Photovoltaic Testing: Low-Cost Smart Solar Simulator

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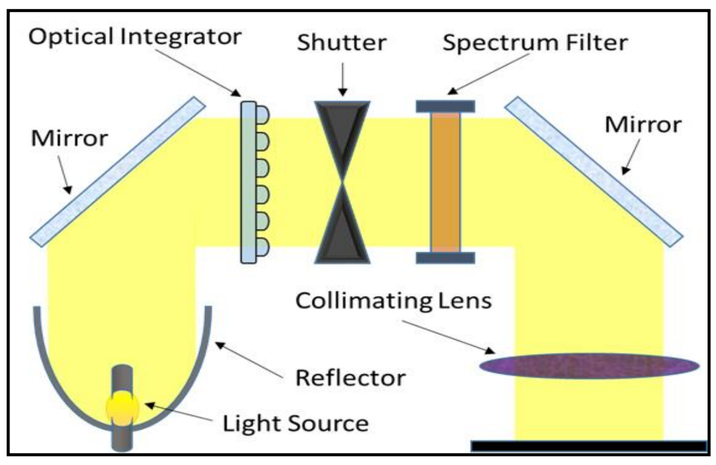
SOLAR SIMULATORS

One of the principal instruments used in the testing of solar technologies are solar simulators. They can replicate the irradiance and spectral output of the sun in order to test photovoltaic solar cells in an indoor environment. In order to be considered a solar simulator the instrument has to meet certain standards stablished by the following organizations: ASTM, IEC or JIS.



Example of one of the most used models in the industry of solar simulators with its main components

DRAWBACKS

Actual Solar simulators in the industry are very expensive and might not be accessible to research and academic teams with a low budget. In addition to the high cost, most solar simulator use light sources that are volatile and have a short life-span. Solar simulators in the market need additional filters and optical lens when using common light sources such as: Xenon Arc, Metal Halide Arc and Quartz Tungsten Halogen

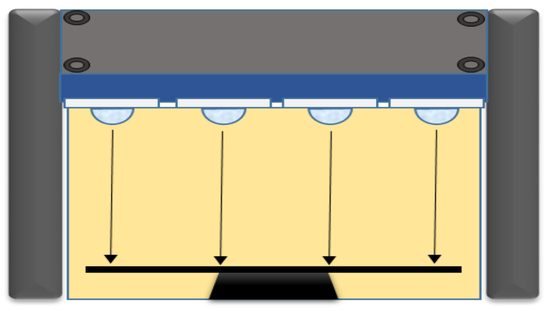
Factors of a solar simulator	Advantages	Disadvantages
Controlled environment	■	
Accuracy	■	
Money		■
Spectral matching		■
Faster testing	■	

PROPOSITION & OBJECTIVES

By changing the light source of the device to LEDs, a better spectral match, longer life expectancy and more accuracy can be obtain while saving money and energy.

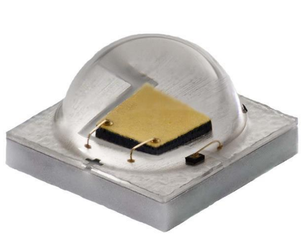
As the project moves forward the focus is:

- The broader analysis to acquire the data for an optimal LED source selection
- The refinement of the testing procedures, the testing platform and tools for compiling the data required for validation against the ASTM standards
- The development of a preliminary prototype for physical testing of design capabilities. Using the acquired data to develop the first official-fully functional solar simulator prototype that can be validated with the ASTM standards



Example of a basic LED direct light source solar simulator system

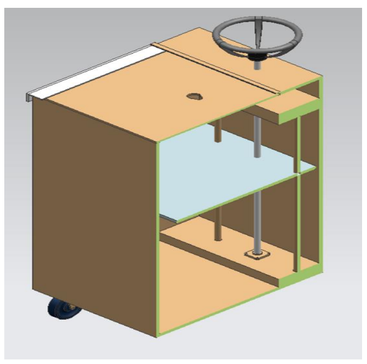
LED SELECTION AND TESTING



LED selection was made in according with the voltage and current of each LED of a specific wavelength, to maintain a lower power consumption in the circuit and LED array. The sensor used was the spectroradiometer GER1500, shown above. This sensor allows to take measurements from direct light. The sensing was done inside of the testing platform, the LED were irradiating in a top wise direction and the sensor was in front of the irradiated direction.

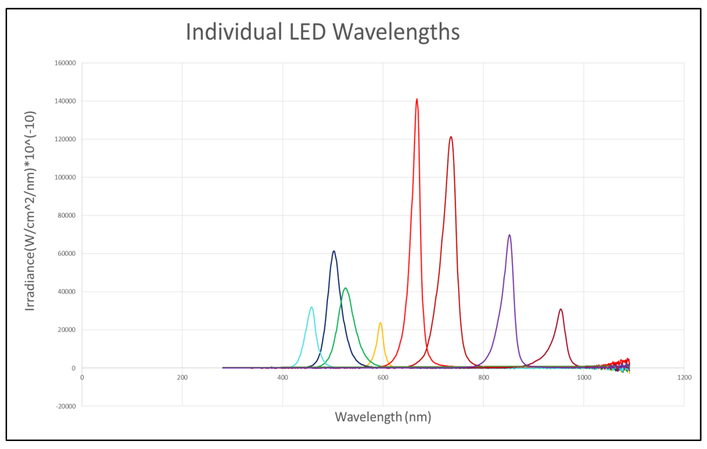
PLATAFORM CONSTRUCTION

The testing platform was created to analyze the behavior of LEDs through a safe environment for the students.



The platform was design with a base for the LEDs in order to change the height of the measurements using the steering wheel. The space below the base for the LEDs can carry a power supply for the LEDs. The design has space for other sensors, if other testing are required, and testing small prototypes.

TESTING RESULTS



Spectrum intensity of the individually LEDs tested

Presented above is the intensity by wavelength of the tested LEDs Testing was done using the testing platform and a 4 point square array.

Important points considered:

•The greater LED count of the same wavelength the better the intensity
•The greater number of LED the better the solar spectrum simulation
•Different LED array can converge into white light
•Different LED array have different uniformity by distance

CONCLUSION

The data obtained form the testing shows that LEDs are dependable light source for a solar simulator. Combining LEDs, the wavelenght, intensity and irradiance the sunlight can be recreated.

FUTURE WORK

- Testing of different LED array for LED selection and optimal uniformity pattern
- Developing a prototype system
- Verify the functionality according to the ASTM standards

REFERENCES

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