ephesus
SPORTS LIGHTING

FLICKER IN THE EPHESUS LUMASPORT

DEFINITION AND PERCEPTION

Flicker is an unsteadiness or pulsing effect in lighting, causing strobe-like effects where motion appears slower or disjointed. While the human eye can perceive some level of flicker, it's even more evident on cameras and especially in those used for high-speed filming. A common example of cameras capturing flicker is on home videos where an older TV display or computer monitor is in the background, it will look as if the screen has lines pulsing across it.

This effect goes beyond monitor display refresh rates to apply to all light emitting systems. This is a critical consideration in sports lighting, since games are recorded on everything from spectator's cell phones to expensive high-speed cameras. Sports lighting flicker was a significant challenge to older magnetic ballast systems and fluorescent lighting, but it can be evident in newer LED systems too. The way a lighting system is designed determines whether or not flicker might be perceptible to the eye and to the camera.

FLICKER MEASUREMENT AND EPHESUS LUMASPORT

The Alliance for Solid-State Illumination Systems and Technologies (ASSIST) uses two properties to evaluation flicker – percentage flicker and frequency. Using both these properties together will determine how likely it is for flicker to be perceived.

Percentage Flicker - this is a property of the lighting waveform, which means comparing the min and max light output while the fixture is operating.

$$Percent\ Flicker\ (p) = \frac{Maximum - Minimum}{Maximum + Minimum} \times 100\ \%$$

This may seem counterintuitive because it appears that a constant amount of light is being emitted when a light is turned on - but that's not always the case. Depending on how the light fixture is powered and controlled can have a significant impact on the flicker percentage. For LED, this is tied to how the fixture is dimmed using two common methods: pulse-width modulation (PWM) and constant current (CC). PWM is essentially turning the fixture on and off faster than a human eye can detect to accomplish a dimming level below 100%. Constant current by contrast provides a constantly-on light but reduces the current to the LED to dim the light.

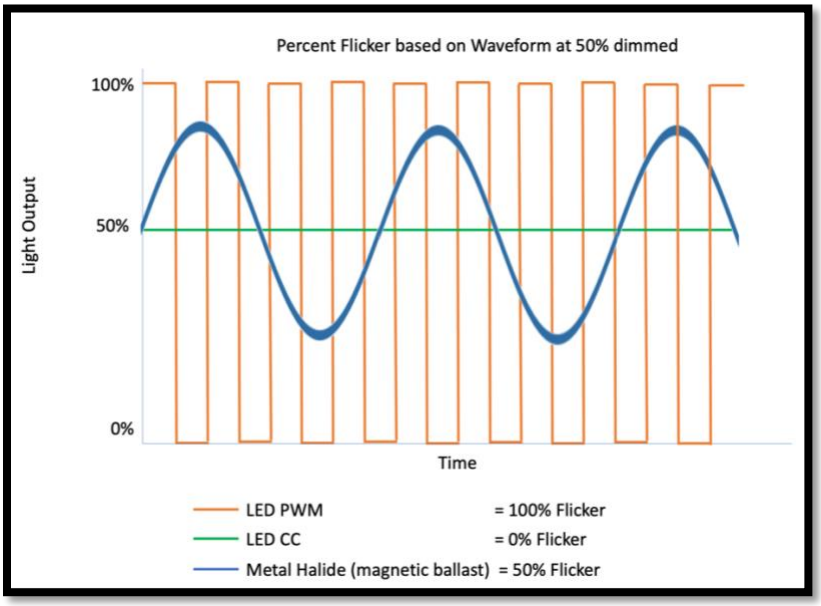

Figure 1: Likelihood of Visible Flicker

The Ephesus LumaSport product uses constant current drivers, meaning the percent flicker is 0%. This has been validated using a flicker meter to sample the output, which returns a value of zero.

Frequency – The percent flicker doesn't tell a complete story, even a fixture with 100% flicker can be imperceptible. Whether or not eyes or cameras see flicker is determined by how quickly the pulsing happens – that is its frequency, measured in Hertz (Hz) which is cycles per second. The human eye cannot directly detect flicker at frequencies higher than 100 Hz.

As cameras capture moving images into individual frames, flicker is caused by frames containing little or no light, making the image seem to sputter or blink. The severity of flicker on camera depends on many variables including the camera frame rate and shutter angle, the light source and the supply voltage. Much of the flickering observed with standard cameras is a result of the camera frame rate being out of sync with lights cycling at 50/60 Hz from AC power. Cell phones record at 100-300 frames per second, and high-speed cameras used for extreme slow motion can capture upward of 2000 frames per second, meaning some of those frames will be very dark and cause visible flicker in the video when played back at slower speeds. For this reason, conventional discharge lighting such as metal-halide and fluorescent lights with older magnetic ballasts are particularly susceptible to flicker, along with low-quality LED solutions that use a low frequency PWM signal to dim.

Higher frequency PWM solutions do not have an issue with camera flicker, because multiple pulses of "on" are captured within one frame of video, so the scene appears fully lit. Constant current solutions have effectively zero flicker.
The amended chart below from the ASSIST study[1] shows how percent flicker and frequency combine to the likelihood that flicker will be noticeable to viewers.

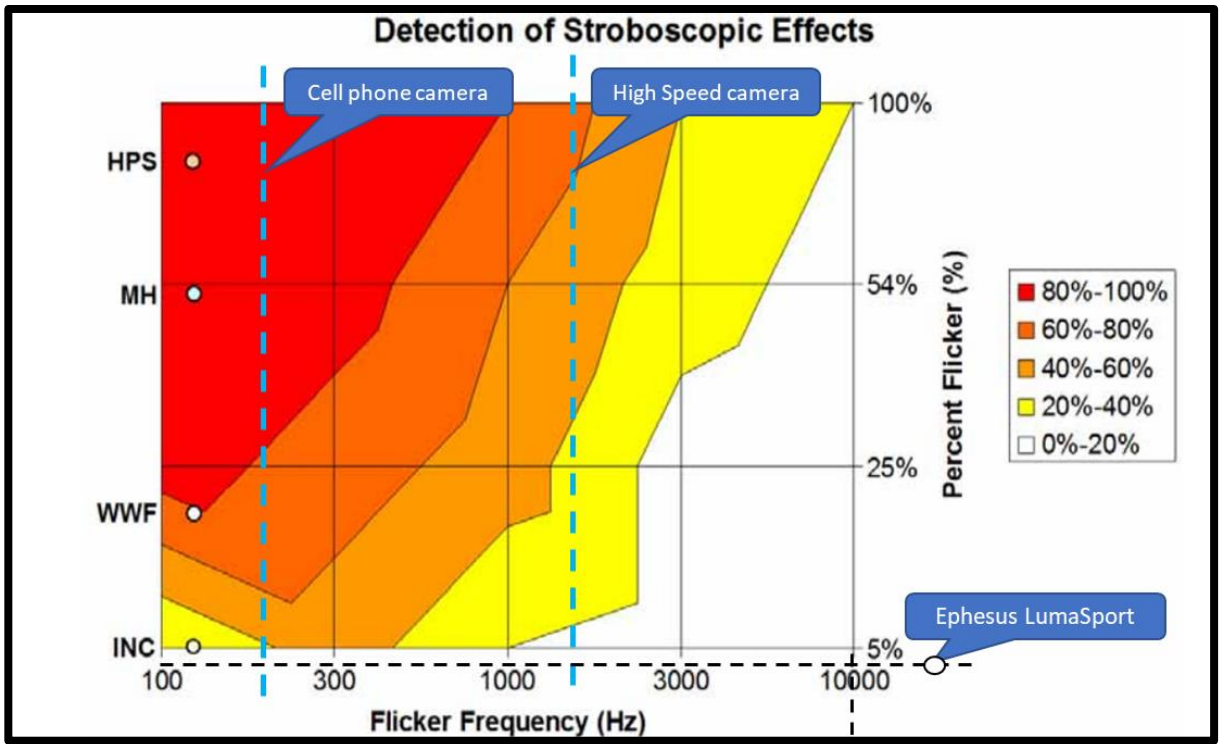

Figure 2: Likelihood of Visible Flicker

References:

[1] Alliance for Solid-State Illumination Systems and Technologies (ASSIST). 2012 *ASSIST recommends … Flicker Parameters for Reducing Stroboscopic Effects from Solid-state Lighting Systems.* Vol 11, Issue 1. Troy, NY Lighting Research Center http://www.lrc.rpi.edu/programs/solidstate/assist/recommends/flicker.asp