UMET

System for testing solar blind UV cameras

Fig. 1. Photo of UMET system

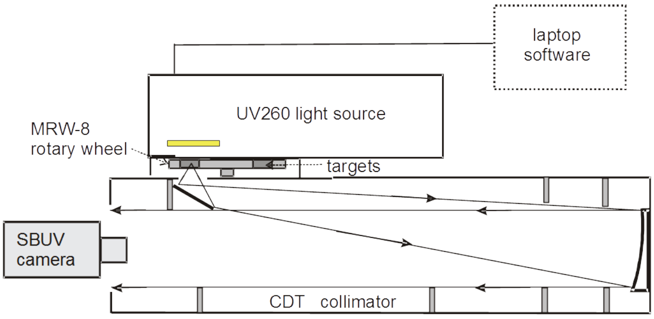

Fig.2. Block diagram of UMET test system

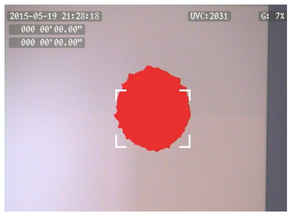

Fig.3. Image of a circular target generated by tested solar blind UV camera

BASIC INFORMATION:

Solar blind UV cameras are imaging devices sensitive to light at wavelengths from about 240nm to about 280nm. Maximal spectral sensitivity of such cameras is about 260nm.

Testing performance of SBUV cameras is important because parameters of such cameras offered on market vary significantly and additionally their sensitivity deteriorates with time.

Manufacturers of SBUV cameras present information on camera UV sensitivity in data sheets. This parameter is typically measured as irradiance at camera optics plane generated by a high temperature blackbody of minimal temperature that makes possible for camera to detect incoming UV light. However, such sensitivity data is misleading because results depends non only on true sensitivity of UV detector but also on camera spectral band and test conditions: distance blackbody-camera, blackbody diameter. Next, this method unjustly favors cameras sensitive to wavelengths over 280nm (cameras that are sensitive to solar light).

UMET is a test system that projects into direction of tested SBUV cameras images of a test target in two spectral bands: monochromatic 260nm band and visible light band. Use of monochromatic light source of the same wavelength as the wavelength of maximal sensitivity of SBUV cameras creates situation that camera that is more sensitive to light emitted by UMET will be also more sensitive to light emitted by corona phenomenon in SBUV band. Other drawbacks of classical method to measure UV sensitivity based on use of high temperature blackbody are eliminated, too. In addition, UMET enables measurement of a series of parameters that precisely describe performance of SBUV cameras.

Finally, UMET is a very valuable tool for scientific institutes working on development of a new generation of SBUV cameras capable not only to detect corona phenomenon but to measure absolute intensity of corona phenomenon (measurement of absolute power of SBUV light). The system can simulate different scenarios that can be met during real work of SBUV cameras.

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HOW IT WORKS:

UMET is a modular test system built from a series of blocks: CDT collimator, UV260 light source, MWR8 rotary wheel, set of targets, laptop and control software. CDT collimator works as projector of image of target located at its focal plane (irradiated by the light source). UV260 is a monochromatic SBUV light source (wavelength 260nm) of exitance regulated at very wide range (dynamic 10^{12}). MRW8 enables rotation and exchange of active target. Set of targets of different shapes and size are used to project different reference images. The tested solar blind camera generates electronic copies of these reference images in both two spectral bands. Quality of electronic images generated by tested camera in UV channel is evaluated by human user with help of software and important performance parameters of solar blind UV cameras are measured.

WHY TO TEST:

Performance of SBUV cameras offered on market vary significantly. Two cameras having almost the same data sheet can perform in much different way in real application. Next, performance of SBUV cameras vary with time due to deterioration of parameters of the crucial block: solar blind UV image intensifier. Due to these reasons testing SBUV cameras is critically important at any stage of life of SBUV cameras.

WHAT CAN BE MEASURED:

At present testing SBUV cameras is totally non regulated. There are no standards, no scientific papers on testing SBUV cameras. Manufacturers present in catalogs a parameter called sensitivity but measured using a method suitable for infrared technology that generates over optimistic results and vary depending on test conditions. 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 such situation Inframet proposes test methodology based on its experience on testing electro-optical imaging systems. In detail following parameters are to be measured:

1. Minimal Detectable Irradiance (sensitivity to point source)
2. Noise Equivalent Radiant Exitance (sensitivity to large source)
3. Event count response function
4. Variable target detectivity
5. UV resolution
6. Visible resolution
7. Center alignment error.
8. Peripheral alignment error
9. Random location error.

Parameters definitions are as below:

Sensitivity

MDI (minimal detectable irradiance) is defined minimal irradiance at optics plane of tested SBUV camera generated by point source of monochromatic 260nm light that can be detected by a human observer looking at video image generated by tested SBUV camera or by software of this camera. It can be treated that MDI is equivalent to UV sensitivity measured using the classical blackbody method but without drawback of the latter method. MDI unit is W/cm^2.

NERE (noise equivalent radiant exitance) is equal to radiant exitance of a large target at peak sensitivity wavelength (typically 260nm) that can generate the same output signal as signal generated by dark noise of the tested camera. It should be noted that NERE depends on camera gain and integration time. NERE unit is W/cm^2 as in MDI case but value of NERE is much higher.

It is also possible to measure sensitivity as minimal detectable radiant exitance of the point SBUV light source.

Event Count Response Function

Event Count Response function ECRF is a ratio between spatio-temporal density of event counts in analyzed image area and input radiant exitance of a large target. In detail, ECRF is calculated as ratio of average number of event counts recorded in time unit and input radiant exitance of a large target. Counting of events is carried out by software of tested camera. EFRF unit is $s^{-1}\ W^{-1}\ cm^2$. Attention: ECRF depends on size of analyzed area.

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Variable target detectivity

Variable target detectivity (VTD) is function of minimal detectable exitance of target of interest versus angular size of this target. Measurement is to be done in only in UV mode by visual observation of the image generated by tested camera by a human observer.

UV resolution

UV resolution is a maximal angular spatial frequency of 3-bar 100% contrast target irradiated by SBUV light that can be resolved by human observer looking on image of this target generated by UV channel of SBUV camera on its display.

Visible resolution

Visible resolution is a maximal angular spatial frequency of 3-bar target 100% contrast irradiated by visible light that can be resolved by human observer looking on image of this target generated by visible channel of SBUV camera on its display.

UV FOV

FOV of UV channel is angular size of maximal target that can be visualized in UV spectral band. Unit is angular degree.

Visible FOV

FOV of visible channel is angular size of maximal target that can be visualized in visible spectral band. Unit is angular degree.

Center alignment error

Center alignment error (CBE) is an angular image shift between UV image and visible image of the same target located in center of FOV of both channels. Unit of CAE is mrad.

Peripheral alignment error

Peripheral alignment error (PAE) is an average angular image shift between UV image and visible image of a series of four (or more) point targets located at peripheral (typically located at 80% of FOV) of field of view of both channels. Unit of PAE is mrad.

Random location error

Random location error (RLE) is temporal variation of center of image of a stationary point target located at center of FOV of the UV channel. Unit of RLE is mrad.

SPECIFICATIONS

Parameter	Value
Modules	CDT980 collimator, UV260 light source, MRW8 wheel, set of targets, laptop, UMET Control program, TAS-U program.
Max angular size of light source	at least 50mrad
Spectral band of non solar source	250nm to 270nm
Spectral band of solar source	400nm to 730nm
Regulated exitance range of non-solar UV source	10^{-20} to 10^{-8} W/cm^2
Luminance range of solar box	0.1 -200 cd/m^2 (simulated approximate illumination 0.3-660 lx)
PC Control	USB 2.0
Mass	up to 40 kg
Dimensions	1050x230x440mm (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

Software support

Software of UMET delivers support to carry out testing SBUV cameras:

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UMET Control program:

1. remote control of UV light intensity of the UV260 light source,
2. rotation of MWR-8 wheel with the targets.

TAS-U program

1. Acquisition of video images from UV/visible channel generated by tested UV camera (user is to choose one of following video standards: analog video, HDMI, CL, SDI, Ethernet, GigE, DVI),
2. Measurement of NERE (objective calculation of noise and signal)
3. Software support in calculation of alignment errors and random location error.
4. Software support in calculation of FOV of both channels.

Attention: It should be noted that UMET offers only limited support for measurement of: MDI, ECRF, VTD, UV resolution, and visible resolution. These are basically subjective parameters that are determined on basis of subjective analysis of images from tested camera.

OPTIONS

Two optional solutions are offered:

1. Measurement of UV sensitivity using classical blackbody method.
2. UMET system of reduced price.

A. Additional HTB25D-1200 blackbody

HTB25D-1200 is high temperature cavity blackbody integrated with a rotary wheel with a set of circular targets that enables measurement of UV sensitivity using classical blackbody method. This method is not recommended by Inframet due to a series of drawbacks. However, if users wants to measure this parameter then this option can be interesting. Technical detail as in https://www.inframet.com/Data_sheets/HTB.pdf

Fig. 4. Photo of HTB25D-1200 blackbody

B . UMET system of reduced price

SBUV cameras are used typically to detect corona defects at distances 30m or more in situation when focal length of optics of such imagers is not higher than about 80 mm. It means that distance to the target of interest is over 375. Therefore, it can treated that SBUV cameras are used for observation of targets that are near optical infinity.
It such a situation it is reasonable to use optical collimator capable simulate optical infinity conditions. It should be also noted that highest accuracy of alignment of UV channel and visible channel can be achieved if both channels see a target located at optical infinity.
Due to such reasons UMET test system uses CDT reflective collimator to project images at optical infinity. However, CDT reflective collimator is a costly device in situation when most SBUV cameras are capable to generate sharp images of targets at distance as low as 2 m. Therefore it is technically possible to remove CDT collimator from blocks of UMET system and to carry out testing SBUV cameras using concept of direct view when tested camera see the target directly.
It means that the tests can be done using UMET systems without collimator. In detail, CDT collimator is replaced by a simple cylindrical hood for protecting target against background light.

In this way price of UMET can be reduced. However, for such a simplified version coded as UMET-S accuracy of checking boresight accuracy is lower and tests are done at focusing at non typical setting.

Fig.4. Photo of UMET-S test system

SUMMARY

UMET station is the first commercially available computerized station for expanded testing solar blind UV cameras. The station enables to evaluate true performance of these expensive cameras available on the market and to monitor performance during their life time. UMET can be a very valuable tool R/D projects on development of new generation of SBUV cameras, too.

Version 2.1

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