NATIONAL RENEWABLE ENERGY LABORATORY

Welcome!

NREL Pyrheliometer Comparisons 2017

NPC-2017

25 September – 6 October

NPC-2016 Participants

15013 Denver West Parkway
Golden, CO 80401
Phone 303-275-3000

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

Radiometers at the Solar Radiation Research Laboratory (SRRL)

Welcome to the 20th NREL Pyrheliometer Comparisons
NPC-2017

25 September – 6 October 2017
Solar Radiation Research Laboratory
Golden, Colorado

The purpose of this NPC is to provide participants with current World Radiometric Reference (WRR) reduction factors for their absolute cavity radiometers and other reference pyrheliometers based on results from the 12th International Pyrheliometer Comparisons (IPC-XII) conducted 28 September – 16 October 2015 at the Physikalisch-Meteorologisches Observatorium Davos/World Radiation Center (PMOD/WRC). Information about IPC-XII is available from : **http://www.pmodwrc.ch/pmod.php?topic=ipcxii**

C O N T E N T S

SRRL Staff

NREL Metrology Laboratory & Sensing and Predictive Analytics (SePA) group

Afshin Andreas	Computer Issues, NREL Cavity Operations
Mike Dooraghi	Solar Trackers, Tools, Electronics and Hardware, NREL Cavity Operations
Aron Habte	General Assistance, Data collection and compilation
Mark Kutchenreiter	Electrical Power, Tools, Electronics and Hardware
Martina Stoddard	Host (Security, Logistics, Food)
Ibrahim Reda	NREL Cavity Operations, NPC Data Collection & Processing, General Cavity Assistance

SRRL Location

Solar Radiation Research Laboratory (SRRL)

Latitude:	39.742 N
Longitude:	105.18 W
Elevation:	1828.8 m AMSL
Mean Station Pressure:	820 mBar
Time Zone:	(GMT – 7.0)
Phone:	303-384-6326
Emergency Phone:	1234 (on-site)

Telephone Numbers:

EMERGENCY = 303-384-6811
Or
1 2 3 4 (From ***any*** NREL Desk Phone)

SRRL = 303-384-6326

Safety

Emergency Phone: **RED BOX** UNDER INSTRUMENT DECK
OR Press **1 2 3 4** from any NREL extension

Evacuation Assembly Area: Northeast Corner of Parking Area

Security

Phone: 303-384-6811 or Press 6811 from any NREL extension

NREL *Visitor Badges* issued on first day of NPC at the Visitor Center. Please wear your badge at all times at SRRL.

Communications

Local (Long Distance): **9** – (1) Area Code – Number

Internet Access:

NREL_Wireless was replaced with NREL-Guest. The new system does not require a user ID and password for access. Users, including visitors and partners, *will only need to accept the terms* of the acceptable use policy to gain access. The acceptable use policy will be presented each time your mobile device has been away from NREL for several days.

Food & Beverages

Lunch Menu will be circulated daily by 9:30 MDT (see Martina)

Non-alcoholic Beverages and snacks provided

Equipment Storage

Please use ***designated areas*** in SRRL staging areas.

NPC-2017 Protocol Summary

1. Schedule

DAY # 1 September 25th

a. Visitor check-in at NREL Site Entrance Building, 15013 Denver West Parkway, Golden, CO 80401.
Please plan to arrive at NREL between 07:00 and 08:00 MDT.
b. Drive to SRRL – Call 303-384-6326 to open gate
c. 08:30 MDT - Equipment Installation & tests:
Dry Weather - See the **outdoor *seating diagram*** below for your workstation.
Wet Weather – Assemble and bench test your equipment inside SRRL.
Locate your equipment and review seating charts
d. 10:00 MDT - Safety and SRRL orientation briefing for all participants.
e. Review of NPC Protocol
f. Review measurement protocol and procedures.
g. 11:00 to Sunset - Practice and/or NPC measurements (weather permitting)

DAYS #2-12: 26 September through 06 October (*Daily*, including the weekend):

a. Clear sky = Take Measurements!
-Arrive at SRRL by 08:00 MDT
-Equipment warm-up for at least 30-minutes
-First Cavity Calibration at 08:55 MDT
-Begin comparison "Runs" by 09:00 MDT (08:00 MST)
-Continue measurements until sundown or the clouds interfere.
b. Cloudy sky = No Measurements, but optionally...
-Review of previous day's data analyses
-Technical Briefings on Radiometry, Measurement Network Operations, etc.
-Equipment Test
-Office Time (wireless available)
c. We will determine the need for continued measurements at the end of each day.

2. Time Keeping

-Wim Zaaiman will again be our timekeeper (as long as his voice holds out!)
-***All time records will be Mountain Standard Time (MST)***
-Outdoor time display is available for guidance ***(Wim's time is the Reference Time!)***
-We need to keep all PC clocks in agreement to better than 1 sec.
-***Set your system clock at the daily start-up*** or as often as needed to keep 1-second accuracy. Check personal computer clocks during the day.

3. Minimum Data Set

Our goal for a minimum data set for these comparisons is to measure irradiance during three different days (all day or portion). Historically, we have acquired more 2,000 data values for each participating cavity radiometer. At least 300 data values are needed to provide a valid transfer of the WRR to the participating radiometers.

4. Measurements

- Do NOT apply any previous **WRR** correction factors to your measurements.
- Use only the **factory calibration factor** to adjust your data. As in the past, we will use the following terms:

"Calibrate" = Perform electrical calibration and wait for next measurement period to begin
"Read" = A measurement of direct irradiance within 1 sec of announcement at 30-sec intervals.
"Run" = Collection of 49 readings taken in sequence (also called a *Series*).

The *Timekeeper* will make the following announcements for each Run:

Next Run Begins at HH:MM (MST) [HH:MM (MDT)]
T minus 6 minutes. BEGIN CALIBRATION
T minus 3 minutes
T minus 2 minutes
T minus 1 minute
T minus 30 sec
T minus 10 sec
T minus 5 - 4 - 3 - 2 - 1 - READ!

Continued countdowns at 30 sec intervals until 49 readings have completed a "Run"

6. Data Transfer

The following *standard data format* will be used by each participant to improve our data processing efficiency. Please see the emailed example file format or see Reda or Aron if you have any questions about the data format.

After the last daily RUN, and ***before*** equipment tear-down, email your data file to Aron and Reda aron.habte@nrel.gov and Ibrahim.reda@nrel.gov. Cavity calibration files are not needed.

7. Data Processing

- Described in each NPC published/distributed report.

8. Data Reporting

-Our goal is to provide each participant with next-day analyses.
-A final report will be published by NREL within two months of the comparisons.

9. Equipment Storage

-Each participant will be given space to store systems at SRRL.
-Please let us know if you wish to have any electronics connected to AC power while in storage.

10. Courtesies

-Please get permission before touching someone else's equipment (turning off power strips, adjusting trackers, etc.) to prevent inadvertent data loss.
-Please return borrowed tools to owner.

11. Dinner on Wednesday (September 27th)

Please join us for the NPC Dinner!
Dinner will be at Romano's Macaroni Grill. We will meet for dinner around 6:30 PM.

NREL Pyrheliometer Comparisons 2017
Seating Diagram

Tracker Info
Organizational Name
Participant Names

NREL Brusag (Spare)	NREL-Solys2
PMOD/WRC	Kipp & Zonen USA, Inc
Wolfgang Finsterle	Victor Cassella
	Joop Mes
	Ilja Staupe

Bench # 1: Breaker # 7

Providing own tracker	Providing own tracker	Providing own tracker
Sandia National Labs (Concentrating Solar Energy)	Campbell Scientific Inc.	Irradiance Inc
Tim Moss	Ajay Singh	Chris Kern
	Matt Perry	

Bench # 2: Breaker # 2

ARM-Brusag 1	ARM-Brusag 2
European Commission Directorate General JRC	DOE Atmospheric Radiation Measurement (ARM) Program
Wim Zaaiman	Craig Webb

Bench # 3: Breaker # 6

Providing own tracker	Providing own tracker
NOAA/ESRL/GMD	EPPLEY LAB
Emiel Hall	Tom Kirk
Jim Wendell	
Sergio Colle	

Bench # 4 East: Breaker # 3 | **Bench # 4 West: Breaker # 3**

Providing own tracker	Providing own tracker	Providing own tracker
Sandia National Laboratories (Photovoltaic Systems Evaluation Lab)	Atlas Material Testing Technology, LLC	Science Systems & Applications, Inc.
Bill Boyson	Patrick Smith	Fred Denn
Charles Robinson		Bryan Fabbri

Bench # 5: Breaker # 9

Providing own tracker	Providing own tracker
EKO Instruments USA, Inc	Naval Research Laboratory
William Beuttell	Anthony Bucholtz
Akihito Akiyama	Elizabeth Reid
Jennifer Meyer	
José Mário Pó	
Mitsuhiro Hasegawa	

Bench # 6: Breaker # 11

BORCAL Brusag 1	BORCAL Brusag 1	BORCAL Brusag 1	
PV Performance Labs	GroundWork Renewables Inc.	HuksefluxUSA, Inc.	
Anton Driesse	Justin Robinson	Jörgen Konings	
# of NIPs 4	**# of NIPs 5**	**# of NIPs 2**	**# of NIPs 4**

On SRRL BMS Platform

Total Pyrheliometers needing tracker support	15

BORCAL Brusags
National Renewable Energy Laboratory (Metrology, SePA, and Cell & Module Certification Group)
Andreas Afshin
Ibrahim Reda
Breaker #1

NREL-2AP #1	NREL-2AP #1
Masdar Institute	SRML University of Oregon
Peter Armstrong	Josh Peterson
Table 1	**Table 1**

Spare Bench: Breaker # 5

Attendees without Instruments	Attendees without Instruments
NOAA/ESRL/GMD	Solar Resource Solutions, LLC
Allison McComiskey	Tom Stoffel
Lantz Kathleen	Steve Wilcox
Christian Herrera	
Chuck Long	

Spectrafy
Richard Beal
Viktar Tatsiankou

Bench # 6: Breaker # 5

ISO CAL supplied tracker
ISO-CAL North America, LLC
Erik Naranen
South East Pad

Bench # 6: Breaker # 4

South East Pad

Bench # 6: Breaker # 4

Participant Contact Information

Full Name	Affiliation	E-mail
Patrick Smith	Atlas Material Testing Technology, LLC	patrick.smith@ametek.com
Ajay Singh	Campbell Scientific Inc.	asingh@campbellsci.com
Matt Perry	Campbell Scientific Inc.	mperry@campbellsci.com
Craig Webb	DOE Atmospheric Radiation Measurement (ARM) Program	craigw@ops.sgp.arm.gov
Akihito Akiyama	EKO Instruments	akiyama@eko.co.jp
Jennifer Meyer	EKO Instruments	jm71208@gmail.com
José Mário Pó	EKO Instruments	mario.po@eko-eu.com
Mitsuhiro Hasegawa	EKO Instruments	hasegawa-m@eko.co.jp
William Beuttell	EKO Instruments USA, Inc	beuttell@eko-usa.com
Tom Kirk	EPPLEY LAB	tomkirk@eppleylab.com
Wim Zaaiman	European Commission Directorate General JRC	willem.zaaiman@jrc.ec.europa.eu
Justin Robinson	GroundWork Renewables Inc.	jrobinson@grndwork.com
Jörgen Konings	HukseфluxUSA, Inc.	jorgen@hukseflux.com
Chris Kern	Irradiance Inc	chris@irradiance.com
Erik Naranen	ISO-CAL North America, LLC	enaranen@isocalnorthamerica.com
Victor Cassella	Kipp & Zonen USA, Inc	Victor.Cassella@kippzonen.com
Joop Mes	Kipp & Zonen USA, Inc	joop.mes@kippzonen.com
Ilja Staupe	Kipp & Zonen USA, Inc	ilja.staupe@kippzonen.com
Peter Armstrong	Masdar Institute	parmstrong@masdar.ac.ae
Ibrahim Reda	NREL (Metrology and SePA)	ibrahim.reda@nrel.gov
Andreas Afshin	NREL (Metrology, SePA, and Cell & Module Certification Group)	afshin.andreas@nrel.gov

Anthony Bucholtz	Naval Research Laboratory	anthony.bucholtz@nrlmry.navy.mil
Elizabeth Reid	Naval Research Laboratory	betsy.reid@nrlmry.navy.mil
Emiel Hall	NOAA/ESRL/GMD	emiel.hall@noaa.gov
Allison McComiskey	NOAA/ESRL/GMD	Allison.McComiskey@noaa.gov
Lantz Kathleen	NOAA/ESRL/GMD	Kathy.O.Lantz@noaa.gov
Christian Herrera	NOAA/ESRL/GMD	christian.herrera@noaa.gov
Chuck Long	NOAA/ESRL/GMD	chuck.long@noaa.gov
Jim Wendell	NOAA/ESRL/GMD (Federal University of Santa Catarina)	jim.wendell@noaa.gov
Wolfgang Finsterle	PMOD/WRC	wolfgang@pmodwrc.ch
Anton Driesse	PV Performance Labs	anton.driesse@pvperformancelabs.com
Bill Boyson	Sandia National Laboratories (Photovoltaic Systems Evaluation Lab)	weboyso@sandia.gov
Charles Robinson	Sandia National Laboratories (Photovoltaic Systems Evaluation Lab)	cdrobin@sandia.gov
Tim Moss	Sandia National Labs (Concentrating Solar Energy)	tamoss@sandia.gov
Fred Denn	Science Systems & Applications, Inc.	Frederick.M.Denn@nasa.gov
Bryan Fabbri	Science Systems & Applications, Inc.	bryan.e.fabbri@nasa.gov
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Steve Wilcox	Solar Resource Solutions, LLC	swilcox303@gmail.com
Richard Beal	Spectrafy	richard.beal@spectrafy.com
Viktar Tatsiankou	Spectrafy	viktar.tatsiankou@spectrafy.com
Josh Peterson	SRML University of Oregon	jpeters4@uoregon.edu