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Adaptation of a Fourier transform spectrometer as a reference instrument for solar UV irradiance measurements

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Within the European Metrology Research Project *Traceability for surface spectral solar ultraviolet radiation* a commercially available Fourier transform spectrometer (FTS) will be adapted for spectral solar UV irradiance measurements to demonstrate the feasibility of using this type of device as an alternative reference spectroradiometer.

Fourier transform spectroradiometers are in use for solar irradiance measurements with high wavelength resolution [1]. In contrast to these facilities, the goal of this project is to evaluate the usability of a commercially available Fourier transform spectrometer as a portable reference spectroradiometer. The usage of Fourier transform spectroradiometers may improve the dissemination of absolute irradiance scales due to the specific advantages of these instruments.

Up to now, scanning spectroradiometers are in use as reference instruments [2]. This type of radiometer has a couple of disadvantages. For example, the solar spectrum is scanned sequentially which needs minutes of time for each spectrum and limits the temporal resolution of the radiometer. This is a big disadvantage considering varying atmospheric conditions. In contrast, Fourier transform spectroradiometers are capable to measure several spectra per second. However, the temporal resolution of an FTS competes against the wavelength resolution and the signal to noise ratio. It is the operator's choice to optimize these instrument settings while considering the goal of the measurement and the atmospheric conditions. Another FTS advantage is the immanent calibration of the wavelength scale which is - in case of the FTS used for this work - traced to the SI via the known wavelength of a HeNe-laser that monitors the movement of the FTS's scanning mirror.

A few steps are necessary to establish an FTS as a solar UV reference spectroradiometer. The first step is to equip the FTS (Bruker VERTEX 80v) with a global entrance optic to be able to perform solar irradiance measurements. Next step is to calibrate the spectral responsivity of the in this way assembled FT-spectroradiometer against a black body radiator of which the temperature has been measured by using PTB filter radiometer standards [3, 4, 5]. These filter radiometers are traceable to the SI via a calibration against a cryogenic radiometer. Finally, the irradiance measurement uncertainty of the FT-spectroradiometer has to be calculated. This uncertainty includes the uncertainty of the calibration itself and further system specific uncertainties which have to be investigated carefully. The dynamic range and the spectral resolution of the FT-spectroradiometer are crucial due to the steep spectral increase of the solar UV spectrum from 290 nm to 350 nm. Furthermore, the radiometer has to be analysed for systematic distortions of the measured spectra. This will be investigated by using different types of radiation (filtered broadband radiation, laser radiation). Finally the system stability is of importance in order to achieve stable irradiance traceability to the SI and the ability to use the FT-spectroradiometer as a reference instrument also under field conditions.

[1] Solar spectral atlases obtained with the Fourier Transform Spectrometer at the McMath/Pierce Solar Telescope situated on Kitt Peak, Arizona, USA, operated by the National Solar Observatory, NOAO - http://nsokp.nso.edu/dataarch.html

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