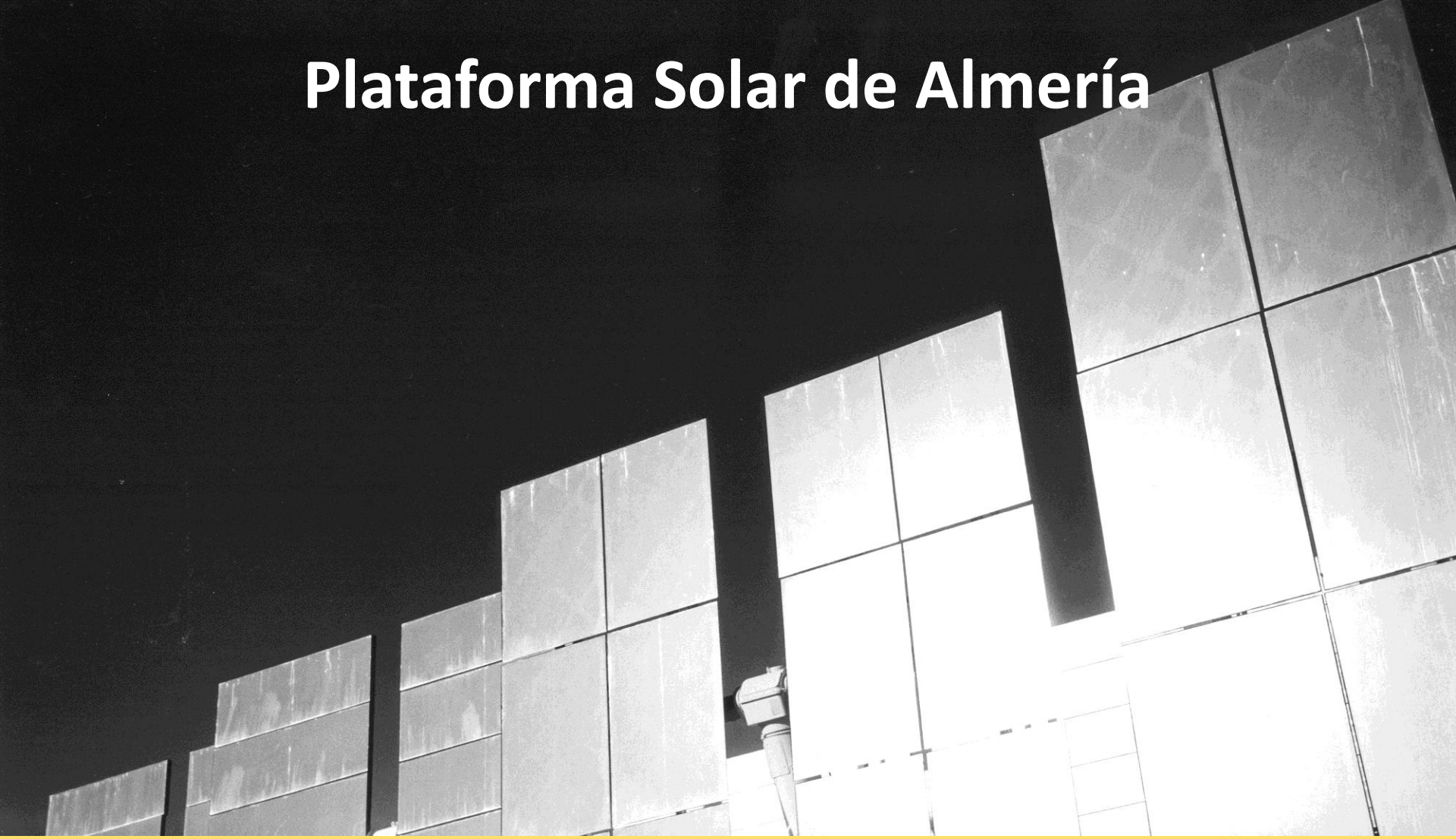
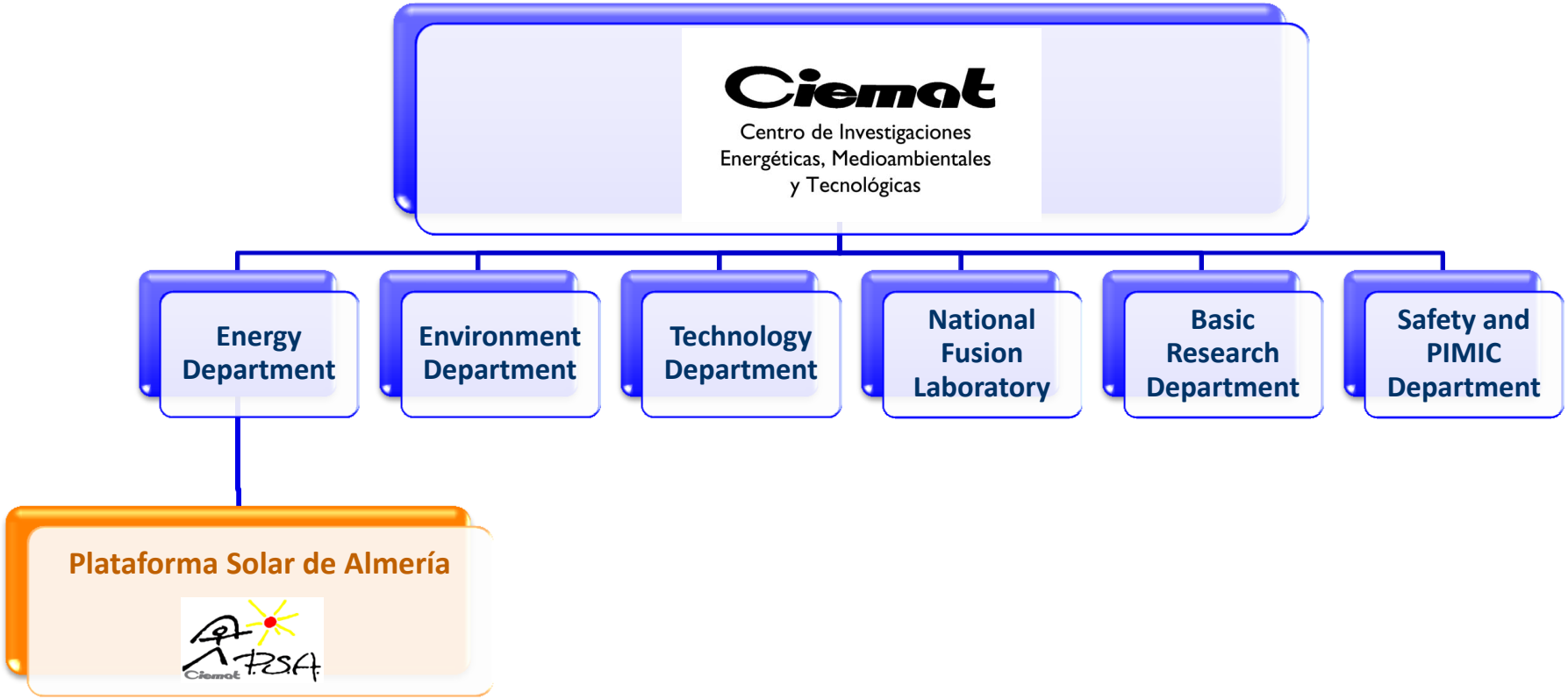
Plataforma Solar de Almería



MINISTERIO
DE ECONOMÍA
Y COMPETITIVIDAD

Ciemat
Centro de Investigaciones
Energéticas, Medioambientales
y Tecnológicas

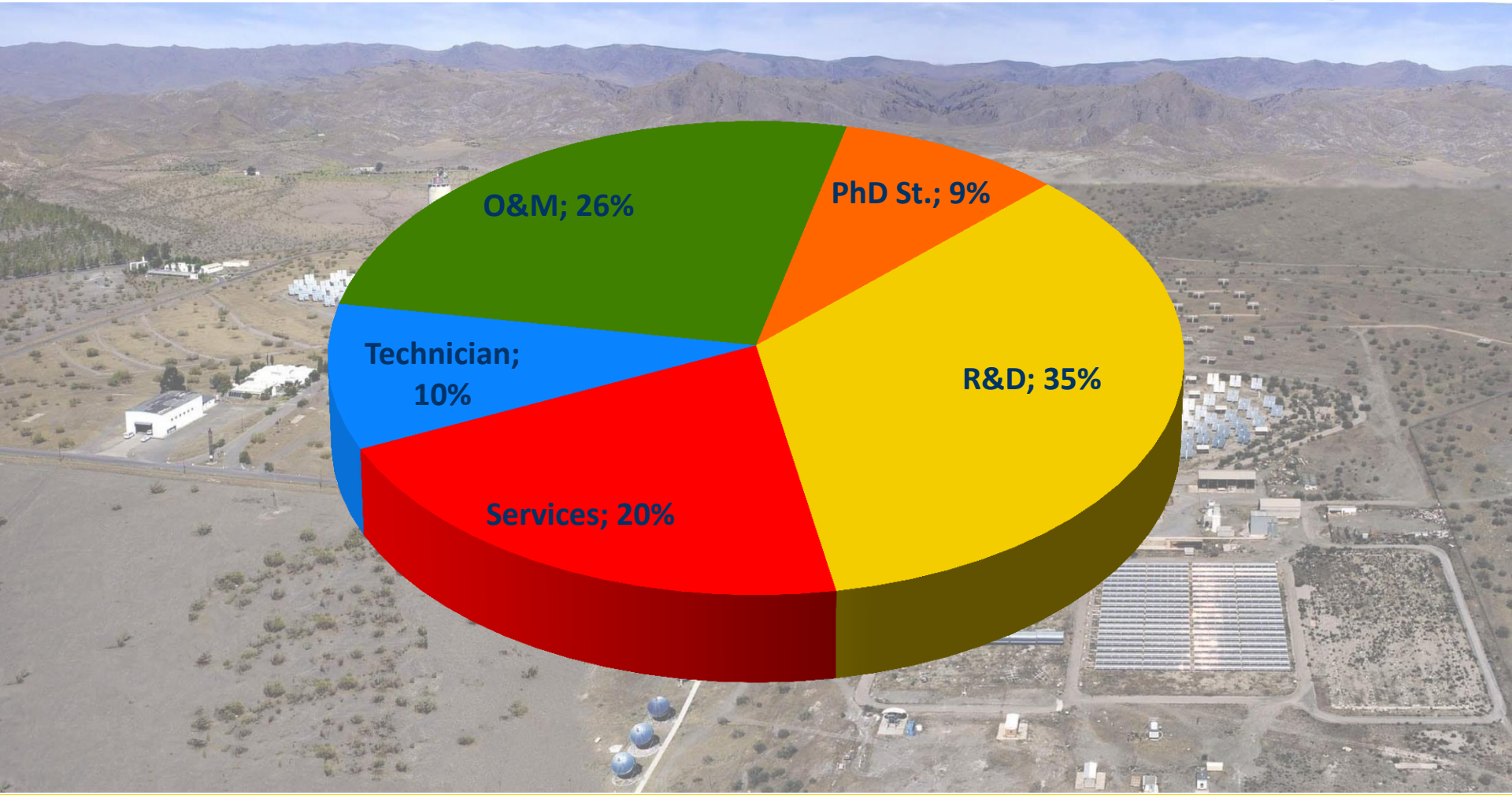
PSA and CIEMAT



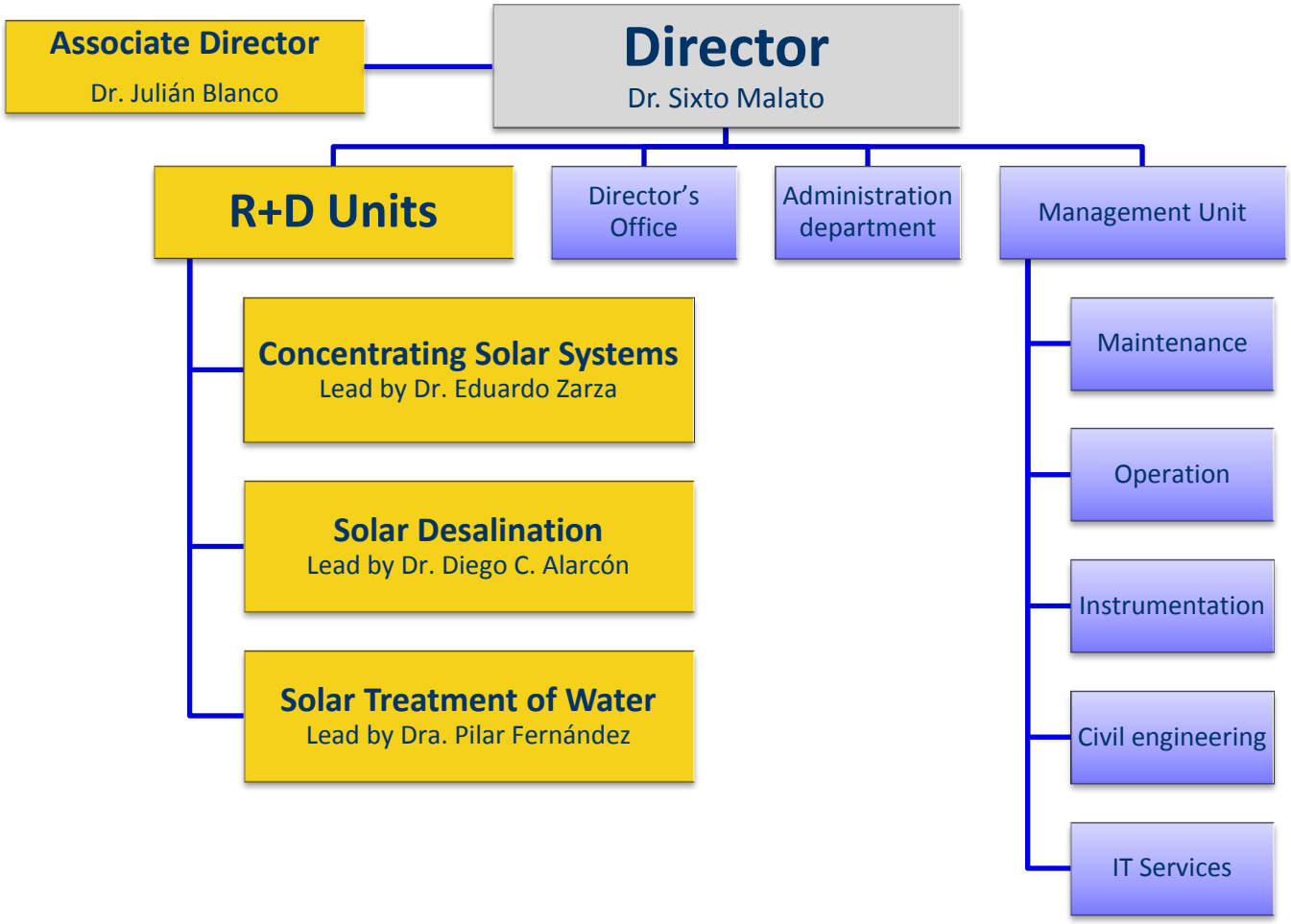
PSA: Basic information

- PSA is an **European Large Scientific Installation**, being the largest and most complete R+D center in the World devoted to solar thermal concentrating systems. PSA is also a **Singular Science and Technology Infrastructure** (ICTS) of Spain.
- Goal: R+D in potential industrial applications of concentrated solar thermal energy and solar photochemistry.
- Location: Distributed over 103 hectares in the Tabernas desert (Almería).
- Budget (2011-2013): Approximately 30 M€, of which 30% was new infrastructure. 50% came from own income.
- Human resources : Approximately 130 persons.

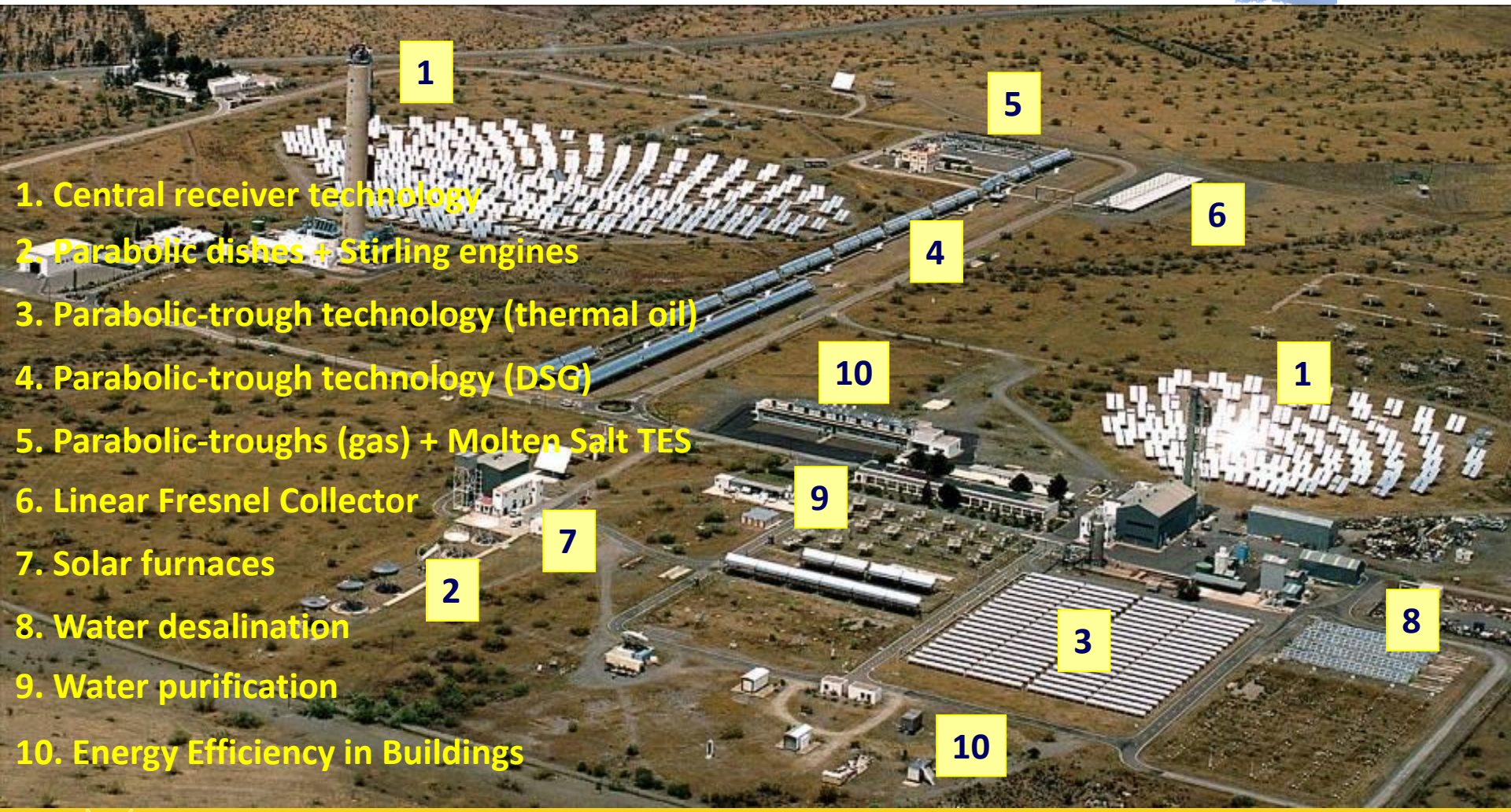
PSA: Basic information



PSA: Organization

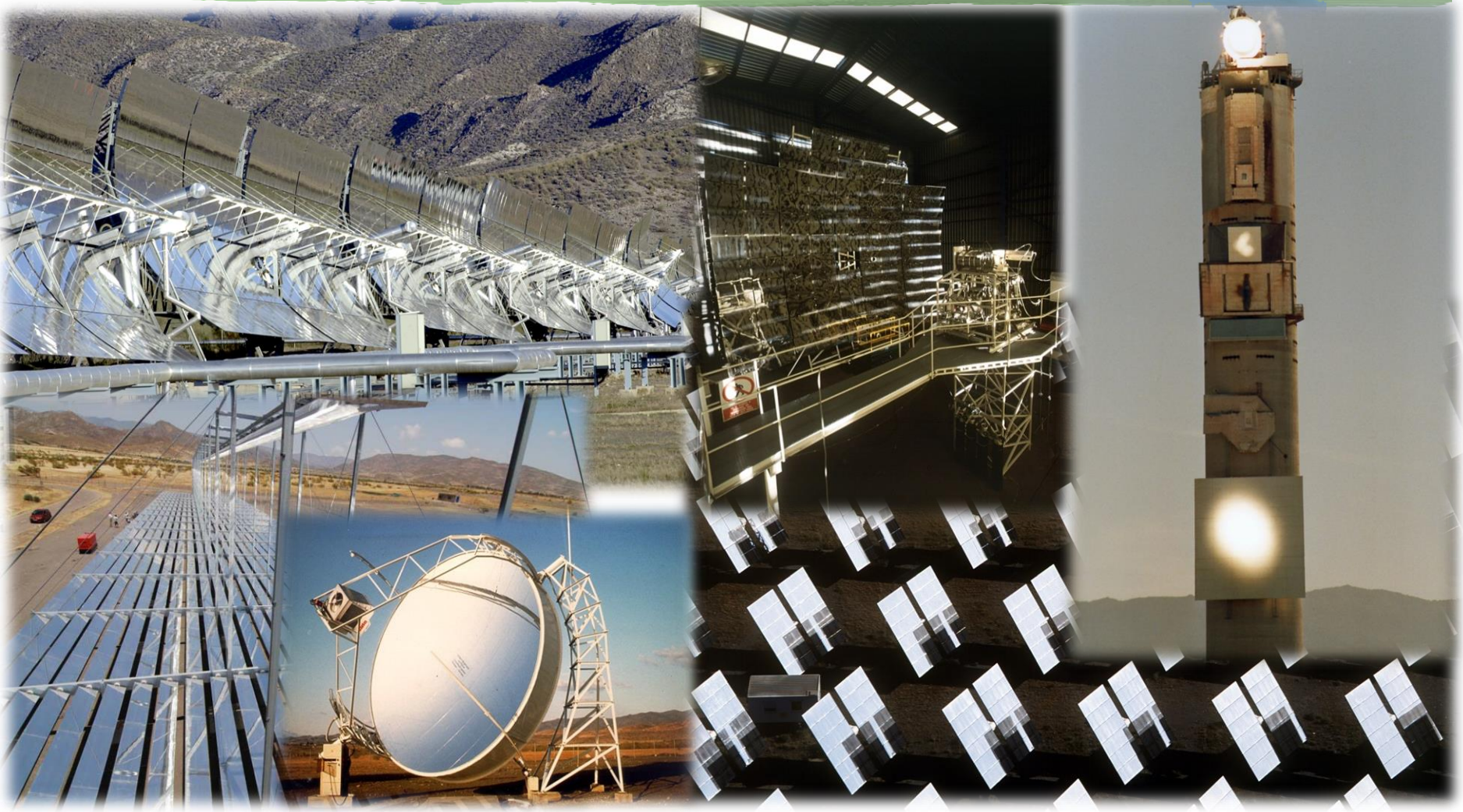


PSA: Main test facilities

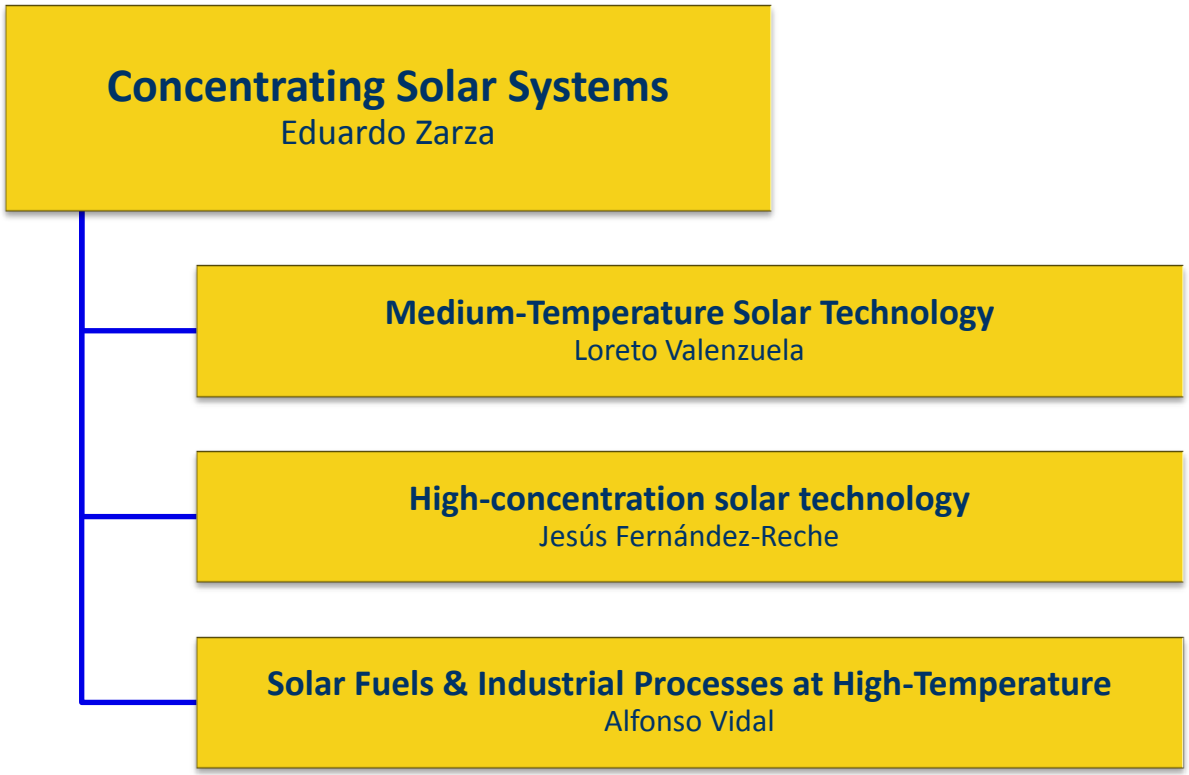


1. Central receiver technology
2. Parabolic dishes + Stirling engines
3. Parabolic-trough technology (thermal oil)
4. Parabolic-trough technology (DSG)
5. Parabolic-troughs (gas) + Molten Salt TES
6. Linear Fresnel Collector
7. Solar furnaces
8. Water desalination
9. Water purification
10. Energy Efficiency in Buildings

Concentrating Solar Systems R+D Unit

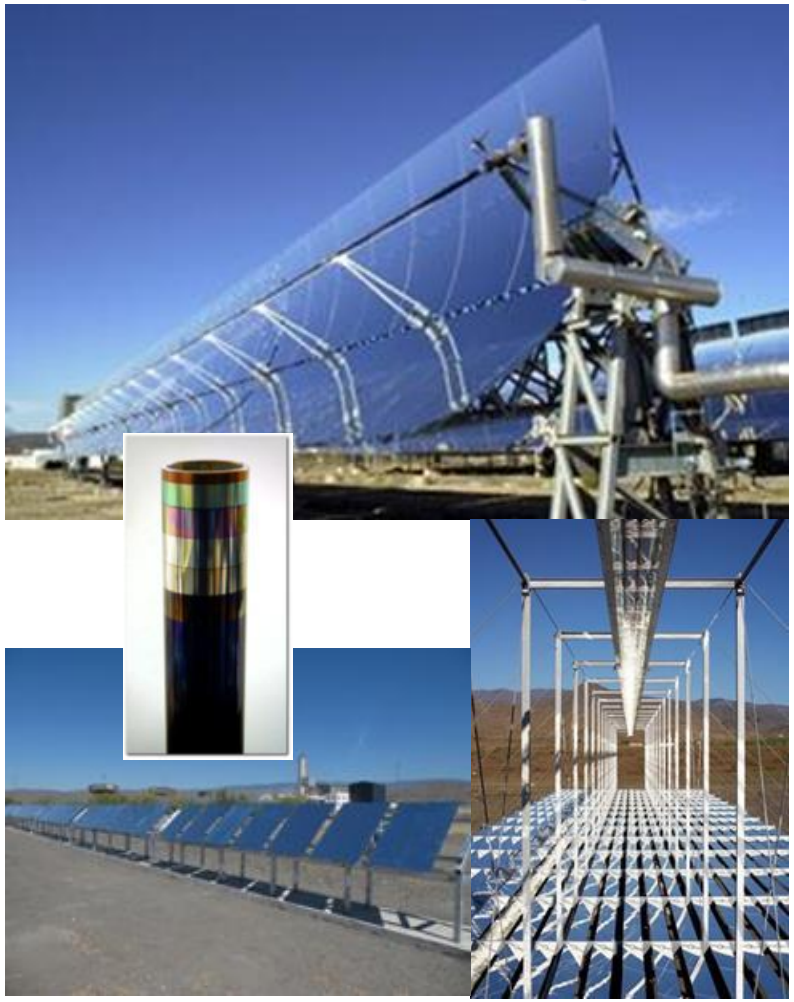


Concentrating Solar Systems R+D Unit



Group of Medium-Temperature Solar Technology

- Development of innovative components for **line-focus solar fields** and applications for using solar energy in the **mid-temperature range: 125°C-500°C.**
  - Design, Testing and Evaluation of ***line focusing*** **concentrators (parabolic-trough and linear Fresnel) and their components** (reflectors, linear receivers, optical coatings, sun-tracking systems…)
  - Research on **new heat transfer fluids** (direct steam generation and pressurized gasses)
  - **Durability and accelerated aging** of solar components (reflectors, receivers, etc.)
  - **Simulation tools** of complete systems.
- **Thermal energy storage (TES)** systems for the mid-temperature range (sensible and latent heat storage; materials for TES; integration concepts)



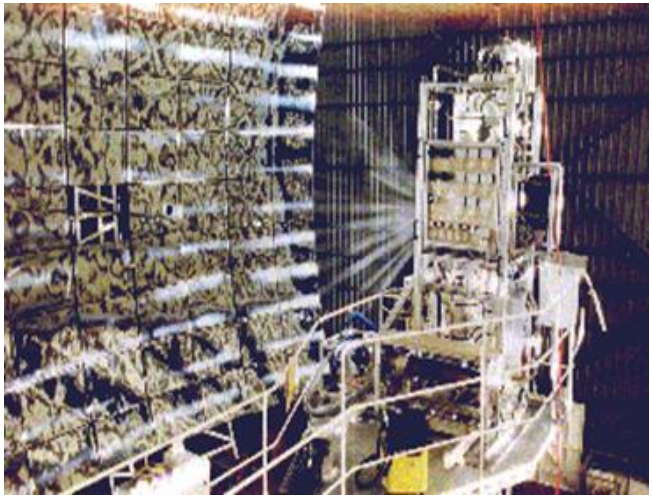
Group of High-Concentration solar technology

- Development of cost-effective systems and components for high solar concentration and temperature
  - Testing and Evaluation of **Solar Central Receivers** for the different technologies & cooling fluids
  - Testing, Evaluation and Durability of **components** for Solar Central Receiver Power Plants
- Improvement of the **O&M procedures and system automation**
- Development of **evaluation and simulation tools** for Central Receiver Plants
- Characterization of **optical & thermal properties and durability of materials** used in high solar concentration and high temperature
- Design, testing and evaluation of **Dish-Stirling systems**

Group of Solar Fuels & IPH at High Temperature

Research activities related to Solar Fuels:

- Development of **solar thermochemical hydrogen production** technologies and other solar fuels
- **R+D activities** related to **hydrogen production:**
  - **Decarbonization of hydrocarbons** for hydrogen
  - **Thermochemical water splitting**



Research activities related to Process Heat Production:

Aplication of **concentrated solar energy** to **endothermal processes at high temperate** (up to 2000ºC) demanding a reduction of CO_2 emissions:

- Ceramic industry
- Powder metallurgy processes

Solar Desalination R+D Unit

Activities on solar desalination

- Applied research on the **effective use of solar thermal energy** in conventional or innovative **desalination processes**
- **R&D topics:**
  - Solar assisted low temperature multi-effect distillation
  - Membrane distillation
  - Energy efficiency enhancement by absorption heat pumps
  - Co-generation plants (Solar Thermal Electricity + Desalination)

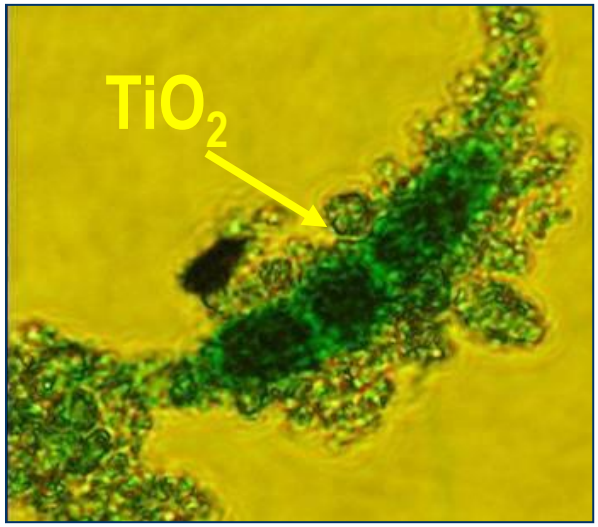
Solar Treatment of Water R+D Unit

Water Detoxification and Disinfection

Applications in industrial and municipal wastewaters:

- Toxic wastewaters
- Biodegradability enhancement
- Priority and emerging pollutants
- Polishing treatment for reuse of effluents from MWTPs
- Decontamination of rejection from membranes water treatment

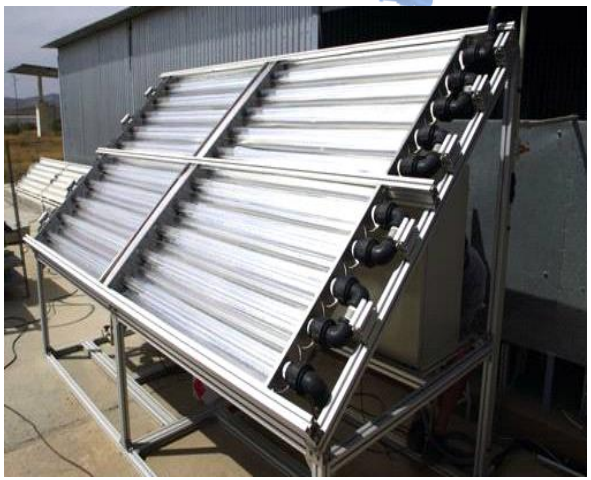
Water detoxification and disinfection



Adsorption of TiO_2 on Fusarium spores

Research topics:

- Inactivation of pathogens present in drinking water in rural areas of developing countries
- Solar Disinfection (SODIS process)
- Inactivation of microbiological species present in irrigation water at hydroponic agriculture
- photocatalytic and photochemical processes for water pathogens removal



Test facilities at PSA of CIEMAT UiE3 R&D Unit

Outdoors full scale test facilities fully monitored . LECE laboratory

PASLINK Test Cell

Solar chimney

CETeB Test Cell

Monozone building

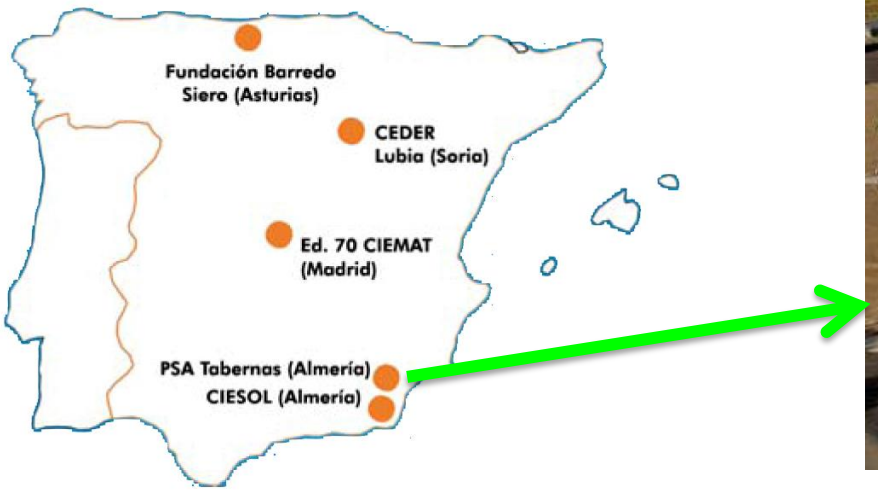
Experimental analysis of buildings and building components

- Energy performance analysis
- Empirical modeling of passive systems
- Comfort evaluation
- Simulation models validation & calibration

Measurement devices

Test facilities at PSA of CIEMAT UiE3 R&D Unit

Outdoors full scale test facilities fully monitored. ARFRISOL building prototype



Office building in occupancy conditions

Experimental analysis of buildings and building components

- Energy performance analysis
- Empirical modeling of passive systems
- Comfort evaluation
- Simulation models validation & calibration

Activities of Solar Radiation Group at PSA

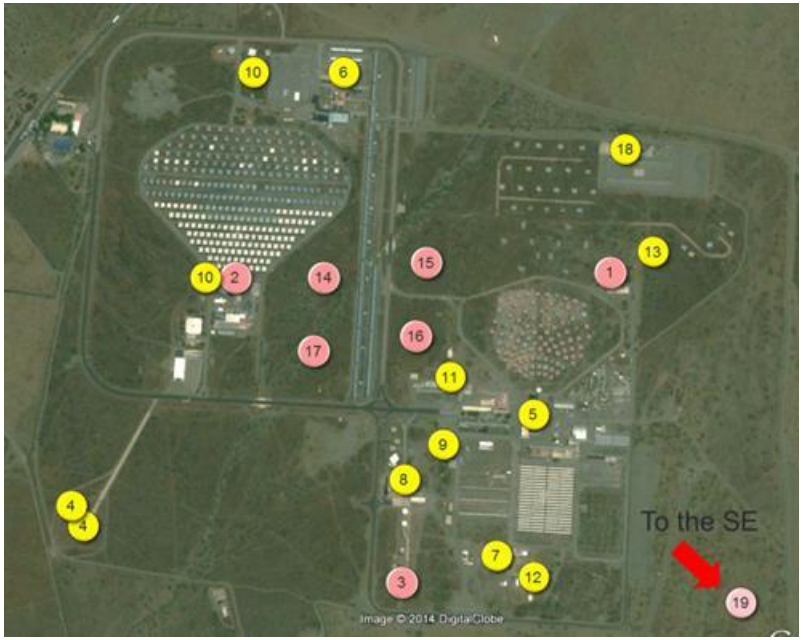
Metas: Meteorological Station for Solar Technologies. Joint installation CIEMAT-DLR.

Solar radiation characterization at PSA are related to

- Testing the standards for calibration solar sensors.
- Standardization procedures for data quality control and TMY generation.
- Assessment of devices and attenuation studies.

Solar radiation network at PSA

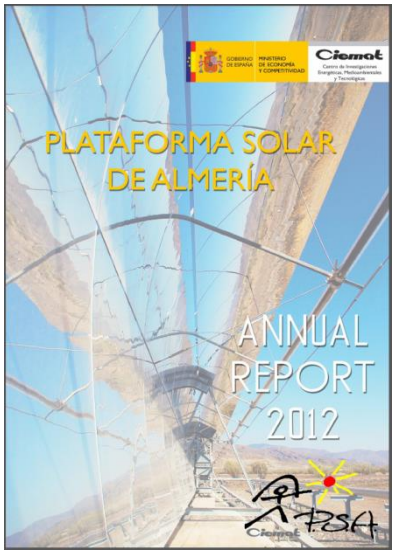
Solar radiation measurements at PSA (from DLR and from CIEMAT projects) for the analysis of spatial variation of DNI.



For further information

www.psa.es

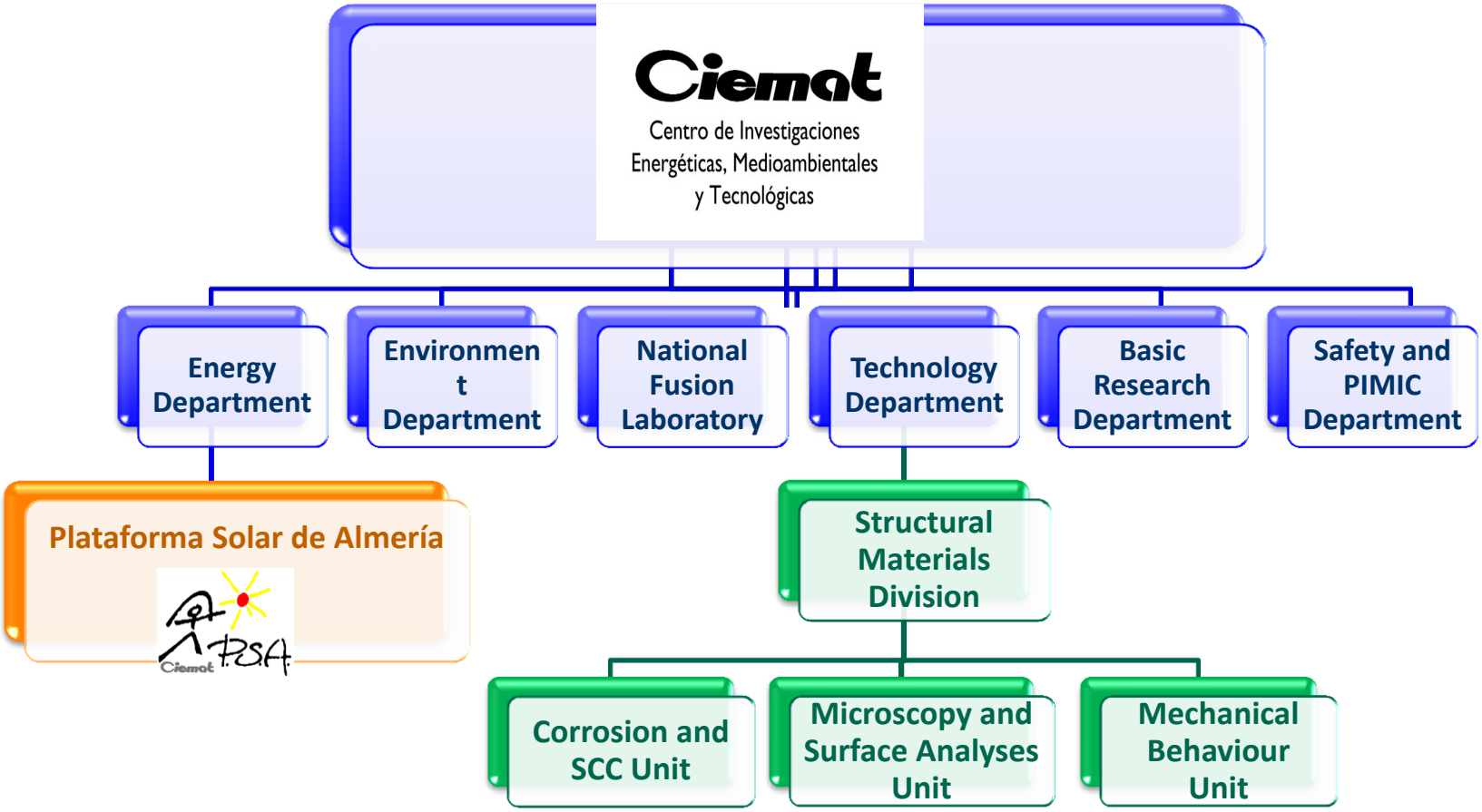
Annual technical reports, free downloadable:



STRUCTURAL MATERIALS DIVISION
TECHNOLOGY DEPARTMENT
CIEMAT

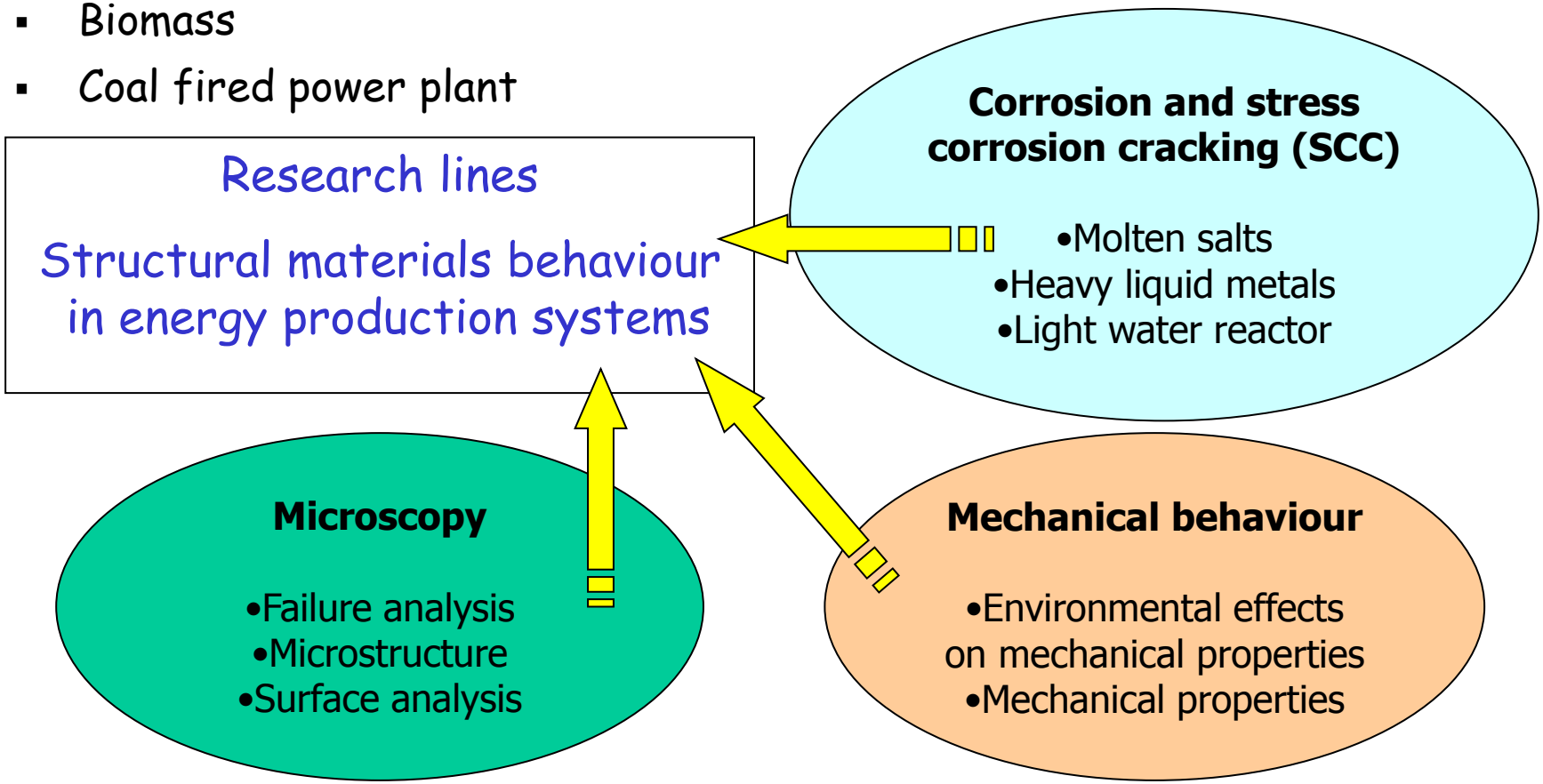
STAGE STE
April 2014
m.navas@ciemat.es

CIEMAT Structural Materials Division



Structural Materials Division: Aim and scope

- ✓ Structural Material Division is focused on the structural materials behaviour in energy production systems:
  - Nuclear power plant in operation (Light Water Reactors)
  - Future nuclear power plant (Gen IV, ADS)
  - Solar Thermal Energy (STE) Plants: Thermal Energy Storage (TES)
  - Biomass
  - Coal fired power plant



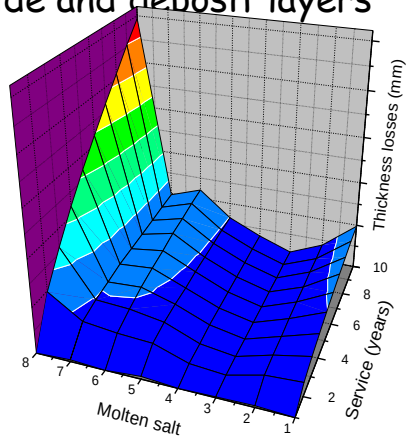
Molten Salts

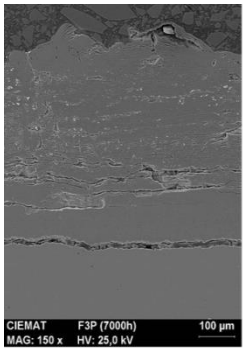
Corrosion studies under operating conditions of CSP Plants

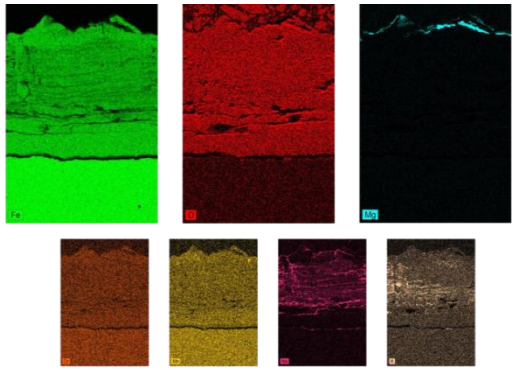
- Research projects: AVANSOL, SOLAR TRES (Spanish and European project)
- Direct agreement with utilities and companies: CORALES Project
- Failure analysis of in-service components of CSP Plants

Long term immersion corrosion test under gas controlled atmosphere

- Weight and thickness losses measurement
- Metallographic examination
- Chemical analysis of the salts
- Surface analysis of oxide and deposit layers





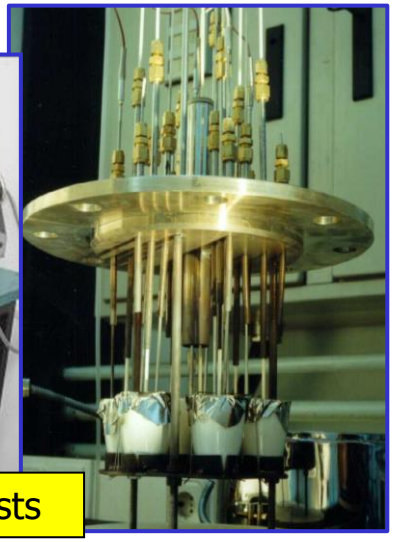


Liquid metals

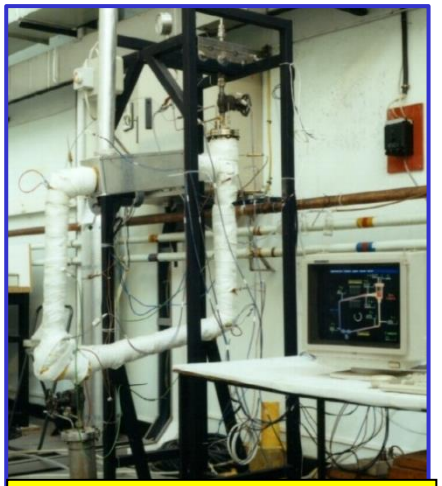
Research projects on structural materials compatibility with liquid metals, possible candidates as PCM materials

- ✓ Lead and lead-bismuth eutectics
  - TECLA, DEMETRA, MATISSE, GETMAT (European Projects)
  - COMETA, COPLOGEN (Spanish National R&D Plan)
- ✓ Aluminium silicon alloys: AlSi 12
  - ALMATSOL (Submitted to Spanish National R&D Plan)

- Facilities for heavy liquid metals



Static corrosion tests



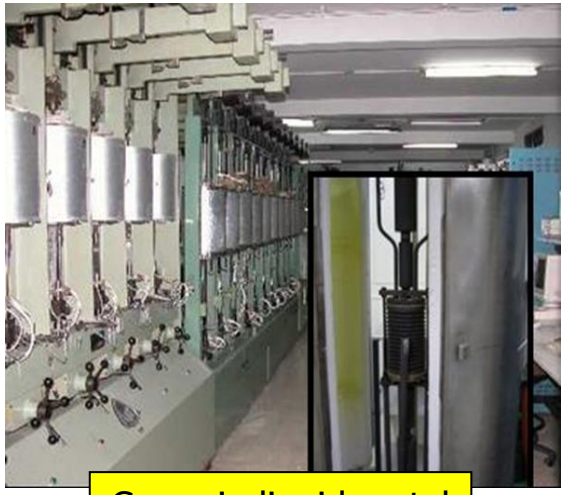
Natural recirculation loop

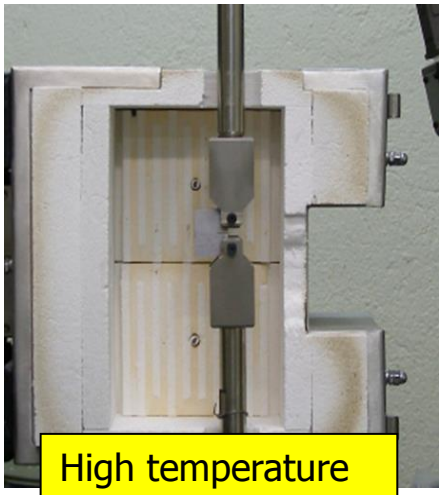
Forced recirculation loop

Structural Materials Division: Laboratories

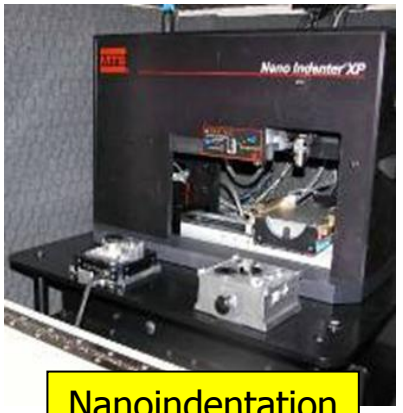
Microscopy and surface analysis

Mechanical characterization


Creep in liquid metal


High temperature
Fracture toughness


KLST Impact



Nanoindentation