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LED Solar Simulator

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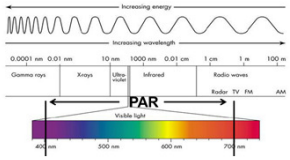
Introduction

To more completely understand the behavior of algae it was desired that Utah State University develop a way to further understand the effects of light on algae. While it is understood that light in the PAR range is required for growth, the spectral effects on algae in this range are not well understood . It was USU intention to design a light source whose light flux could be varied at specified wavelengths within the PAR range.

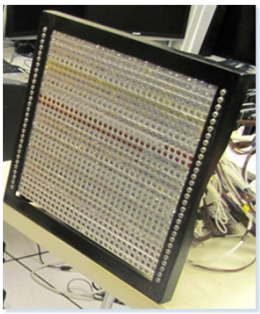
The figure directly to the right illustrates where on the electromagnetic spectrum that the PAR range or also known as the visible light spectrum occurs.

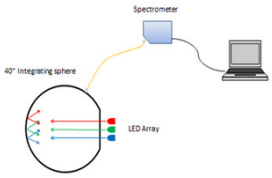


Some studies have indicated that by providing a monochromatic light source of a particular color yielded algae pigments of the complimentary color. This pigment alteration could be significant for the cosmetic, food, and pharmaceutical industries.

Methods and Testing

26 different types of 5mm LEDs were chosen to make the light source spanning from 375nm to 720nm. There are a total of 900 LEDs that make up the LED array shown here in the figure directly to the right. Once the array was assembled the output was tested using an integrating sphere and a spectrometer.



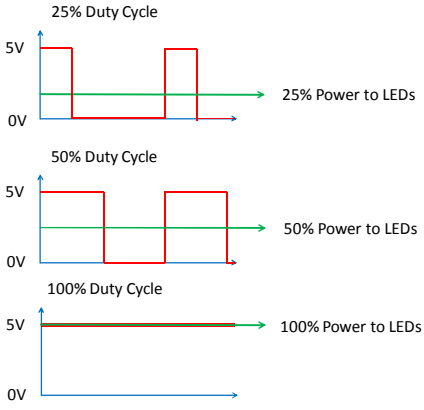


The diagram to the left illustrates the test setup of the spectrometer and integrating sphere.

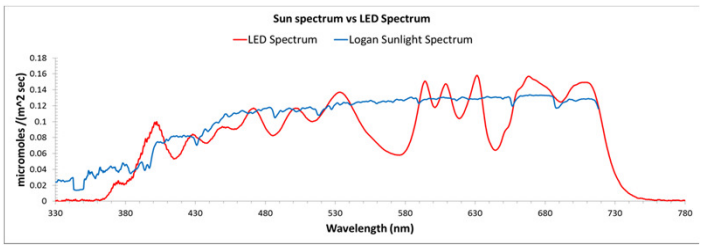
This is a look inside the 40" integrating sphere at the LEDs during testing showing how the light is diffused throughout the inside surface. Thus capturing all light leaving the front of the LED array.

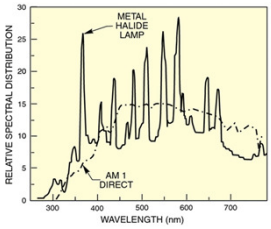
Control System

PWM's from National Instruments were used to control each bank of LEDs. Each bank is made up of LEDs of the same nominal peak wavelength. There are currently 32 available banks/channels controlling the LEDs. The LED intensity is altered by changing the duty cycle of that particular channel.



Solar Spectrum vs. LED spectrum





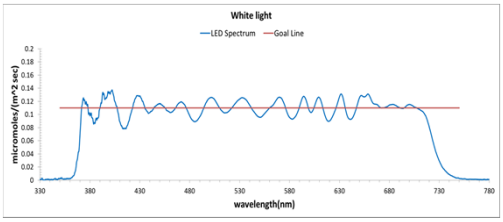
Many light sources attempt to mimic the solar spectrum. Here in the figure above we have been able to tune our light source to mimic the solar spectrum. The blue line represents the solar spectrum while the red line represents the actual output of the Led array at a much lower light intensity than full sunlight. This can be beneficial in biological studies since full sunlight intensity can inhibit growth.

Commonly metal halide lamps are used in solar simulators. In the figure to the left the solar spectrum is seen as the dashed line while the output of the Metal Halide Lamp is represented by the continuous line.

The LED array has the ability to follow the solar spectrum curve even without any filtration much closer than traditional light sources such as metal halide lamps .

White Light

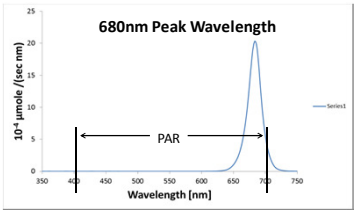
Through tuning of the control system we are able to have a neutral output of intensity at all wave lengths through the interested range. The red line found on the figure to the right represents the goal or ideal output while the blue line represents the actual output of the LED array. This is significant in that it would provide a baseline in algae light experiments. From this comparisons could be made with very narrow wavelength bands. Thus indicating effects certain wavelengths of light have on algae.



LED

Why LEDs were chosen to build the light source:

- Narrow spectral band widths as can be seen in the figure to the right
- When connected to PWM (pulse width modulation) the LEDs can be pulsed
  - This prevents photo inhibition
  - Provides more efficient growth
- LEDs produce what is known as "cold" light meaning that more of the electricity is used to make light in the intended region rather than generating heat.



Acknowledgments

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