



# Primary Standards Laboratory Metrology Program

## Fact Sheet

### Optical

The Primary Standards Laboratory (PSL) maintains a variety of primary optical standards to assure accurate and traceable measurements for its customers.

Primary optical standards are directly traceable to the National Institute of Standards and Technology (NIST). Primary optical power and energy standards are based on heat-flow calorimetry, while spectral responsivity is based both on NIST-certified and "absolute" Si detectors.

Laser power in the range 1 mW - 10 W is measured with a heat-flow calorimeter which is certified based on NIST calibration, electrical substitution calibration, and comparison with an "absolute" Si detector. Wavelengths in the range 0.25 - 10.6  $\mu\text{m}$  can be used, though reflectivity corrections must be made at 10.6  $\mu\text{m}$ . The standard is used with various lasers to certify customer laser power meters.

Laser welding power meters for the range 10 - 1000 W are calibrated using a water-cooled calorimeter standard and a customer-supplied laser. The standard is calibrated at NIST at high powers and is cross-checked against the heat-flow calorimeter at 10 W. Both YAG and CO<sub>2</sub> lasers can be used, either pulsed or CW. Beam energy in a single pulse is measured from the average power and the repetition rate.

Laser pulse energy meters for Q-switched YAG lasers are measured against a standard using the customer's laser as the source. The standard is calibrated using both electrical pulses and optical pulses extracted from a CW beam using a shutter. The present useful wavelength range is 0.4 - 1.2  $\mu\text{m}$ , and the energy range is 2 mJ to 1 J.

The standard of solar power (insolation) is another calorimeter designed for outdoor use and calibrated against the low-power laser standard, the World Radiation Reference, and by electrical substitution. This calorimeter is used to calibrate a pyrheliometer by direct comparison while both are tracking the sun.



**Laser Power Meter Calibration**

Pyranometers, which measure the light from the full sky, are calibrated vs. the calorimeter using a shading technique. Customer devices are certified using the working standard pyrheliometer or pyranometer.

Spectral responsivity of customer devices is measured using a monochromator source and a Si standard detector in the solar systems department at Sandia. The standard, in turn, is calibrated against similar NIST-certified detectors over the wavelength range 0.3 - 1.1  $\mu\text{m}$  and against "absolute" Si detectors over their limited range of applicability (0.4 - 0.7  $\mu\text{m}$ ).

The working ultraviolet meter for measuring the irradiance at the 365 nm line of Hg is calibrated against the laser power meter. Light is provided by an Hg-Xe lamp and monochromator setup, and customer uv meters are calibrated by substitution. Irradiances between 50 and 1000  $\mu\text{W}/\text{cm}^2$  can be provided.

### Capabilities



- **LASER POWER**
  - 1 mW to 10 W                       $\pm 0.5 \%$
  - 10 to 1000 W                       $\pm 4 \%$
- **LASER PULSE ENERGY**                       $\pm 3 \%$
- **SOLAR POWER**
  - Pyrheliometer                       $\pm 2 \%$
  - Pyranometer                       $\pm 4 \%$
- **SPECTRAL RESPONSIVITY**                       $\pm 2 \%$
- **UV METER (365 nm)**                       $\pm 10 \%$

### **Selected Accomplishments**

- Sandia developed new calibration hardware and software for calibrating the primary solar radiometer. The primary calibration was compared with solar radiometers from all over the world at the National Renewable Energy Laboratory in Golden, Colorado. The incident solar power density measured by our primary solar radiometer fell within 0.1% of the accepted world value.
- Sandia participated in the Detector Measurement Assurance Program sponsored by the NASA Jet Propulsion Laboratory (JPL). We compared our silicon standard detector with 2 standard detectors as supplied by JPL. The 2 standard detectors supplied by JPL were used to calibrate a standard detector in the Solar Systems Department.

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