

Validation of absolute spectral irradiance responsivity measurements using mode-locked lasers

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Mode-locked lasers show great promise for characterization of detectors. Therefore,

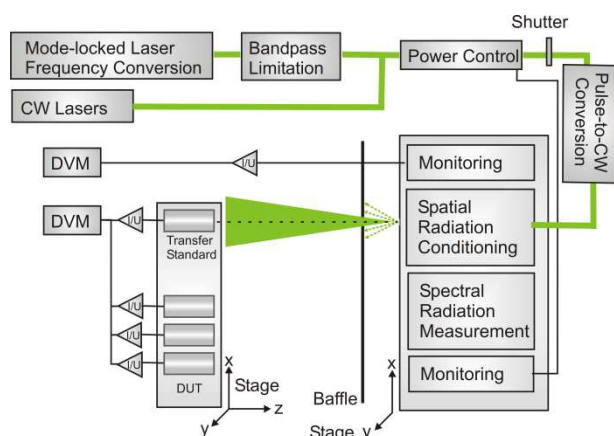


Figure 1: TULIP - Tunable laser based measurement setup for the spectral irradiance and radiance responsivity calibration of large-area detectors

PTB has upgraded its validated spectral calibration setup TULIP (Tunable Lasers in Photometry) with a new mode-locked (ML) laser setup (Fig. 1). The application of this new system enables research for the new realization of the SI-Unit Candela as well as detector characterization in the wavelength range from 230 nm to 3000 nm. Depending on the wavelength the spectral bandwidth may be set between 0,1 nm to 15 nm. High power is necessary to perform the spectral and spatial radiation conditions to achieve a highly uniform radiation field at the detectors reference plane. To prove the applicability and performance of the ML laser system for absolute spectral irradiance responsivity, a validation procedure has been developed using the substitution method against a trap reference detector in the visible wavelength range. The validation in the red wavelength range from 690 nm to 780 nm of the ML-TULIP setup has been carried out with a diffuserless filtered radiometer against the CW-TULIP setup and against a monochromator based setup. For the validation in the visible wavelength range from 360 nm to 830 nm the spectral responsivity of different photometers with diffusers determined with the ML-laser setup have been compared with monochromator-based measurements. The calculated values of their luminous responsivities have been additionally compared with measurements at the photometric bench (Fig. 2) against reference photometers. In terms of validation, all results are in good agreement according to their uncertainties in the spectral range from 360 nm to 830 nm. The validation process for the infrared and ultraviolet wavelength range is still in progress. Preliminary results suggest also in this case a good agreement between the applied measurement procedures.

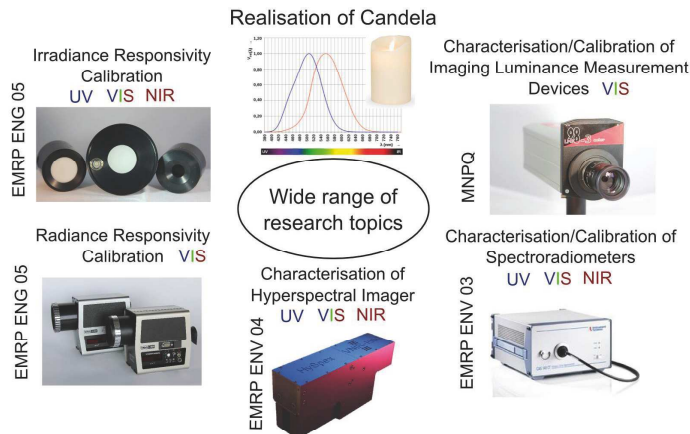


Figure 2: Photometric bench setup for the determination of the luminous responsivity of photometer heads

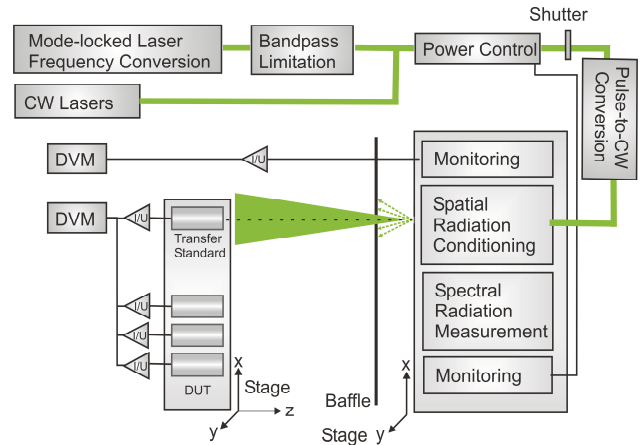
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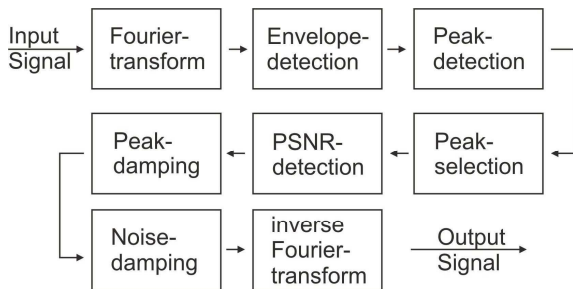
Challenges for setup:



Tuneable Lasers In Photometry (TULIP) setup:

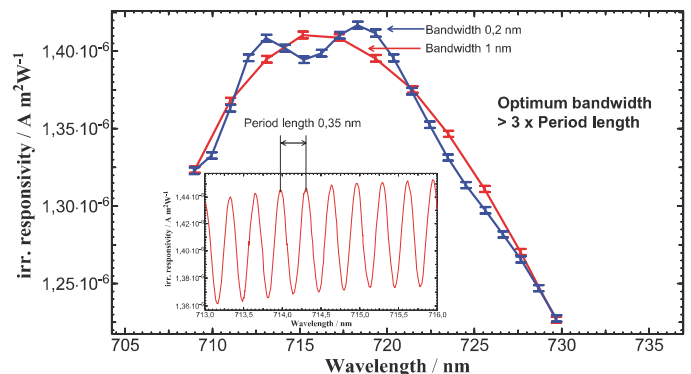


Correction algorithm for interference-affected measurement data:



Input signal is measured with cw lasers and filters for peak damping and noise damping are designed with Matlab

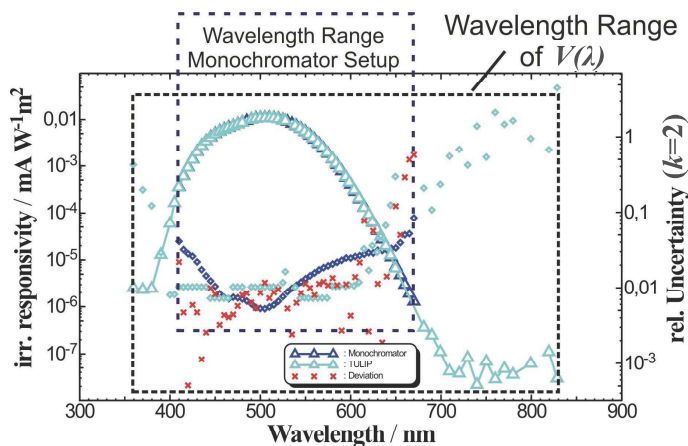
Finding the optimum bandwidth for mode-locked lasers:



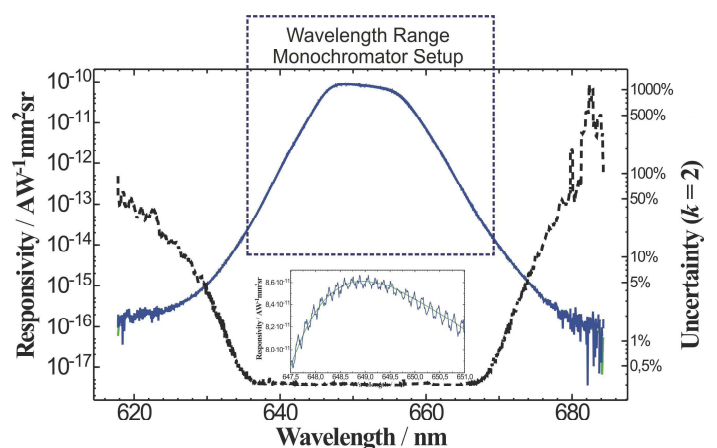
Irradiance responsivity of a filtered radiometer with interference oscillation (small picture) and measured with different bandwidths

Measurement results and validation:

Validation against at least two other validated measurement setups like monochromator setup and photometric bench (photometer measurements, left picture), blackbody radiator, monochromator setup and eutectic fixpoints (Cu, Au) (pyrometer, right picture)



Irradiance responsivity of a photometer head and deviation between measurements at TULIP and at a monochromator setup



Radiance responsivity of a pyrometer with interference oscillation (small picture) and after correction

