USOL

Station for measuring solar sensitivity of solar blind UV cameras

Fig. 1. USOL system

1 Basic information

Target emitting UV light due to corona phenomenon shall not be detected by a SBUV camera if target background illuminated by solar light generates stronger signal at camera electrical output comparing to signal generated by the corona target. Therefore sensitivity to solar light is a crucial parameter of SBUV cameras.

USOL test system simulates a light source that is considered as a reference solar background and allow to measure sensitivity of tested SBUV camera to solar light. It can be also used to determine spectral sub-band where solar light is detected by tested SBUV camera.

Design of USOL system is based on assumption that a light source of absolute spectral radiant exitance near equal to spectral irradiance of standard AM 1.5G global tilt solar spectrum in spectral range from 280nm to 800nm can be treated as a reference solar background when testing SBUV cameras. Next, it is proposed to characterize solar sensitivity of SBUV cameras by Solar To Noise Ration (STNR) parameter defined as a ratio of signal at output of SBUV camera generated by the standard solar background simulated using USOL system to average output signal generated by camera noise.

The leaking subband of tested SBUV camera is to be determined by simulation of the reference solar light source in several changeable spectral subbands and measurement of STNR tested SBUV camera for each subband.

USOL is a computerized system optimized for measurement of sensitivity of SBUV cameras to solar light. It is a modular system built from four main blocks: LS-SOL light source, PC set, frame grabber, and software (SOL Control program, TAS-SOL computer program).

LS-SOL light source is a crucial block of USOL test system. It is a directional calibrated light source of regulated light intensity and of spectrum near identical as relative spectral irradiance of standard AM 1.5G global tilt solar spectrum in total spectral band 280-800nm. User can regulate light intensity and also make simulated spectral band more narrow (typical simulated subbands: 1)>310nm,2) >400nm, 3) >600nm). One of modules of LS-SOL light source is an internal refractive collimator that projects image of a light emitter into direction of tested SBUV camera. The tested camera sees a circular uniform light source of angular size over 3° that fills at least central part of FOV of typical SBUV camera.

Test software using a frame grabber can capture video image from tested SBUV camera and compare output signal (number of event counts from a specified area in time unit) generated by LS-SOL source with output signal generated by camera internal noise and to calculates solar sensitivity of tested SBUV camera (STNR parameter).

Both light intensity and spectrum of solar background around corona target vary with geographical position, time, weather condition and angular position of SBUV camera. Therefore it should not be expected from USOL to simulate realistically solar background met at any conditions. USOL is to simulate solar background that can be considered as average solar background met in USA (the geographical reference AM 1.5G global tilt solar spectrum is defined). In spite of this limitation USOL can be considered as a useful tool to measure solar sensitivity of SBUV cameras to solar light. If one of two SBUV cameras is more sensitive to light emitted by USOL then it means that the same camera will be more sensitive to solar light in majority of real applications.

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2 Test capabilities

The main aim of USOL test system is to enable measurement of Solar To Noise Ration (STNR). This parameter is defined as a ratio of signal at output of SBUV camera generated by standard solar background generated by USOL to average output signal generated by camera noise. STNR is a crucial parameter of SBUV cameras that makes possible to evaluate performance of these cameras at day conditions.

The secondary aim it to help designers to determine spectral band where solar light is detected by tested SBUV camera.

3 Why USOL?

It looks easy to test sensitivity of SBUV cameras to solar light by pointing tested SBUV camera againt Sun. Practically such solution makes no sense for two main reasons. First, signal at camera output generated by Sun light vary a lot on geographical position, time, pollution level. Second, looking directly against Sun is not normal operation condition and create conditions not met in real application (background like sky, land, sea). Therefore results for direct Sun tests are totally not reliable and an artifical simulator of solar background is needed.

There are many solar simulators offered on international market. However, all these commercially available solar simulators are of limited or very limited usefulness for testing SBUV cameras due to several reasons.

First, typical solar simulators are designed to simulate target of interest being irradiated by a light of standard solar irradiance spectrum when a source emitting light of average radiant exitance of backgrounds of corona targets is needed for testing SBUV cameras.

Second, spectral band from 280nm to about 320nm is outside calibrated spectrum of almost all solar simulators because is not interesting for typical applications like photovoltaic cell testing due to extremely low flux in this band comparing to total flux in full spectrum. However, this spectral band is of critical importance when testing influence of solar background on performance of SBUV cameras because of possible overlapping of solar spectrum with spectral sensitivity function of tested camera .

Third, there are a few solar simulators (called as UV solar simulators) developed for cosmetic industry to irradiate tested specimen using light of calibrated spectrum from 250nm to 800nm. However, the irradiance levels in band 250-320nm are too high to simulate solar background when testing SBUV cameras. It is officially accepted in this type UV solar simulators that minimal measurable irradiance at 290nm is 10^{-4} W/nm m^2 when some SBUV cameras are capable to detect light at this wavelength several magnitude weaker.

4 Technical specifications

Table 2. Technical specifications of modules of USOL system

Parameter	**Value**
Angular size of simulated solar source	At least 3°
Calibrated spectral band	280nm to 800nm (or more narrow subbands)
Way of regulation of light intensity	Computerized, continuous
Relative spectral radiant exitance	Near equal to relative spectral irradiance of standard AM 1.5G global tilt solar spectrum (see Fig. 2)
Reference absolute radiant exitance	Equal to absolute spectral irradiance of standard AM 1.5G global tilt solar spectrum
Range of regulation of light intensity	At least from 0.1 to 10 times comparing to the reference ASTM level
Number of sub-bands	At least three: 1)over 310nm, 2)over 400nm, 3) over 600mm
Method to change subband	Motorized change of filter
PC Control	RS 232/USB 2.0

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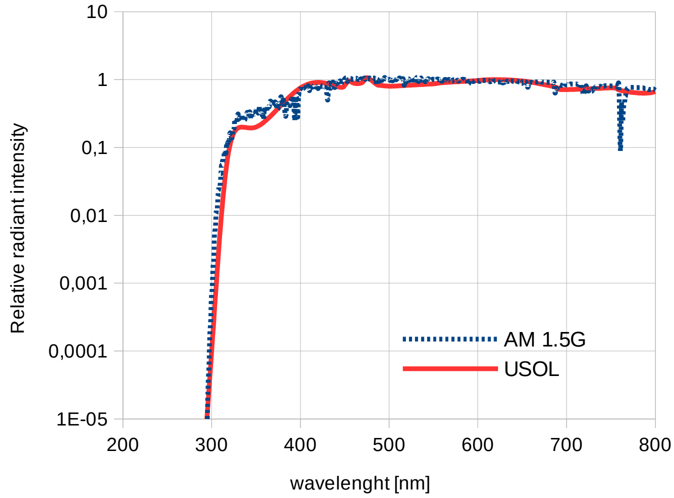

Fig. 2. Relative spectrum of USOL simulator versus standard AM 1.5G spectrum

SUMMARY

USOL is the first commercially available test system that enable accurate repeatable testing of solar sensitivity of SBUV cameras. The station can be a very valuable tool to evaluate true performance of these expensive cameras at day condition in real life applications.

Version 1.2

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