Angular Response Calibration System for Solar Radiation Instruments coupled to a Digital Galvanometer

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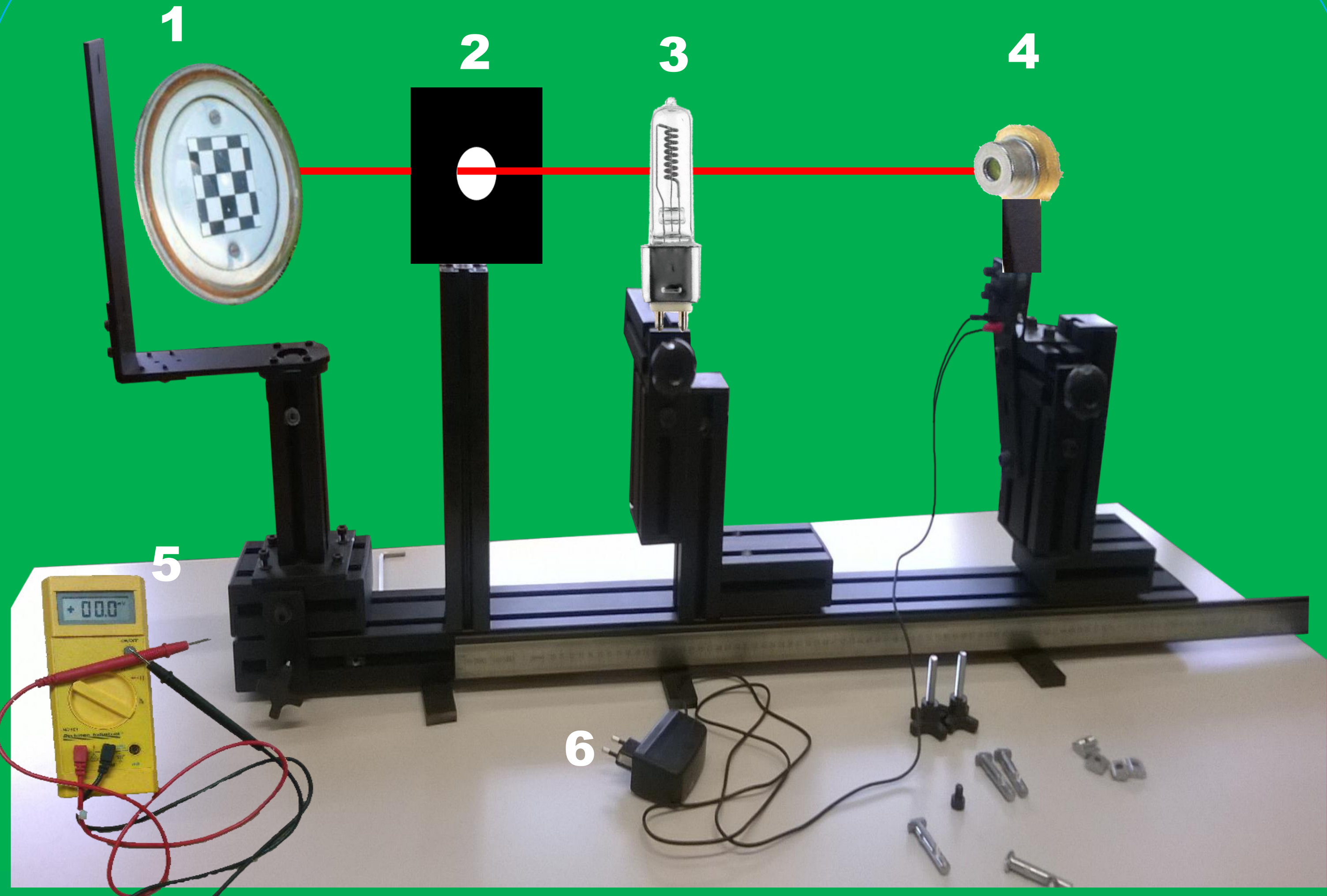
Abstract:

With the objective to determine the sun altitude correction factor (Fh) for pyranometers used on measurements for Solar Radiation Diagnostic Service for Cuba (SDRS, http://www.goac.cu/actino/), an Angular Response Calibration System has been installed. This system will be operated by the Atmospheric Optics Group of Camagüey (GOAC). The installation of this system, unique of its kind in the country, has been possible through a collaboration project with the Atmospheric Optics Group of Valladolid University (GOA-UVA). For the use of this system, has been necessary design and construct both, a power source for the halogen lamp used in the calibration procedure, as well as, a digital galvanometer to collect data measurements. This last one instrument is coupled to the sensors during the calibration process will be replicated in order to substitute their analogic homologues in the SDRS.

Local Characteristic

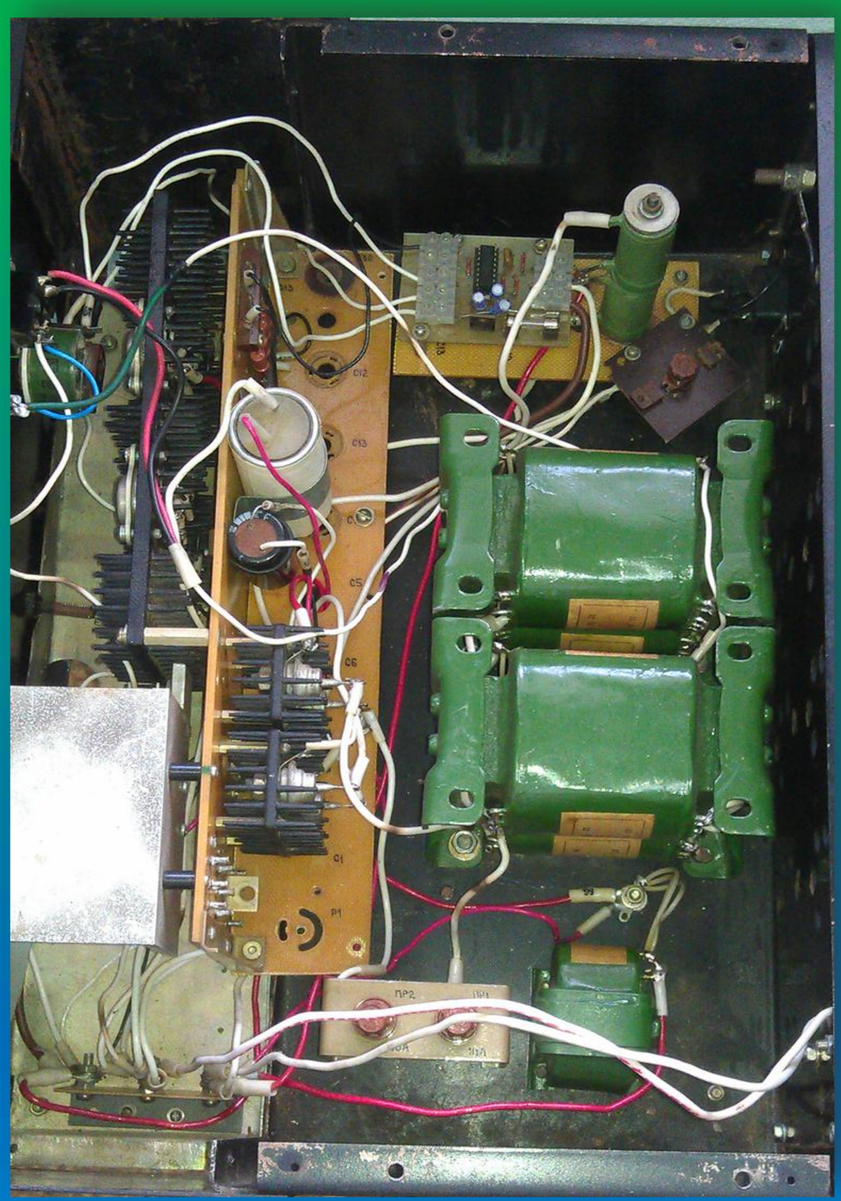
Walls and roof painted of matt black to avoid the light reflection, with the objective that sensor receive only the lamp light.

Angular Response Calibration System



1- Pyranometer 4- Pointer Laser 5- Voltimeter
2- Baffle 3- Patron Lamp 6- Laser Supply

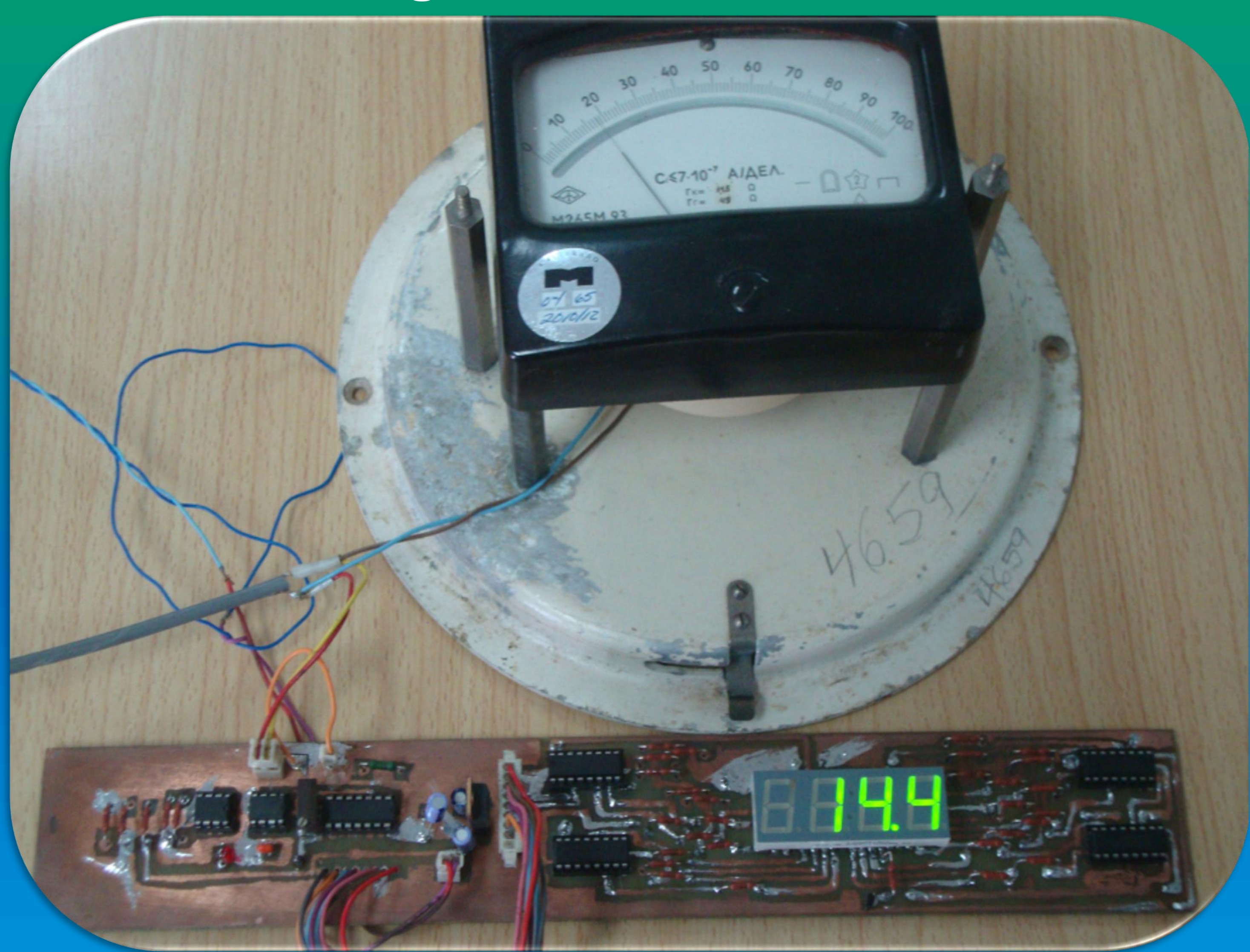
Lamp Power Supply



Almost all the components were recycled from old soviet power sources.

Vin= 220Vac/60Hz
Vout= 5 – 24Vdc
Iout = 10A
P = 250W

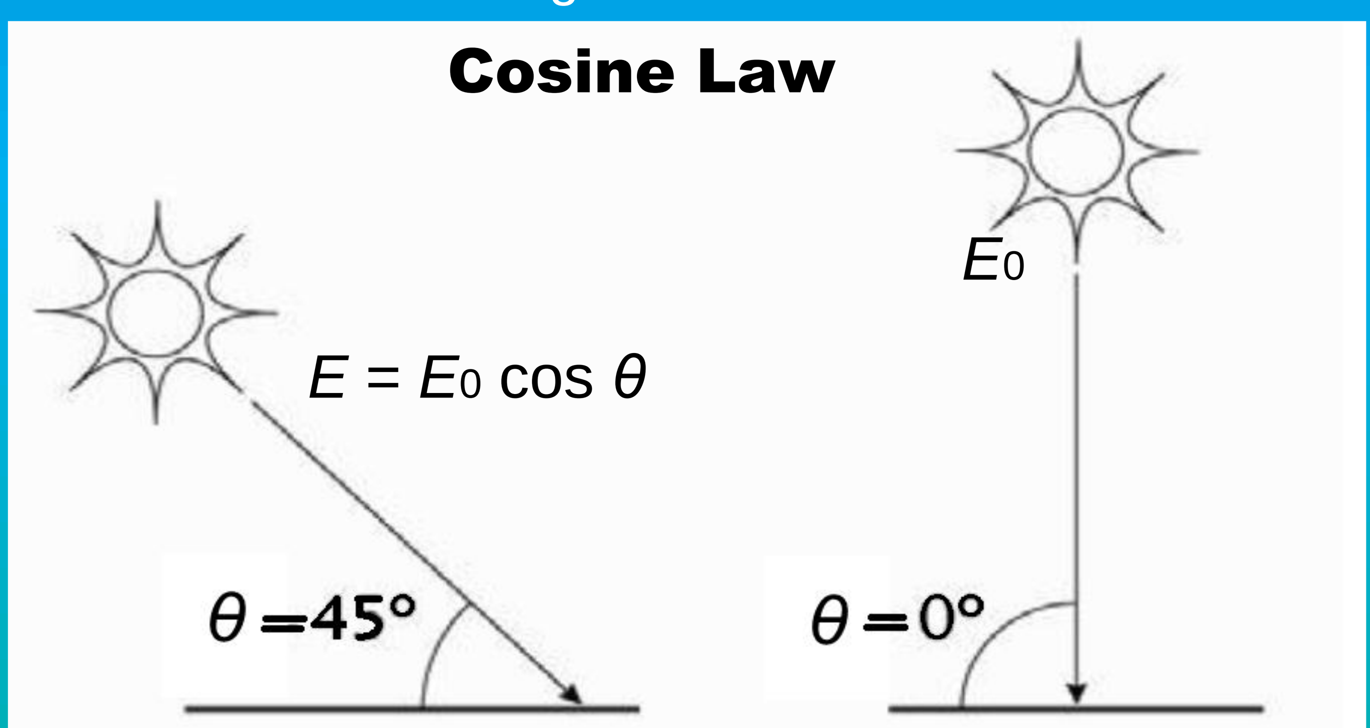
Digital Galvanometer



The digital galvanometer will replace the old analog version and will improve the measurements quality taken by the observer, eliminating, between others, the parallax error.

The cosine error for radiometric instruments is defined as the deviation present in the measurements due to the difference between the instrument angular response and the ideal angular response, also known as cosine or Lambert-Law response.

The Lambert-Law (or Lambert's cosine law) states that the lighting produced on a given surface by a punctual light source is proportional to the cosine of the angle of incidence.



The correction factor (*Fh*) is defined as quotient between measurement global irradiance by the instrument ($E^g_{measurement}$) and global irradiance (E^g_{ideal}) according to Lambert-Law response.

$$Fh = \frac{E^g_{mearsurement}}{E^g_{ideal}}$$

General equation for the determination of the correction factor.

Equation for determining *Fh* in the facility.

$$Fh = \frac{U_{(\theta)}}{U_{(\theta=0^\circ)}\, cos\theta}$$

Where $U_{(\theta)}$ is the measured signal at the θ angle, and $U_{(\theta=0^\circ)}$ is the corresponding incident signal to the normal. This value, $U_{(\theta)}$, is obtained from the digital galvanometer in millivolt.

Conclusions

- With this calibration system, unique of its kind in Cuba, we will be able to use recovered pyranometers.
- The power supply source of the lamp and the built digital galvanometer are instruments that will save lot of money to the country by importation concept.
- In the case of the galvanometer, only will be necessary to buy some components, which is cheaper than buying a voltmeter.
- The digital galvanometer improves the quality of actinometrical measurement observations.

Acknowledgements

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