A NEW SILICON PHOTOVOLTAIC PYRANOMETER FOR MEASURING SOLAR IRRADIANCE

IN METEOROLOGICAL AND SOLAR RESOURCE APPLICATIONS

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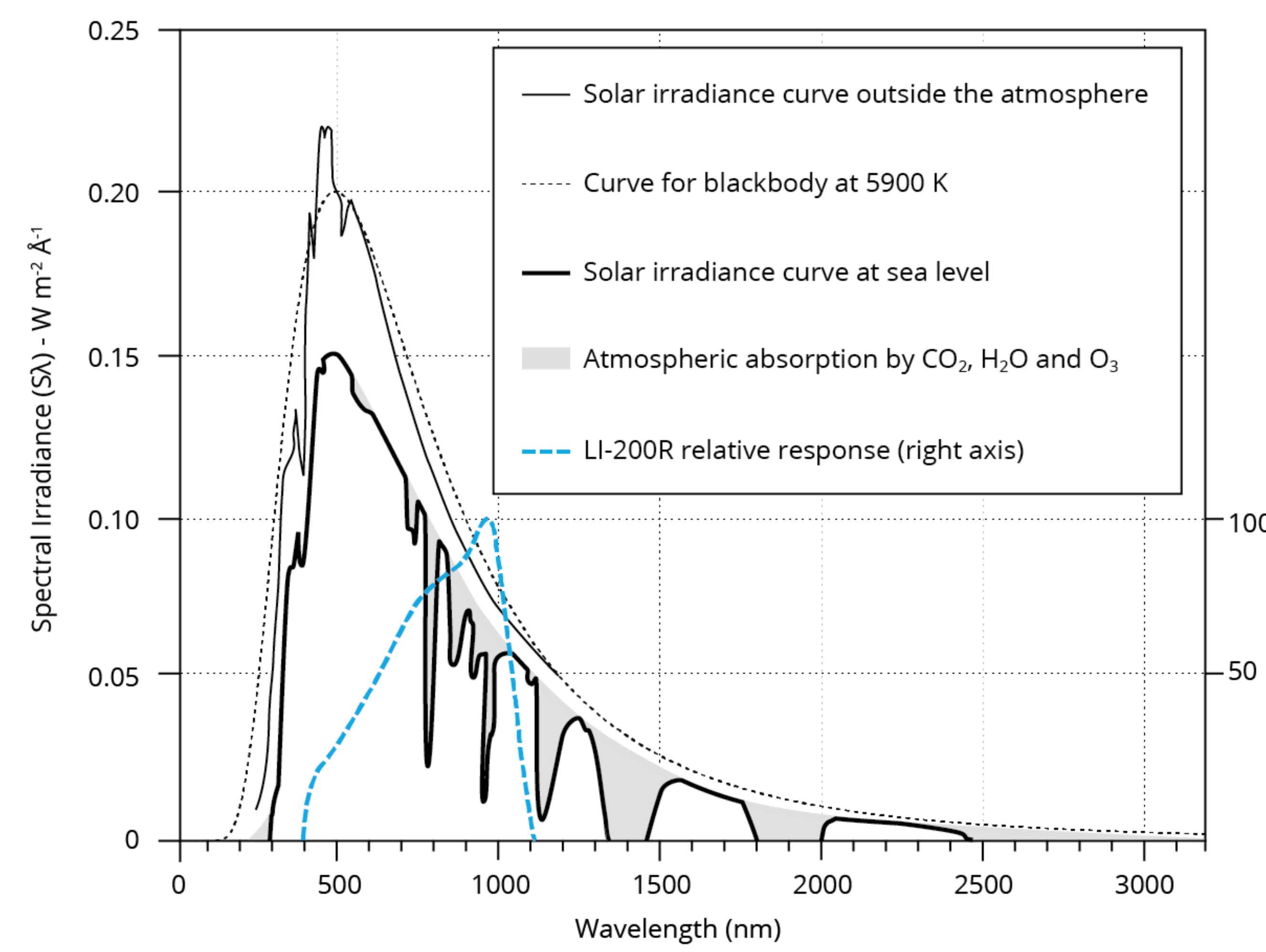
INTRODUCTION

- LI-COR solar radiation measurements:
  - Designing solar radiation sensors for over 40 years
  - Sensors used at thousands of locations around the world
  - Used for solar resource assessment, photovoltaic efficiency monitoring, meteorological and agricultural studies
- Silicon photovoltaic design advantages of LI-200 Pyranometer:
  - Low-maintenance, proven field performance [2, 3]
  - Lower cost than thermopile designs
  - Lower sensitivity to dust and dirt compared to thermopile designs
  - Response time less than 1μS (2m cable terminated into 147 Ω load)

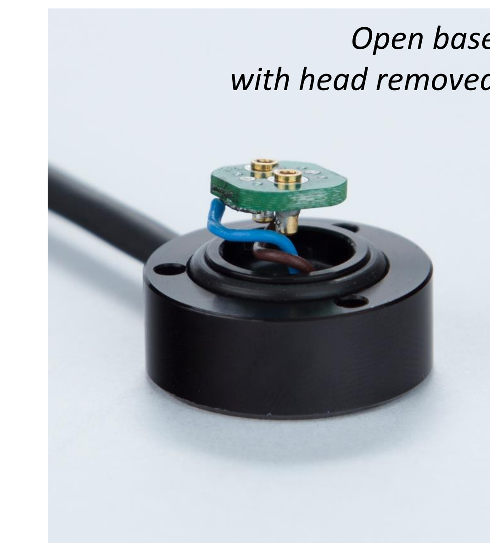
REFERENCE LI-200 PYRANOMETER



The LI-200SA Pyranometer spectral response along with the energy distribution in the solar spectrum. [1, 2]

- In unobstructed daylight conditions, LI-200 Pyranometer compares well with thermopile pyranometers [1, 2, 3]
- LI-200: silicon photovoltaic detector, fully cosine-corrected miniature head, current output directly proportional to solar radiation

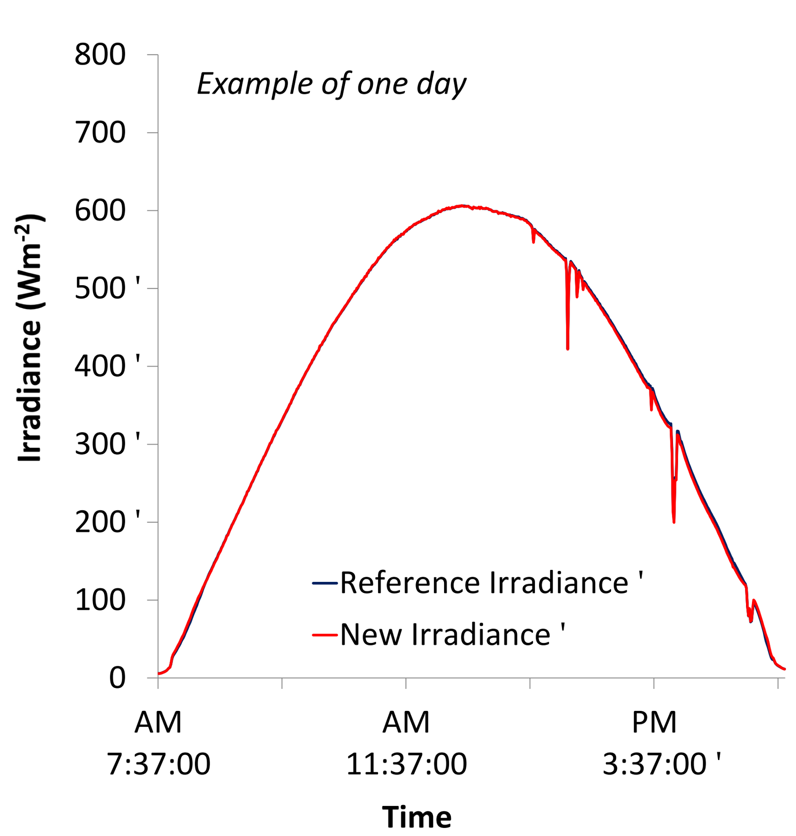
NEW LI-200R PYRANOMETER



- Detachable sensor head
- Easy removal for calibration w/o unwiring
- Larger drain for improved water shedding
- High-speed, fully cosine corrected
- Designed for continuous monitoring
- μA and mV (with adapter) output
- Sensitivity typically 90μA per 1000 Wm^{-2}

PERFORMANCE OF NEW vs OLD DESIGNS: LATEST RESULTS

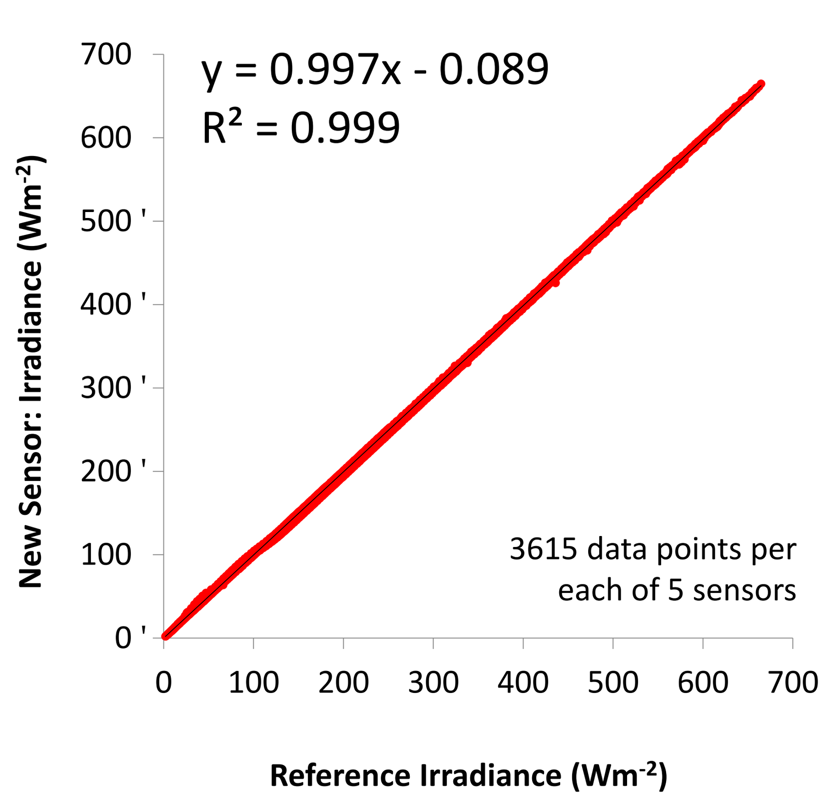
Daily Irradiance



Irradiance from new LI-200R and reference LI-200 sensors. Values represent an average of 5 pyranometers.

Under unobstructed daylight conditions, new LI-200R pyranometer compared well with reference LI-200

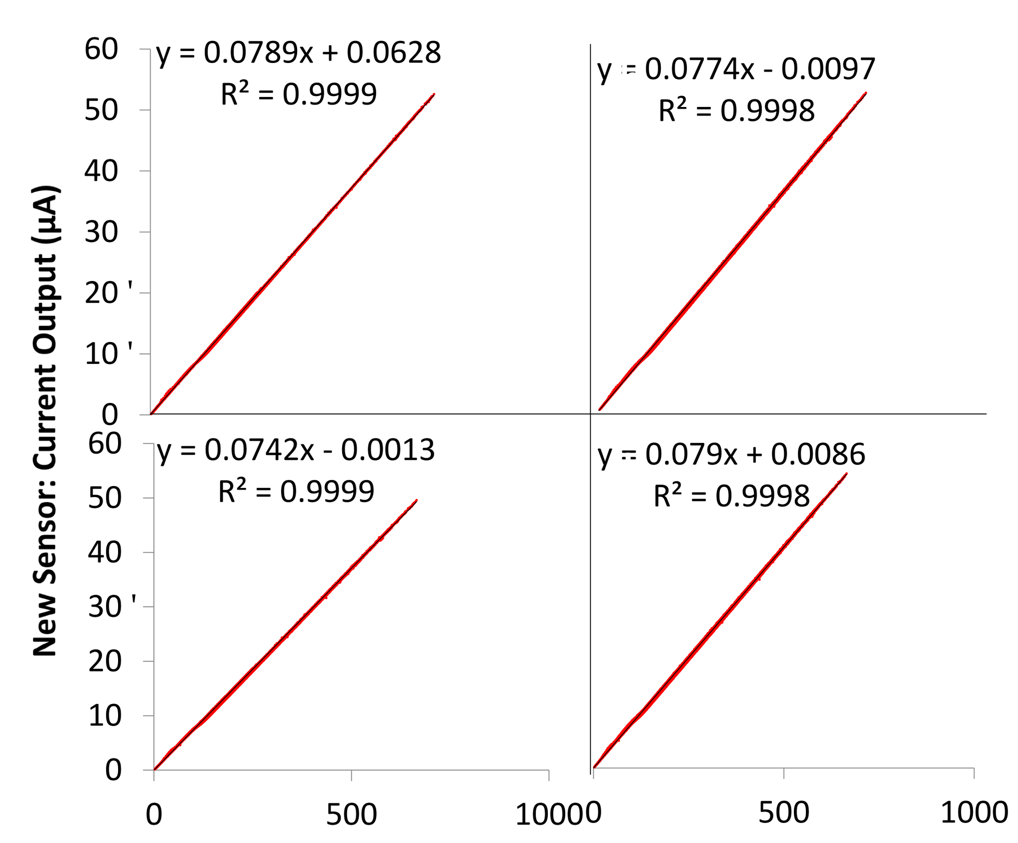
Irradiance Response



Irradiance from new LI-200R sensors plotted against irradiance values from reference LI-200 sensors

In 1:1 comparison, new LI-200R performed well vs reference LI-200 at 1 minute intervals with no averaging

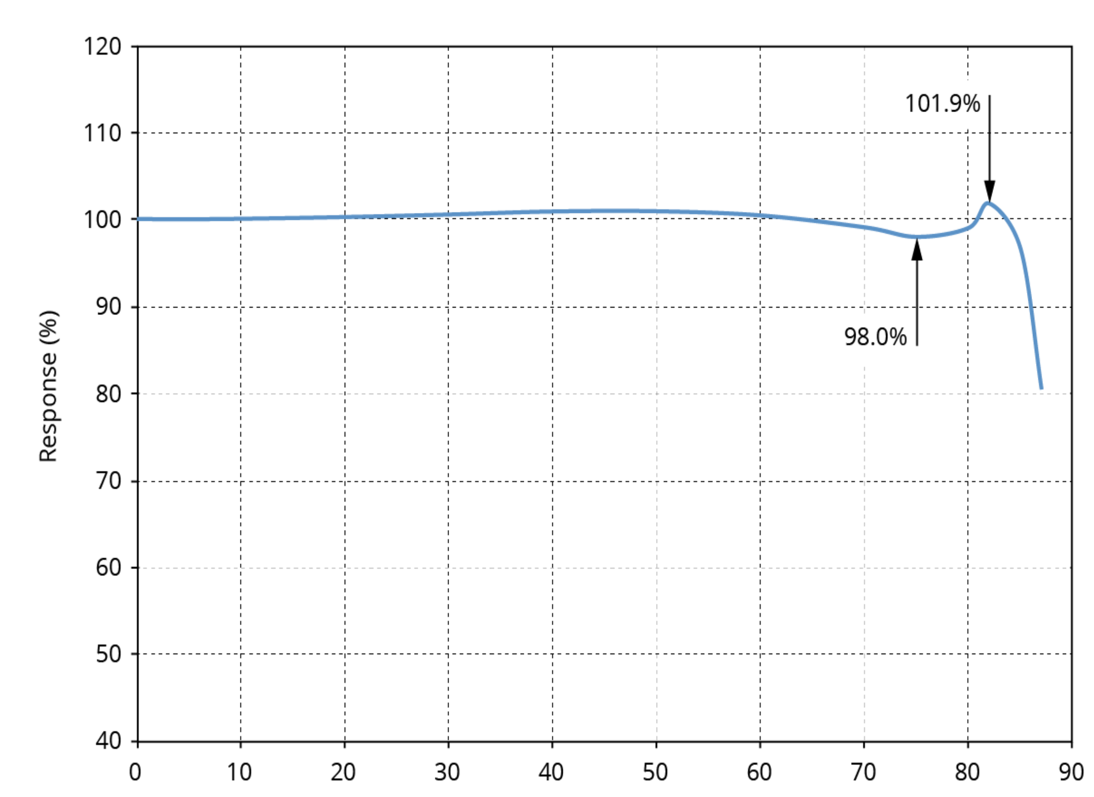
New Design Output vs. Reference



Current (μA) output from new LI-200R sensors as function of reference LI-200 irradiance (Wm^{-2})

New LI-200R performed well vs reference LI-200 (data for 1 minute intervals with no averaging)

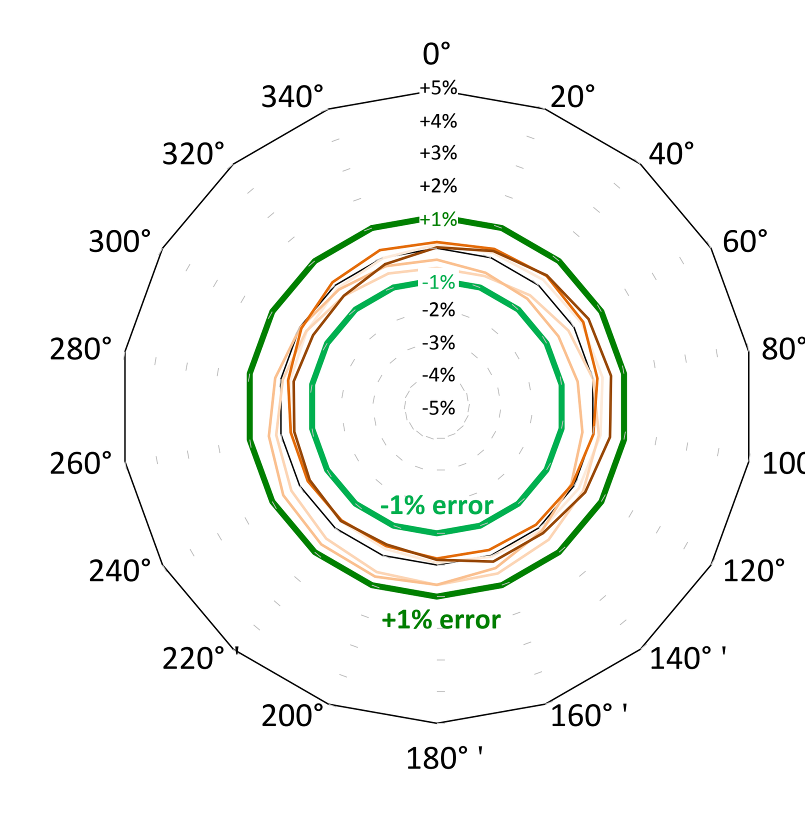
New Design Cosine Response



The sensitivity of new LI-200R sensors as a function of angle of incidence

Cosine response is corrected well up to 82° angle of incidence*

New Design Azimuth Response



Azimuth errors for a set of 5 new LI-200R sensors at 45° angle of incidence

Errors were below 1% in new LI-200R over 360° at 45°elevation

*A sensor without an accurate cosine correction can give a severe error at low solar elevation angles. The cosine error at angle 0 is the percent difference of the ratio of the measured output at angle 0 and normal incidence (angle 0°) as compared to the cosine of angle 0

REFERENCES

[1] Biggs, William W. (1984). Principles of Radiation Measurement. LI-COR, Inc. Lincoln, NE
[2] Kerr, J. P., Thurtell, G. W., & Tanner, C. B. (1967). An integrating pyranometer for climatological observer stations and mesoscale networks. Journal of Applied Meteorology, 6(4), 688-694.
[3] Weiss, A., & Norman, J. M. (1985). Partitioning solar radiation into direct and diffuse, visible and near-infrared components. Agricultural and Forest meteorology, 34(2), 205-213.