QUASAR SCIENCE

Light Engine Fundamentals

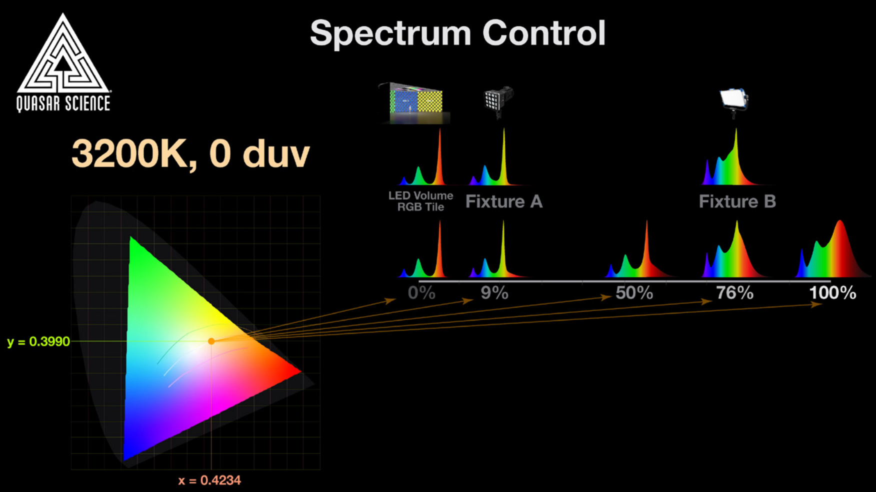
THE COLOR ENGINE

Image-based lighting (IBL) is added to virtual production setups for a number of reasons. Sometimes it's done to increase light levels beyond what the video wall can produce, or to create light from a direction where there simply isn't any video wall coverage, particularly from above. It's also used because the color quality of the video wall's light may be unflattering to subjects in the real world scene, particularly people. Achieving those goals, as well as matching IBL to the output of the video wall, demands a lot from the LED emitters in production lights and the electronics which control them – the light's color engine.

Good-quality LED production lighting will involve at least four, often five or six groups of emitters of different colors. Basic designs allow for control of color and color temperature by mixing those emitter groups together. More advanced designs will allow for precise correction of color balance, green-to-magenta shift, and simulation of popular gels from filter manufacturers as illuminated by various types of light. Control software increasingly lets users select colors using CIE xy coordinates, which describe specific colors unambiguously, ideally allowing color matching even between different lights using different technologies.

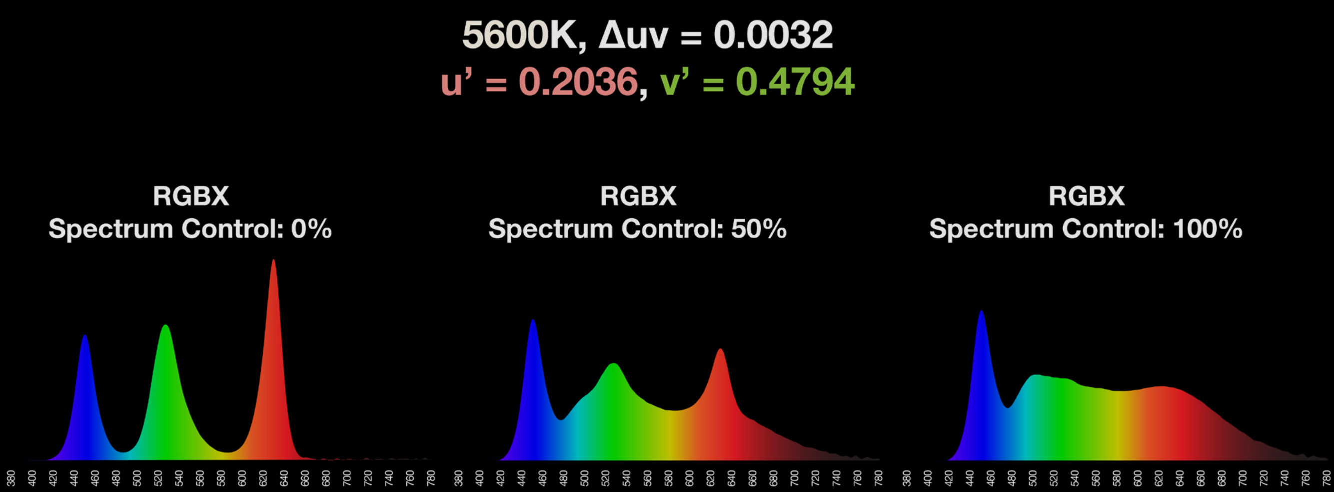
SPECTRUM AND METAMERISM

One of the most powerful motivations for IBL in virtual production is the improved color quality of production lighting over the light emitted by the wall itself. While it's strictly speaking true that the red, green and blue emitters of the wall might combine to make white light, that light may only look white to the human eye, and even then when the light is falling on a substantially colorless surface. In reality, huge ranges of color are missing from the light's spectrum.



The phenomenon by which that incomplete spectrum looks like white, while the complete spectrum of sunlight also looks like white, is called metamerism. Similar things can occur with any color. An orange, for instance, reflects orange light. A video wall has no orange light, so it blends a lot of red light with a little green. That looks orange, but those two identical-looking orange lights may not behave similarly in all circumstances; they are metamers of one another.

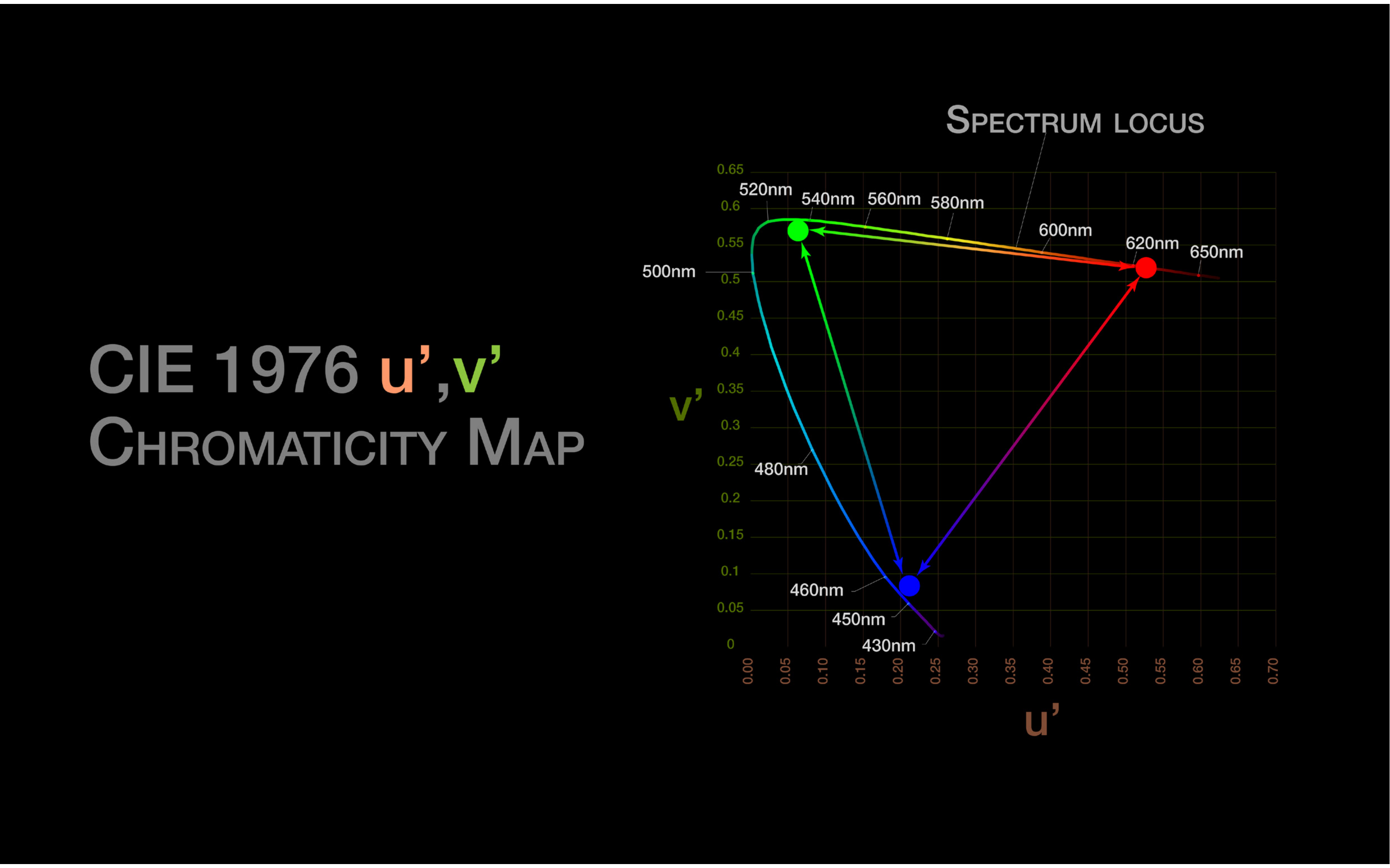
Metamerism works for cameras, too, so it is theoretically possible to adjust many different LED light sources, including video walls, so that they ostensibly match. Because the behavior of cameras is not quite the same as the behavior of eyes, lights which match to the eye may not match on camera, and vice versa. Some LED production lights have knowledge of the behavior of specific cameras and will make small adjustments to compensate.



LIGHT ENGINE FUNDAMENTALS

The limits of what any production light can do are determined by two things: the LED emitters, and the electronics and firmware which control them.

Emitters used for production lighting are descended from decades of research into devices originally used as indicator lights. All of them use similar physics at the lowest levels, but they break down into two main groups, both of which are widely used in production lighting. Direct emission types generate light directly from the LED device itself, which is has a very narrow spectrum but is highly efficient. Phosphor converted emitters use blue LED to illuminate a phosphor which emits other colors, or white. This is less efficient, but produces a broader spectrum which is generally beneficial to color quality.



There are many useful emitter configurations involving both these technologies. Lights which use only red, green and blue emitters are generally made only for live event and theatrical productions, and are not suitable for cinematography unless the intent is to deliberately create a special effect. Many also use dimming techniques which will cause them to flicker on camera. Production lighting is likely to use phosphor-converted emitters and a larger number of different types of emitters in each light, and to use dimming techniques designed to mitigate or entirely avoid flicker.

CONTROL SYSTEMS

The electronics which control those emitters have a huge influence over the capability of the light in terms of controls available and color quality. Altering the intensities of groups of LED emitters to create useful color effects is a complex topic, and the specifics are often highly proprietary, lending different products very different capabilities. The simplest designs, for instance, might create colors by simply ramping the intensities of red, green and blue emitters in response to a changing hue control. That works, but in the simplest implementations, the hue numbers shown by one light are, again, unlikely to create matching results on another.

Subtleties like that are just one example of how a capable light engine can make a light more useful. Better hue-and-saturation controls are possible, though perhaps the most useful example of light engine capability is the option to specify colors using a CIE xy coordinate. Referring to a position on the familiar horseshoe-shaped chart of all visible colors, those coordinates specify a particular color of light as observed by the human visual system, and as such are completely unambiguous.

The emitter configuration of most lights won't allow them to create colors representing all of that chart. Within the available area, though, CIE xy coordinates should allow very different lights to emit closely matching colors. Because those different lights may have different emitter configurations, the colors are likely to be metamers of one another, with a different spectrum but looking similar. Generally, well-made light engines will ensure a reasonably close match both to the eye and on camera.

INTERFACES

Anyone with experience working with intelligent lighting will be familiar with the idea of lights using several control channels for different features, perhaps with different profiles for different situations which alter how the light behaves. Light engines designed to provide full color mixing will, by definition, require at least three channels to define a color. Most use more, so that overall intensity, color temperature, and plus- or minus-green can be controlled independently of hue and saturation. Multiple-pixel tubes might use dozens or channels per light fixture for individual control of each pixel.

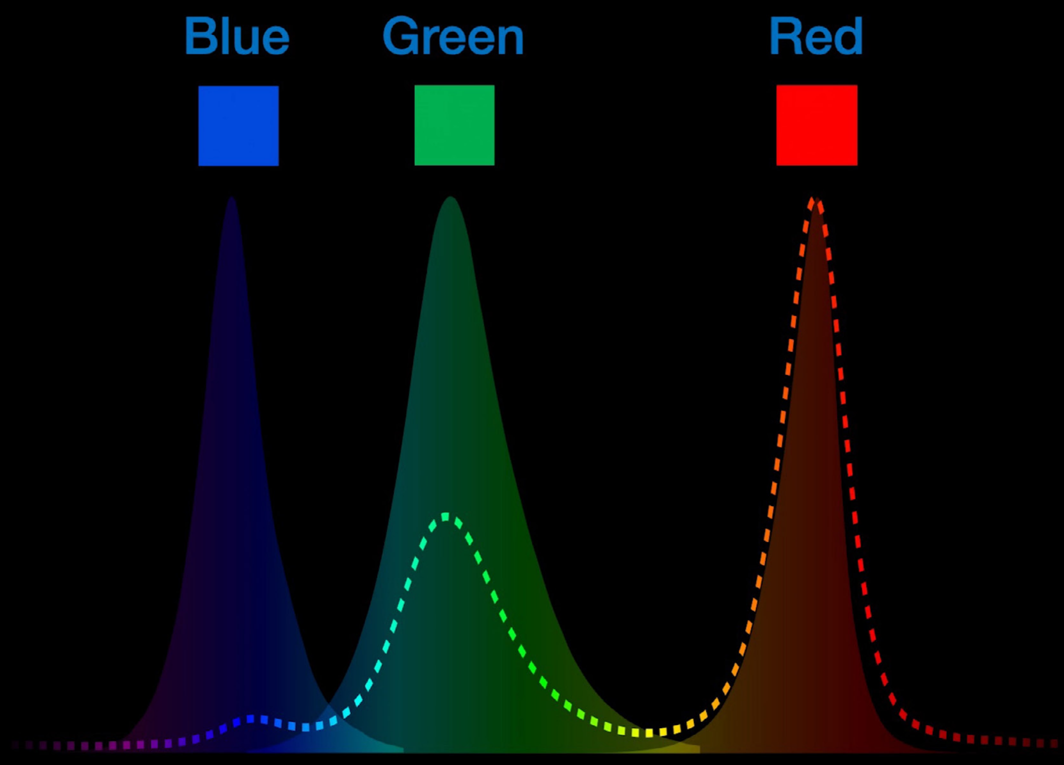
SPECIAL EFFECTS

Most LED production lighting implements various special effects, from flashing police lights to animated fire, although it's usually the purpose of IBL to create exactly that type of effect in such a way that it's directly tied to the virtual environment.

Occasionally, cinematographers have deliberately selected lights with poor color quality to evoke specific effects, often in science-fiction or industrial environments. Technologies such as mercury vapor gas discharge lights or older types of fluorescent tube are sometimes chosen, although in principle any light source might be valued for its deliberately poor color performance. LED light engines, on the other hand, generally aim to create high color quality, to ensure that all colors – particularly skin tones – are well-illuminated.

Some light engines are beginning to implement options to deliberately reduce the color quality of their output, making it more possible to accurately simulate those classic industrial lights. While the video wall itself tends to have poor color quality, the intent is not generally to match that, which would defeat the object of supplementing the wall's light using high color quality production lighting. The relevance of deliberately reduced color quality to IBL will be very dependent on the particular situation at hand, but will find use in specific circumstances.

RGB LIGHT SPECTRUM



The gaps in the volume wall's RGB LED spectrum can't convey cyan or yellow well so skin tones saturate red. The Rainbow series fills in these gaps. No more lobster lighting!

VIDEO STANDARDS

One light engine capability which is particularly relevant to virtual production and IBL is the implementation of color standards typically used for video. As we discussed in chapter 3, these standards specify red, green and blue primaries as well as the relationship between signal level and absolute brightness. If the same signals are sent to several different lights which all implement the same standards, the colors should match.

Several things may limit this capability, especially at the extremes of color saturation. Video standards such as the commonly-encountered BT.709 were designed to accommodate the behavior of light-emitting phosphors in old-style, glass-tube video displays. Most LED video wall panels and

LED-based production lights can achieve at least as large a range of color, although the capabilities may not entirely overlap and some colors available to 709 monitors may not be available to LED wall panels or production lights.

More modern standards, such as BT.2020, specify extremely large color capabilities which many devices will struggle to fully implement (in fact, a full implementation is theoretically impossible). Even so, more modest capabilities are enough to create very convincing interactive lighting. As these standards become more commonly implemented, many of the concerns we've discussed are likely to become less time-consuming to fix.

THE FUTURE

Continued development of light engines, particularly with regard to available LED emitter technology, is likely to continue improving flexibility and color quality. Particularly, better availability of very deep blue or ultraviolet LEDs will improve both the blue output of current designs, and potentially make more phosphor-converted options available. Most of these changes are unlikely to require any changes in technique from the user, with the light simply creating better results out of the box. What may change is improvement in standardization, and since virtual production and IBL are so new, it's not clear how that might work – though it's certainly likely to simplify things.


Credit: Orbital Virtual Studios

QUASAR SCIENCE SOLUTIONS

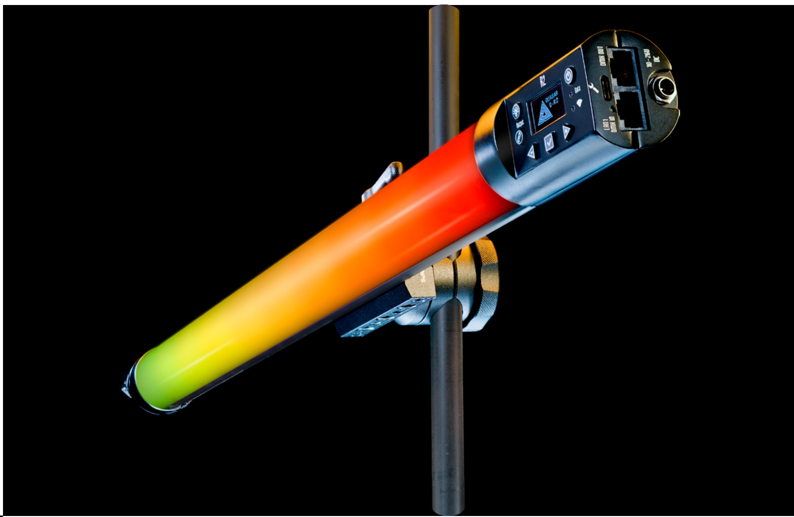
Image-based Lighting (IBL) is transforming the way DPs, console programmers, and technicians approach set lighting. Using the same assets projected onto the volume wall, IBL creates pixel mapped lighting that adds heightened realism to the virtual set. Subtle nuances in light texture, movement, and spectral characteristics create dramatic effect, elevating the storytelling potential of virtual production.

IBL is paving the way for a new level of creativity and excitement in visual storytelling, but not without some challenges that we solve with Quasar Science solutions.

RAINBOW 2

The premier linear LED for motion picture and content creation. High quality tunable white light and the highest RGB color saturation with multiple pixels to maintain super smooth, flicker free dimming, the R2 will be your workhorse. This linear LED light offers incredible data connectivity whether wired or wireless and can be powered anywhere via AC and DC power inputs. Integrated Ossium Mounting System (OMS) allows for rigging in ways previously unobtainable.

Available in: 2’ 4’ 8’



DOUBLE RAINBOW

The Double Rainbow (RR) Linear LED, with its two rows of high fidelity RGBX pixels, creates realistic lighting with vibrant saturated colors and intense white light. A unique shape provides a powerful light source using little space. Wireless and wired data connections mean no data boxes, receivers or transmitters. Built in network switch for simple native connectivity. Integrated Ossium Mounting System (OMS)rigging adapts to everything. AC/DC inputs for continuous power whenever and wherever.

Available in: 2’ 4’

OSSIUM FRAMES

Combine Rainbow tubes into stacked arrays to create a wall of light. Both Rainbow 2 and Double Rainbow bolt on using the integrated Ossium Rail, supported by the solid Ossium Frame. Power up with the included multibank adaptor, and add data for dynamic control of your lighting array. Direct Connect of every industry standard wired and wireless control option from DMX and Bluetooth through to sACN. Simple to set up, with the power to be complex in all the right ways.

Available in: 2’ 4’

Arrays for up to six Double Rainbows or twelve Rainbow 2’s. Please enquire for bespoke 8’ installations.

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