Solar Concentrating Research Facilities

High-Flux Solar Furnace

Concentrating Solar Power (CSP) systems use concentrated solar radiation as the energy source of high-temperature heat for electricity generation and fuels production. PSI's state-of-the-art solar concentrating research facilities – the solar furnace and the high-flux solar simulator – serve as unique experimental platforms for investigating novel solar receivers/reactors, and for testing advanced materials for efficient thermal and thermochemical conversion processes.

PSI's High-Flux Solar Furnace (HFSF) consists of a sun-tracking flat heliostat on-axis with a fixed parabolic concentrator. It is capable of delivering up to 40 kW of solar power at a peak solar flux of 5000 suns (1 sun = 1 kW/m^2). Higher solar concentrations are attainable by using secondary concentrators (CPCs).

Measurement techniques

The concentrated solar flux is measured optically by a calibrated CCD camera that records the sun's image on a water-cooled Lambertian target. A Venetian-blind shutter regulates the solar power input. All operational parameters, including data acquisition of temperatures, pressures and mass flow rates, as well as online gas analysis and heliostat, experimental platform and shutter settings, are remotely controlled. The solar power level of 5–10 kW$_{th}$, with a mean flux concentration of 3500 suns over a 60 mm aperture, is well suited for solar receiver/reactor technology development and optimization.

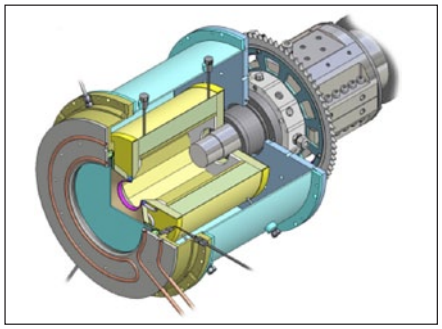


Figure 1: **Solar reactor for dissociation of ZnO.**

Applications

- Solar H_2O/CO_2-splitting thermochemical cycles
- Solar syngas by cracking, reforming, and gasification of fossil fuels
- Solar metallurgy
- Solar thermogravimetry
- Solar-driven combined cycles

The facilities at PSI are best suited for applications involving:

- Solar spectrum
- Solar transients
- Solar thermal, thermochemical and photochemical testing

Key Parameters

C_{max} = 5000 suns
$C_{mean,\ 60mm}$ = 3500 suns
(over a 60 mm aperture)
T_{max} = 2500 K
P_{solar} = 40 kW$_{th}$

Availability: May–September

Commissioned: 1997/2009
Heliostat: 120 m^2 flat glass

Parabolic mirror:
Diameter: 8.5 m
Focal length: 5.13 m
Rim angle: 45 degrees

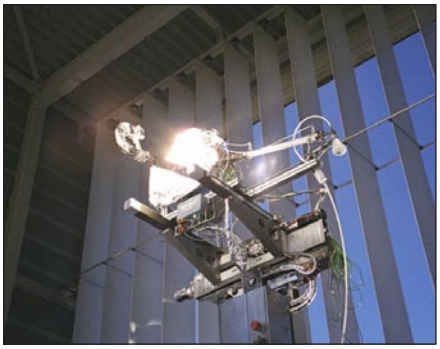


Figure 2: **Solar reactor at focus.**

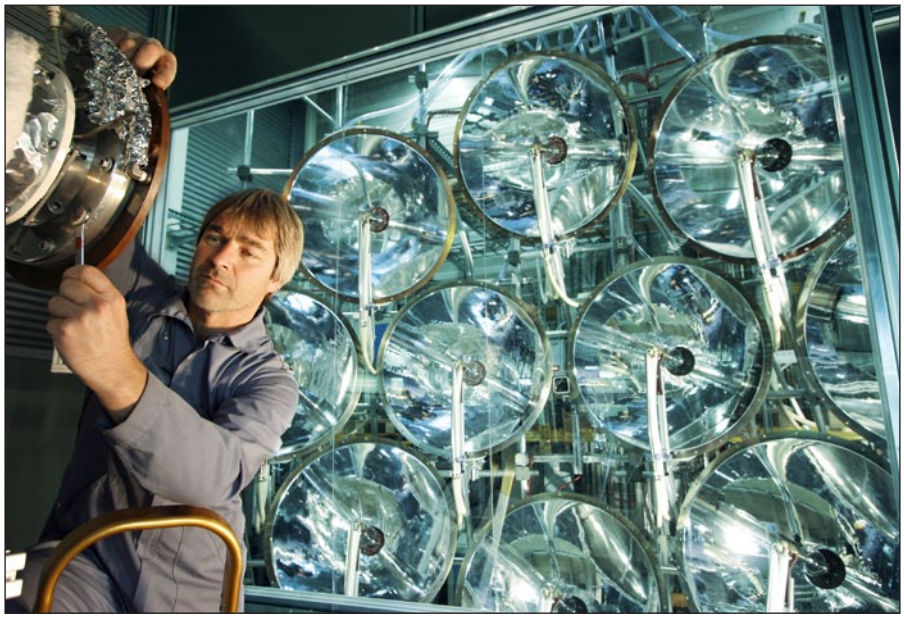
Solar Concentrating Research Facilities

High-Flux Solar Simulator

PSI's High-Flux Solar Simulator (HFSS) consists of an array of 10 xenon arc lamps, and is capable of delivering over 50 kW of radiative power at a peak solar radiative flux exceeding 11,000 suns (11 MW/m^2). This facility closely approximates the radiative heat transfer characteristics of highly concentrating solar systems, e.g. solar towers and dishes.

The 10 xenon arc lamps can be operated and individually adjusted for variation of the radiative heat flux. A Venetian-blind shutter provides fine-grained control of the radiative power input. The radiative flux is measured using a calibrated CCD camera to record the image on a water-cooled Lambertian target.

The solar simulator at PSI enables experimental work under controlled steady and unsteady conditions, for reproducible measurements at temperatures up to 3000 K and high heating rates, up to 1000 K/s.



Applications

The HFSS is best suited for applications requiring:

- Reproducibility
- Accurate, steady power input
- High solar fluxes (> 10,000 suns)
- High heating rates (up to 1000 K/s)
- High temperatures (up to 3000 K)
- Varying rim angles (via different sets of lamps)
- Advanced materials testing
- Solar thermal, thermochemical and thermo-electrochemical testing

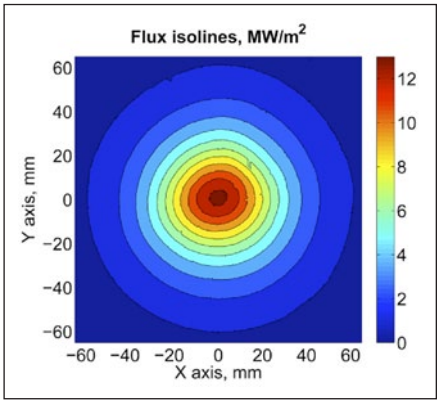


Figure 3: **Focal plane flux distribution.**

User Lab

PSI's solar concentrating research facilities are part of the European network SFERA (Solar Facilities for the European Research Area) providing access to researchers from industry and academia:
http://sfera.sollab.eu/

References

- Haueter P., Seitz T., Steinfeld A., J Sol Energy Eng (1999) **121**, 77-80.
- Petrasch, J. et al., J Sol Energy Eng (2007) **129**, 405-411.

Key Parameters

C_{max} = 11000 suns
$C_{mean,\ 60mm}$ = 6800 suns
(over a 60 mm aperture)
T_{max} = 3000 K
P_{solar} = 50 kW_{th}

Availability: all year

Commissioned: 2005
Xenon arc lamps: 10
Rim angle: 21 – 42 degrees

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