Summary of Total Solar Irradiance Workshop held at NIST - July 18-20, 2005
(Current Practices and Status of the Sensors)
CEOS/WGCV/IVOS
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Frascati, Italy

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http://physics.nist.gov/Divisions/Div844/div844.html

Outline

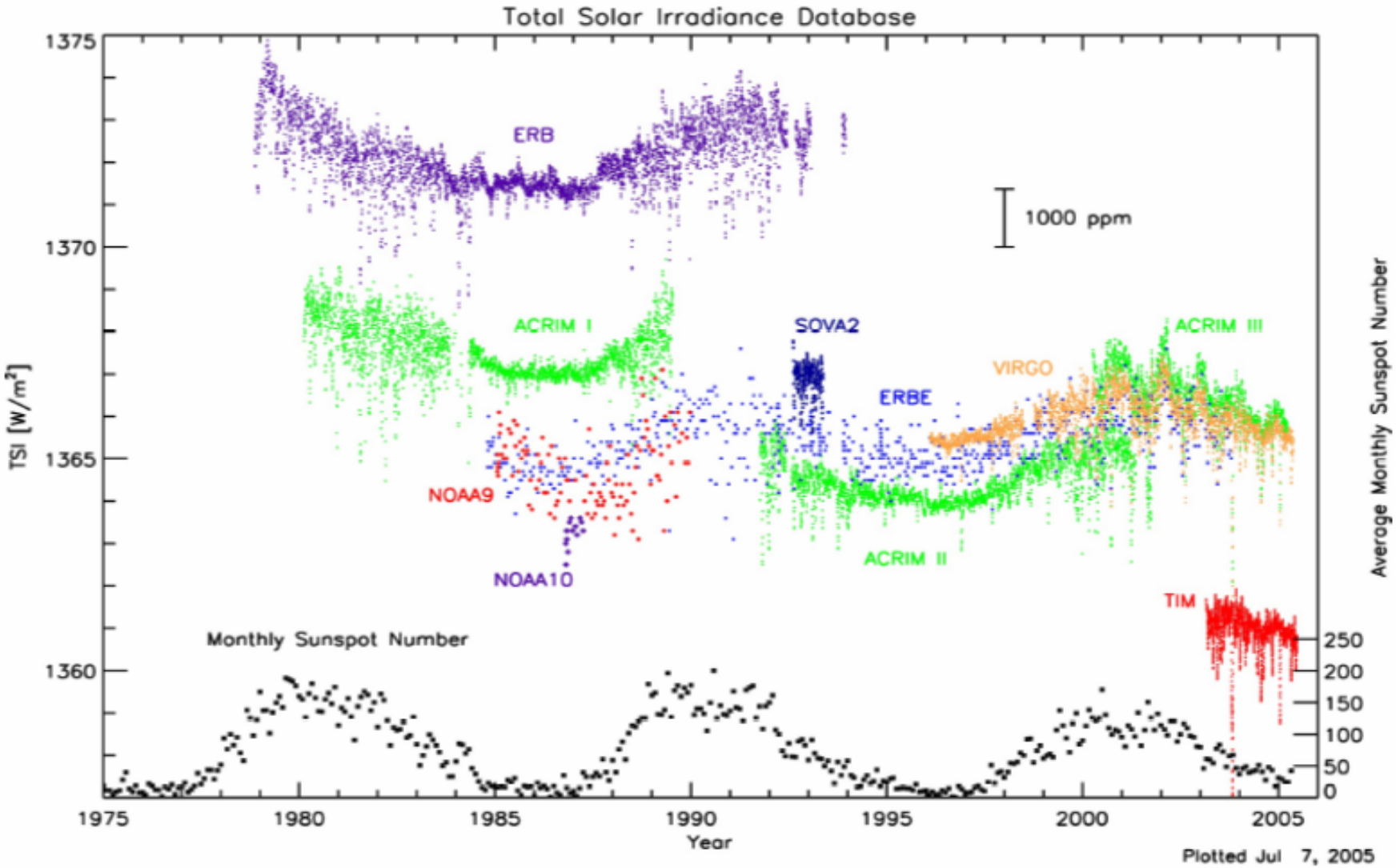
- Workshop Organizers and Participants
- Problem - Current status of Total Solar Irradiance Data
- Workshop Goals
- Proposed Laboratory Inter-comparison of TSI Radiometers at NIST
- Conclusion

Organizers and Participants

Organizers: James J. Butler, Robert A. Barnes [NASA (Goddard)]
Participants:

NASA:	Robert F. Cahalan, Douglas M. Rabin
ACRIM:	Richard C. Willson, Roger Helizon
ERBE:	Robert B. Lee
PMO6:	Claus Frohlich et al.
DIARAD:	Dominique Crommelynck, Steven Dewitte
TIM:	Greg Kopp, George Lawrence, Gary Rottman, Chris Pankratz
NIST:	B. Carol Johnson, Eric L. Shirley, Maritoni Litorja, Joel B. Fowler, Joseph P. Rice, Raju V. Datla
NPOESS (IPO):	Hal Bloom
NPL:	Nigel P. Fox
L-1:	Steven R. Lorentz

Problem


Total Solar Irradiance Database
TSI [W/m²]
1375
1370
1365
1360
ERB
1000 ppm
ACRIM I
SOVA2
ACRIM III
VIRGO
ERBE
NOAA9
NOAA10
ACRIM II
TIM
Monthly Sunspot Number
Average Monthly Sunspot Number
250
200
150
100
50
0
1975
1980
1985
1990
1995
2000
2005
Year
Plotted Jul 7, 2005

Workshop Goals

(1) Identify/assess potential sources of current differences in on-orbit TSI measurements;
(2) Recommend measurement and algorithm-based approaches to address those differences.

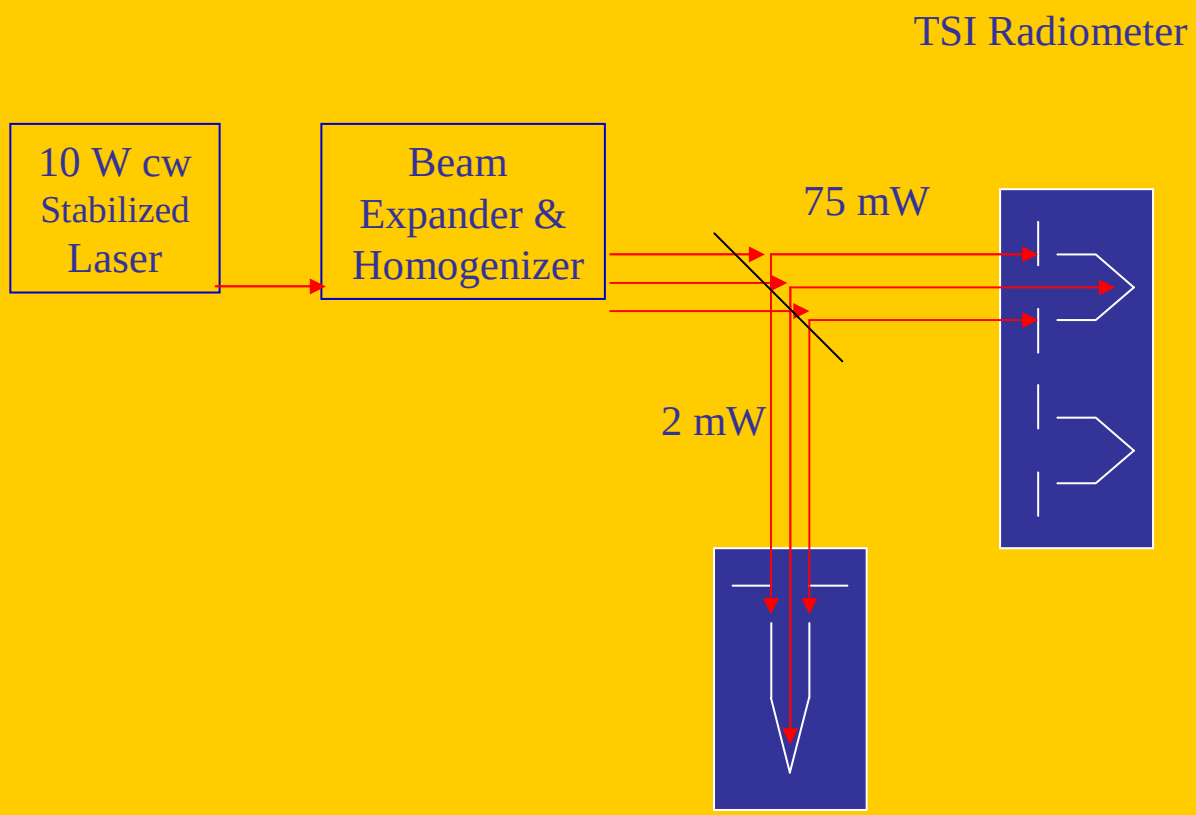
Day 1: Satellite TSI measurement uncertainty session will quantify/validate the significance of absolute differences.

Day 2: Satellite and ground-based TSI measurement comparison session will examine the past/present/future role of measurement comparisons in understanding differences.

Day 3: Lab-based comparison and characterization session will examine the application of past/present/future metrologies in understanding differences.

Proposed Laboratory Intercomparison of TSI Radiometers at NIST

- Direct system-level comparison with TSI radiometer in a vacuum chamber.
- Irradiance-mode: Beam overfills apertures with 136 mW/cm^2.
- Laser wavelengths: 488 nm, 514.5 nm, 532 nm.
- Beam expander for variable beam diameters up to 15 mm: probe power and irradiance.
- Homogenizer produces a top-hat profile: simulates solar irradiance geometry.
- Beamsplitter ratio (transmittance/reflectance) measured in a separate step.
- A power-mode variation of this has been done by NPL/PMOD, and found agreement between the WRR (PMO6) and the SI radiometric scales (NPL) to within 182 ppm. See Romero, Fox, Frohlich, *Metrologia* **28,** 125-128 (1991); *Metrologia* 32, 523-524 (1995/96)


TSI Radiometer
10 W cw
Stabilized
Laser
Beam
Expander &
Homogenizer
75 mW
2 mW
Cryogenic Radiometer Standard
or Irradiance-Mode Si-diode Trap

Conclusion

- No obvious reason yet identified for the 5 W/m^2 difference.
- Some pieces of the puzzle have been thoroughly examined (i.e. diffraction corrections computed, value used for AU).
- Some pieces of the puzzle have been well examined (i.e. aperture area, laboratory comparisons against the SI power scale), but not for all instruments.
- Several pieces of the puzzle have been examined, perhaps thoroughly by some instrument representatives, but not believed yet by all instrument representatives (i.e. phase sensitive detection, scattered light, thermal effects from each field of view).
- Properly performed laboratory irradiance comparisons of cryogenic radiometers with TSI radiometers will provide additional clues.

Cryogenic Electrical Substitution Radiometry

- Thermalized optical laser power is compared to thermalized electrical power in a black cavity.
- Generally, active cavity radiometers in vacuum at 2 K to 5 K.
- Primary standard at NIST and in most other industrialized nations for optical power responsivity of transfer detectors such as Si-diode trap detectors
- Intercompared internationally via portable transfer detectors at 0.02% (k=2) uncertainty.

Primary Optical Watt Radiometer (POWR)