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The spectral irradiance traceability chain at PTB

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Spectral irradiance is a fundamental radiometric unit. Its application to measurement results requires qualified traceability to basic units of the international system of units (Système international d'unités, SI). The Physikalisch-Technische Bundesanstalt (PTB) is amongst other national metrological institutes responsible for the realization, maintenance and dissemination of various radiometric and photometric units based on and traceable to national standards.

The unit of spectral irradiance is realized and represented by a blackbody-radiator as the national primary standard of the PTB [1]. Based on Planck's law, the irradiance is calculated and realized for any wavelength taking into account the exact knowledge of the radiation temperature and the geometrical parameters.

Using a double-monochromator-based spectroradiometer system, secondary standard lamps can be calibrated by direct comparison to the blackbody-radiator (substitution method). These secondary standard lamps are then used at the PTB to calibrate standard lamps of customers. The customers themselves use these so-called transfer standards to calibrate their working standard lamps. These working standards are then used to calibrate own spectroradiometers or sources.

This rather complex calibration chain is a common procedural method that for the customers generally leads to satisfying measurement results on site. Nevertheless, the standard lamps in use have to fulfill highest requirements concerning stability and reproducibility. Only this allows achieving comparably low transfer measurement uncertainties, which occur at each calibration step.Thus, the PTB is constantly investigating the improvement and further development of transfer standards and measurement methods for various spectral regions.

The realization and dissemination of the spectral irradiance using the blackbody-radiator at the PTB is accomplished with worldwide approved minimized measurement uncertainties confirmed by International intercomparisons. Ultimately, the spectral irradiance can be realized with expanded measurement uncertainties of far less than 1 % over a wide spectral range. Thus, for customers with high demands on low measurement uncertainties, it is possible to calibrate their working standards directly against the blackbody-radiator [2], taking into account the higher necessary effort. In special cases it is possible to calibrate the customer's spectroradiometric facilities directly in front of the blackbody-radiator [3].

In the context of the European Metrology Research Project Traceability for surface spectral solar ultraviolet radiation [4], the traceability chain will be improved and adapted.

[1] P. Sperfeld, S. Pape and B. Barton, From Primary Standard to Mobile Measurements - Overview of the Spectral Irradiance Calibration Equipment at PTB, MAPAN- Journal of Metrology Society of India, 25 (2010) 11-19.

[2] J. Gröbner and P. Sperfeld, Direct Traceability of the Portable QASUME Irradiance Scale to the Primary Irradiance Standard of the PTB, Metrologia, 42 (2005) 134-139.

[3] G. Thuillier, T. Foujols, D. Bolsée, D. Gillotay, M. Hersé, W. Petermanns, W. Decuyper, H. Mandel, P. Sperfeld, S. Pape, D.R. Taubert and J. Hartmann, SOLAR/SOLSPEC: Scientific Objectives, Instrument Performances and Its Absolute Calibration Using a Blackbody as Primary Standard Source, Solar Physics, 257 (2009) 185-213.

[4] http://projects.pmodwrc.ch/env03