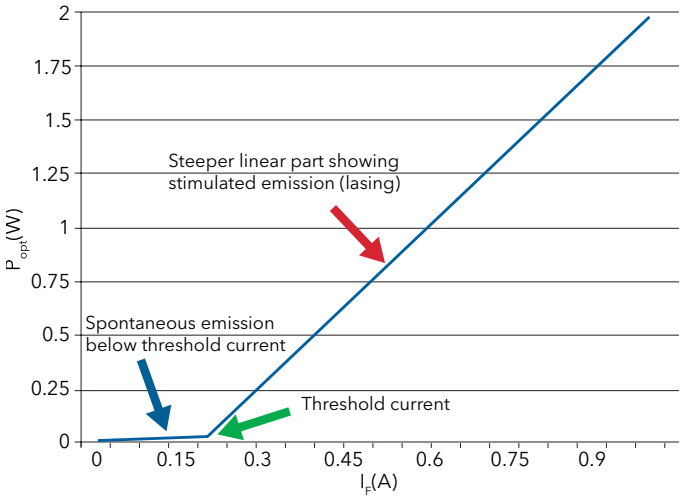
Where RGB pure laser technology shines

RGB pure laser's solid-state, laser diode rays overcome the color and brightness limits of laser phosphor's complex spinning laser phosphor wheels. Three laser diode array sources generate red, green, and blue primaries, with a single projector able to provide as much as 75,000 lumens of illumination. Christie® all-in-one RGB pure laser projectors—such as the D4K40-RGB, Griffyn™ 4K32-RGB and M 4K25 RGB for ProAV, and CineLife+™ Series for cinema—achieve best-in-class Rec. 2020 color space performance and maintain extremely accurate and stable brightness and color using a new technology called Christie LiteLOC™.

How does LiteLOC maintain brightness and color?

To understand how LiteLOC controls brightness and color, we need to look a little closer at how a typical laser diode operates. There are many in each red, green, or blue multi-laser diode array. See figure 1. The first thing to note is that as laser diode drive current increases, spontaneous emission starts, as electrons are driven to higher energy states and then decay, emitting photons similar to an LED. At a certain threshold current, enough photons are shooting about that they start stimulating the emission of more photons that bounce back and forth between parallel mirrors within the gain cavity. Only those along one axis reinforce and amplify, and the device begins to lase and produce a highly directional beam. Coherent waves form and break free of the mirrored facet in a narrow, collimated beam of photon wave/particles that have the same distinctive frequency and wavelength. The good news is that the power output of this laser diode is very nearly a straight line—a linear function. (Basu, 2013)

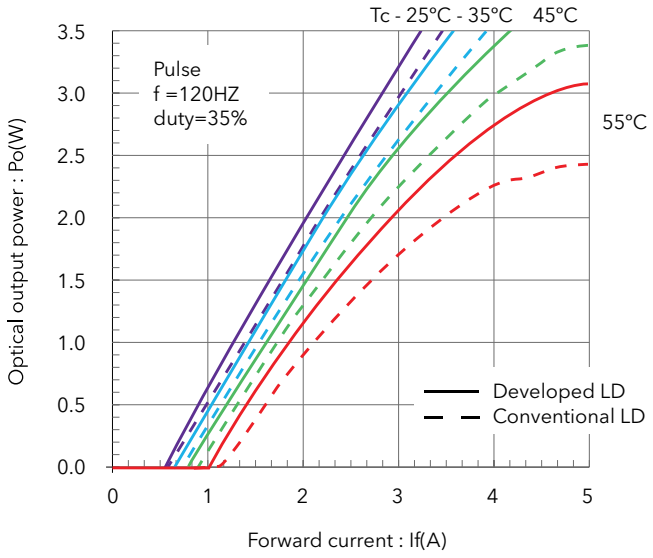
Figure 1 – Optical power out versus input current for laser diode (from Basu et al. 2013)



How do laser diodes react to temperature?

Let's look at a representative 3.5W red laser diode developed for cinema markets from a recent SPIE paper. See figure 2. Like many electronic devices—and people—they operate better if kept cool. The most efficient operation is at a case temperature of 25°C/77°F (shown in purple), where output power in watts is highest for a current around 3.2 amps. As the temperature increases (shown in red) to 55°°C/131°F, the power drops. If it gets too hot, the laser diode will at first drop in power, then may fail completely. If it gets too cold—below the dew point in humid environments—condensation can form, greatly decreasing life. Hence temperature control in the 'sweet spot' is very important. The wall-plug efficiency of this red laser diode is 43%, the world's highest in 638nm. Note this is far more efficient than trying to extract red light with a filter from yellow phosphor wheel emission in the case of laser phosphor-illuminated projectors. (Hagimoto, 2019)

Figure 2 – Output power vs drive current & temperature for red laser diode (from Hagimoto 2019)



Achieving brightness and color control

The answer to achieving near-perfect brightness and color control in a projector was hidden in the laser diode physics. Christie scientists developed an elegant algorithm using matrix mathematics to solve linear equations for precision current-control drive software to match a chosen color target.

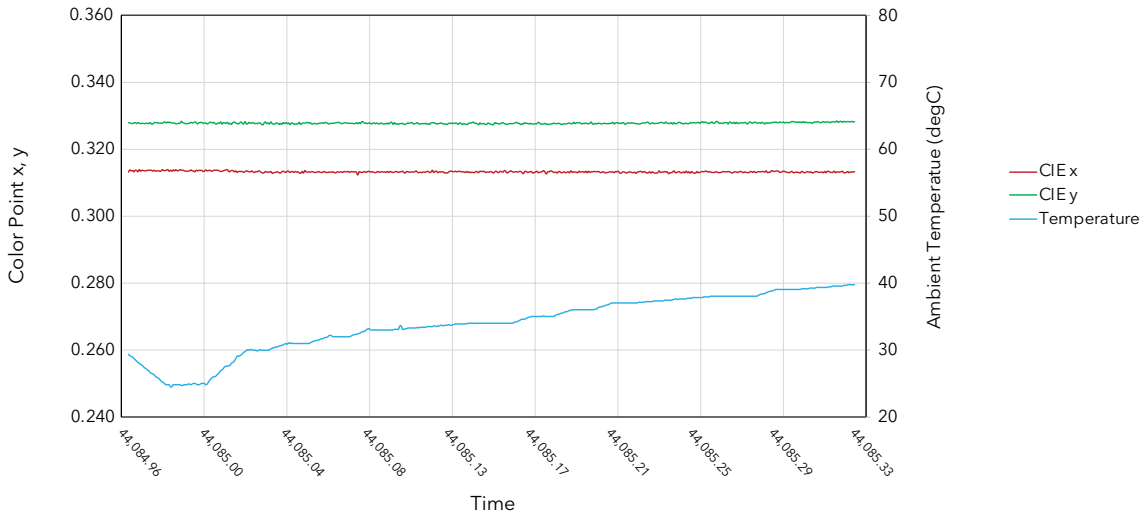
The algorithm allows an internal color sensor to be used in a feedback loop, maintaining RGB laser output while temperatures fluctuate and the lasers age. It continues to perform that feedback loop over years to keep color constant.

While the math and software to do this is complex, the results are staggeringly good—color is locked to the white point target. No more color drift over time, unlike lamps or degrading laser phosphor wheels. And the LiteLOC algorithm quickly adapts to sudden changes like thermo-electric cooler readjustments, etc. Closed-loop feedback is a simple but effective idea, relating control parameters directly to feedback parameters.

LiteLOC in action

The proof is in the pudding, so here's some hard evidence that shows LiteLOC works well for the Christie Griffyn™ 4K32-RGB pure laser projector. In figure 3 we see how LiteLOC maintains almost constant color point (CIE x in red and CIE y in green), despite big changes in temperature—from 25-40˚C/77-104˚F (shown in blue) over an 8-hour period.

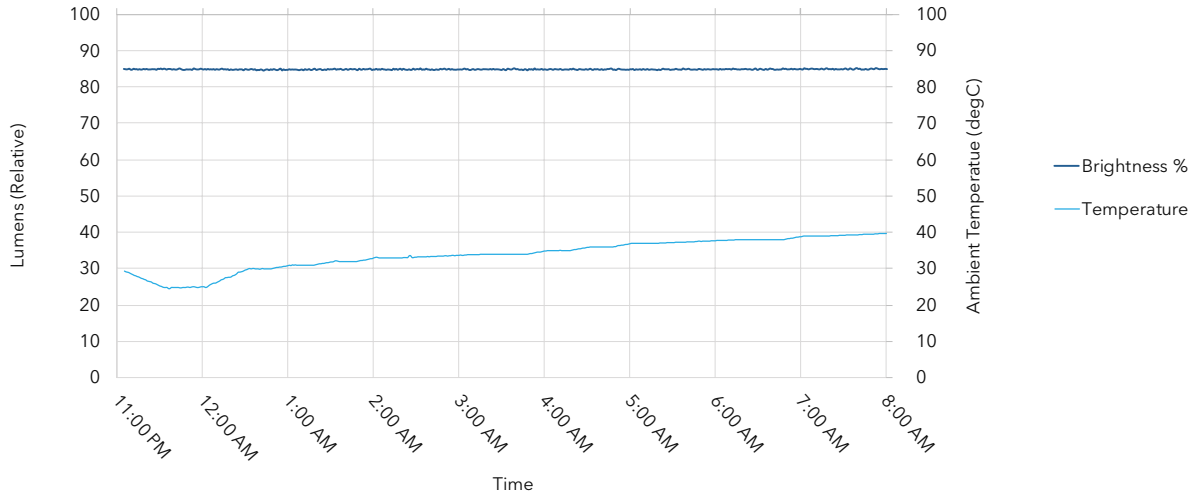
Figure 3 – LiteLOC maintains constant color in Griffyn 4K32-RGB over wide variations of ambient temperature



Constant brightness

In figure 4 we see how steadily Griffyn keeps overall brightness over time (shown in dark blue) at 85% power[1] with the same huge temperature variations over time (shown in cyan). This means you can use RGB pure laser projectors that have LiteLOC in demanding environments such as concerts, outdoor projection mapping, or long-term installations in entertainment venues, dome theaters or theme park dark rides, and not just inside temperature-controlled projection booths.

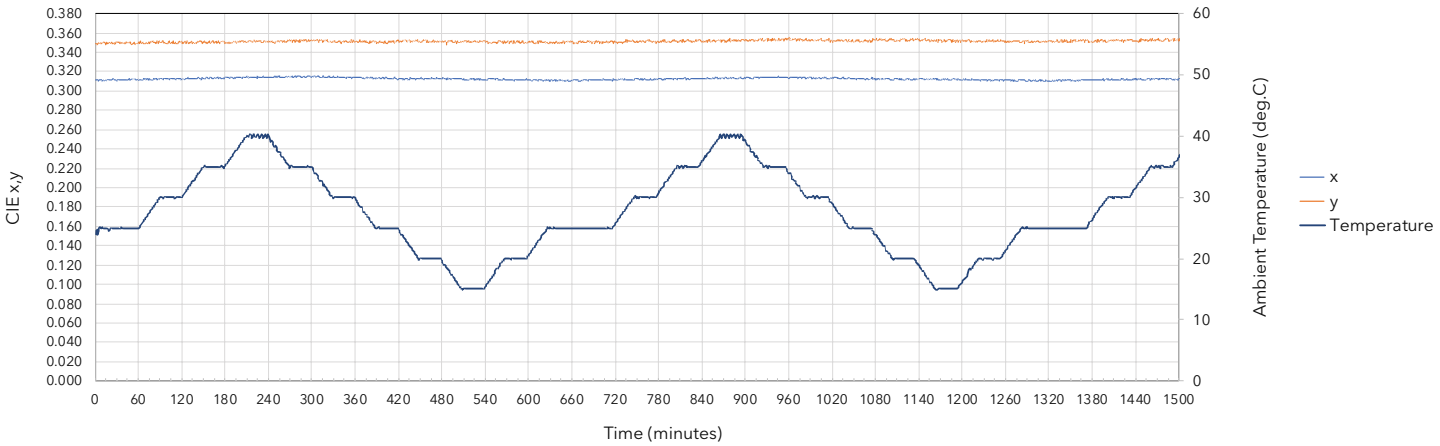
Figure 4 – LiteLOC maintains constant brightness in Griffyn 4K32-RGB over wide variations of ambient temperature



Stable color

The 45,000-lumen Christie DK40-RGB laser projector also uses LiteLOC technology and in this graph (figure 5) is shown to steadily maintain DCI-P3 Theater CIE x_w, y_w color white point at D63 6300K (0.314, 0.351), despite huge swings in temperature (shown in blue)[1]. Basically, you can 'set and forget' brightness and color—the projector monitors and corrects itself. It's one less thing to worry about. For multiple blended projectors on a dome, for example, that's a huge benefit.

Figure 5 – LiteLOC maintains stable color in D4K40-RGB over wide temperature changes



1 - In cases when the projection system is already operating at maximum power, LiteLOC may require a reduction in brightness in order to maintain color accuracy.

Christie LiteLOC for constant image brightness and color

LiteLOC automatically maintains color and brightness throughout your all-in-one RGB pure laser projector's[2] operational life for years of stable, virtually maintenance-free operation.

Christie RGB pure laser outperforms

As an industry pioneer and innovator, Christie continues to lead the way by offering the widest range of RGB pure laser projectors in the industry. Perfect for premium large-format cinema, live event staging, projection mapping, Giant Screen theaters and theme park attractions, and quickly becoming the standard for mainstream cinema, RGB pure laser technology achieves the most expansive color gamut of any projection technology. It offers the reliability and longevity of solid-state illumination and best-in-class operational efficiency.

Explore our full range of projectors »

Rec. 2020 tech brief

Let's take a deep dive into the world of color, color spaces, and how RGB pure laser produces Rec. 2020 color

RGB laser webinar

Watch our webinar, **RGB laser – a leap forward in color space**, to learn even more about color

Are you interested? Have any questions?

We're here for you

Let's connect today!

[2] LiteLOC is included in D4K40-RGB, Mirage 4K40-RGB, Griffyn™ 4K32-RGB, M 4K25 RGB, and all CineLife™ and CineLife+™ Series projectors.

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