Calibration of a broadband reflective spectrometer for high-resolution spectral characterization of radiation sources

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The development of compact radiation sources has enabled a multitude of lab-size applications, especially in the field of metrology [1]. A broadband spectral characterization of the source emission is of utmost importance for the investigation of photon-induced processes and metrology [2].

In this study, the authors present a unique setup and corresponding measurement results for the high-resolution broadband spectral characterization of radiation sources covering the extensive wavelength range from 5 nm to 1000 nm [3]. The achievable resolution is 0.02 nm in the short wavelength range and the resolving power ($\lambda/\Delta\lambda$) exceeds 500 for the full range.

For the vacuum wavelength range (5 nm to 200 nm) the setup employs several flat-field diffraction gratings with varying line density as dispersive elements. The wavelength range above 200 nm is measured with two Czerny-Turner spectrometers. Higher diffraction orders are filtered out by a selection of spectral thin film filters, necessitating the collection of multiple partial spectra. The main components of the spectrometer and the thin film filters have undergone rigorous characterization at the Physikalisch-Technische Bundesanstalt (PTB, Berlin). The results from these characterizations are then used to correct the measured partial spectra, resulting in relatively calibrated partial spectra. These are combined to obtain the full spectrum without any higher diffraction order contributions, which is then absolutely calibrated through a measurement of the absolute intensity in a small interval.

The contribution will cover the overall design, the wavelength calibration and the relative as well as the absolute intensity calibration of the measured spectra.

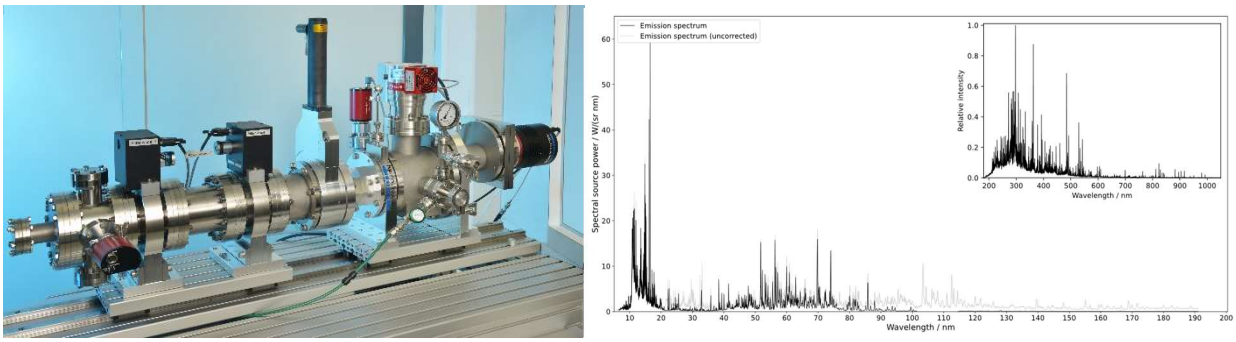

Figure 1 *Broadband spectrometer setup (left) Emission spectrum of a xenon discharged-produced-plasma (DPP) radiation source with higher diffraction orders correction, inset: extended wavelength range up to 1000 nm from Czerny-Turner modules (right).*

[1] S. Schröder, L. Bahrenberg, N. K. Eryilmaz, S. Glabisch, S. Danylyuk, S. Brose, J. Stollenwerk, P. Loosen, (2020), Proc. SPIE 11517, 115170S

[2] Z. Bouza, J. Byers, J. Scheers, R. Schupp, Y. Mostafa, L. Behnke, Z. Mazzotta, J. Sheil, W.M.G. Ubachs, R. Hoekstra, M. Bayraktar, O. Versolato, (2021), AIP Advances 11, (12), 125003: 1-9

[3] I. Gisch, S. Schröder, S. Glabisch, S. Brose, S. Danylyuk, J. Stollenwerk, C. Holly, (2024), Proc. SPIE 13215, 1321515