

2008 Solar Annual Review Meeting

Session: Modeling and Analysis

Organization: National Renewable Energy Laboratory

Project: Solar Radiometry and Metrology



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NREL National Renewable Energy Laboratory

*A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy*

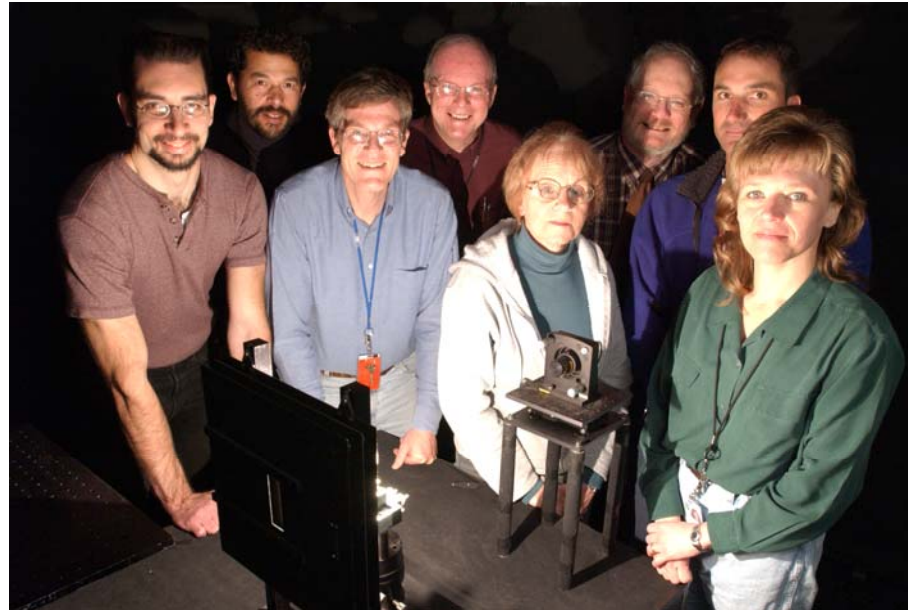
Innovation for Our Energy Future

CREDITS: Team/Task Members

Faces behind the curtain



- Mary Anderberg
- Afshin Andreas
- Peter Gotseff
- Beverly Kay
- Ibrahim Reda
- Thomas Stoffel
- Stephen Wilcox



Metrology, Measurements, and Instrumentation

- [Overview](#)
- [SRRL Tour](#)
- [Unique Features](#)
- [NREL Metrology Lab](#)
- [NREL Optics Lab](#)
- [Data Access](#)
- [SRRL Personnel](#)



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Budget and Solar America Initiative Alignment



Project Beginning Date	FY07 Budget	FY08 Budget	Total Budget
10/1/2006	\$745K	\$800K	\$1.545 M

- This project supports the Solar America Initiative by:
 - Providing solar radiometric measurements, data, and related technical information support to:
 - NREL Measurements and Characterization Task
 - NREL Reliability and Durability Task
 - Systems and component testing and evaluation for the SAI TPPs
 - Requests from industry
 - Producing credible radiometric measurements traceable to recognized standards for performance and Industry applications in accordance with ISO-17025 accreditation scope
 - Contributing to consensus codes and standards for performance and measurement techniques for NREL R&D, SAI TPPs, and industry applications

Project Overview: Solar Radiometry and Metrology



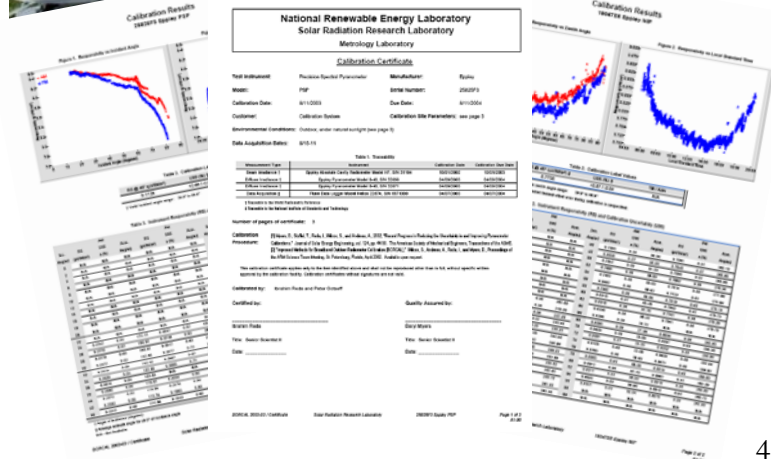
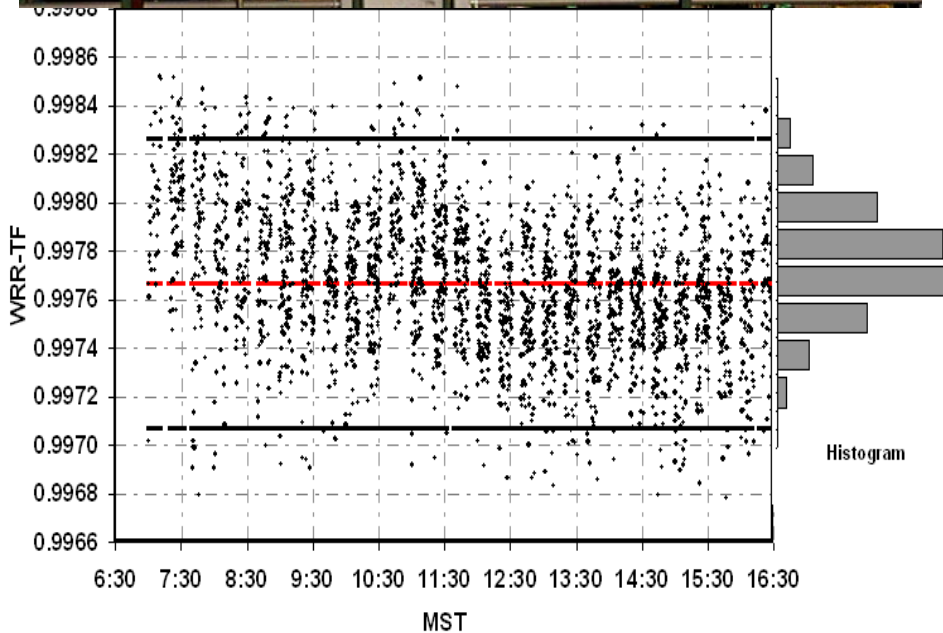
- Maintain stability of the NREL solar radiation reference (absolute cavity radiometers)
- Execute high quality detailed radiometric calibrations for broadband and spectral radiometers to meet NREL research and PV industry needs
- Participate in national and international consensus standards development, contributing technical expertise, data, and analysis where appropriate
- Provide technical information on solar radiation resource data and applications to meet research and industry needs
- Transfer technology in this area to other researchers and industry via publications and conference papers and presentations.

Industry and R&D Support



NREL & SANDIA SOLAR RADIOMETRIC REFERENCES

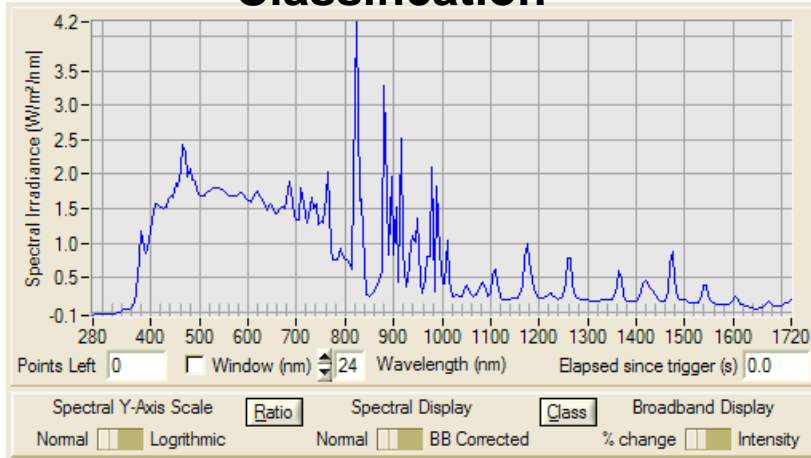
> 400 Radiometer Calibrations



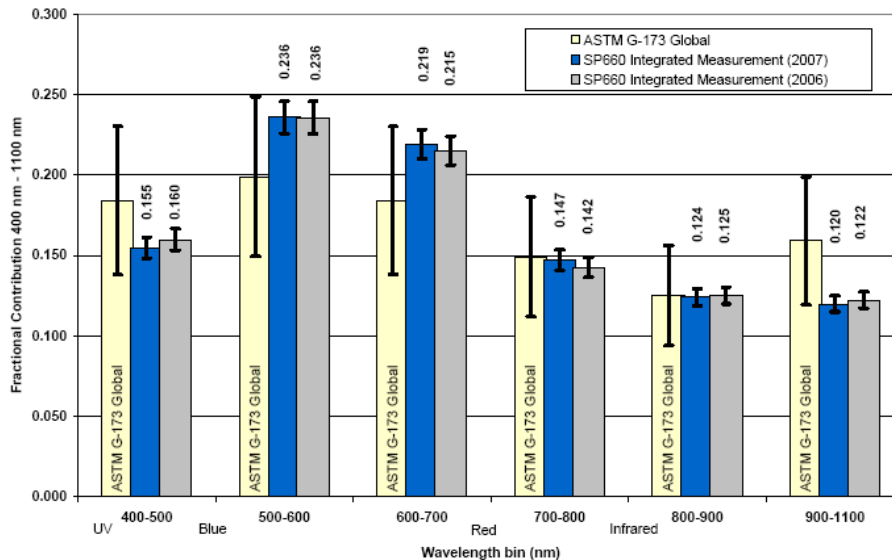
Industry and R&D Support



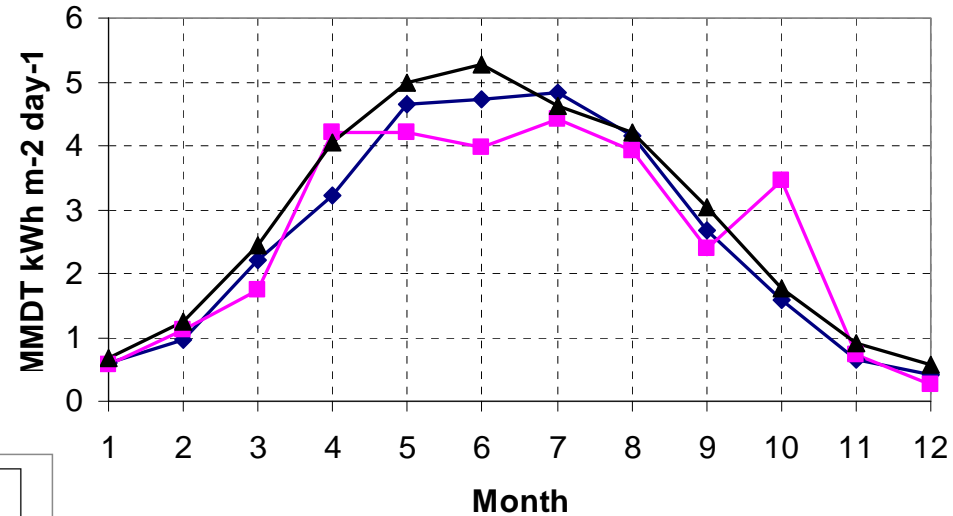
Industry Flash Simulator Spectral Classification



FSEC SP660 E-927-04 Analysis April 2007 (NREL PASS/C260)
 (Error Bars on ASTM Bars are Permitted Deviation under ASTM E-927-04 for Classes A)
 (Error Bars on Integrated Measured Data are Measurement Uncertainty)



Differences Between Solar Radiation Resource Data Bases



◆ Potsdam-MET ■ Potsdam SoDa ▲ Potsdam SSE

Monthly mean solar irradiance data for Potsdam, Germany, from three different solar databases (NASA SSE, SoDa, Meteonorm)

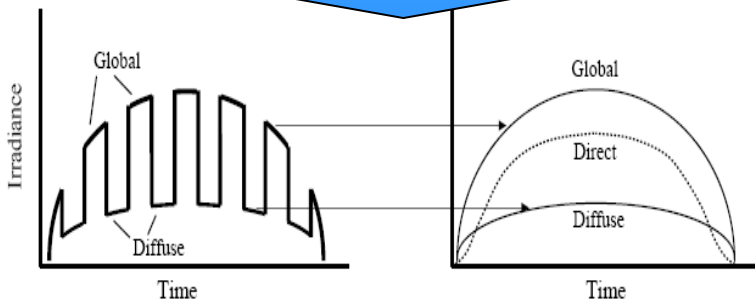
Industry and R&D Support



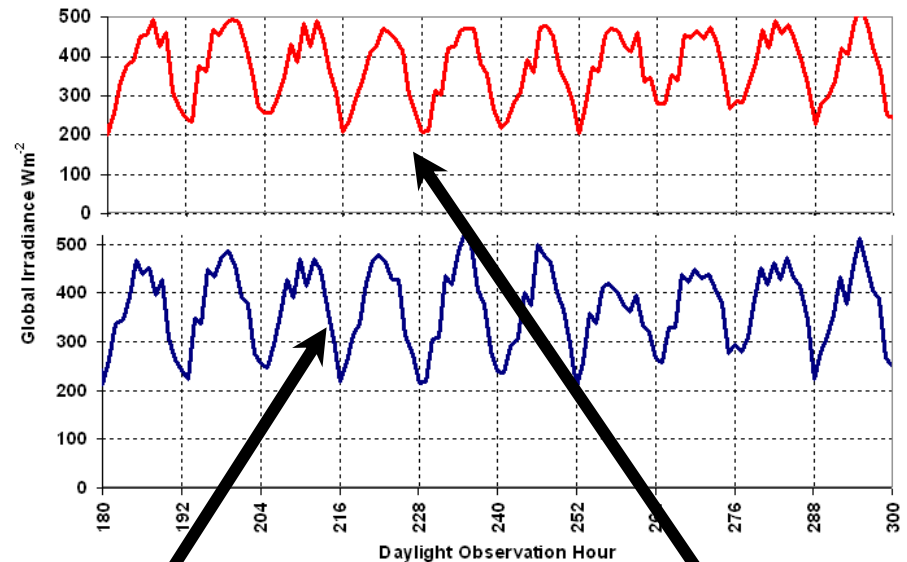
Experimental Passive Measurements of Solar Components R&D



$$F = G * w * \cos(z)^b$$



Improved Cloud Cover Modifier for Clear Sky Models

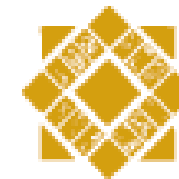


Data Base data derived from complex cloud cover model

Simple Clear sky model (REST2, BIRD, IQBAL P B with simple cloud cover modifier

Industry and R&D Support

> 120 Tech Transfer Exchanges



Newport Oriel Instruments



Shell Solar



ausra



Project Update



	Planned work since last Program Review	Status
Past	NREL WRR traceability verified (NPC)	9/28/2007 Accuracy $\pm 0.45\%$, Precision $\pm 0.01\%$
	13 NREL Spectroradiometer systems calibrated	Sep 30, 2007 (26 calibrations)
	> 400 broadband radiometers calibrated for industry, academia, and NREL	Aug 30, 2007 (405 calibrations)
	15 NREL and Industry flash solar simulators characterized. PASS system for SPIRE internal use.	FY 07: Sep 30; FY08 SPIRE TPA closed 15 May (\$40K total)
	Technical transfer, publications and conferences (ASES 2007, SPIE Solar Measurements and Models, Council Optical Radiation Measurements/NIST/CIE-USA)	Sep 30 (organized two conferences, 5 conf papers, 3 book chapters, 2 draft standards; >120 inquiry responses)
	Future	NREL Pyrheliometer Comparison 2008
Develop Spectral Distributions from Broadband (TMY)		Anticipated Sept 2008
Perform Spectral and Broadband Calibrations per R&D and Partners Needs		Anticipated Sept 2008

Obstacle Discussion



Barriers that may inhibit success of programs

- **Cost and complexity of measurement systems**
 - Traceable reference standards
 - \$18K NIST spectral reference lamps (50 hour lifetime)
 - \$30K cavity radiometer systems (custom automation)
 - \$50K calibration data acquisition systems (custom)
 - Solar radiometric (\$15K to \$50K for high quality system)
 - Spectral (\$25K -\$80K for high quality system)
- **Measurement Accuracy and Uncertainty Limitations**
 - Broadband 3% to 5% (high quality)
 - Spectral 5% (high quality)
 - 8%-10% for Ultraviolet (typical)
 - Sufficient to determine real improvements, or predict long term performance, over short periods of time?

Increasing number of requests for assistance