OPTICAL CALIBRATION FACILITY AT THE IZAÑA ATMOSPHERIC RESEARCH CENTER

C. Guirado [1] [2], R. Ramos [2], Á. de Frutos [1], A. Berjón [3] [1], A. Redondas [2], C. López [4], V. Cachorro [1], E. Cuevas [2], R. González [1], S. González [1], M. Hernández [4]

[1] Atmospheric Optics Group, Valladolid University (GOA-UVA), Spain, carmen@goa.uva.es
[2] Izaña Atmospheric Research Center, Meteorological State Agency of Spain (AEMET), Spain
[3] Laboratoire d'Optique Atmosphérique, Université Lille, France
[4] Sieltec Canarias SL, Spain

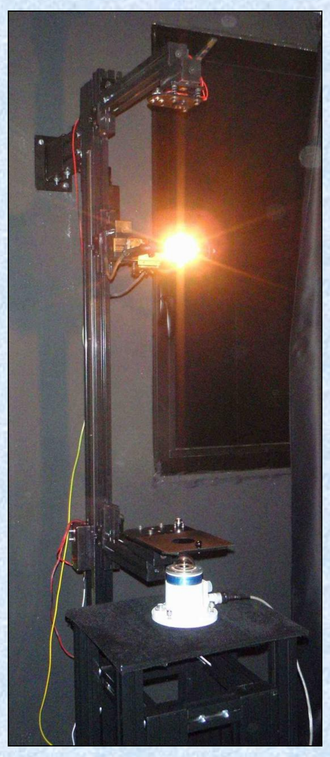
OPTICAL CALIBRATION FACILITY

During the last years a new optical calibration facility have been developed and deployed at the Izaña Observatory for the calibration and characterization of radiation instrumentation within research activities. The new systems are the result of a joint effort between the Izaña Atmospheric Research Center (AEMET) and the Atmospheric Optics Group of Valladolid University (GOA-UVA).

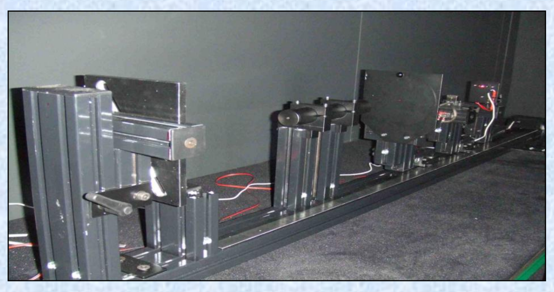
This new facility allows the absolute, spectral and cosine response calibration of the atmospheric measurement instrumentation of the Izaña Atmospheric Observatory (IAO) in an isolated dark room where, at this time, six set-ups are available for the above mentioned response characterization.

The systems have been built in a modular way, and the control and acquisition software have been developed such way the calibration facility could be easily adapted and meet the specific requirements of each sensor to be calibrated depending on its physical features as shape, size and weight.

Absolute Irradiance Calibration



Picture 2. Vertical Absolute Irradiance Calibration Set-up

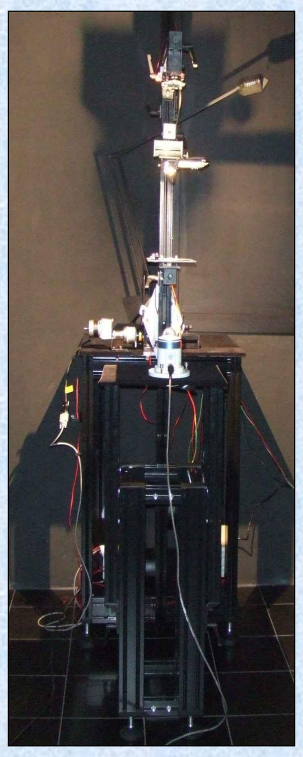


Picture 3. Horizontal Absolute Irradiance Calibration Set-up

The basis of the absolute irradiance scale consists on a set of DXW-type 1000 W lamps (for vertical set-up) and 1000 W FEL (for horizontal set-up) lamps traceable to the primary irradiance standard of the National Institute of Standards and Technology (NIST). The accuracy in the intensity of the lamp during the calibration and the distance between the optical entrance of the instrument and the lamp are tightly controlled.

Angular Response Calibration

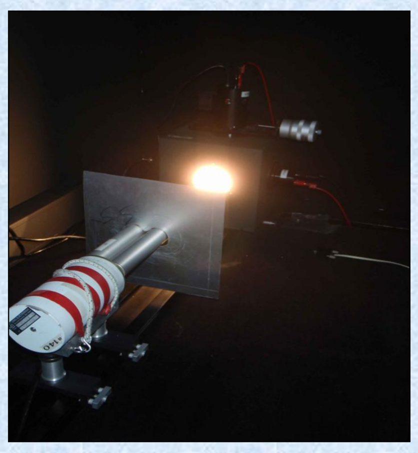
The irradiance measurements require the detector to weight incoming radiation with the cosine of the incoming angle relative to normal incidence (http://www.pmodwrc.ch/).



Picture 4. Angular Response Function Set-up

The relative angular response function is measured rotating the mechanical arm where the seasoned DXW-type 1000 W lamp is located. The rotation is controlled by a stepper motor with 0.01º of precision. Rotation over 360º is possible but only ±90º of rotation is used for the calibration while the instrument is illuminated by the uniform and parallel light beam of the lamp.

Absolute Radiance Calibration



Picture 5. Radiance Calibration Set-up

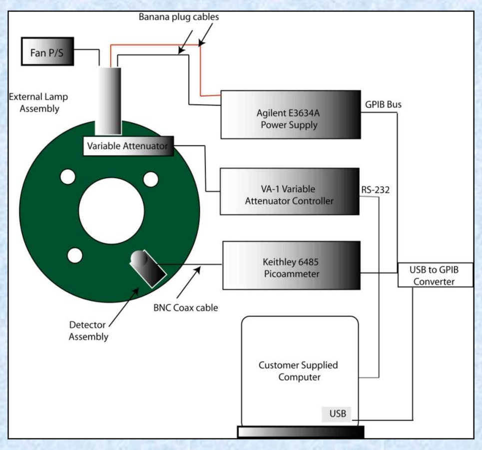


Figure 1. System block diagram and wiring scheme

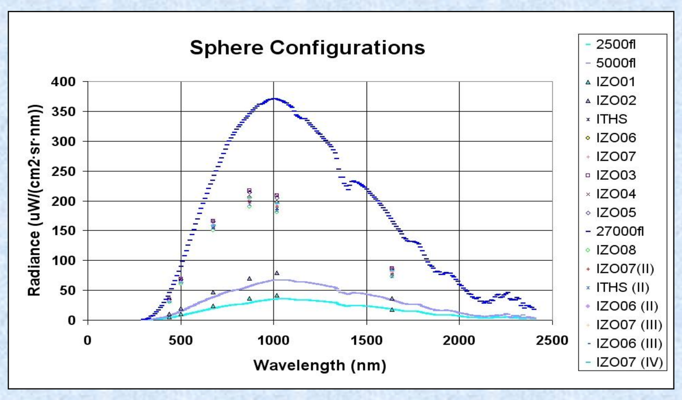


Figure 2. Several sphere configurations. The working sphere configuration is chosen based on the features of the sensor to be calibrated

The light source for the radiance calibration come from an integrating sphere. Its calibration certificate is traceable to the National Institute of Standards and Technology and three times a year a recalibration of the sphere is accomplished by comparison to the travel Master Cimel sun photometer of the National Aeronautics and Space Administration (NASA) (figure 2). The accuracy of the calibration is dependent on the stability of the radiance emission and the alignment between the sphere and the detector to be calibrated.

Spectral Response Calibration

Picture 6. Spectral Response Function Set-up

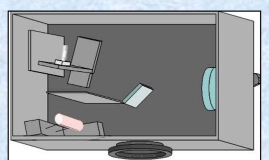


Figure 3. Light source

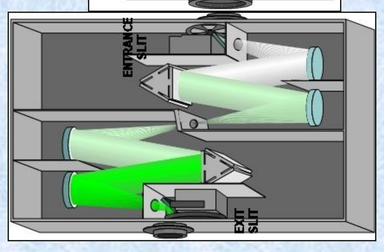
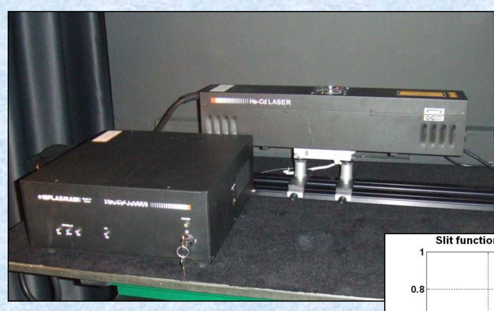


Figure 4. Optronic OL 750

Radiation measurements with broadband filter radiometers fundamentally depend on the relationship between the measured radiation spectrum and the spectral responsivity of the radiometer. The relative spectral response set-up consists of an Optronic double monochromator OL 750 (figure 4). The wavelength can be selected within the range 200 to 1100 nm through three gratings. An OL 740-20 light source (figure 3) positioned in front of the entrance slit acts as radiation source and two lamps, UV (200-400nm) and Tungsten (250-2500nm) are available.

Slit Function Determination



Picture 7. Slit Function Determination Set-up

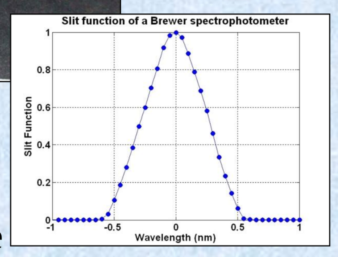


Figure 5. Slit function, normalized to the maximum intensity, calculated for a Brewer spectrophotometer

The components of the set-up are a VM-TIM He-Cd laser and power supply. The laser features are the following:
Nominal wavelength: 325 nm.
Power: 6mW.
Beam diameter: 1,8 mm.

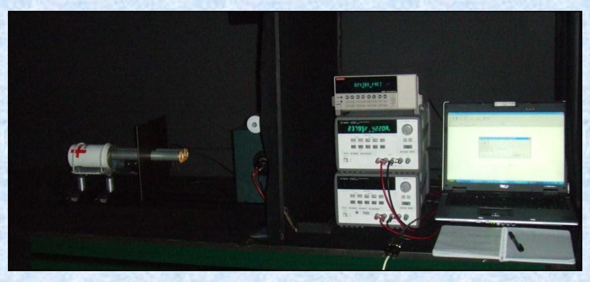
IZAÑA ATMOSPHERIC RESEARCH CENTER

The high altitude Izaña Atmospheric Observatory (IAO) is involved in several national and international atmospheric and environmental research networks and programs (i.e. GAW, BSRN, AERONET, NDACC, RBCC-E) in which is crucial a robust and traceable Quality Assurance & Quality Control system for the different broad band radiometers, photometers and spectrometers, which measure, among other ones, spectral solar radiation, aerosol optical depth and total ozone amount.

Picture 1. Panoramic view of the roof at IAO where most of the atmospheric measurement instrumentation is located

RADIANCE AND IRRADIANCE CALIBRATIONS DEVELOPED AT THE OPTICAL CALIBRATION FACILITY OF IZAÑA

Absolute Radiance Calibration of the Cimel Sunphotometer #380



Picture 8. Radiance calibration of the Cimel#380

Time	1020 nm	870 nm	670 nm	440 nm
9:48:31	0.019529	0.014046	0.019755	0.033614
9:58:14	0.019497	0.014035	0.019741	0.033593
14:39:04	0.019396	0.014002	0.019711	0.033542
14:51:16	0.019361	0.01399	0.019695	0.033506
Mean	0.019446	0.014018	0.019726	0.033564
St. Dev. (%)	0.411559	0.189308	0.138867	0.145846

Table 1. Aureole radiance calibration factors

Time	1020 nm	870 nm	670 nm	440 nm
9:48:31	0.004445	0.002957	0.004017	0.008079
9:58:14	0.004437	0.002955	0.004014	0.00807
14:39:04	0.004407	0.002947	0.004002	0.008046
14:51:16	0.004398	0.002946	0.003998	0.008038
Mean	0.004422	0.002951	0.004008	0.008058
St. Dev. (%)	0.514844	0.188404	0.229026	0.240712

Table 2. Sky radiance calibration factors

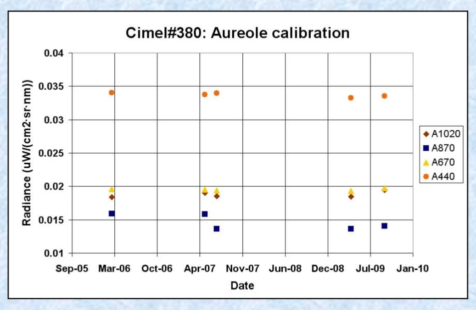


Figure 6. Temporal evolution of the aureole radiance calibration factors

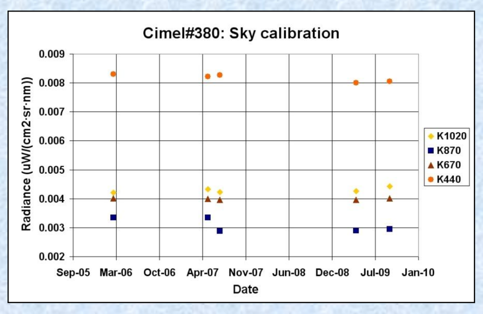
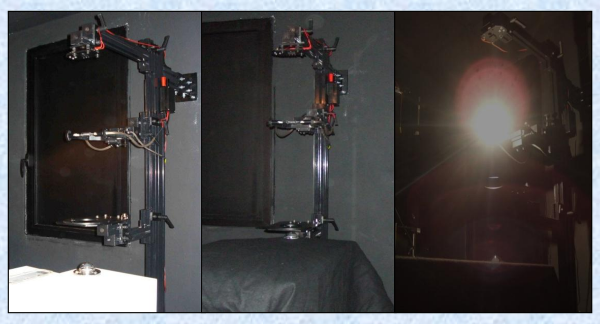


Figure 7. Temporal evolution of the sky radiance calibration factors

On September 11th, 2009 the Cimel#380 was calibrated. Two measurements in the morning and two ones in the afternoon were done, getting at the same time the aureole and the sky calibration (tables 1 & 2). Figures 6 & 7 show all the calibrations done at Izaña to the Cimel#380. The files containing the calibration factors are sending to AERONET (Aerosol Robotic Network, http://aeronet.gsfc.nasa.gov/) and are used until the next calibration.

Absolute Irradiance Calibration of the Brewer Spectrophotometer #201



Picture 9. Several steps of the irradiance calibration of the Brewer#201

On March 10th, 2010 the Brewer#201 was calibrated. The intensity and the voltage applied to the lamp (figure 8) and the Hg step parameter (figure 9) were checked during the calibration. The Hg step is a parameter of the Brewer which indicates the right alignment of the grating, i.e., the accuracy in the measuring wavelength. Finally the ultraviolet response of the Brewer was calculated (figure 10). This response is applied to the UV radiation measurements of the Brewer spectrophotometer.

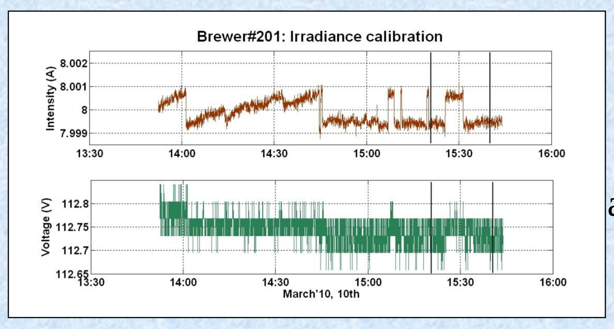


Figure 8. Intensity and voltage applied to the lamp (black lines show the interval time of calibration)

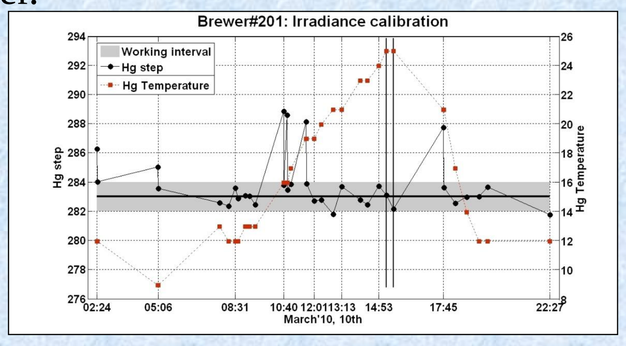


Figure 9. Hg step and temperature of the Brewer#201. Hg step should be between the grey band (black lines indicate the beginning and the finishing time of the calibration)

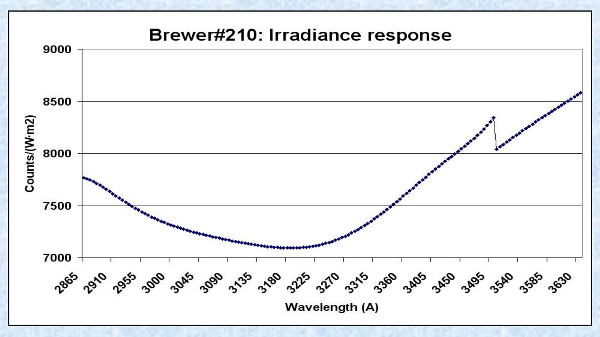


Figure 10. UV response of the Brewer#201

Acknowledgements: This work was developed within the Specific Agreement of Collaboration between the University of Valladolid and the CIAI-AEMET "Establish methodologies and quality assurance systems for programs of photometry, radiometry, atmospheric ozone and aerosols within the atmospheric monitoring program of the World Meteorological Organization. Financial supports from the Spanish MICIIN (ref. CGL2008-05939-CO3-00/CLI and CGL 2009-09740) and from the GR-220 Project of the Junta de Castilla y León are gratefully acknowledged.

References:
Calibration Services of European Ultraviolet Calibration Center (EUVC) at Physikalisch-Meteorilogisches Observatorium Davos / World Radiation Center (PMOD/WRC), http://www.pmodwrc.ch/euvc/euvc.php?topic=calibration_services