

# SPECTRAL EVOLUTION

## Measuring LED Light Intensity & Color

Runway lights play a key role in landing an aircraft as they help the pilot transition from instrument flight to visual flight for landing. As part of its research into more efficient and effective lighting systems, the Federal Aviation Administration (FAA) is assessing the replacement of conventional incandescent based light systems with new LED lighting systems.

Light Emitting Diodes – LEDs – compared to conventional lights use less power and last longer. They represent potential savings as well as more reliable operation. However, before implementing an LED system, the FAA rigorously tests to ensure the LEDs deliver the light intensity and color required for such a crucial system as runway/landing lights.

LEDs consist of a die of semiconductor material impregnated, or doped, with impurities to form a p-n junction. When the LED is switched on – when a forward bias is applied to the LED – current flows from the anode (p side) to the cathode (n side). At the junction, higher energy electrons fill lower energy “holes” in the atomic structure of the cathode material, due to the voltage difference across the electrodes. The energy released by the electrons filling the holes produces both light and heat. The light is reflected upward and the heat is transferred downward into the base of the LED and eventually dissipated. LEDs provide distinct advantages such as exceptionally long life, lower energy consumption, smaller size, faster switching, greater durability, and increased reliability.

In its research, the FAA Lighting System Office calculated that replacing incandescent lights in its Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR), could result in savings close to 24.7 million dollars and that the cost of switching might be amortized by energy savings in only two years.

The program has so far tested LED green threshold lamps to ensure that they produce similar light intensities and colors to incandescent lamps already in use so that pilots would have the same familiar visual cues as now. As part of the testing process, which is performed at William J. Hughes Technical Center, a field portable spectroradiometer is used.

The FAA procured a SPECTRAL EVOLUTION extended range portable spectroradiometer for use in their Visual Guidance Program to test the LEDs. The spectroradiometer provides the following requisite capabilities:

- ◆ Fixed array detectors with a range of 350-2500nm
- ◆ Weight not to exceed 10 lbs.
- ◆ Capable of operating in standalone mode without requiring a laptop
- ◆ Bluetooth communications capability
- ◆ Windows Mobile data acquisition software
- ◆ Software that can automatically calculate both CIE 1931 2 degree and CIE 1964 10 degree chromaticity results

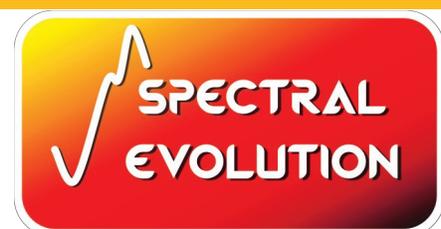


*The FAA has identified LED lighting as a beneficial alternative to current incandescent lighting systems for airport runways.*



*The PSR+ field spectroradiometer is ideal for measuring LED chromaticity and luminosity to meet FAA requirements.*

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## PSR-3500 Capabilities:

- ◆ Fast, full spectrum UV/VIS/NIR measurements with a spectral range from 350-2500nm with just one scan
- ◆ Ultra-fast operation with autoshutter, autoexposure and auto-dark correction before each new scan – no optimization step
- ◆ Small and lightweight with rechargeable Li-ion batteries for field operation
- ◆ Superior signal to noise ratio with faster scan times and better reflectance measurement
- ◆ Reliable field performance with an all photodiode array platform and no moving gratings
- ◆ Single user operation with optional rugged PDA that provides a sunlight readable screen plus the ability to tag spectra with GPS, digital camera images, and audio notes
- ◆ Standalone operation with 1,000 scan storage

In addition to the PSR-3500 and other portable spectroradiometers, SPECTRAL EVOLUTION also offers a full range of portable spectrometers, lab spectrometers, and spectrophotometers. For more information, visit: [www.spectralevolution.com](http://www.spectralevolution.com).

*The PSR-3500 can be used to measure and compare the spectral radiance of an LED (red) versus a halogen (blue) light source.*

LEDs are typically characterized by manufacturers in bins based on lumen, color, and sometime voltage. LEDs within these bins can vary across acceptable performance ranges. Part of the FAA's task is to ensure that the LEDs being used will perform to the criteria required. In addition, as the FAA has continued to bring LED technology to various aviation lighting applications, the agency has performed tests to understand the benefits and differences that LEDs bring to the table. For example, research with LEDs on signal light brightness includes measurement of color saturation since that characteristic increases the perception of brightness. In tests, the FAA conducted a study to identify brightness/luminous intensity ratio values for white, green, and blue LED signals relative to incandescent signals of the same nominal color. The results indicated that the LED signals were generally judged brighter than their incandescent counterparts. The results helped the FAA develop a general model for testing signal lights of any chromaticity within the FAA color boundaries to ensure that they met brightness/luminous intensity requirements.

The FAA has also researched their chromaticity boundaries for white light, adjusting the current color boundary based on LEDs to extend less into the "yellow" region and expanding slightly into the "blue" region. The research also investigated the acceptability of chromaticity points to pilots as they would be observed in use.

Within the FAA's research, the ability to accurately measure the chromaticity of LEDs as well as the brightness/luminosity is key not only to correctly characterize LEDs for use as acceptable, but also to measure projected lifecycle use with color shift. As LEDs are used over time, they have a tendency to shift colors as performance decreases. Measuring color stability is a key characteristic in aviation applications such as runway, signal, and taxiway light systems. A PSR-3500 field spectroradiometer can deliver measurement capabilities to help the FAA set the standards necessary to realize the full potential of LED lighting in these applications.



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