European Commission
FP7 Grant Agreement
No: 609837

Key contributions to Materials and Tower Technology

Latest joint efforts between Research and Industry for strengthening European CSP leadership (STAGE-STE Workshop)

European Economic and Social Committee

Brussels, January 23rd, 2018

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EERA European Energy Research Alliance

Comité économique et social européen
European Economic and Social Committee

Main contributions of STAGE-STE to Materials for STE-Components

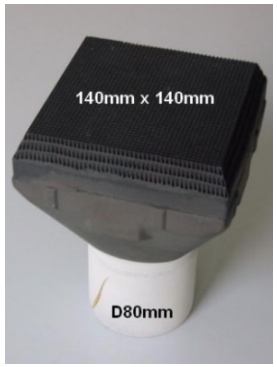
- **Technological Improvements**

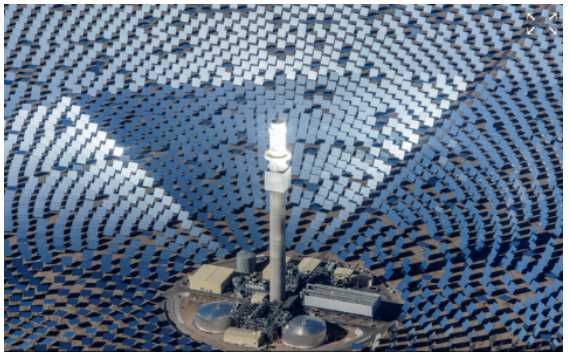
  Development of test procedures for durability testing of key components

  Innovations in absorbers, heliostats and heliostat fields

- **Non Technological contributions**:

  Guidelines for standards, dissemination





Main contributions of STAGE-STE to Materials for STE-Components

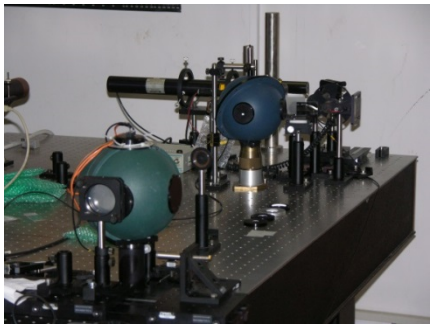
- **Challenge for Mirrors**

  Develop methodology to predict durability in commercial plants

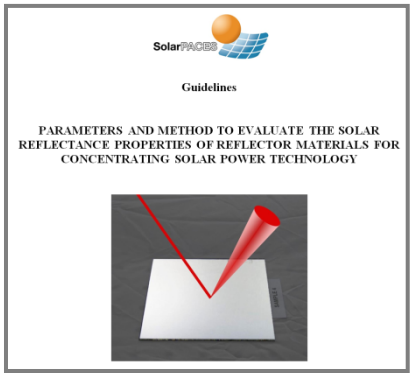
- **Results**

  Development of new measurement instruments

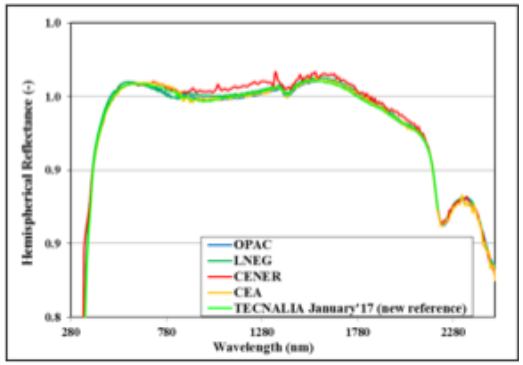
  Input to SolarPACES Task III and AENOR/ CTN206/SC117 guidelines of how to measure reflectance, also for reflector samples after aging



New instruments (ENEA/Ciemat/DLR/Fraunhofer)



New SolarPACES guideline for nomenclature and measurement of aged samples



Round Robin Measurement

Main contributions of STAGE-STE to Materials for STE-Components

- **Challenge for Mirrors**

  Develop methodology to predict durability in commercial plants

- **Results (Corrosion)**

  Collection of relevant data from outdoors (wind, humidity, UV, soil)

  Sample exposition (12 sites, 700 probes)

  Reproduction of corrosion mechanism in laboratory

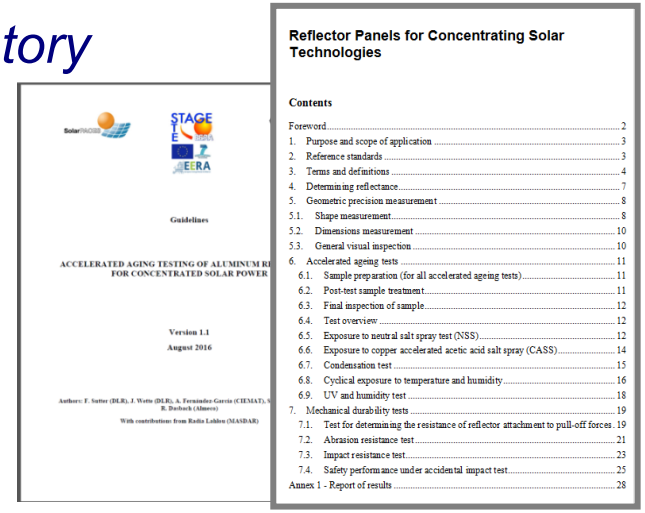
  Guideline for accelerated corrosion test

Outdoor exposure

Test	Duration
Neutral Salt Spray (NSS) ISO 9227	480 h
CASS ISO 9227	120 h
Condensation ISO 6270-2	480 h
UV and humidity ISO 16474-3	2000 h

Accelerated aging tests defined in AENOR

AEN/CTN 206/SC 117



Reflector Panels for Concentrating Solar Technologies

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Guideline/Standard

Main contributions of STAGE-STE to Materials for STE-Components

- **Challenge for Mirrors**

  Develop methodology to predict durability in commercial plants

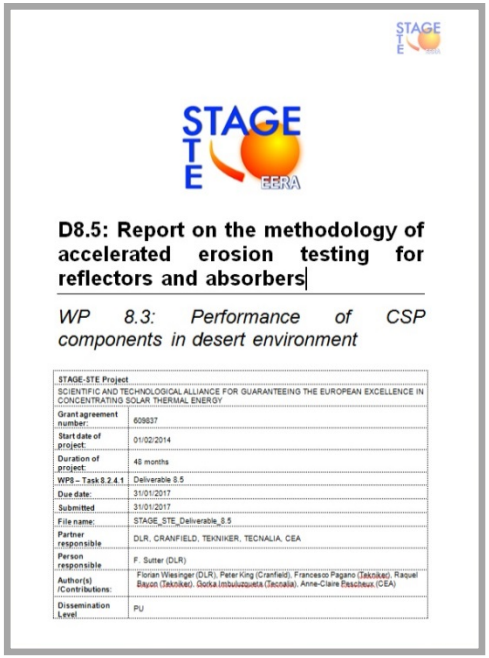
- **Results (Erosion)**

  Soil type and soiling impact characterization

  Modelling of erosion on glass surface

  Development of test benches for erosion testing

New test benches of different partners (CIEMAT, DLR, CRANFIELD, TECNALIA)



D8.5: Report on the methodology of accelerated erosion testing for reflectors and absorbers

WP 8.3: Performance of CSP components in desert environment

STAGE-STE Project	SCIENTIFIC AND TECHNOLOGICAL ALLIANCE FOR GUARANTEEING THE EUROPEAN EXCELLENCE IN CONCENTRATING SOLAR THERMAL ENERGY
Grant agreement number:	609837
Start date of project:	01/02/2014
Duration of project:	48 months
WP8 – Task 8.2.4.1	Deliverable 8.5
Due date:	31/01/2017
Submitted	31/01/2017
File name:	STAGE_STE_Deliverable_8.5
Partner responsible	DLR, CRANFIELD, TEKNIKER, TECNALIA, CEA
Person responsible	F. Sutter (DLR)
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Dissemination Level	PU

Guideline for testing

Main contributions of STAGE-STE to Materials for STE-Components

- **Challenge for absorbers**

  Investigate influence of soiling on high temperature absorber

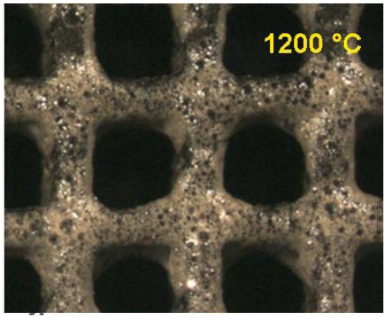
- **Results**

  Test bench designed and built, max. outlet air temperature up to 1000°C

  Analysis of chemical content of soiled absorbers

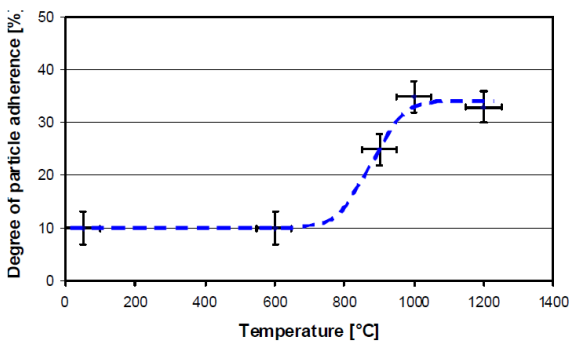
  Adhesion (sintering) between dust particles and SiC is poor as long T <1200ºC (silica-rich dust) or 1150ºC (lime-rich dust), respectively

Dish test bench

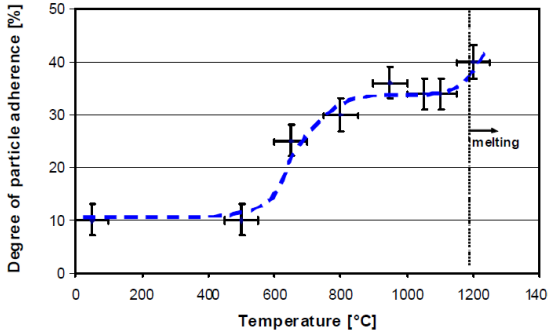


Soiling of absorber

Silica-rich dust



Lime-rich dust



Main contributions of STAGE-STE to Tower Technology

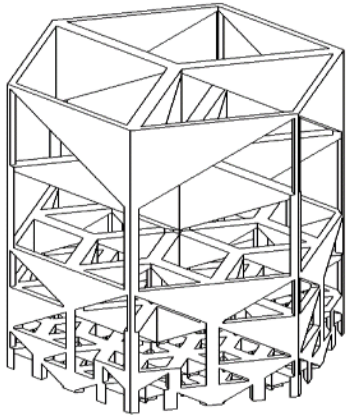
- **Challenge**

  Innovative Receiver Structures

- **Results**

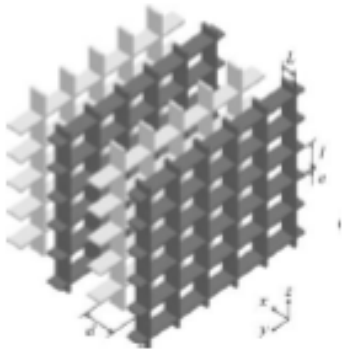
  Stacked-grid structures have been analyzed and tested

  SLM (Selective Laser Melting) absorbers developed and tested



SLM absorber structure

Porous SiC foam



Stacked-grid structures

Main contributions of STAGE-STE to Tower Technology

- **Challenge for Heliostat Fields**

  Develop a new concept of small heliostat

- **Results**

  4 heliostat designs developed based on different low-cost strategies

  Developed a heliostat cost analysis tool

  Common procedure to test heliostats

CENER and TKN

CSIRO and Cyl

ENEA

UNAM/UNISON

Main contributions of STAGE-STE to Tower Technology

- **Challenge for Heliostat Fields**

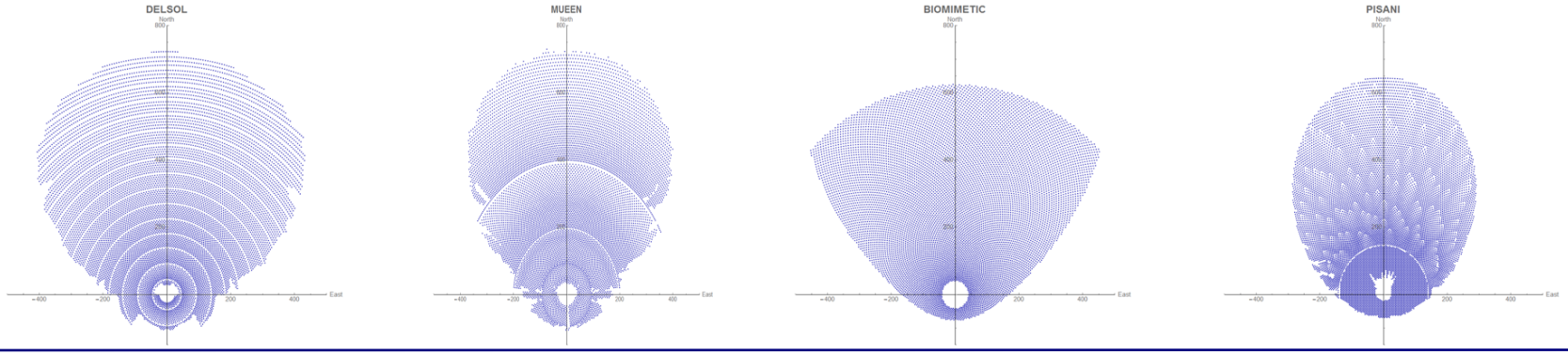
  Develop an innovative heliostat field layout code

- **Results**

  State of Art of existing algorithms for heliostat field generation

  Benchmark test between four algorithms to generate heliostat field layout (DELSOL, Mueen, Biomimetic and Pisani code)

  New algorithm proposed based on a macroscopic method for fast heliostat field layout optimization



Main contributions of STAGE-STE to Tower Technology

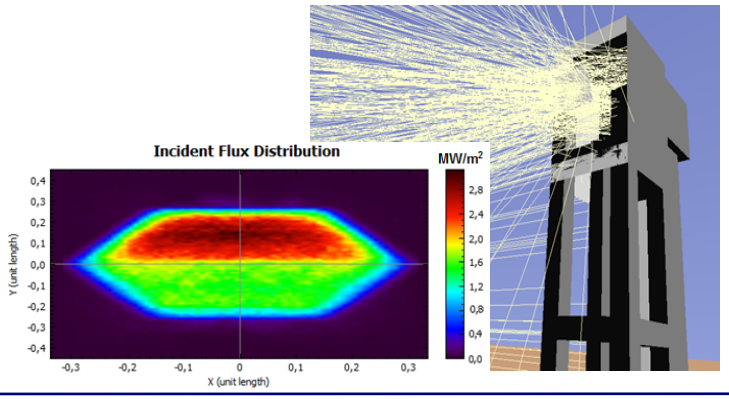
- **Challenge for Heliostat Fields**

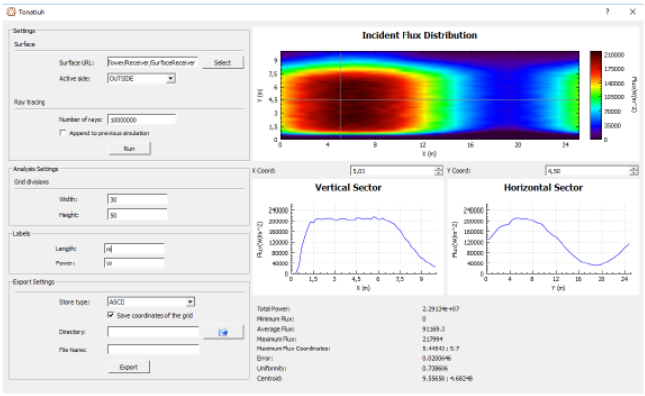
  Improve optical simulation tools and codes

- **Results**

  New tools implemented in Tonatiuh, an open source ray-tracing software

  - Utility to calculate the flux distribution inside Tonatiuh
  - Plugin created and implemented to analyze optical properties dependent on incident angle
  - Plug-in to add the capability of importing CAD surfaces implemented and tested





Main contributions of STAGE-STE to Tower Technology

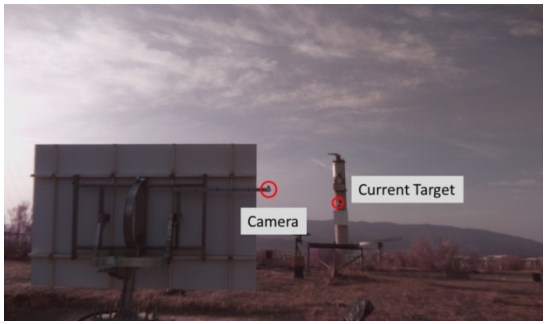
- **Challenge**

  Fast calibration procedures for large heliostat fields

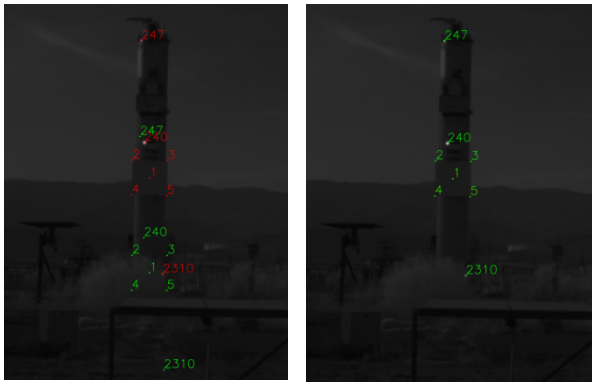
- **Results**

  Two new methods have been developed: "Calibration method for heliostats" and "Backward-gazing method" (both patented)

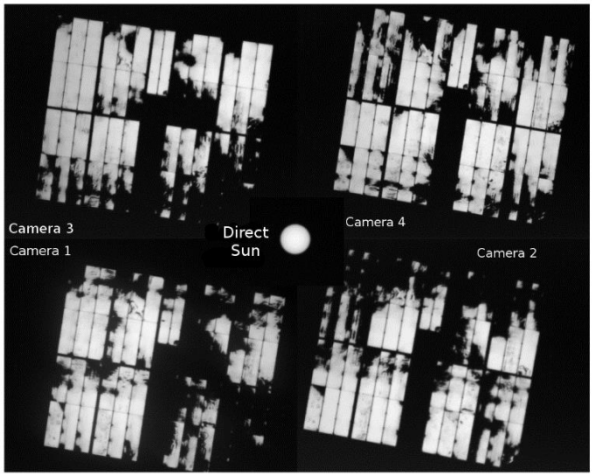
  Accuracy test showed convincing results



Camera mounted on heliostat



Targets before (left) and after (right) calibration



Heliostat reflection captured by four cameras

Thank you for your attention