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Engineering Note

Topic: STS Spectrometer Electric Dark Correction

Product Affected: STS Spectrometers

Date Issued: 12/20/2011

Description

The STS automatically compensates for baseline drift with temperature in a way that is at least as effective as electric dark correction for every measurement other than Scope mode.

The STS cannot do exactly the same electric dark correction available on other Ocean Optics spectrometers because its detector does not have optically masked pixels. However, the STS does perform an on-board temperature compensation that achieves most of the desirable effects of electric dark correction. For almost every measurement (scope minus dark, absorbance, reflection, transmission, relative/absolute irradiance, and subsequent calculations like color and photometry) the compensation that the STS does automatically is at least as good as what other Ocean Optics spectrometers achieve through electric dark correction.

Consider that the digitized value of a given pixel on a detector is a function of multiple terms:

$$Vp = Pp + B + T + D + E$$

Where:

- Vp is the digitized value at pixel p
- Pp is the photonic response at pixel p (the change in value due to photons actually received)
- B is the baseline level of the detector which is due to analog offsets
- T is an offset in the baseline due to temperature
- D is dark current: leakage of charge in the detector that is cumulative over the integration time
- E is other error: linearity error, quantization error, noise, etc. This does not include stray light because that is a photonic response as far as the detector is concerned, even if it is not desirable.

In an ideal situation, $Vp = Pp$. That is, ideally, the value for a pixel is the photonic response and nothing else. To create an effective instrument, the other terms need to be removed, or at least significantly reduced. This is typically done as follows:

- B is removed by subtracting a dark spectrum early in a measurement
- E is mitigated through linearity correction, averaging, boxcar, etc.

This leaves the drift in baseline due to temperature (T), and dark current (D). How these are compensated for depends on the detector.

Some detectors have pixels that are optically masked. For these pixels, $Pp = 0$ (at least it should be). Through averaging, E can be practically zero. This means that these "electric dark" pixels have a response as follows:

$$V\_edp = B + T + D$$

By subtracting the value of these pixels from the rest of the spectrum, the baseline, dark current, and temperature offset are effectively removed, leaving just Pp and E, where E is reduced through averaging/boxcar.

The ELIS detector in the STS does not have "electric dark" pixels. However, there is a way to very accurately estimate and remove T (the drift in baseline due to temperature), which makes the effective baseline (B) constant at 1500 counts. This means that there are two remaining terms that need to be removed to make an effective measurement: B (baseline) and D (dark current).

Both of these terms are removed simply by subtracting a dark spectrum in the application and keeping the integration time the same (which is recommended practice anyway) to keep the dark current constant.

Thus, the spectrum from an STS can be compensated at least as well as for other spectrometers as long as a dark spectrum is being subtracted as part of the measurement. The only time this is not the case is in Scope mode, which is not recommended for anything other than diagnostics due to unit-to-unit variation. In some ways, the STS temperature compensation is superior; it is less noisy than electric dark correction because it has more information to work with, and it is all done automatically within the device.