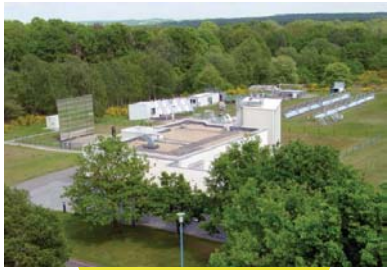
Current CSP Research Facilities In Europe

The 'SFERA' Project: An FP7 'Integrating Initiative' on CSP

Diego Martínez-Plaza, Robert Pitz-Paal, Gilles Flamant

CSP Research Infrastructures Worldwide

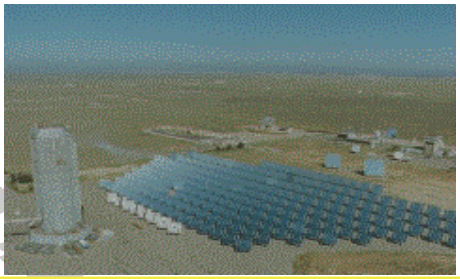
SolarPACES



DLR (D)

ETH-PSI (CH)

CNRS (F)



SNLA (US)

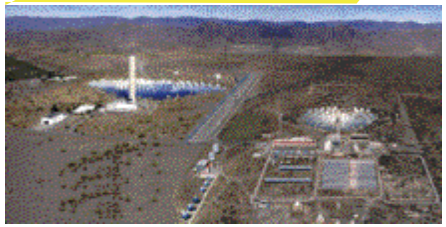
SOLAB
ALLIANCE of EUROPEAN LABORATORIES
on solar thermal concentrating systems

CONCENTRATING • SOLAR • POWER
Sun • Lab

ENEA (I)

NREL (US)

PSA (E)



WIS (IL)

CSIRO (AUS)

DLR | MINISTERIO DE EDUCACIÓN Y CIENCIA | Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas | ETH Swiss Federal Institute of Technology Zurich | PAUL SCHERRER INSTITUT PSI | CNRS CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

The First Step Since October 2004

Alliance of European Laboratories for Research and Development on Solar Concentrating Systems

CNRS-PROMES

Centre National de la Recherche Scientifique (CNRS), France ;
Processes, Materials and Solar Energy Laboratory - PROMES

DLR-TT.SR

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany;
Institute for Technical Thermodynamics, Solar Research Division,

CIEMAT-PSA

Centro de Investigaciones Energéticas, Medioambientales y Tecnologicas (CIEMAT), Spain;
Plataforma Solar de Almeria

ETHZ-REC

Eidgenössische Technische Hochschule Zürich (ETHZ), Swiss Federal Institut of Technology Zürich, Switzerland;
Professorship in Renewable Energy Carriers

PSI

Paul Scherrer Institut (PSI), Switzerland;
Solar Technology Laboratory

Objectives:

The ‘SolLab’ Alliance aims at strengthening human and scientific links between the Parties to promote and stimulate research on concentrating solar systems at the European level in the context of sustainable development.
Consequently, the Parties intend **to take a first step** to create the European Research Area in the field of solar concentrating technologies.

Means for achieving S&T collaboration:

- Exchange of scientific and other personnel dedicated to research and development.
- Exchange of scientific information.
- Execution of joint scientific meetings.
- Planning and implementation of joint programmes and projects.
- Utilization of a Party's facilities.

SFERA: Solar Facilities for the European Research Area

An FP7 Integrating Initiative

2009-2012

EUROPEAN COMMISSION
Community research

Objectives of an Integrating Activity project

Structure better and integrate, on a European scale, the way research infrastructures operate and develop, in a given class:

- **By opening and optimising the access to and the use of the existing research infrastructures in the different Member States and Associated States**

- **By better structuring and integrating, on a European scale, the operation(s) of research infrastructures, and by fostering their joint development (qualitative and quantitative)**

EUROPEAN COMMISSION
Community research

Integrating Activity in FP7

- **Collaboration of existing research infrastructures in a given field of science**
  - ➔ **Normally all major RI's in Europe in one field**
  - ➔ **At least 3 MS or AS**
- **3 types of activities obligatory in one project**
  - ➔ **Networking Activities**
  - ➔ **Trans-national Access, service activities**
  - ➔ **Joint Research Activities**
- **Project type: *combination of* collaborative project + coordination and support actions**
- **Based on the continuation of the successful FP6 instrument "I3"**

THE PARTNERSHIP

Beneficiary nº.	Beneficiary organisation name	Country	
1 (Coordinator)	CIEMAT	SPAIN	**'SOLLAB' MEMBERS**
2	DLR	GERMANY	
3	CNRS	FRANCE	
4	PSI	SWITZERLAND	
5	ETH	SWITZERLAND	
6	WEIZMANN	ISRAEL	
7	ENEA	ITALY	
8	DIN	GERMANY	
9	UPS	FRANCE	
10	AUNERGY	SPAIN	
11	CEA	FRANCE	
12	INESC-ID	PORTUGAL	

PROJECT OBJECTIVES

- The **purpose of this project** is to integrate, coordinate and further focus scientific collaboration among the leading European research institutions in solar concentrating systems and offer European research institutions and industry access to the best-qualified research and test infrastructures.
- Through **co-ordinated integration** of their complementary strengths, efforts and resources, progress will be made more effective by:
  - **Increasing the scientific and technological knowledge base** in the field of concentrating solar systems in both depth and breadth,
  - Providing and **improving the research tools** best-suited for the scientific and technologic community in this field
  - **Increasing general awareness** and especially of the scientific community in the possible applications of concentrated solar energy, including creation of new synergies with other scientific disciplines (e.g., materials treatment)

PROJECT OBJECTIVES (ii)

- The overall goal of these efforts is **to create a unified virtual European Laboratory for Concentrating Solar Systems** easily accessible to interested researchers, and thus serving as the structural nucleus for growing demand in this field in the developing **European Research Area.**

Networking Activities

- WP2: Organisation of training courses and schools
- WP3: Internal and external communication: Organisation of meetings, workshops and conferences
- WP4: Organisation of expert working groups and round tables
- WP5: Exchange of personnel for harmonization of procedures
- WP6: Joint management of 'Transnational Access'

Trans-national Access Activities

-Free access to the following facilities is offered:

- PSA-Almeria (WP7)
- Weizmann Institute-Rehovot (WP8)
- Paul Scherrer Institüt-Villigen (WP9)
- CNRS Promes-Odeillo (WP10)
- ENEA-Casaccia (WP11)

Total weeks	420
Total projects	174
Total users	345

- Access Unit: 1 week.
- Travel & accomodation of users are included, as well as facility running costs.
- User Proposals to be selected annually by an Independent Experts Selection Panel and based on scientific merit.
- Next call for proposals to be launched in October !!!

Joint Research Activities (I)

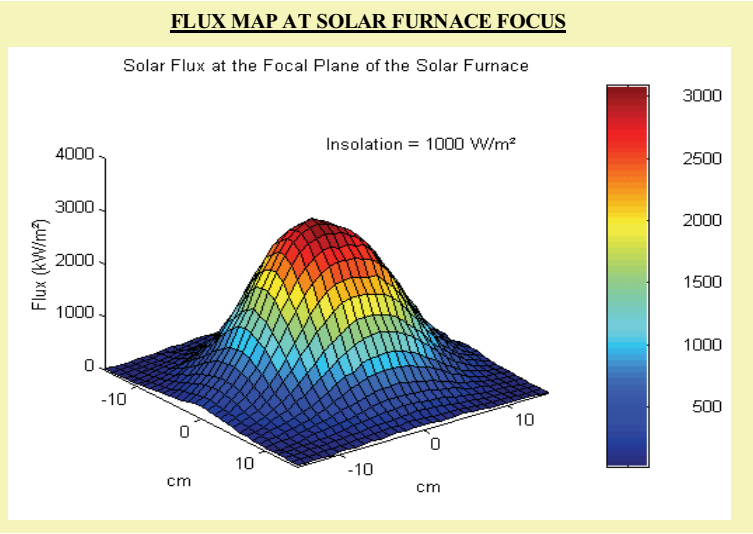
Work Package 12: Improve Quality of Testing Services at R&D Infrastructures for CSP

-**Task 1** Development of guidelines and procedures for testing in a systematic approach relevant for all facilities in Europe.

-**Task 2**: Flux and temperature measurement techniques and devices

-**Task 3:** Study and development of high flux solar simulators.

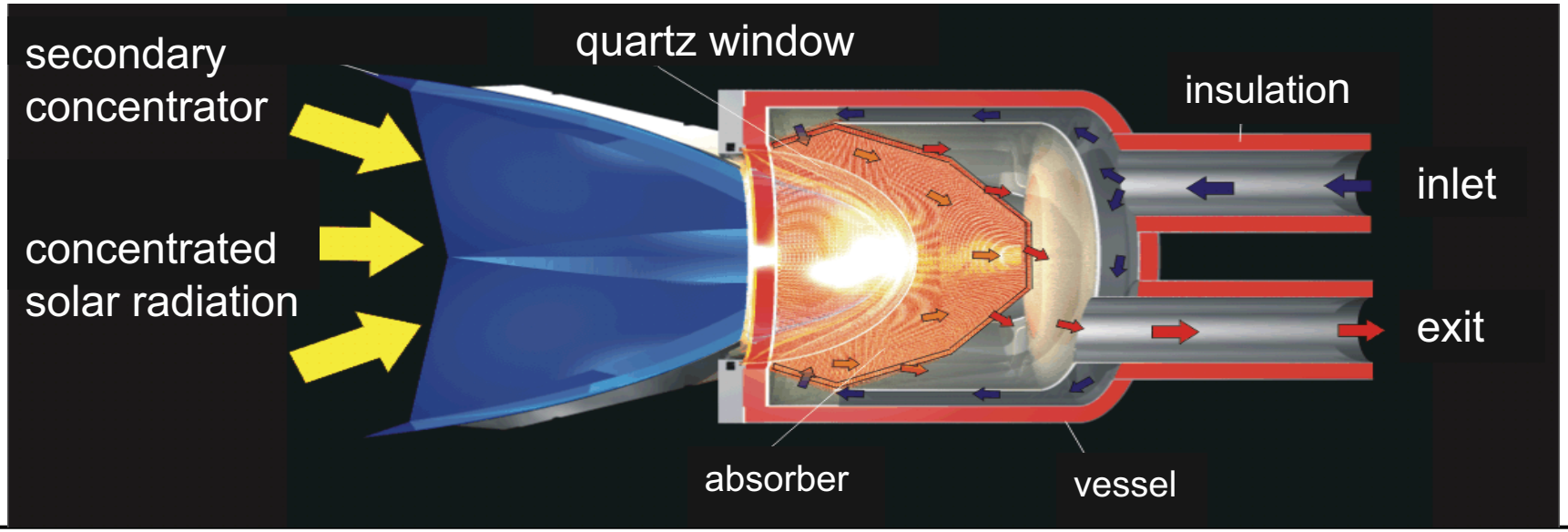
-**Task 4:** Training of future users of concentrated solar systems by use of virtual tools.



Joint Research Activities (II)

Work package 13: Improving the capabilities to achieve ultra-high concentration in CSP facilities:

- **Task 1** Sunshape measurement and impact evaluation
- **Task 2** Characterization of secondary concentrating optic devices



Joint Research Activities (III)

Work package 14: Infrastructure improvements to perform durability predictions of CSP components by accelerated aging

•**Task 1**: Improve and adapt the CSP Test Facilities for comparative durability tests and accelerated aging

•**Task 2**: Define and validate new methodologies for selection of most durable candidate materials for commercial plants by accelerated aging

•**Task 3**: Definitions of common procedures for accelerated aging tests to be used by all CSP R&D installations in the future

Joint Research Activities (IV)

Work package 15: Methodology for Testing, Assessment and Characterisation of Storage Technologies and Materials

- **Task 1** Characterisation of different storage systems
- **Task 2** Methodology and definition of standardised testing procedures
- **Task 3** Methodology to characterize storage materials
- **Task 4** New measurement system for PCM storage
- **Task 5** Methodology and software tool for evaluation and assessment of different energy storage technologies

EC Funds Breakdown

- Networking ~ 921 k€
- Trans-national Access ~ 3,325 k€
- Joint Research ~ 3,153 k€

- **Total project cost: 9,040 k€**
- **Total EC funding: 7,400 k€ (81.8 %)**
- **A four-year project, started July 1, 2009**

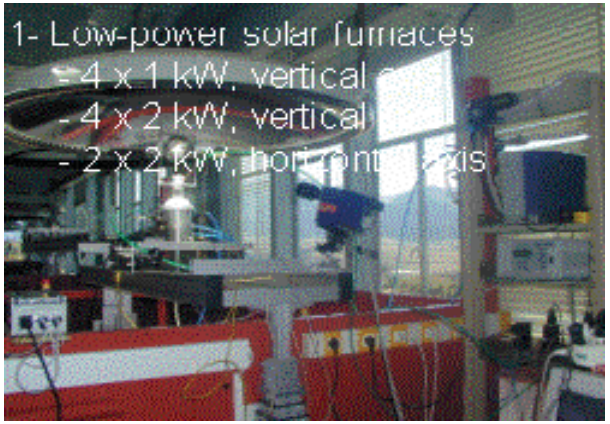
http://sfera.sollab.eu

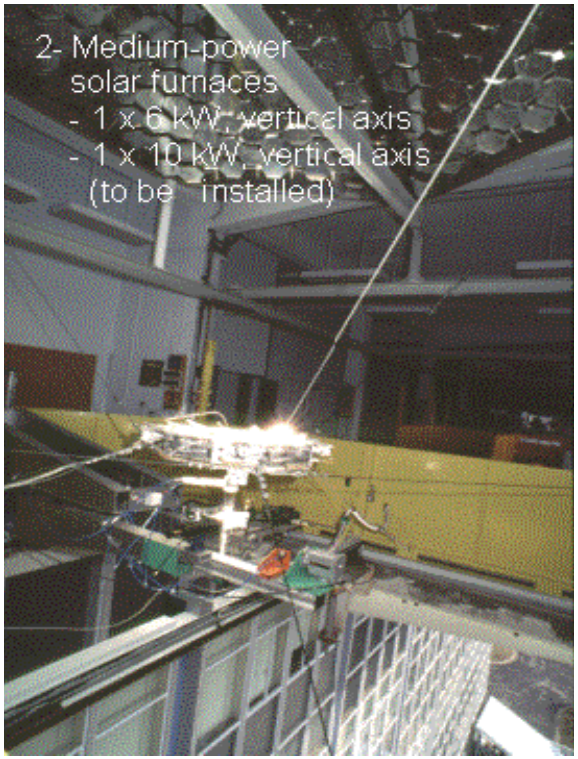
Next call for proposals by the end of 2010

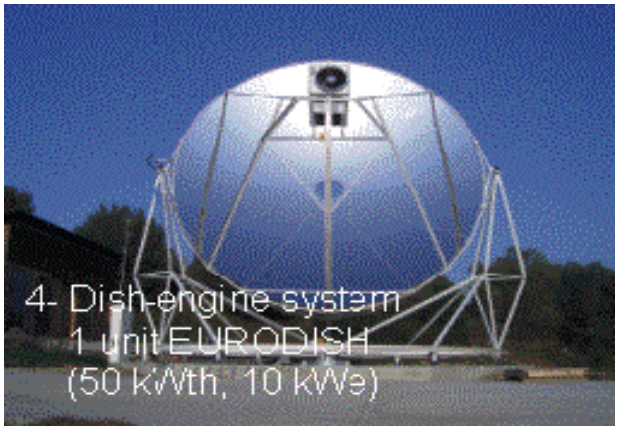
Laboratoire Procédés, Matériaux et Energie Solaire (PROMES – CNRS)
UPR 8521, Odeillo et Perpignan

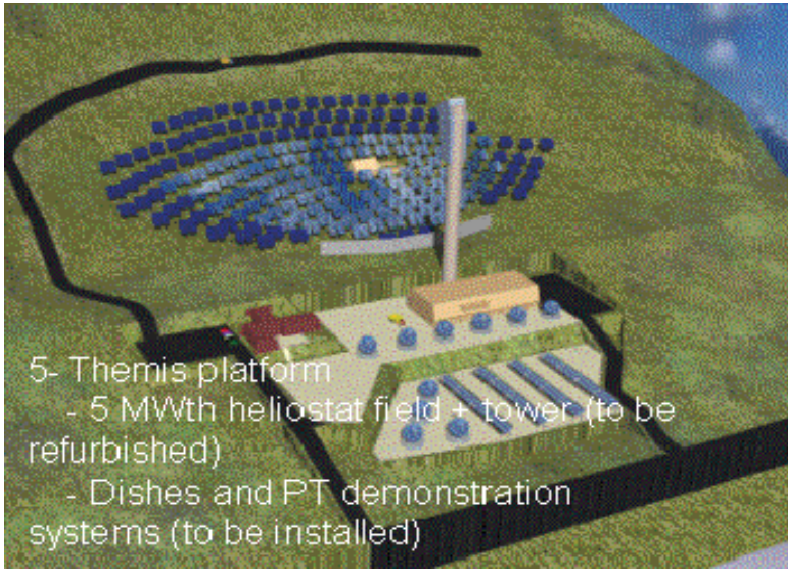
Research Infrastructure: Research and technology centre for high flux density and high power solar thermal concentrating systems

THEMIS and CNRS-PROMES solar facilities, transnational access









Presentation of the solar facilities

- The solar tower Thémis
- The MegaWatt Solar Furnace (MWSF)
- The EuroDish system
- Eleven mid-scale facilities (MSSFs)

The solar tower Thémis

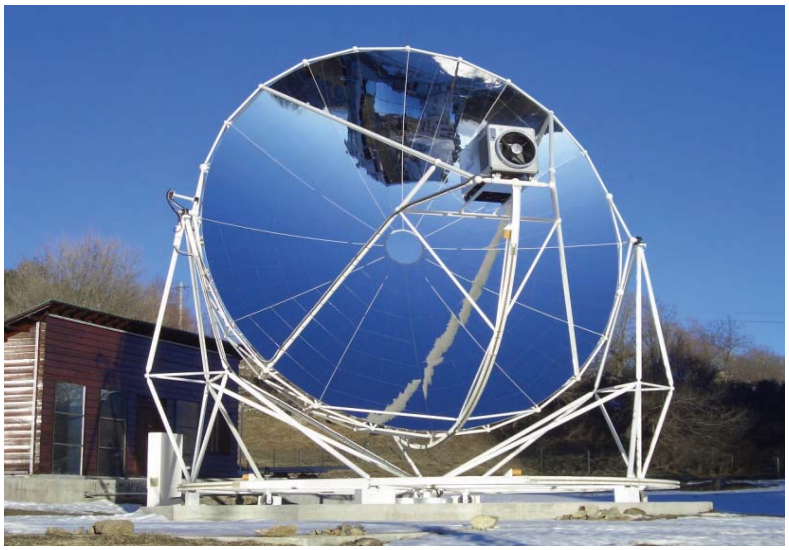
- It offers from about 50 kW to nearly 5,000 kW thermal power with peak flux from 20 to about 2,500-3,000 suns

The MegaWatt Solar Furnace (MWSF)

- The most powerful solar furnace in the world, with a peak flux of 10,000 suns for 1,000 kW of available thermal power, allowing peak temperature beyond 3,000 K on a large working area

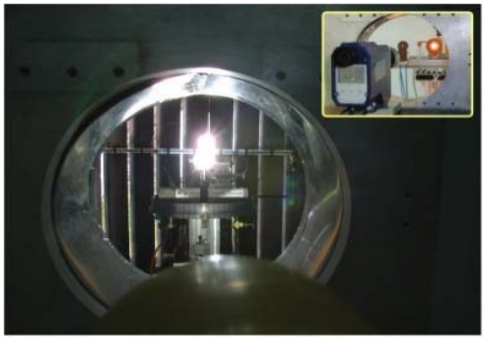
The EuroDish system

- An integrated system developed in the EnviroDish project which combines a parabolic concentrator with a solar powered Solo Stirling engine to produce 10 kW electricity or any other experiments up to 52 kWth with peak flux of 9500 kW/m2



Eleven mid-scale facilities (MSSFs)

- Four 2 kW - Four 1 kW vertical axis solar furnaces equipped with shutters for flux regulation

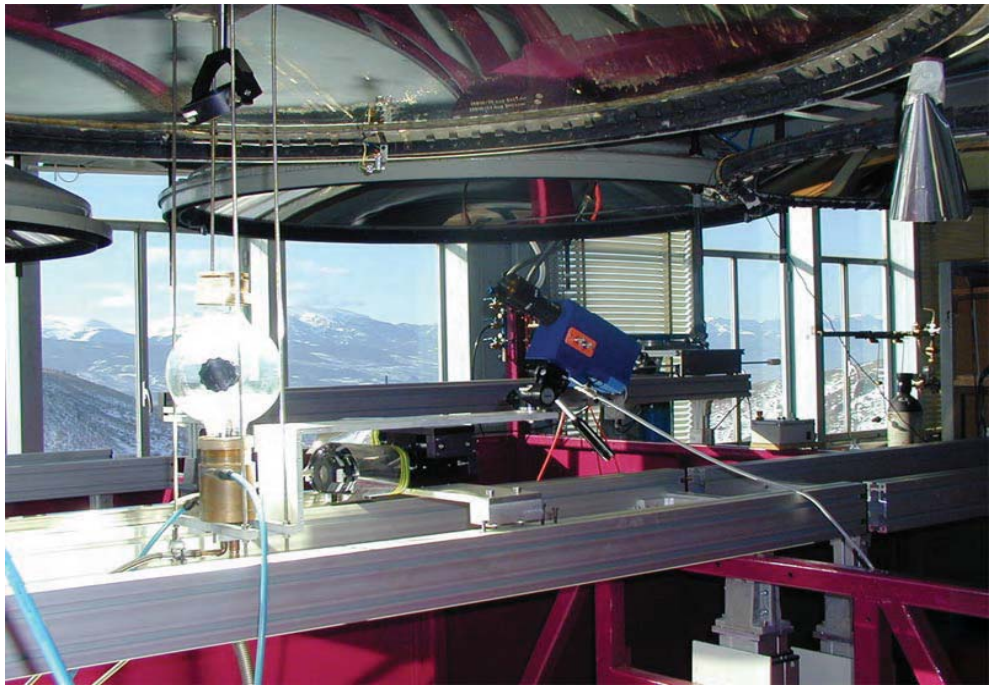


- Two 2 kW furnaces are with a horizontal axis

- One 6 kW solar furnace equipped with a shutter to finely modulate the solar radiation

Solar reactors and chambers

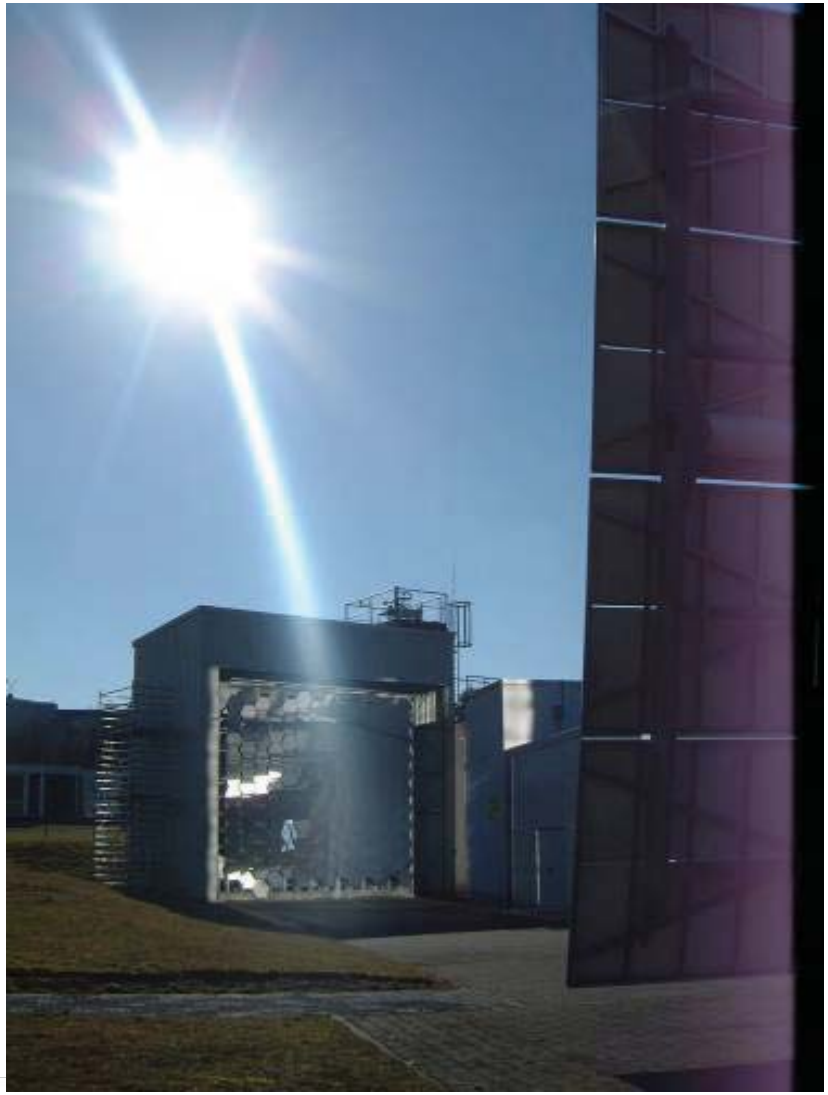
- The solar furnaces MWSF and MSSFs are associated to numerous reactors :
  - MEDIASE (MWSF)
  - MECARBSOL (MSSF)
  - MESOX (MSSF 6kW)
  - EXCSOL (MSSF vertical)
  - DISCO (MSSF horizontal)
  - PVDSOL (MSSF vertical)
  - ROCSOL (MSSF horizontal))
  - GINOSOL (MSSF vertical)
  - NANOSOL (MSSF vertical)
  - SURFSOL (MSSF vertical)

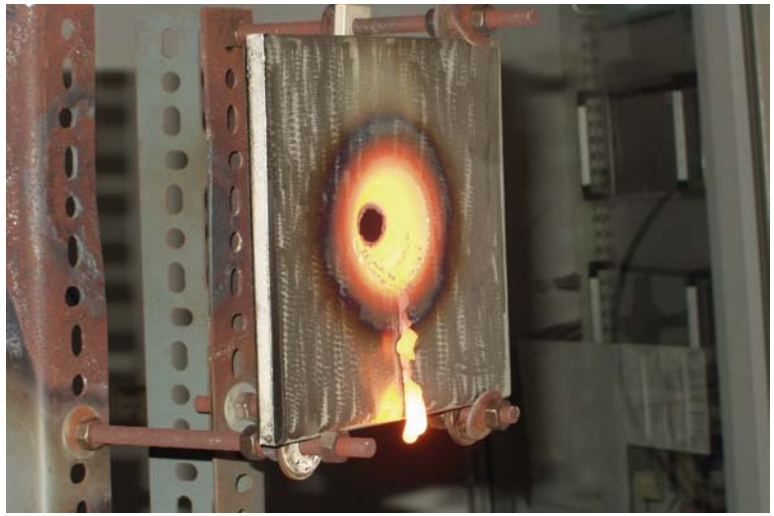


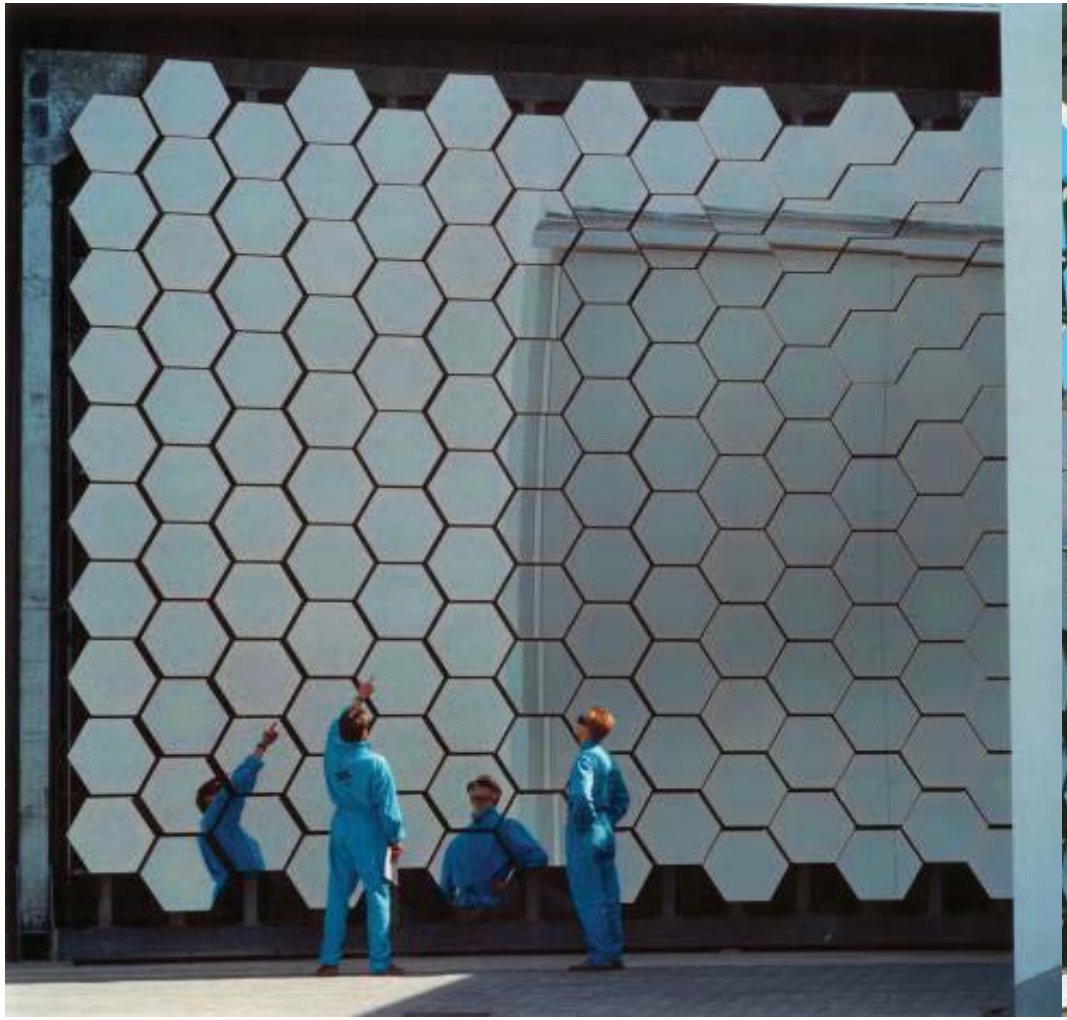
DLR Solar Furnace Cologne

- Concentration 5500
- Power on focus 22 kW
- Flux-density 4,5 MW/m^2
- Max. temperature 2500 °C
- Operating range 600 °C - 1300 °C

- Solar thermal experiments
- Solar chemistry
- Solar material research
- Space industry component testing
- Flux measurement system development
- others







Xenon Short-Arc High Flux Solar Simulator HFSS

Performance Characteristics

10 Xenon short arc lamps

6 kW electrical power input each

20 kW optical power

4,1 MW/m^2 flux density

HFSS in operation

HFSS in operation

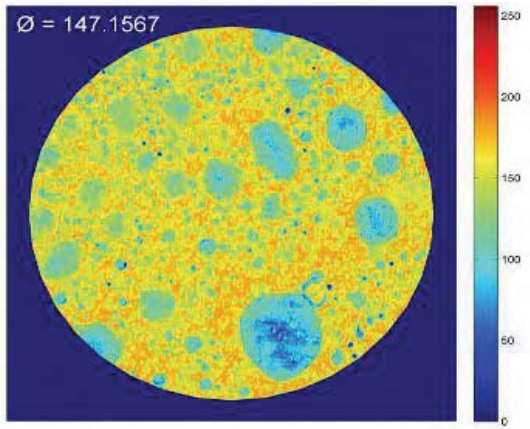
QUARZ®
Test and Qualification Center for CSP Technologies

Cologne, Germany

Plataforma Solar de Almería (CIEMAT)
Spain

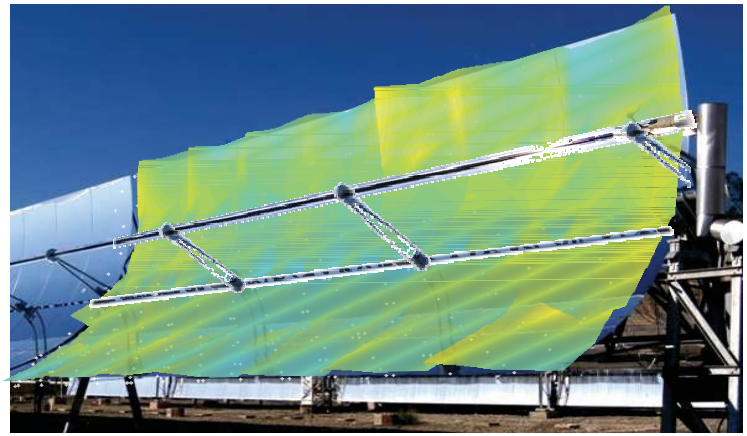
Mirror and Absorber Qualification

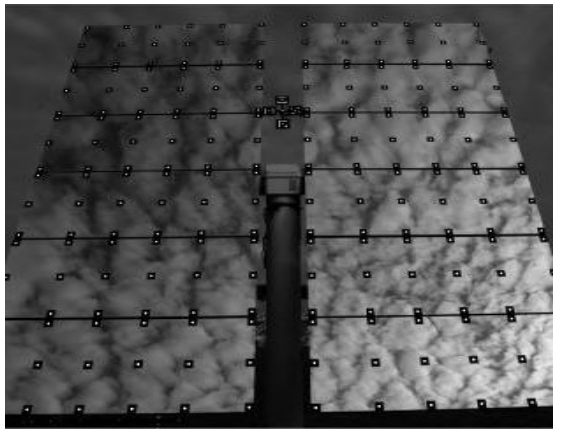
- Measurement of optical quality of mirrors and absorbers
- Durability testing
- Accelerated aging for life time predictions



Collector Qualification

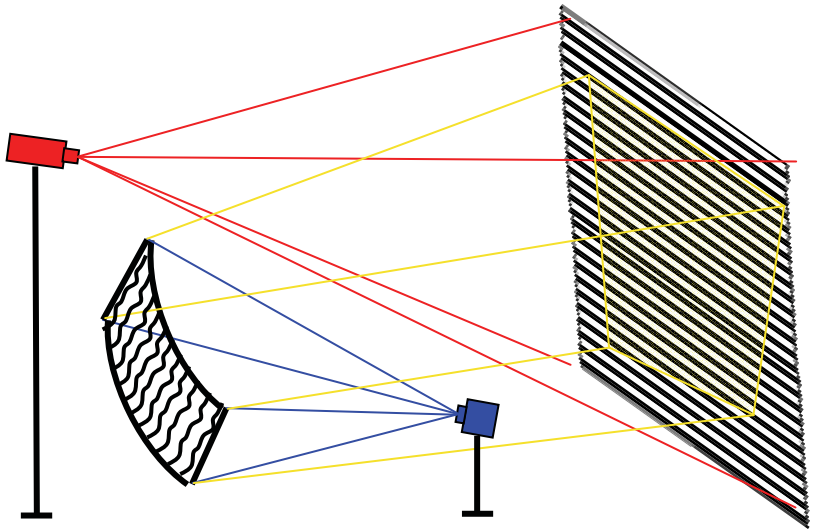
- Evaluation of large structures
- Quality assessment of geometry
- Automated system for production line

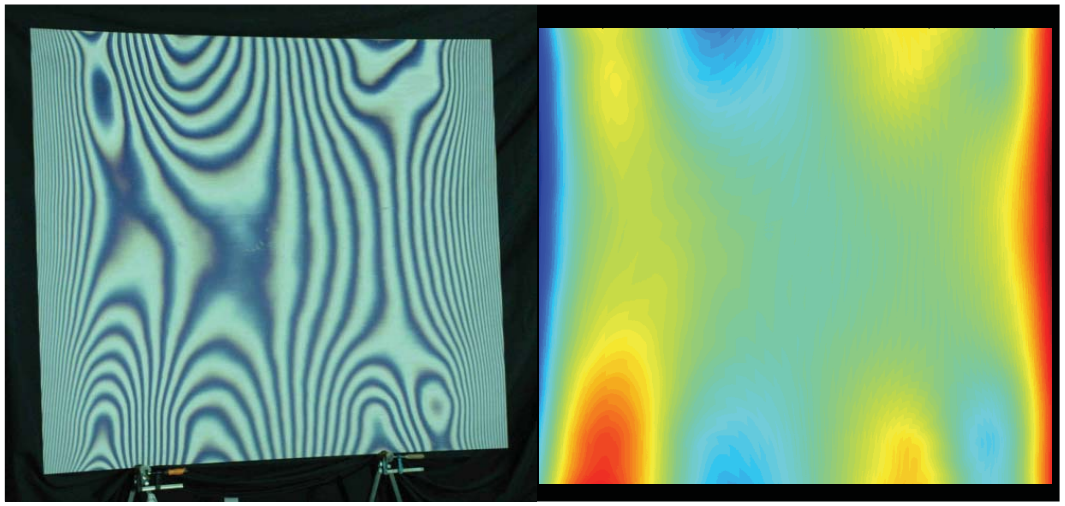




Mirrors and Collector Shape Qualification

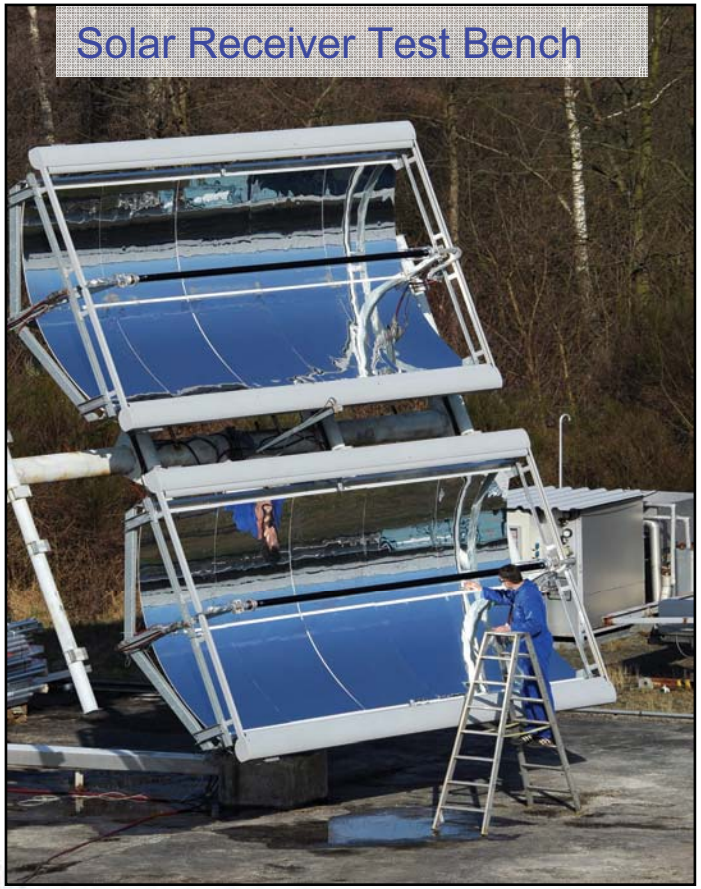
- Measurements of mirror shape accuracy
- Prediction of energy yield according shape errors

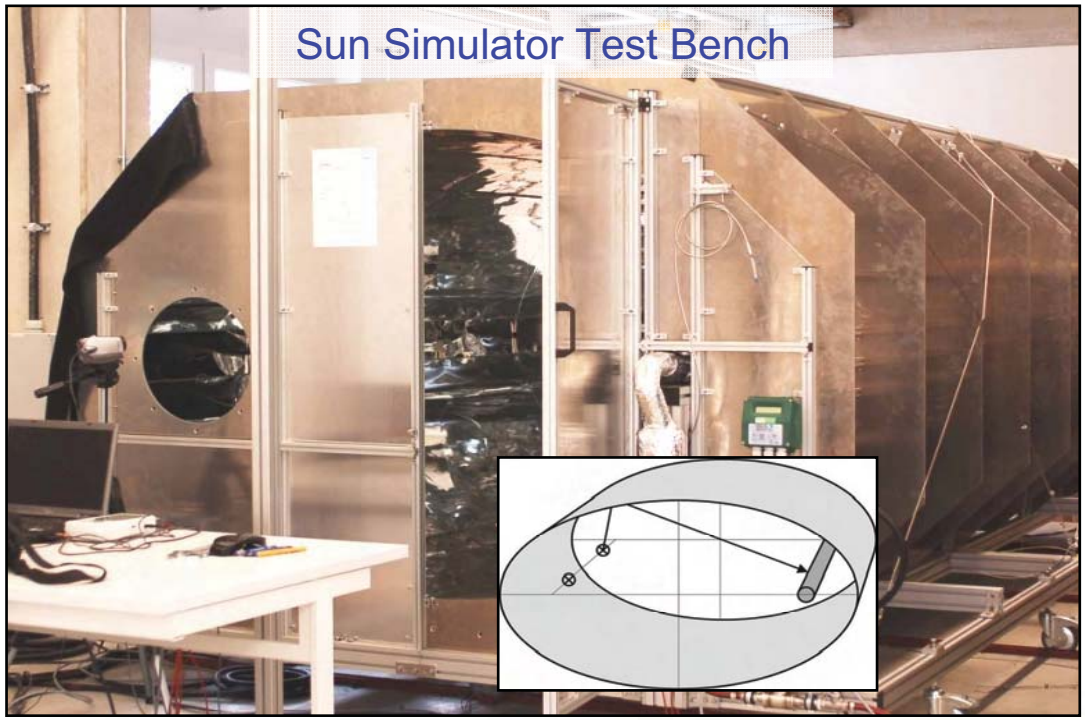




Receiver Qualification

- Thermal losses
- Optical efficiency





Testbed Kontas at PSA

Measurements:

- ❑ Standardized Component Qualification
- ❑ Optical and thermal efficiency
- ❑ Component performance

- ➢ rotative test-platform
- ➢ max. collector length: 20 m
- ➢ active temperature control
- ➢ heat transfer fluid: Syltherm 800
- ➢ operation temperature: ≤ 400 °C
- ➢ mass flow: 21 m³/h
- ➢ high precision meteo station
- ➢ highest possible accuracy of measurement

Testbed Kontas

- Joint implementation by DLR and Ciemat
- Location: Plataforma Solar de Almería (PSA), Spain
- Cost: 1.2 Million Euros
- Funding:
  - German Ministry for Environment, Nature Conservation and Nuclear Safety (BMU)
  - Spanish Ministry for Science and Innovation
- Status: Commissioning

Concentrating Solar Research Facilities

PSI's High-Flux Solar Furnace

Peak concentration: 5,000 suns

Total power: 40 kW_{th}

Power on 6-cm diameter target: 10 kW_{th}

Max. temperature: 2500 K

Commissioned: 1997 / 2009

PSI's High-Flux Solar Simulator

Peak concentration: 11,000 suns

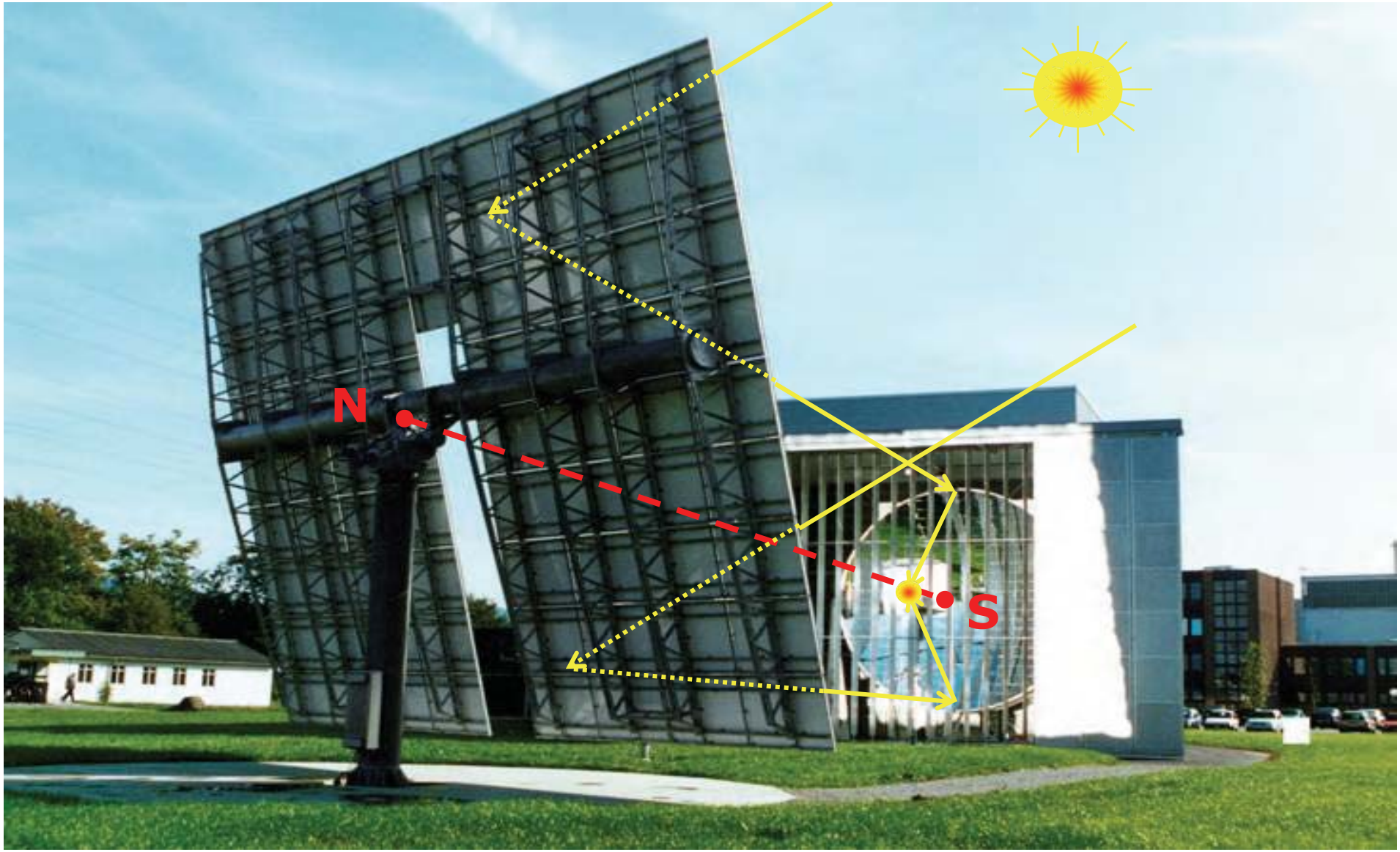
Total power: 50 kW_{th}

Power on 6-cm diameter target: 20 kW_{th}

Max. temperature: 2500 K

Commissioned : 2005

PSI's High-Flux Solar Furnace (HFSF)



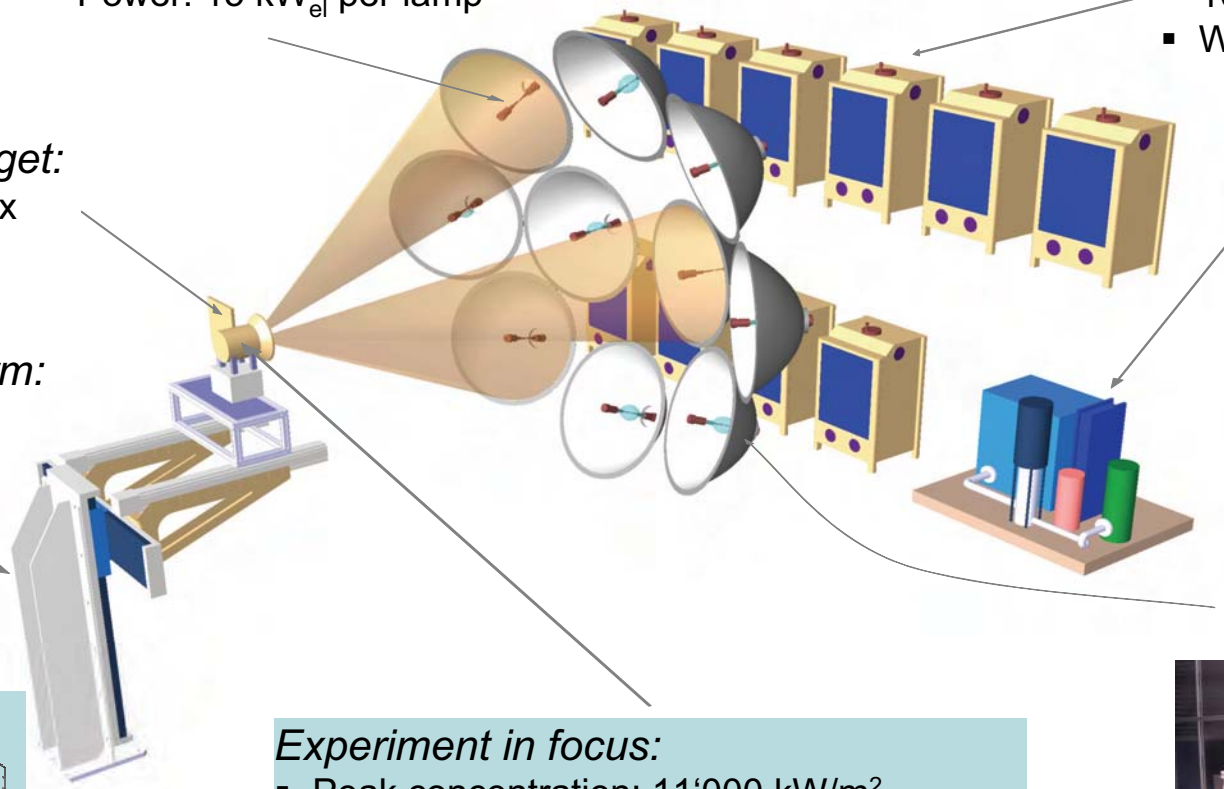
PSI's High-Flux Solar Simulator (HFSS)

Radiation source :
- 10 Xenon arc lamps (water-cooled)
- Power: 15 kW_{el} per lamp

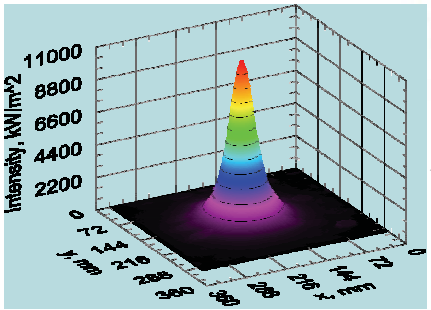
Power and Cooling:
- 10 rectifiers
- Water and air cooling

Lambertian Target:
- For radiative flux measurements

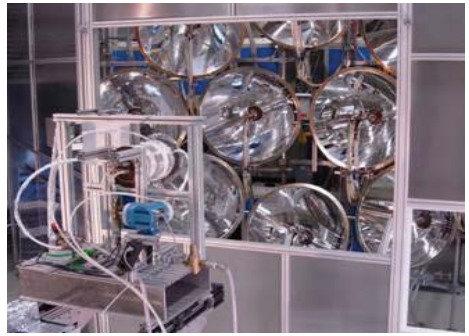
Experimental Platform:
- 3-axis movement
- Max. weight: 500 kg



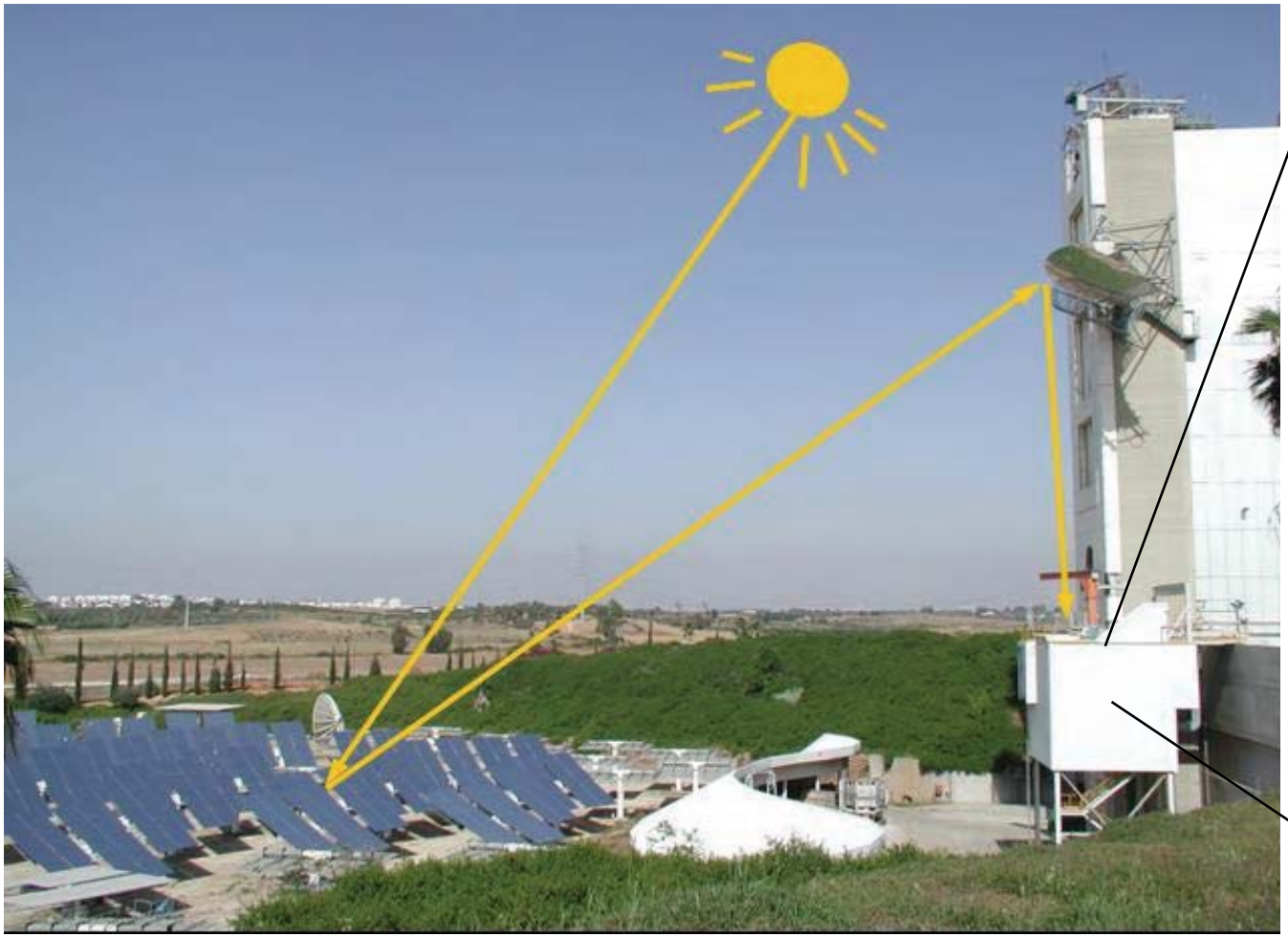
Reflectors:
- Ellipsoidal
- Reflecting aluminum coating



Experiment in focus:
- Peak concentration: 11'000 kW/m^2
- Total power: 50 kW_{th}
- Power on 6-cm diameter target: 20 kW_{th}
- Max. temperature: 3000 K



Beam-Down Optics



Solar facilities at WIS (with beam down optics)

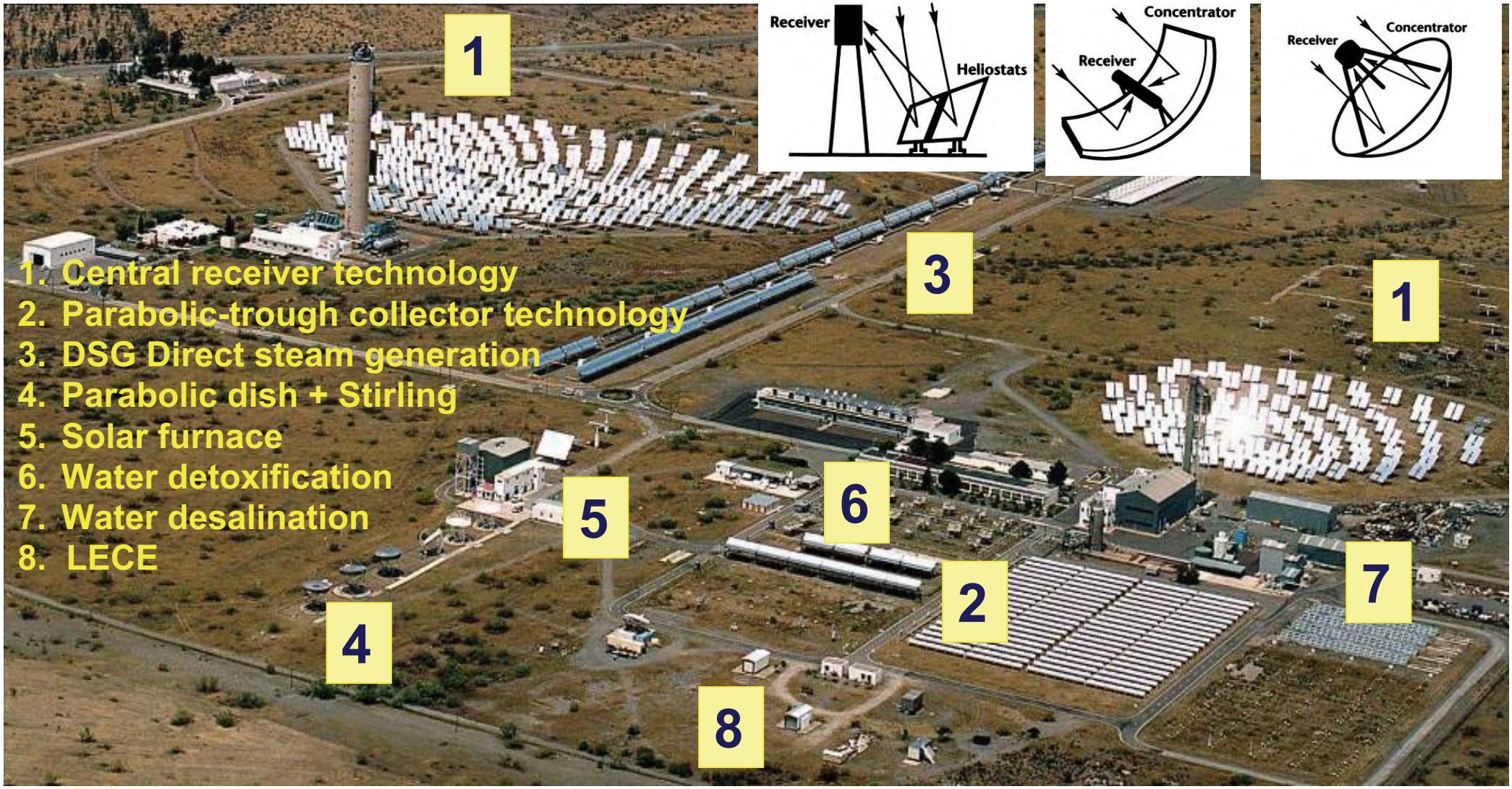
Secondary concentrator

ENEA Facilities- Solterm (Casaccia)

The **PCS** facility is the main testing loop built in the SOLTERM unit and it is unique in the world.
It consist in a two lines of high temperature parabolic trough collector using as heat transfer fluid a binary component salt (60% of Sodium nitrate and 40% of Potassium nitrate) operating up to 550 °C. It is working since 2004 and it is constituted by a close loop totally instrumented (flow rate, pressures, temperatures, etc.) a molten salt storage (5 m3 of useful volume), electric heaters and Salt to air heat exchanger.

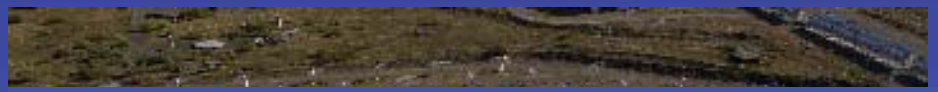
The **MOSE** facility cover the experimental needs related to materials characterization in respect to their behaviour with molten salt. It is suitable for dynamic corrosion testing and all other durability testing of steels, sealings, weldings.

PSA TEST FACILITIES



CESA-1

- Thermal power: 7 MW.
- 300-heliostat field.
- 80 m.-high tower with 3 testing platforms.



- Testing area for newly designed heliostats.

CRS: Central Receiver System

- Thermal power: 2,7 MW
- 111-heliostat field.
- 43 m.-high tower with two testing platforms.

DISS: Direct Solar Steam

- Thermal power: 1,8 MW
- Steam flow rate: 1 kg/s
- T max = 400 ºC
- P max = 100 bar
- 650 m.-long collectors in two rows.

HTF: Heat Transfer Fluid

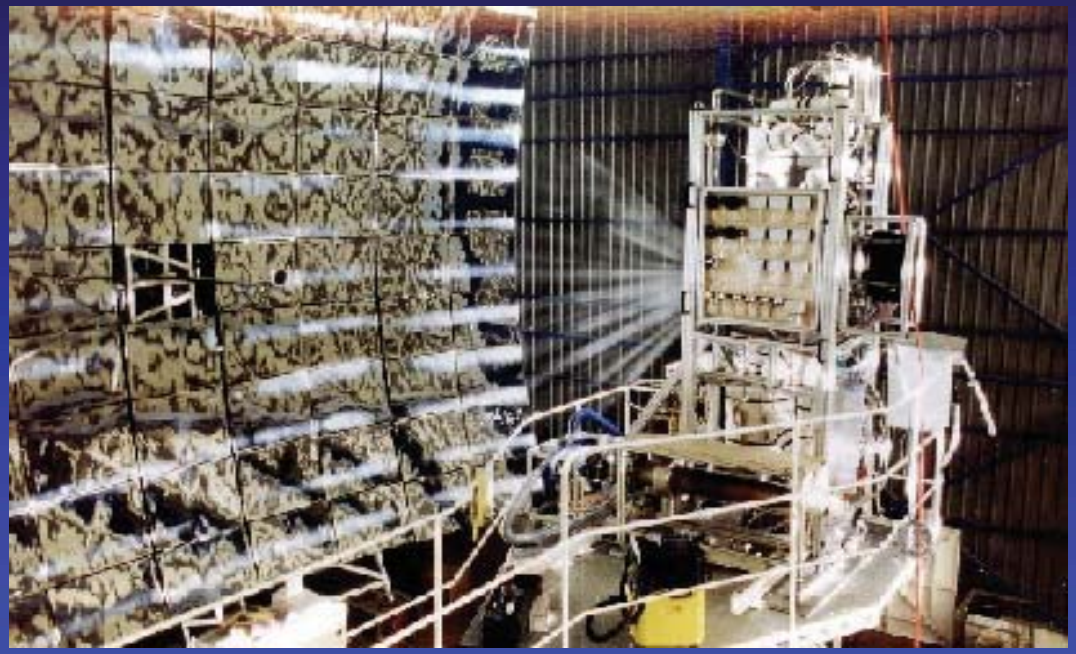
- LS3 and EuroTrough collectors in two parallel rows.
- Used for testing of components.
- Thermal power: 345 kW

- Working fluid is a synthetic thermal oil.
- T max: 420ºC
- Currently coupled to a thermal storage testing loop.

DCS: Distributed Collector System

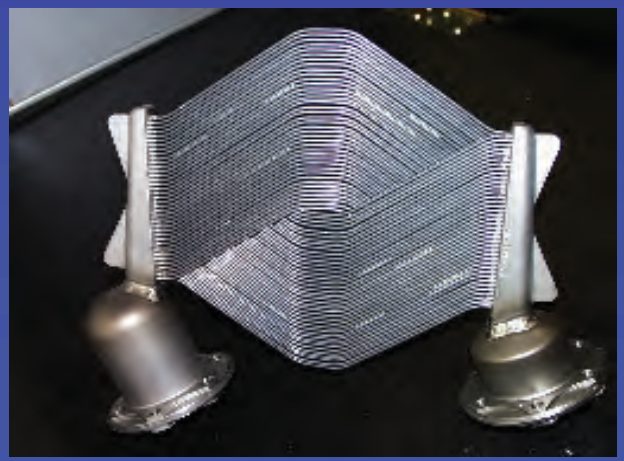
- Thermal power: 1,2 MW
- Heat storage: 5 MWh
- Coupled to a MED plant:3 m3/h

Solar Furnace



- Thermal power: 60 kW
- Peak flux density: 2,500 suns
- Focal length: 7,5 m.
- Dish area: 100 m2.

DISTAL: Dish-Stirling Almeria



- 6 units / 3 generations
- Direct solar tracking
- Thermal power: 50 kW
- Electric power: 10 kW

DETOX: Detoxification Loop

- Set of 6 CPC for water detoxification by UV.
- Total volume: 405 l.
- Aperture area: 33 m2

- Set of 4 two-axis tracking PTC.
- Working flow: 400-5000 l/h.
- Aperture area: 128 m2

LECE

- Four 16-m^3 thermally insulated test cells with one wall prepared for testing architectural components.
- These tests allow thermal losses and some optical properties of the component as, for instance, transmissivity of light, to be evaluated.

- Thanks for your attention !!!!