Calibration Report: Pyrheliometer
Kipp and Zonen CH1P-160454
World Meteorological Organization number 78001
(For the Baseline Radiation Network)

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Calibration date: 2025 April 17.
Next calibration due: 2027 April 17.
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 µV/(W/m^2). The reference standard was Eppley Laboratories Inc., absolute cavity radiometer AHF-31041, with its associated data acquisition system. The AHF-31041 calibration is traceable Through the Golden Colorado National Renewable Energy Laboratory's (NREL) September 2022 National Pyrheliometer Comparison (NPC) to the World Radiation Reference Maintained at the Physikalisch-Meteorologisches Observatorium Davos / World Radiation Center. The NREL cavity reference group attended the International Pyrheliometer Comparison held in Davos during September and October of 2021, and is therefore traceable to the World Radiation Reference.

The sensitivity factor and its associated uncertainty (95%) are as follows:

Manufacturer	Serial Number	µV/(W/m^2)	U95
Kipp and Zonen	CH1P-160454	8.403	± 0.49%
WMO number 78001			

Application

I = (mV output)/S ± sqrt(2)*U95%

Where: I = the irradiance measured by the pyrheliometer
(mV output) = microvolt output of the pyrheliometer
S = calibration coefficient of the pyrheliometer
U95% = the 95 % confidence level of a field measurement.

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

CALIBRATION LOCATION

NASA Langley Hampton VA.
Latitude = 37.1038 deg., Longitude = -76.3872 deg., Elevation = 6 meters.

CALIBRATING PERSON(S)

Fred Denn, Bryan Fabbri

TRACEABILITY

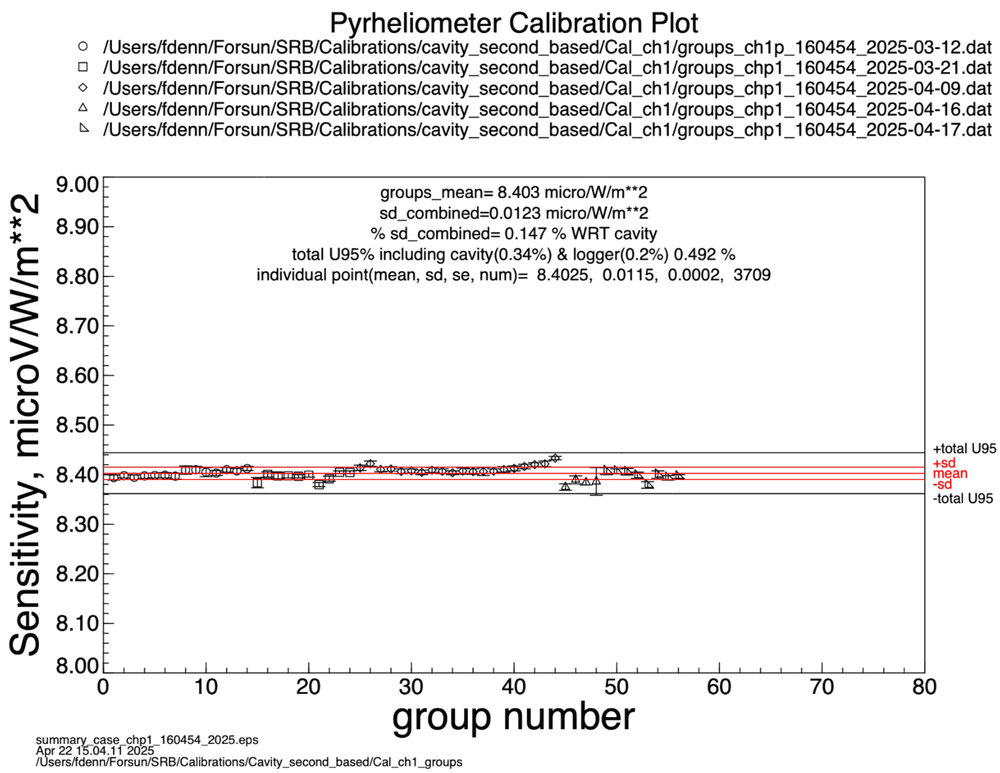
The reference standard was Eppley Laboratories Inc., absolute cavity radiometer AHF31041, with its associated data acquisition system. Cavity AHF31041 participated in the 2000, 2005, 2010, and 2015 International Pyrheliometer Comparisons (IPC) at the Physikalisch-Meteorologisches Observatorium, in Davos Switzerland, where the World Radiation Reference (WRR) is kept. Cavity AHF31041's calibration is verified annually at the National Pyrheliometer Comparison (NPC) held at the National Renewable Energy Laboratory (NREL) in Golden Colorado. In 2021 a new Campbell CR1000x data acquisition system was developed by a member of our group (Fred Denn) at NASA Langley. Traceability of the new data acquisition system to the WRR was established at the September/October 2022 NPC.

HARDWARE CONFIGURATION

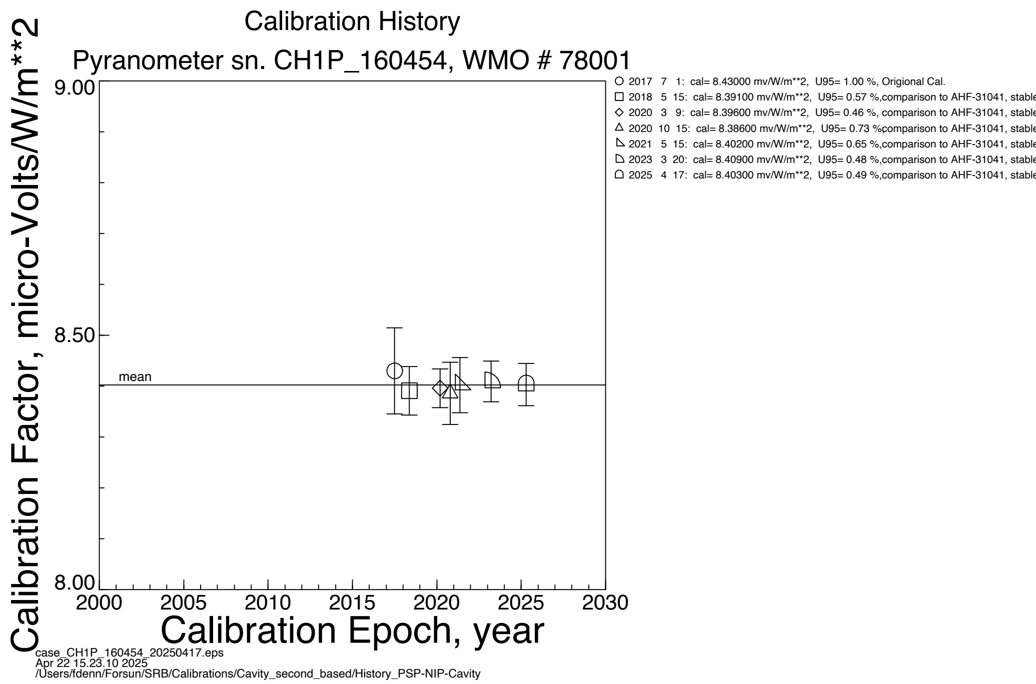
The pyrheliometer was mounted on a Kipp Zonen sun tracker and aligned with the sun.

DATA DAYS

Data for this calibration event were collected on the days shown in the plot below. Only the mean of measurements between solar zenith angles of 40º and 50º were used for the final value. Data outside that range illustrate the solar zenith angle response of the pyranometer.



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



Calibration history for pyrheliometer CHP1-160454. 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

Pyrheliometer: Kipp and Zonen CH1P-160454.

Date	S ($\mu V/(W/m^2)$)	U95 (%)	Method
2025 Apr 17	8.403	0.49	1Hz, ref. AHF-31041
2023 March 20	8.409	0.48	1Hz, ref. AHF-31041
2021 May 15	8.402	0.65	1Hz, ref. AHF-31041
2020 Oct 15	8.386	0.73	1Hz, ref. AHF-31041
2020 March 09	8.396	0.45	1Hz, ref. AHF-31041
2018 May 15	8.39	0.46	1Hz, ref. AHF-31041
2018 Jan xx	8.43	?.??	manufactures original

A Very Brief Description of the Calibration Process.

1) Pyranometers are to be mounted horizontally, while pyrheliometers are to be mounted on the tracker pointing at the sun.
2) Deploy the Cavity Radiometer, select the 4 second data collection parameter file. Start the cavity calibration process.
3) Modify the field radiometer program, so that a file of second data is produced in addition to the minute resolution data file.
4) Prepare the tracker hardware to operate in manual shade/unshade mode. Either in manual mode or with the automatic pneumatic cylinder.
5) Start the cavity system, first calibrating the cavity, then collecting data for about 20 minutes before doing a recalibration. Repeat the calibration/measure process for the entire calibration period.
6) Collect pyranometer data in the unshaded configuration for about 5.0 minutes, and in the shaded configuration for about 5.0 minutes.
7) Continue this process while sky conditions permit while cavity irradiance is greater than 700 Watts/meter**2.
8) Transfer the cavity and pyranometer data to the data processing computer.
9) Remove unstable (greater than 1 w/m**2 variation over 3 seconds) in the cavity data file. This depends on which cavity control system is used.
10) Run a splitter program on the field radiometer file to generate a separate file for the shaded and unshaded periods for each instrument.
11) 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 records.
12) Run calibration programs to determine the calibration coefficient for each instrument.
13) Combine several days of calibration data to get a final calibration coefficient.
14) Produce a calibration document, such as this one, for each instrument. To be considered valid, a calibration must be documented and traceable to recognized standards, in this case the World Radiation Reference (WRR) in Davos Switzerland.