SPECTRAL EVOLUTION

Confidence in Calibration

Calibration produces trusted data based on traceability to standards, awareness of measurement uncertainties, verification and validation. Calibration characterizes the parameters needed to understand and describe a sensor's performance. Radiometric calibration identifies and quantifies a sensor's response to a known radiometric input—usually from an integrating sphere. In a perfect scenario, there would be an unbreakable audit trail of calibration from standards to integrating sphere to a satellite sensor in space. To achieve this goal, scientists and engineers start with NIST-traceable radiometric calibration standards. As satellite sensors improve in precision and accuracy, the need for rigorous pre-launch radiometric calibration becomes increasingly important. A series of detailed calibrations are used to fully characterize satellite sensors' wavelength scale, spectral response functions, pointing sensitivity, radiometric accuracy and other key parameters.

Detailed calibrations using integrated spheres are used to fully characterize satellite instruments.

Integrating spheres show very uniform radiance distribution and are used in a range of applications for the testing and calibration of imaging and non-imaging systems such as focal plane arrays and cameras. They may be used to perform pixel gain normalization, photographic sensitometry, and remote observation system calibration, including the test and calibration of instruments for multi-spectral and hyperspectral imaging. To ensure traceability back to standards, integrating spheres need periodic calibration. Typically, shipment back to a vendor's lab is rarely practical and scientists require a way to calibrate at their location. That location is usually a room where a large sphere using high wattage FELS lamps can create ambient heat. For some spectroradiometers and radiometers, the heat can cause the silicon arrays used to overheat, giving uncertain results in the UV-VIS wavelengths.

The SR-4500 and SR-4500A portable spectroradiometers are designed for radiometric calibration transfer, and cover the spectral range from 350-2500nm.

An ideal transfer standard, according to NIST, would have uniform and smooth power distribution with high correlated color temperature across the intended spectral range, low aging rate, uniform spatial intensity distribution, and good reproducibility. To meet the needs of integrating sphere owners who have system lamps with high operating hours, light sources more than two years old, a mandate for annual calibration, or systems too large to send out for calibration, the SR-4500, SR-4500A and SR-6500A spectroradiometers from SPECTRAL EVOLUTION can be used for on-site calibration and deliver stable performance without drift across a range of ambient temperatures.

The SR-6500A delivers the highest resolution available in a portable spectroradiometer plus high drift stability.

Lightweight and portable, the SR-4500, SR-4500A and SR-6500A provide the ultimate in high performance and measurement stability across a wide range of ambient temperatures and environments. The SR-4500, SR-4500A and SR-6500A's measurement stability eliminates variability between various integrating spheres and retains NIST traceability. The SR-4500, SR-4500A and SR-6500A include three thermoelectrically cooled photodiode arrays and have been built to meet the needs of our customers such as NIST and NASA.

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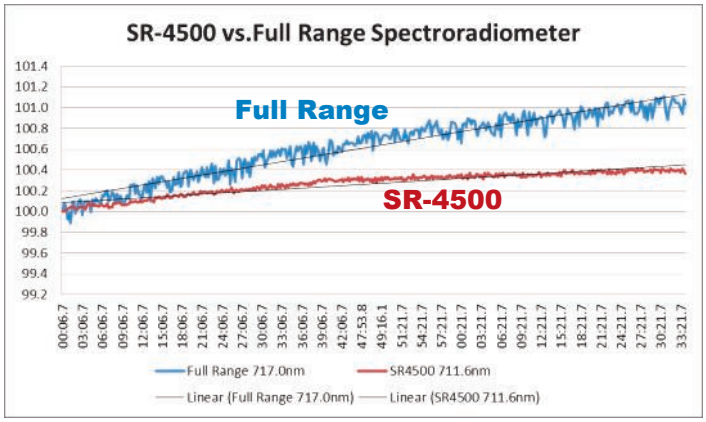
SPECTRAL EVOLUTION

SR-4500/SR-4500A Features

- Spectral range: 350-2500nm
- 3 TE-cooled photodioide arrays
  512 element Si (350-1000nm)
  256 element extended InGaAs (1000-1900nm)
  256 element extended InGaAs (1900-2500nm)
- Wireless Bluetooth and USB interfaces, optional Ethernet interface available
- Spectral resolution:
  3nm @700nm
  8nm @ 1500nm
  6nm @ 2100nm
- Sampling bandwidth:
  Data output in 1 nm increments; 2151 channels reported
- Unmatched Noise Equivalence Radiance performance superior to uncooled Si array instruments (1.2 meter fiber optic)
  $0.2x10^{-9}$ W/cm^2/nm/sr @ 400nm
  $0.2x10^{-9}$ W/cm^2/nm/sr @ 700nm
  $0.9x10^{-9}$ W/cm^2/nm/sr @ 900nm
- Optional Labview Virtual Interface also available
- DARWin SP Data Acquisition software

SR-6500A

- Spectral resolution
  1.5nm @ 700nm
  3.0nm @ 1500nm
  3.8nm @ 2100nm
- Noise Equivalence Radiance (with 1.5 meter fiber optic)
  $0.8x10^{-9}$ W/cm^2/nm/sr @ 400nm
  $0.3x10^{-9}$ W/cm^2/nm/sr @ 1500nm
  $5.8x10^{-9}$ W/cm^2/nm/sr @ 2100nm
- Drift stability: ≤ 0.4%
- DARWin SP Data Acquisition software



Comparison of Si detector stability –
SR-4500 vs. a full range spectroradiometer
The SPECTRAL EVOLUTION SR-4500 and a full range spectroradiometer were run side-by-side at room temperature (23°C), measuring the radiance of the same 50 watt tungsten halogen source using a 1.2 meter fiber optic cable reflected off the same 5x5 inch reflectance panel. The x axis shows elapsed time from the start of the test; the y axis represents the ratio of the measured radiance value to the starting radiance value, over a period of 154 minutes. The SR-4500 uses a 512 element silicon photodiode array which is thermoelectrically cooled. The full range spectroradiometer uses a 512 element silicon photodiode array which is not thermoelectrically cooled. After a 30 minute period, the SR-4500 shows very little drift. The spectroradiometer demonstrates a slightly wider variation over the course of the test. Both instruments use identical thermoelectrically cooled extended range InGaAs photodiode arrays for NIR performance. The SR-4500 also offers improved NER measurement—better than 2x the performance available with a typical full range spectroradiometer. The SR-4500 has a drift stability of 2.0%.

SR-4500A

- Drift stability improved to 0.1% for greater accuracy for long-term stability measurements of integrating spheres and light sources
- Stability achieved through heating and cooling thermal-management features
- A temperature controller maintains the instrument housing at a stable temperature along with the individually temperature stabilized detector arrays
- All temperatures are integrated into DARWin SP Data Acquisition software readout for monitoring

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