

## ***Interactive comment on “Optical laboratory facilities at the Finnish Meteorological Institute – Arctic Research Centre” by K. Lakkala et al.***

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Received and published: 20 May 2016

Authors' response to the review of the manuscript “Optical laboratory facilities at the Finnish Meteorological Institute - Arctic Research Centre” by Lakkala et al.

The Authors appreciate the constructive comments of the Referee #1 and respond here below to each remark. The answers are marked as A:. The manuscript has been upgraded following the review comments and uploaded as supplement.

B) Specific scientific comments All technical parts of the different calibration and measurement procedures are well described; however the paragraph of the control circuit of the irradiance standard lamp is not easy to follow and needs to be rewritten to improve the quality of the manuscript: The control of the current passing through the lamp is the most important step for absolute irradiance calibrations. The traceability of this

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value is usually obtained through a calibrated resistor and a calibrated voltages measuring device (DMM). This should be clearly explained in the corresponding paragraph.

A: The paragraphs describing the control circuit has been modified following the suggestions. They are now :

“For absolute irradiance calibrations, the most important is controlling the current passing through the lamp. The lamp current is acquired by the voltage measurement over the reference shunt and controlled with the control room PC. The electrical circuit diagram of a calibration is shown in Fig. 1, where the main circuit is bolded. The system allows the current accuracy to be  $\pm 0.001A$ . To ensure the accuracy, the multimeter and the shunt are sent every one-two years to SGS FIMKO Testing and Certification Services, Finland, for checking and calibration. During the last calibration (6.-7.5.2014) the uncertainty of the shunt was  $\pm 0.007\%$  which makes  $\pm 0.007m\Omega$ . The reported uncertainty was based on a standard uncertainty multiplied by a coverage factor  $k = 2$ , providing a level of confidence of approximately 95%. The last calibration confirmed the specifications of the multimeter provided by the manufacturer, in which the accuracy of the voltage measurement over 24 h was 0.06 ppm.

A LabVIEW System Design Software (LabVIEW), National Instruments, has been tailored to read the voltage drop of the shunt measured by the multimeter, and to regulate the lamp current to the defined value. The regulation can be done in steps of 12 mA using the power supply (HP6675A). As there is a need for higher precision, an adjustable voltage reference with control voltage of 0 - 14 mV is connected to the external analog input of the power supply to finely tune the current regulation (Fig. 1).

In order to safely monitor the voltage over the lamp, which results from the current regulation, a voltage limiter and a voltage converter are need to give the right input signal to the datalogger. Galvanic isolation is made at the same time with the conversion. The voltage readings can be used to monitor the long term stability of the lamp and for quality control of the measurements. The readings from the voltage converter,

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temperature and UVB/A sensors are transferred via the datalogger to the control PC.”

At FMI Sodankylä, the lamp current is acquired by the voltages measurement (HP3458A ) over the reference shunt (Burster 1282, 0.1 Ohm). The details of the calibration of these devices (frequency, uncertainty) could be given. Using this current value the software controls the lamp current via the power supply (HP6675A). The current uncertainty is finally the combination of the reference devices uncertainties (Shunt and DMM) and the feedback precision.

A: The uncertainty of the shunt and the accuracy of the multimeter are now given. The text is now:

“The system allows the current accuracy to be  $\pm 0.001\text{A}$ . To ensure the accuracy, the multimeter and the shunt are sent every one-two years to SGS FIMKO Testing and Certification Services, Finland, for checking and calibration. During the last calibration (6.-7.5.2014) the uncertainty of the shunt was  $\pm 0.007\%$  which makes  $\pm 0.007\text{m}\Omega$ . The reported uncertainty was based on a standard uncertainty multiplied by a coverage factor  $k = 2$ , providing a level of confidence of approximately 95%. The last calibration confirmed the specifications of the multimeter provided by the manufacturer, in which the accuracy of the voltage measurement over 24 h was 0.06 ppm.”

The reason for the additional devices is unclear: What is the current-to-voltages converter? Looking at the schematic (Fig. 1) it looks more like a simple voltage measurement performed from the Data Logger QLI50. This value is a result of the current regulation and thus interesting as a long term stability and quality criterion for the lamp in use.

A: The current-to-voltage converter includes the voltage limiter and the voltage converter with galvanic isolation. It is used to safely monitor the voltage over the lamp. The Figure 1 has been updated. The text has been updated to “In order to safely monitor the voltage over the lamp, which results from the current regulation, a voltage limiter and a voltage converter are needed to give the right input signal to the datalogger.

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Galvanic isolation is made at the same time with the conversion. The voltage readings can be used to monitor the long term stability of the lamp and for quality control of the measurements. The readings from the voltage converter, temperature and UVB/A sensors are transferred via the datalogger to the control PC. ”

The paragraph describing the electronics of the laboratory has been accordingly updated, including information of the voltage limiter and the voltage to voltage converter:

“The electronics of the laboratory includes a  $0.1\ \Omega$  shunt resistor (Burster-1282-0.1), a high precision digital multimeter (Hewlett Packard 3458A), a high precision power supply (Hewlett Packard 6675A system DC Power supply 0-120V/0-18A), a voltage limiter (from 150 VDC to 10 VDC), a voltage to voltage converter with galvanic isolation (Nokeval Signal Converter 641) (from 10 VDC to 2.5 VDC with galvanic isolation), an adjustable voltage reference, a datalogger (QLI50 Sensor Collector, manufactured by Vaisala Oyj) and a control PC. “

Finally: What is the fine tuning procedure and what is its purpose?

A: The following description has been added to the text: “

“A LabVIEW System Design Software (LabVIEW), National Instruments, has been tailored to read the voltage drop of the shunt measured by the multimeter, and to regulate the lamp current to the defined value. The regulation can be done in steps of 12 mA using the power supply (HP6675A). As there is a need for higher precision, an adjustable voltage reference with control voltage of 0 - 14 mV is connected to the external analog input of the power supply to finely tune the current regulation (Fig. 1).”

C.) Presentation The manuscript is clearly structured. Minor modifications are recommended to improve the quality of the paper: Page 3, line 7: (Typo) Internation -> International

A: The text has been corrected. “The NILU-UV instruments have also been set up to measure on the peatland field experiment and forest experiment of the Finnish Ultravi-

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olet International Research Centre (FUVIRC) during summers of 2002-2011.”

Page 3, line 17: Reference to the manufacturer ADS Inc.

A: The suggested reference has been added. The text is now: “The spectroradiometer of type Analytical Spectral Devices (ASD) FieldSpec Pro JR Full Range, manufactured by Analytical Spectral Devices, Inc., nowadays PANalytical, measures solar UV spectrum in the wavelength region from 350 nm to 2500 nm covering the longer wavelengths of the UV part of the solar spectrum as well as the visible and near infrared part of the solar spectrum.”

Page 3, line 4: (Typo) “current passes through the lamp” whereas “Voltages is measured over the lamp”. The HP6675A specifications are 0-120V and not 0-12V.

A: The text has been corrected following the remark:

“...a high precision power supply (Hewlett Packard 6675A system DC Power supply 0-120V/0-18A)”.

And the typo has been corrected, as the corresponding sentence is now: “In order to monitor the voltage over the lamp which results from the current regulation, a voltage limiter and a voltage converter are used.”

Page 5, line 15: Reference to the manufacturer of the QLI50. I could not find this Instrument.

A: As suggested, a reference to the manufacturer has been added: “The readings from temperature and UVB/A sensors and the converter are transferred via a datalogger QLI50 Sensor Collector, manufactured by Vaisala Oyj, to the control PC.”

Page 5, line 22: (Typo) T +20 C 250 C -> Probable +-2.5 degC ?

A: The text has been corrected: “ The temperature in the temperature chamber (UT12, Thermo) can be regulated between ambient temperature T (+20degC) and +250degC. The regulation range of the cold chamber (SRC 1812/3.1 B (L), Porkka) is between

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+2degC and +12degC, and its dimensions are 1800 mm x 1200 mm x 2000 mm. “

Page 6, line 21: Define “X minutes”

A: The text has been updated: “The current is controlled by the LabVIEW program, which allows the current to increase slowly during 2-3 minutes before reaching the final level.”

Page7, line 21: (Typo) “the Spectralon” -> “a Spectralon”

A: the text has been corrected following the suggestion: “The fixed setup of the optical laboratory is also used for monitoring the stability of the ASD field spectroradiometer and a Spectralon reference plate.”

Page 8, line 26: IHP = “Improving Human Research Potential”, Reference missing

A: The text has been updated following the suggestion. “Several international groups have performed studies at FMI-ARC and used the facilities for stratospheric, snow, vegetation and ionospheric studies during the Lapland Atmosphere - Biosphere Facility (LAPBIAT) project under the Improving Human Research Potential – Access to Research Infrastructures of the European Union (contract no. 025969-TA, [www.sgo.fi/lapbiat](http://www.sgo.fi/lapbiat)).”

Captions on the Figures are too short; more information is needed. The illumination of the photographs could be much improved.

A: Unfortunately the authors didn't find better photographs, as it is hard to take pictures of black instruments in black surroundings. However the authors think that they are good enough to give an idea of the measurement installation. More information has been added to the caption of the Figures, see below.

Figure 1:the electrical circuit

A: The caption of Figure 1 has been corrected following the suggestion: “The electrical circuit of the optical laboratory in FMI-ARC. The main circuit is bolded. The vertical

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black dashed line denotes the separation between the dark room and the control room. Instruments at its left side are in the dark room, while the instruments in the right side are in the control room.”

Figure 2: For users who have never seen a brewer irradiance calibrations: The lamp inside the lamp holder is not visible. The Brewer is the white box with the quartz entrance dome seen in the bottom left corner. Indicat the locations of the different devices(lamp in the holder, Brewer, baffle, alignment assembly, Monitor diodes.)

A: More information has been added to the Figure caption:”Lamp measurement with the Brewer spectroradiometer. The diffuser of the Brewer is on the left bottom corner under the baffles. The lamp is placed in the lamp holder over the baffles. The goniometer is seen in the middle and the UVA and UVB sensors on the right bottom corner.”

Figure 3: NILU - bottom white, Lamp unit – black top

A: More information has been added to the Figure caption:”Lamp measurement of the NILU-UV radiometer. The NILU-UV is the white cylinder. The lamp is placed inside the black cylinder on the top of the NILU-UV. “

Figure 4: What is the light spot on the wall? Where is the entrance of the cosine Receiver?

A: The light spot on the wall is reflection of the laboratory light, which are off during the measurements.The entrance of the cosine receiver is the small white spot straight under the lamp.

Please also note the supplement to this comment:

<http://www.geosci-instrum-method-data-syst-discuss.net/gi-2015-43/gi-2015-43-AC1-supplement.pdf>

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Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., doi:10.5194/gi-2015-C7

43, 2016.

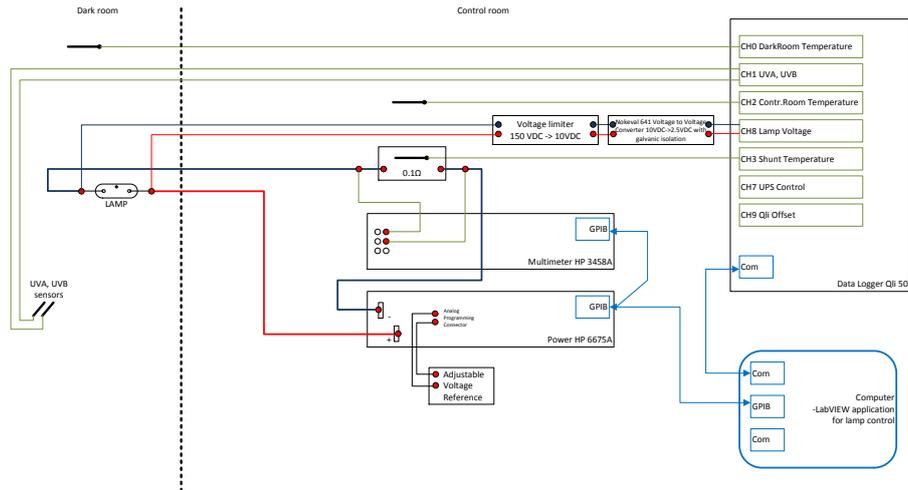


Fig. 1.

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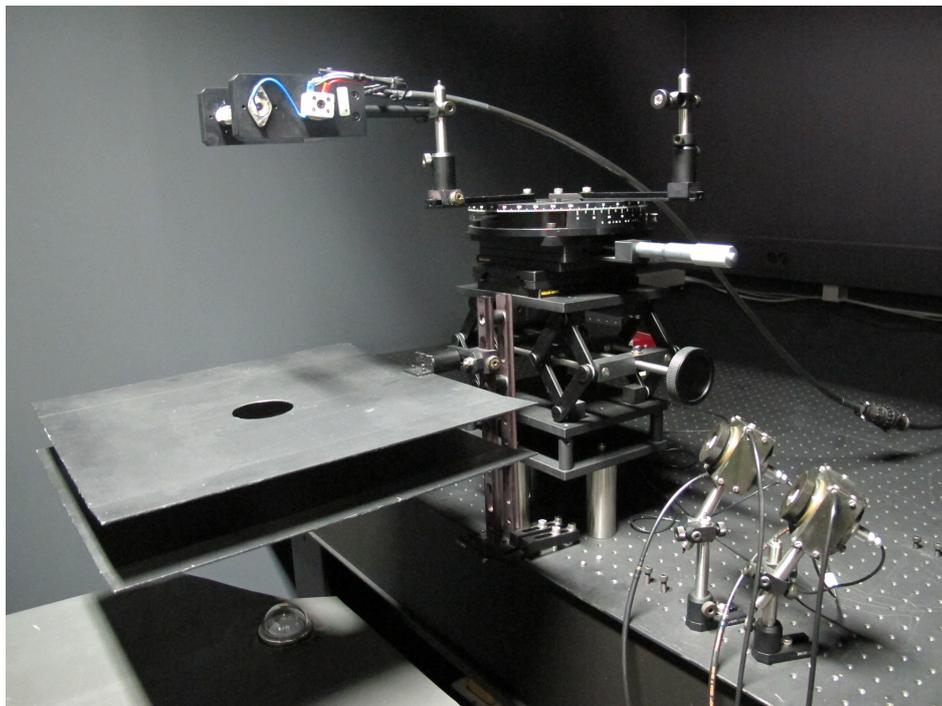


Fig. 2.

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Fig. 3.

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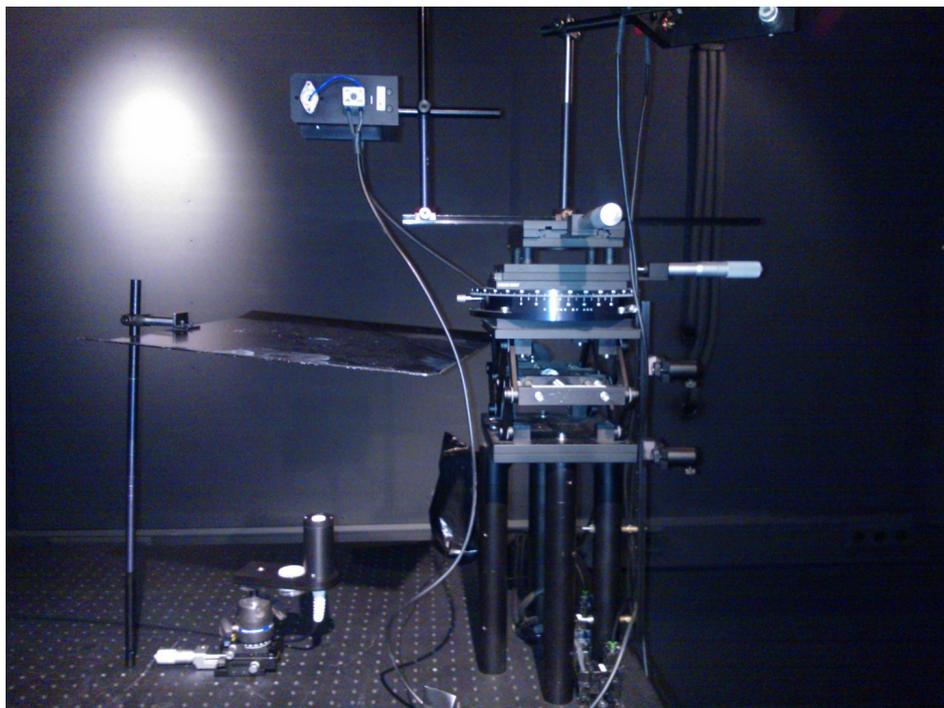


Fig. 4.

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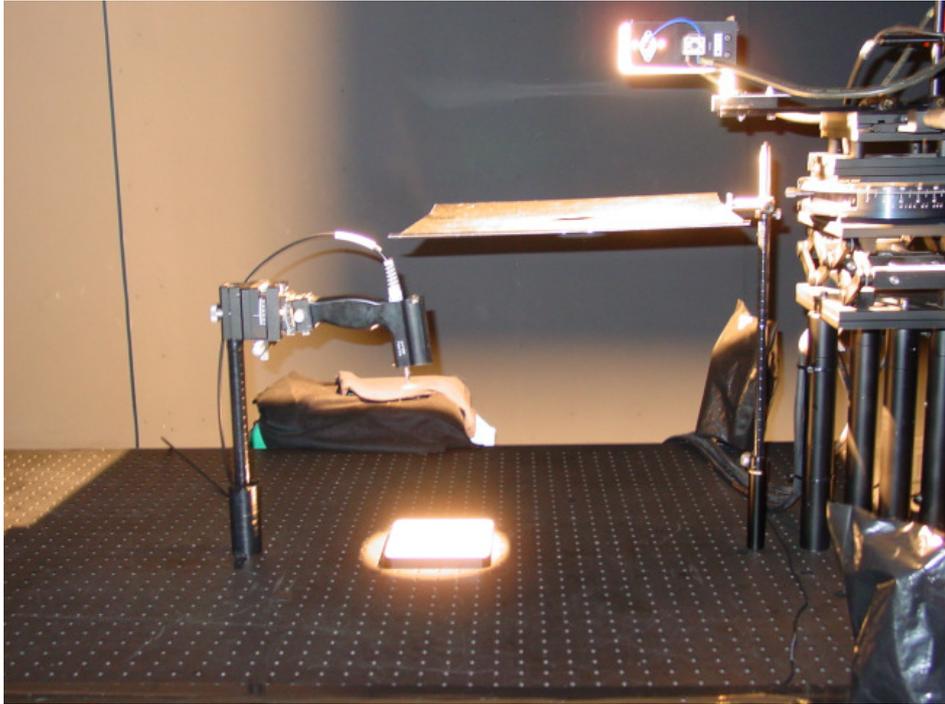


Fig. 5.

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