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Downward Blue Drift of Quantum Sensors

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Silicon photodiodes are known to decrease more rapidly in response to blue light than to longer wavelengths (Korde and Geist, 1987). Older quantum sensors thus appear to calibrate accurately using the LI-COR 1800-02 Optical Radiation Calibrator, but may under-report radiation in the 400 – 500 nm wavelengths (blue) due to degradation of the silicon photodiode in the sensor.

This has been observed in all three of the LI-COR LI-190 quantum sensors used in the NCERA-101 Quantum Sensor Calibration Package. These ten-year-old sensors (sn about 25000), have been stored under cool, dry laboratory conditions and are calibrated multiple times each year. Over time, we have observed that the sensors read low under fluorescent lights when compared to new LI-COR sensors. During the past two years all three of the original sensors have required replacement of the photodiode. We have also added a fourth, new sensor.

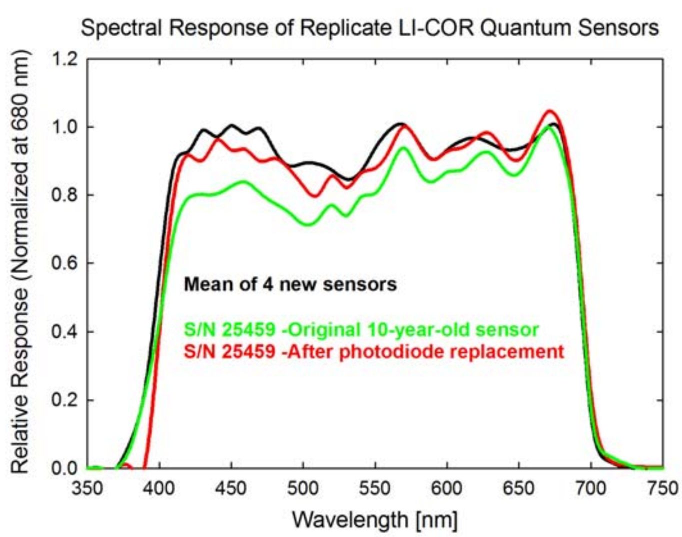
Silicon photodiode output is reduced over time in two ways:

1) General degradation, characterized by a reduction in output across the entire 400 – 700 nm bandwidth. To correct this, the calibration multiplier is increased.

2) Selective degradation in the blue (400–500 nm) wavelengths. This cannot be corrected by increasing the calibration multiplier.

Positive diagnosis of this blue drift must be made using a monochromator. However, a field diagnosis can be made by comparing the output of the sensor in question under light sources with a low and a high fraction of blue light. Compare the output under high-pressure sodium lamps to the mean of 3 newer, recently calibrated, quantum sensors. Then compare the sensors under cool-white fluorescent lamps. If the older sensor is more accurate under HPS than CWF it is likely due to selective blue drift.

A sensor with selective blue drift will need to have the photodiode replaced by LI-COR. You should clearly instruct LI-COR to check for blue drift and replace the photodiode if their monochrometer test indicates blue degradation. LICOR does not replace photodiodes until the overall error in calibration is greater than 5%. The sensor represented by the green line at the right, originally passed the LICOR calibration test, but was rebuilt at our request.



Korde R. and Geist, J. 1987. Quantum efficiency stability of silicon photodiodes. Applied Optics 26:24: 5284-5290.