Calibration Report: Pyranometer CM21-041282

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Document date 2019 April 24.

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Calibration date: 2019-04-24.
Next calibration: 2021-04-24.
Reference standard: AHF-31041

The calibration coefficients and their associated uncertainties (U95%) have been determined for one pyrheliometer. The unit of the calibration coefficient (S) is $\mu V/(W/m^2)$. The reference standard was Eppley Laboratories Inc., absolute cavity radiometer AHF31041, with its associated data acquisition system. Cavity AHF31041 participated in the 2015 International Pyrheliometer Comparison (IPC XII) at the Physikalisch-Meteorologisches Observatorium, in Davos Switzerland. It is therefor traceable to the World Radiation Reference. Cavity AHF31041's calibration is verified annually at the National Pyrheliometer Comparison held at the National Renewable Energy Laboratory in Golden Colorado, most recently in September of 2018. AHF31041 is first used to calibrate CM22-040100. The CM22-040100 calibration value was then transferred to CM21-041282 under global measurement conditions during April 19 through April 23 of 2019.

The sensitivity factors and their associated uncertainties (95%) are as follows:

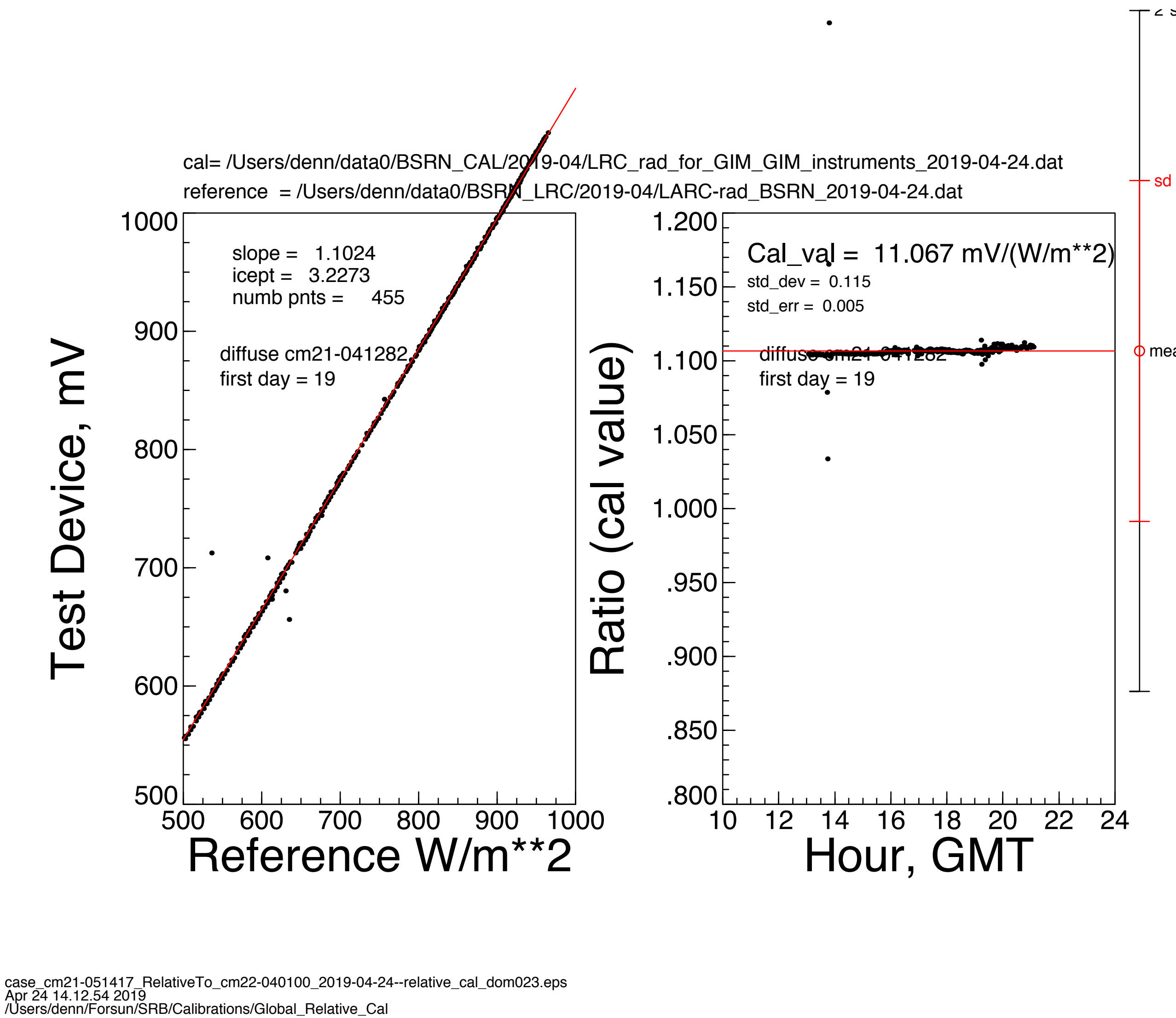
Sensor	S ($\mu V/(W/m^2)$) ± U95%	Method
CM21-041282	11.074 ± 1.45%	relative to CM22-040100

Application

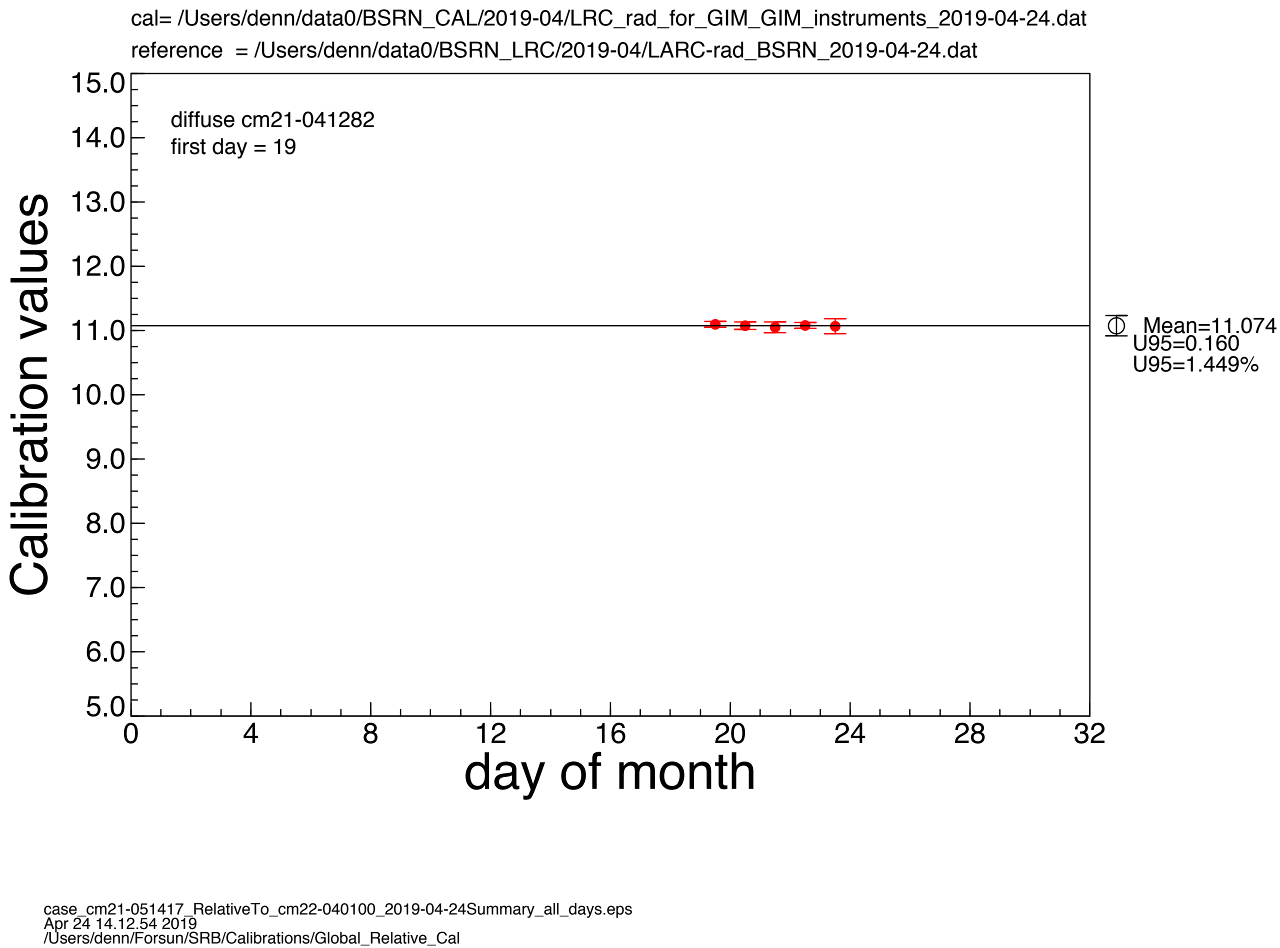
$$I = (\mu V \text{ output})/S \pm \text{sqrt}(2)*U95\%$$

Where: I = the irradiance measured by the pyranometer
(μV output) = microvolt output of the pyranometer
S = calibration coefficient of the pyranometer
U95% = the 95 % confidence level

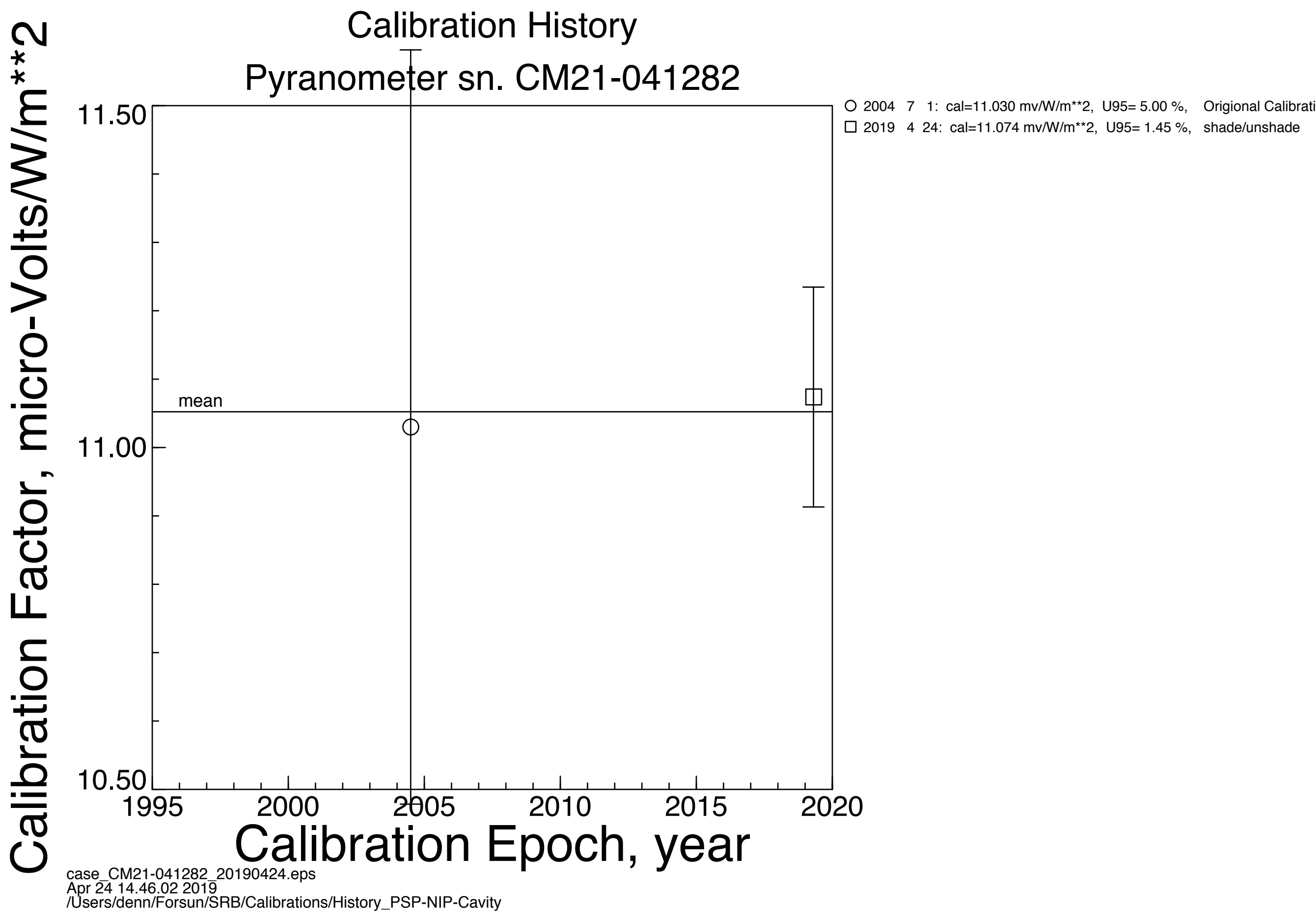
Some supporting plots, a list of past calibration values, and a brief description of the calibration process is presented below.



One day of relative calibration data. CM31-040100 was the reference, CM22-041282 was the instrument being calibrated.



Calibration coefficients for several days. Each symbol represents the mean calibration coefficient for a given day. These data are combined to get a final calibration coefficient for the entire, multi-day, calibration session.



Calibration history for pyranometer CM21-041282. The solid horizontal line represents the mean value. The symbols and their error bars represent the mean and U95 of each calibration event. The column on the right presents numerical values for each calibration event and a brief description of the calibration method used.

CALIBRATION HISTORIES

(doy = day of year)

Pyranometer: Kipp and Zonen CM22-040100

date	S ($\mu V/W/m^2$)	U95 (%)	calibration type
2019-04-24	11.074	1.45	relative to CM22-040100
2004-07-01	11.03	5.00	manufacturers original

A Very Brief Description of the Calibration Process.

1) Deploy the Cavity Radiometer, select the 4 second data collection parameter file. Start the cavity calibration process.
2) Modify the field radiometer program, set the parameter that causes one second data collection.
3) Prepare the tracker hardware to operate in manual shade/unshade mode. Either in manual mode or with the automatic pneumatic cylinder.
4) Start the cavity in sun-run mode, do this on a minute that is a multiple of 5 into the hour. Note a cavity calibration and sun-run takes almost 30 minutes.
5) Raise or lower the tracker shading balls every 5 minutes, on multiples of 5 minutes into the hour.
6) Continue this process as long as sky conditions permit while cavity irradiance is greater than 700 Watts/meter**2.
7) On both the cavity computer and the field radiometer computer, open a web browser and email the data files to the data processing computer, Files could also be copied to an external memory stick.
8) Remove data that is flagged as "unstable" in the cavity data file.
9) Run a splitter program on the field radiometer file to generate a separate file for the shaded and unshaded periods for each instrument.
10) Run a plotting program on each data file so the data can be reviewed for: cloud events; bad shading; errors in the splitting routine; etc. Remove bad data.
11) Run a calibration program to determine the calibration coefficient for each instrument.
12) Combine several days of calibration data to get a final calibration coefficient.
13) Produce a calibration document, such as this one, for each instrument. To be considered valid a calibration must be both traceable to recognized standards, in this case the World Radiation Reference (WRR) in Davos Switzerland, and documented.