CREATE
any spectrum

Spectral Radiance Calibration Service

On-site service for recalibration and servicing of uniform source systems

Service recommended if:

- System lamps have been operated for more than 50 hours
- System is more than two years old
- System has operated or been stored in dusty environment
- Quality Management System mandates annual calibrations on critical measurement equipment
- Monitor detector disagrees with the original calibration certificate

Service features

- Professional assessment of the overall condition of system
- Relamping the sphere with before and after measurements
- Power supply calibration option
- NIST traceable measurements with reported uncertainty
- Calibration is certified on-site
- Minimal downtime with flexible scheduling

Labsphere
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The spectral radiance measurement service of an integrating sphere source of uniform radiance ("uniform source") is performed by direct comparison of measurements carried out with equipment and methods traceable to the NIST. Measurement uncertainty is determined by best practices of expressions of uncertainties.

The measurements are accomplished by referencing a calibrated Spectralon® target of known diffuse reflectance factor that is irradiated by an FEL type tungsten halogen spectral irradiance lamp standard. The Spectralon target becomes the reference source of spectral radiance expressed as:

$$L_{\lambda} = \frac{E_{\lambda}\rho_{\lambda}}{\pi} \qquad (mW/cm^2\ sr\ nm)$$

Where L is the spectral radiance of the target, E is the spectral irradiance of the FEL at its calibrated distance and ρ is the spectral reflectance factor of the Spectralon target.

The spectral radiance is then used to calibrate the field service spectroradiometer. The spectroradiometer spectral radiance responsivity is achieved by scanning and collecting the spectral radiance of the irradiated target and recording the responses. The spectral radiance responsivity calibration is performed on a full range UV-VIS-NIR dispersive spectroradiometer. The spectral measurements are performed with this FOV positioned at the center of the plane of the diffuse target. The radiance of the Spectralon target is transferred to the diffraction grating array spectrometer with a fixed mounted 1.2 meter metal clad fiber optic cable coupled to a 5 degree field of view foreoptic radiance detector head via an SMA-905 connector. Long pass order sorting filters are used reduce stray light and block higher orders.

The baseline of an FEL Target Irradiance which is within 1.8-2.3% is the basis for our primary calibration at our laboratory. Reference values can be provided upon request.

The validation of our on-site calibration service is the key aspect to this service. The estimated measurement uncertainty of an on-site measurement is determined as follows:

$$L_{DUT} = \frac{S_{DUT}L_{ref}}{S_{ref}} = \frac{S_{DUT}}{S_{ref}} * \frac{\beta\rho_{45}E_{e0}\left(\frac{I_e}{I_{e0}}\right)^{M_3}(1-\alpha\Delta t)*50^2}{\pi*\left(\sqrt{D^2-x^2-z^2}\right)^2}$$

Expression of Radiance Uncertainty for Radiometric Transfer with Spectral Radiometer

S_{DUT} is the spectral response of the spectral radiometer to the customer DUT

S_{ref} is the spectral response of the spectral radiometer to the calibration reference

L_{ref} is the spectral radiance of the calibration reference

β is the angular dependence of the reflectance factor

ρ is the Spectralon target spectral reflectance factor

E is the spectral irradiance of the FEL reference standard

I is the FEL operating current

M is FEL irradiance relationship factor

$(1 - \alpha\Delta t)$ is the FEL tungsten halogen lamp aging factor

D is the calibration distance of the FEL

x is the lateral tilting offset of the distance measurement, and

z is the offset of the between the target and the center and the reference plane of the target

In accordance with the GUM guidelines a contribution element analysis was conducted using the following gathered data on the transfer standard, target, physical variables and contribution of the spectral radiometer (Example given at 2000 nm) to derive an expanded uncertainty table.

No.	Quantity X_i	Symbol	Units	Value x_i	Type of Evaluation	Standard Abs. Uncertainty $u(x_i)$	Sensitivity Coefficient c_i	Uncertainty Contribution $c_i u(x_i)$
1	Spectral irradiance of FEL reference standard	$E_{e\lambda}$	mW/cm^2-nm	6.71E-03	B	2.95E-05	2.34E+00	5.90E-05
2	FEL Reference standard operating current	I_s	Amp	8.00E+00	B	5.90E-04	2.20E-02	1.18E-05
3	FEL Reference standard current-irradiance relationship factor	Mf	NA	1.40E+00	B	4.45E-04	[illegible]	-8.89E-11
4	FEL Reference standard aging factor	$\alpha\Delta t$	NA	5.00E-03	B	1.92E-05	-1.58E-02	-3.85E-07
5	[illegible]	D	cm	[illegible]	B	[illegible]	[illegible]	-3.00E-05
6	Lateral tilting offset	x	cm	2.00E-01	A	1.15E-01	2.52E-06	3.46E-07
7	Offset between target center and reference plane of the target holder	z	cm	2.00E-01	A	[illegible]	6.31E-04	6.93E-05
8	Reflectance factor	R	NA	9.74E-01	B	1.53E-02	1.61E-02	2.47E-04
9	Angular dependence of reflectance factor	β	NA	1.00E+00	A	2.24E-04	1.57E-02	3.58E-06
10	Spectrometer reading of reference radiance	s_{ref}	mW/cm^2-sr-nm	2.08E-03	A	1.15E-05	-7.55E+00	-8.72E-05
11	Spectrometer reading of DUT radiance	s_{DUT}	[illegible]	1.57E-02	A	2.47E-06	1.00E+00	2.47E-06
	Total Std Uncertainty (mW/cm^2sr-nm)		2.4E-04					
	Expanded Relative Uncertainty ($k=2$)		3.1%					

Typical derived uncertainties with a strong Signal-to-Noise ratio are given below:*

Wavelength (nm)	Reference STD Expanded Relative Uncertainty (k=2)	Total Relative Uncertainty (k=2)
300	7.1%	10.0%
350	5.1%	5.4%
450	3.3%	3.4%
555	3.3%	3.9%
654.6	3.4%	3.7%
900	3.2%	3.6%
1600	3.5%	3.8%
2000	3.2%	3.6%
2300	5.7%	5.9%
2400	5.4%	5.9%

There is direct relationship at the extreme wavelengths for low signals. Values above 1.0 mW/cm2-sr-nm @ 600 nm would be a recommended lowest level of calibrated spectral radiance. Your system levels and suitability for on-site measurements should be validated by Labsphere prior to purchasing one of our services. Labsphere also may elect to bring an Optical Validation Kit to selected sites to validate the levels and performance of our calibration equipment and the customer DUT.

*Uncertainties in measurement results will vary at customer locations due to ambient conditions.

Ordering Information

RC-00001-000 1 Day Spectral Radiance Calibration Service**
RC-00002-000 2 Day Spectral Radiance Calibration Service**
RC-00003-000 On-Site Power Supply Calibration of LPS-100 and LPS-150

**The requirement for a 1 or 2 day service will be determined through a site survey questionnaire and advisement with Labsphere's service department.