CONCENTRATING SOLAR POWER

Sun Lab

Sandia National Laboratories, Albuquerque, NM
National Renewable Energy Laboratory, Golden CO

Operated for the United States Department of Energy

TESTING CAPABILITIES

NSTTF (AZTRAK) ROTATING PLATFORM

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NREL

Testing Solargenix Prototype Aluminum Space Frame

The Rotating Platform, or Aztrak, Precision Measurement System

It is a unique national facility with the following capabilities:

- **Ability to track sun in azimuth at 0 degrees incidence angle (eliminate off-axis cosine affects)**
- **Ability to track sun in azimuth at any constant incident angle (measure off-axis cosine affects)**
  - **Azimuth tracking: resolution of 0.09 deg., accuracy of 0.30 deg.**
  - **Elevation tracking: Resolution of 0.04 deg.; accuracy of 0.08 deg.**
- **Heat transfer fluid thermal stability at the test device of ± 0.2°C at temperatures up to 400°C at a flow rate of 55 ± 0.2 l/min for a 15 to 20 minute test window**
- **System is highly stable and adjustable to meet test requirements**

Test Methodology

- **Developed by numerous SunLab participants over past 20 years (or so)**

  Extension of both ANSI/ASHRAE (Std 93-2003) and ASTM (E905-01) standard test methods; e.g., tracking accuracy and steady-state conditions more critical, derivation of overall measurement uncertainty.

- **Definitive Test Plan documented in:**

  SAND94-1884, Test Results: SEGS LS-2 Solar Collector

  (Vern Dudley, Greg Kolb, Rod Mahoney, Mike Sloan, Dave Kearney)

- **Excellent documentation of test plan, test article and facility, results, HCE modeling approach and predictions, and rigorous error analysis**

Precision Measurement Trough Testing System

Meteorological weather station with DNI measurement

Temperatures taken with precision 4-wire RTDs and Thermistors

Flow measurements taken with two turbine flow meters

All instruments are calibrated with NIST traceability

NIST traceability obtains statistically defensible and reproducible data

Accuracy and traceability of measurement uncertainty becomes more important as receiver performance improves

Collector module mirror alignment using distant observer technique with digital imaging and analysis

Efficiency measurement uncertainty typically ± 2 to 5 percent

Minimizing measurement uncertainty is not a trivial task!!

Performance Metrics Measured

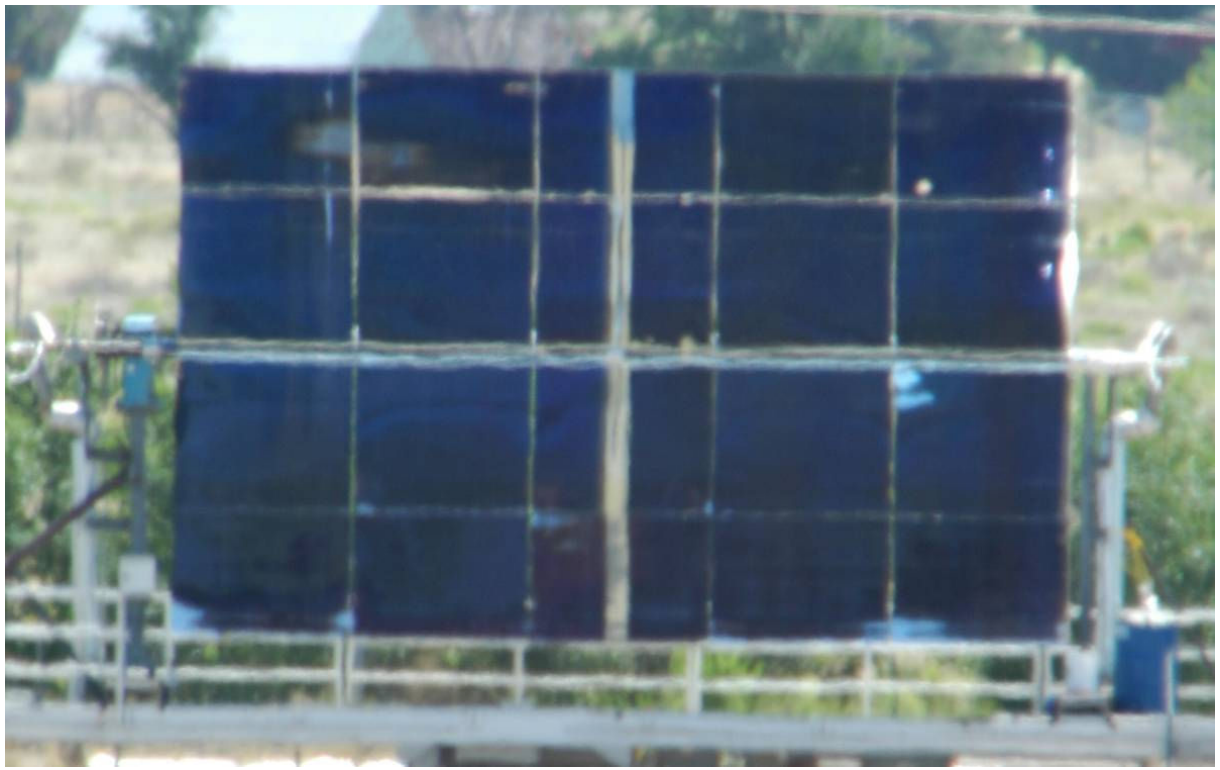
- Mirrors and receiver glass envelope washed generally before each test
- Solar averaged mirror specular reflectivity measured before each test, typical values are 93 ± 1.5%
- Documented collector mirror and receiver alignment - customized capabilities using distant observer and/or TOP Alignment techniques
- Steady state Efficiency and In-Focus Heat Loss vs. ΔT and $\Delta T/I$ where ΔT = temperature above ambient, and I = direct normal insolation
- Out-of-Focus Heat Loss vs. ΔT during nighttime clear sky conditions
- Transmittance, reflectance, absorptance, and normal emittance of HCE optical components (Sandia Primary Standards Lab)
- Collector module elevation and azimuthal incident angle modifiers, if needed

Examples of Test Results on the Rotating Platform

Mirror Alignment Before Correction Using Distant Observer Technique

Effective Mirror Area: 79 ± 2%

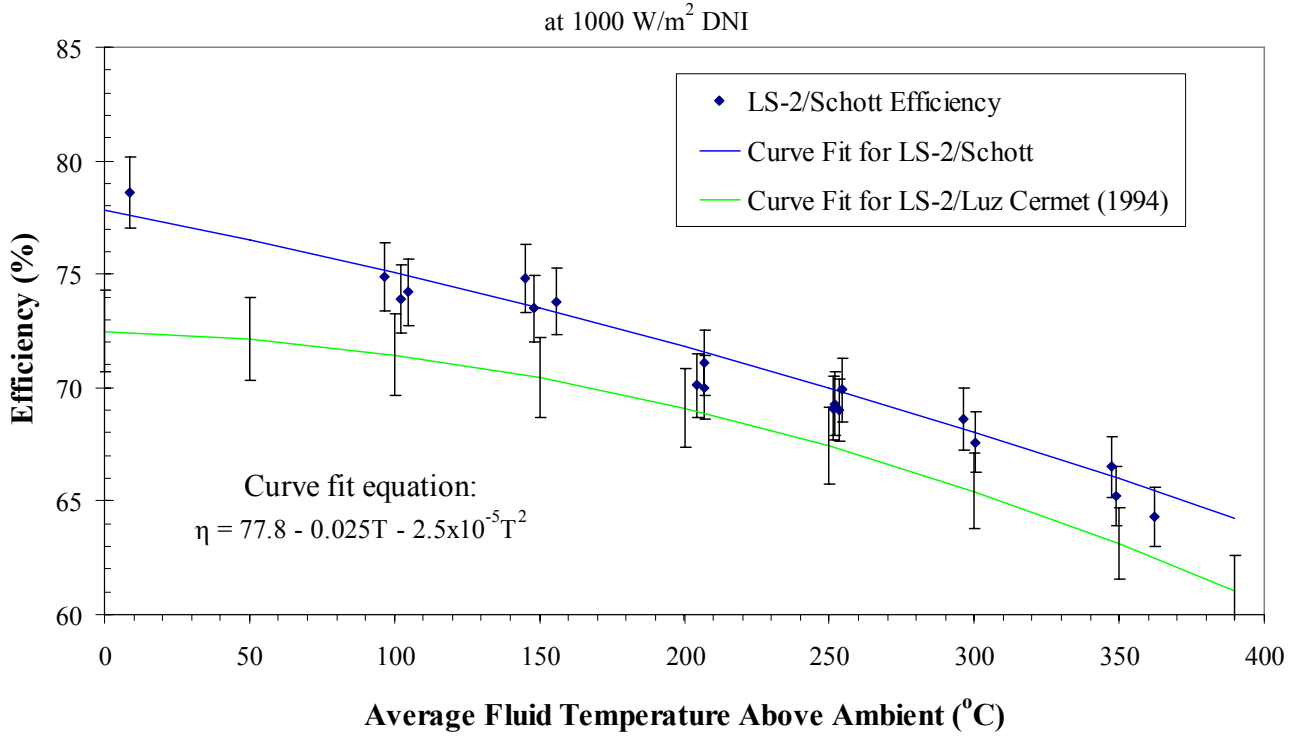
Mirror Alignment After Correction Using Distant Observer Technique



Effective Mirror Area: 94 ± 2%

Schott Receiver Performance on LS-2 Collector

Efficiency vs. Average Fluid Temperature Above Ambient for the LS-2/Schott system



Schott Receiver Out-of-Focus (nighttime) Heat Loss Data