SOLSTICE	Name of the PhD candidate: **Inma PEREZ LOPEZ** Title of the PhD thesis: **Multi-tube particulate solar receiver, hydrodynamics, heat transfer and sizing tool** Dates (start/end): 01/11/2016 – 30/09/2020
Supervisors	Gilles Flamant and Françoise Bataille (CNRS – PROMES and UPVD)
Other contributor	Co-funding European project Next-CSP & SOLSTICE

Context and objectives

The use of particle suspensions as heat carrier to transfer solar heat from the receiver to the energy conversion process offers major advantages in comparison with water/steam, thermal fluids or molten salts. Since the particle suspension has a heat capacity similar to that of molten salts without temperature limitation (except for the maximum allowable wall temperature of the receiver tube, suspension temperatures of up to 750°C can be tolerated for refractory steel tubes and even higher when using ceramic or glass tubes), thus offering new opportunities for highly efficient thermodynamic cycles such combined cycles and supercritical steam or CO_2. The feasibility and potential of the fluidized particle-in-tube technology was previously proved in the framework of the "CSP2" European FP7 project. This work is part of the H2020 "Next-CSP" project that aims at developing the technology at the industrial pilot scale including all the component of a commercial solar thermal power plant (solar field, receiver, storage, heat exchanger and gas turbine), as illustrated in Figure 1. The PhD thesis scope focuses on particle flow in the solar receiver.

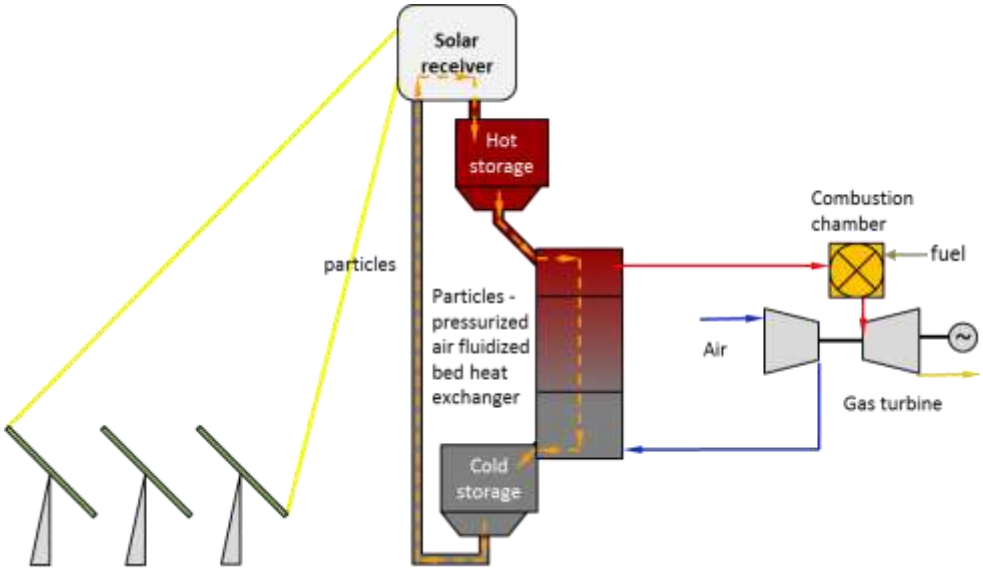

Figure 1. Concept of the Next-CSP project

Approach

The approach includes four main steps

1. Study of particle suspension flow in long (> 3 m) tubes, cold experiment (Figure 2).
2. Heat transfer (and intensification of heat transfer) between solar-heated tubes and fluidized particles up to 900°C.
3. Simplified model of heat transfer.
4. Experimental study of a 4 MWth pilot scale solar receiver.

Figure 2. Drawing of the 3-tube cold experiment devoted to the study of particle flow in long tubes and interaction between tubes.

Main results

The project just started consequently complete experimental data are yet not available. Nevertheless, on-sun experiments with a 1m-long (irradiated) single tube show that particle temperature elevation in the range 150-400°C can be obtained as a function of particle mass flow rate and incident solar irradiation..

Publications in scientific journals (previous work)

Perez Lopez I, Benoit H, Gauthier D, Sans J-L, Guillot E, Mazza G, Flamant G. « On-sun operation of a 150 kW_{th} pilot solar receiver using dense particle suspension as heat transfer fluid" Solar Energy (2016) 137, pp. 463-476; 10.1016/j.solener.2016.08.034.