UVIC

Tester of solar blind UV cameras

Fig. 1. Photo of UVIC test station

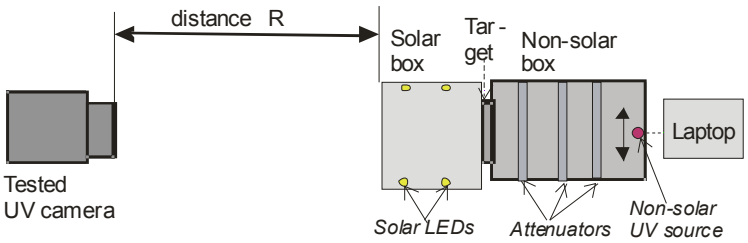

Fig.2. Block diagram of UVIC test station

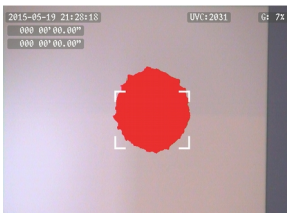

Fig.3. Image of a circular target generated by tested solar blind UV camera

BASIC INFORMATION:

Solar blind UV cameras are imaging devices optimized to detect ultraviolet light of wavelengths below about 280nm. Such cameras are insensitive against sunlight due to negligible sensitivity to visible and long wavelength UV light.

Solar blind UV cameras are used in a series of applications like corona detection, fire detection, combustion analysis, plasma research, testing UV lamps, etc. However, highly sensitive corona detection is the main mass application and these devices are of crucial importance in electric power industry. These imaging devices enable easy detection of degraded insulators of high voltage transmission lines, distributions and substations. They can see the emission of UV light when discharges occur at defect insulators.

From design point of view solar blind UV cameras are actually bispectral imaging systems built by combining true UV camera with typical visible camera. These bispectral imaging system generate output image as overlay of typical visible image with UV image of analyzed UV source.

As mentioned earlier important decisions are made on basis of information provided by solar blind UV cameras. Next, sensitivity of UV cameras can significantly deteriorate with time. Further on, manufacturers of UV cameras typically present sensitivity parameter in camera data sheets but without any information about test method. Therefore, it is not clear if sensitivity is defined as minimal detectable flux at target plane, optics plane, filter plane or at UV sensor plane and how exactly this parameter is measured. At the same time it should be noted that sensitivity measured at the sensor plane is thousands times better than sensitivity measured at the target plane when only the latter parameter is really interesting for final camera users. Therefore precision evaluation of non solar UV camera on basis of typical data sheet is not possible. In such situation systems capable to do reliable testing of solar blind UV cameras can be potentially very useful to evaluate true performance of these cameras available on market and to monitor performance of the cameras during their life time.

UVIC is a tester of solar blind UV cameras that enables precision evaluation of these important and expensive imaging systems. UVIC test station generates images of several standard targets at regulated light intensity in both ultraviolet and visible spectral bands. The tested solar blind camera generates electronic copies of these test images in both two spectral bands. Quality of electronic images generated by tested camera is evaluated and important performance parameters of solar blind UV cameras are measured.

UVIC

Tester of solar blind UV cameras

HOW IT WORKS:

UVIC test station is built from four main blocks: UVIC base block, set of targets, portable laptop, and control software. The UVIC main block can be further divided into three modules: solar box, target pocket, non-solar UV box, and set of attenuators.

Tested UV camera is located at a distance about 1-3m from UVIC station and is looking into direction of this station. The UVIC station is equipped with a set of exchangeable targets (3-bar, triangle, circle etc). One of these targets can be in active position between the solar box and non solar box. Both boxes irradiate the test target and create image of this target visible in both shortwave UV (solar blind band), long wave UV/visible (solar band). Radiation intensity in both non solar band and in solar band can be regulated in ultra wide band (regulation dynamic over 10^{12} in non solar band). Tested UV camera generates electronic copy of original test image generated by UVIC station. This final electronic image generated by tested UV camera is analyzed by its user and important parameters of tested UV camera can be determined.

WHY TO TEST:

UVIC enables performance tests of solar blind UV cameras. Test results give answers to a series of important questions:

1. What is minimal level of UV light emission that can be detected (how weak can be detectable electric discharges) at different gain level of tested camera?
2. What is relationship between minimal detectable level of UV light and angular size of circular UV source (what is maximal distance when an UV source can be detected)?
3. What is minimal distance between two small UV sources that can be detected as two separate sources?
4. What is minimal illumination of observed scenery needed for visible light channel to generate useful image?
5. How small image details the visible channel can generate?
6. What is boresight error between UV channel and visible channel (what is displacement between images generated by UV channel and image generated by visible channel)?
7. How resistible is tested UV camera to solar light?

WHAT CAN BE MEASURED:

At present testing UV cameras is totally non regulated. There are no standards, no scientific papers on testing UV cameras. Manufacturers present in catalogs a parameter called sensitivity but it is not clear how this parameter in defined or measured. Practically users of solar blind UV cameras have no chance for proper evaluation of these measuring tools. Situation is particularly annoying at companies/institutes that implemented so called quality systems and are required to calibrate these measuring tools to international metrological system.

In this situation Inframet proposes test methodology based on its experience on testing electro-optical imaging systems. The aim UV cameras is generally similar to aim other electronic cameras (thermal imagers, VIS/NIR cameras): to detect and later recognize targets of interest (UV sources). However, in case of most solar blind UV cameras the user cannot see true noisy image generated by UV imaging sensor but only artificial red spots that indicate detected UV source. Therefore Inframet proposes test methodology that is similar to one used for testing VIS/NIR cameras but with significant modifications.

Table 1. List of performance parameters of solar blind UV cameras

Parameter	Definition
UV channel parameters	
Sensitivity	Sensitivity is a parameter equal to minimal detectable radiant exitance from a large UV source . Units: W/m^2 or W/cm^2 . Source is considered as large if its size is over 5% of camera FOV. Camera can work at maximal gain. This parameter gives information what is minimal flux of UV source that can be detected.
Variable Gain Sensitivity	VGS is a sensitivity parameter determined for different gain setting of tested camera.
Minimal Detectable Exitance function	MDE is a function of minimal radiance of a non-solar UV source (240-280nm), that irradiate a circular shape target, needed to enable detection of this target versus angular size of the target. Units: W/m^2 and $mrad^{-1}$. This function gives information how camera sensitivity varies with angular size of the UV source (distance camera – source).
Halo function	Function of ratio of angular size of image of circular UV source to true size of the source versus source radiance. Measurements can be done for different gains of tested camera. This function gives information about apparent increase of detected strong UV sources.

UVIC

Tester of solar blind UV cameras

Triangle Orientation Discrimination	TOD is a function of minimal radiance of a non-solar UV source, that irradiate a triangle target, needed to discriminate shape of the target versus target angular size. Units: W/ m^2 and $mrad^{-1}$. This function gives information how big and how strong UV source must be if shape is to be determined.
Resolution	Resolution is maximal spatial frequency of image of a three-bar target that can be resolved by camera operator looking on UV image generated by tested camera. Unit: lp/mrad. Measurements can be done at different gain of tested camera.
VIS Channel parameters	
Resolution	Spatial frequency of minimal 3-bar target that can be resolved on image generated by tested visible camera. Test are done at optimal illumination condition. Unit: lp/mrad.
Sensitivity	Minimal illumination of large circular target that can be detected. Unit: cd/m^2 or lx.
Other parameters	
Boresight error	Angular displacement of position of the same point target on images generated by UV channel and visible channel

SPECIFICATIONS

Parameter	**Value**
Modules	UVIC base station, set of targets, laptop, UVIC Control program
Solar box aperture	160x120 mm
Non-solar source aperture	36 mm
Spectral band of non solar source	From 250nm to 275nm
Spectral band of solar source	360nm to 730nm
Exitance range of non-solar UV source	10^{-18} to 10^{-6} W/cm2
Luminance range of solar box	0.1 -300 cd/m^2 (simulated approximate illumination 0.3-1000 lx)
Targets	UV targets: set of six circular targets (diameter: 1.6; 3.2; 6.4; 12.8; 25.6; 34 mm), set of four triangle targets (size size: 5, 10, 20, 30 mm); set of six 3-bar resolution targets of bar width: 5; 3; 2; 1.41; 1mm Visible targets: USAF 1951 resolution target (spatial frequency from 1 lp/mm to 7.13 lp/mm), black circle target
PC Control	RS 232/USB 2.0
Mass	12 kg
Dimensions	390x380x310mm (without laptop)
Operating temperature range	5°C to 40°C
Storage temperature range	-5°C to 55°C
Humidity	Up to 95% (non-condensing)
Power	AC230/110 V (option DC12V)

*specifications are subject to change without prior notice

SUMMARY

UVIC station is the first commercially available station for testing solar blind UV cameras. The station can be a vary valuable tool to evaluate true performance of these expensive cameras available on the market and to monitor performance during their life time.

Version 1.3 dated 10.11.2015

CONTACT:
Tel: +48 604061817 Fax: +48 22 3987244 Email: info@inframet.com

• INFRAMET