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ILLUMINANCE RESPONSIVITY CALIBRATION OF REFERENCE PHOTOMETERS AT THE NIST SIRCUS AND SCF FACILITIES

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The illuminance responsivities of photometers can be determined at two different responsivity calibration facilities at NIST. At the Spectral Irradiance and Radiance Responsivity Calibrations with Uniform Sources (SIRCUS) facility, stabilized tunable lasers are introduced into integrating spheres. A monochromator is used at the Spectral Comparator Facility (SCF). Earlier we compared the illuminance responsivity of two reference photometers calibrated at both facilities. The obtained difference was 0.4 %. The SIRCUS reported uncertainty was 0.1 % ($k=2$) and the SCF based illuminance responsivity uncertainty is 0.39 % ($k=2$). Though, the obtained difference is within the reported uncertainties, our goal is to decrease the SCF based uncertainty and to obtain a better agreement between the two different photometric scale realizations.

The two independent photometric scale realizations have been analyzed. The uncertainty of the SIRCUS calibrations has been dominated by a constant 0.08 % irradiance responsivity difference in the visible wavelength range between the two transfer-standard trap-detectors used to calibrate the reference photometers. The uncertainty of the SCF-based photometric scale, realized in 1991, had a large uncertainty component of 0.24 % ($k=2$) which was dominated by the internal reflections of the f/8 beam of the monochromator inside of the photometers. Since the input geometry of the individual photometers, within the group of the calibrated photometers, was different, a variation (spread) was obtained in the illuminance responsivities. Also, the aperture areas obtained with the f/8 beam utilized raster-scan method, had a systematic error compared to the geometrical aperture area measurements. In order to decrease these dominating uncertainty components, higher radiometric quality transfer standard photometers have been developed and the working standard photometers are calibrated against these reference standards. The spectral irradiance responsivity of the reference photometers has been determined at both the SCF and SIRCUS facilities. The aperture area was determined from a raster-scan method at the SCF (with removed filters) and also from an irradiance-to-power responsivity ratio measurement at the SIRCUS. The latter area determination was made against a trap detector (at one laser wavelength) whose aperture was calibrated at the NIST aperture-area calibration facility with 0.02 % ($k=2$) uncertainty. The obtained area was multiplied by the SCF measured spectral power responsivity to obtain the SCF-based spectral irradiance responsivity which was compared (after normalization) to the SIRCUS measured spectral irradiance responsivity. After the spectral irradiance responsivity comparisons, the illuminance responsivities of the reference photometers are compared and evaluated.