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New technologies to reduce stray light for measuring solar UV with array spectroradiometers

L. Egli (1), J. Gröbner (1), M. Smid (2), G. Porrovechio (2), T. Burnitt (2,7), K. Nield (3), S. Gibson (3,6), J. Dubard (4), R. P. Stanley (5), and M. Tormen (5)

(1) Physikalisch-Meteorologisches Observatorium Davos / World Radiation Center (PMOD/WRC), Davos-Dorf, Switzerland (luca.egli@pmodwrc.ch), (2) Czech Metrology Institute (CMI), Prague, Czech Republic, (3) Measurements Standards Laboratory (MSL), Lower Hutt, New Zealand, (4) Laboratoire national de métrologie et d'essais (LNE), Paris, France, (5) Centre Suisse d'Electronique et de Microtechnique (CSEM), Neuchatel, Switzerland, (6) Department of Physics and Astronomy, Canterbury University, Christchurch, New Zealand, (7) Principal Optics, Reading, UK

Spectral global solar UV irradiance measurements in a wavelength range between 290 nm to 400 nm require instrumentation that are sensitive to measure solar low flux levels entering the entrance optics of the system ranging from 10^{-6} to 10^{0} W m^{-2} nm^{-1}(e.g. about 5 to 6 orders of magnitude, depending on time and atmospheric conditions). Conventionally, this requirement is achieved using scanning double grating monochromators equipped with a single photomultiplier detector. These scanning spectroradiometers acquire the solar UV spectrum sequentially requiring substantial scanning time.

An alternative approach is to use a single monochromator imaging the entrance slit onto an array detector. This would have the advantage of capturing quasi simultaneously the solar irradiance spectrum. However, due to the impact of stray light radiation and the inherent sensitivity of the detector at short UV wavelengths, typical monochromator array spectroradiometers can cover only dynamic range of about 3 orders of magnitude over the UV solar spectrum. Therefore, new technical approaches are needed for stray light reduction to improve the measurement characteristics of cost-effective array spectroradiometers, which could then be appropriate for the use in extended solar UV networks.

In the following, three different technologies are investigated to evaluate their potential to improve stray light characteristics of array spectroradiometers taking into account field operation.

1. Arrays of binary fast controllable micro mirrors (DLP®), which allow modulating the dynamic range of the solar UV spectrum in the optical path between the entrance optics and the array detector.
2. Tunable gratings based on MEMS (Micro Electro Mechanical Systems) technology, to partially pre-disperse the solar UV spectrum at the entrance of the array spectroradiometers.
3. Tailored band pass filters in existing array spectroradiometers for the pre-separation of stray light relevant wavelengths. From the preliminary characterisation of a UV optimized spectroradiometer, a filter will be designed to further reduce stray light contribution.

This feasibility study presents the optical design and mechanical elements of potential systems. The study highlights the advantages and disadvantages of all three technologies in terms of stray light reduction, reproducibility of absolute global UV radiation measurement, reliability and cost efficiency. The potential and limitations for implementing these new technologies in a prototype device are discussed.