# Comparison of Simulated and Measured Flux Distributions at the Aperture of the Next-CSP Solar Receiver

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## 1. Introduction

In the framework of the Next-CSP project [1] that aims at demonstrating the fluidized particles-in-tube solar receiver concept at pilot scale, a thorough control of the heat flux distribution on the tubes is crucial in order to avoid the appearance of hot spots likely leading to receiver damage. The control of the heat flux distribution is carried out by an aiming point strategy on the receiver tubes and validated by comparing simulated and experimental flux distribution at the aperture of the solar receiver by using a scanning bar. The following sections describe the aiming point strategy carried out on the receiver tubes. Then the measurement method is explained. Finally, the simulated and experimental solar flux distributions at the receiver aperture plane are compared for a single heliostat focusing at the aperture of the Themis tower.

## 2. Aiming point strategy

Aiming point strategy (APS) is investigated by applying the TABU meta-heuristic method [2] associated with the convolution-projection optical model UNIZAR [3]. The APS is carried out on an aperture plane located on the mid-plane of the tubes. A 3 m x 3 m aperture plane is considered and 25 points are defined.

An objective normalized flux distribution is defined and located at the mid-plane of the tubes, with a limitation in the maximum flux density of 600 kW/m². After reaching the optimized results, taking into account a constraint on the spillage loss, the aiming points are introduced into the ray-tracing software *Solstice* [4] which computes the flux distribution on the receiver tubes, as well as on the plane where the scanning bar travels.

Fig. 1 shows a typical result of the flux distribution on the receiver tubes when the APS is applied.

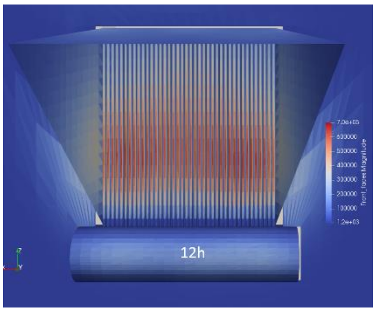



Fig. 1: Flux distribution on the receiver tubes after applying the APS

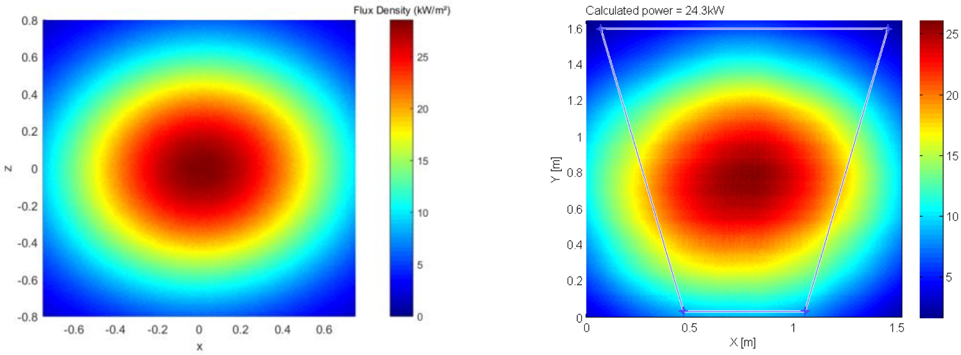
## 3. Measurement of the flux distribution

The flux distribution is measured using the method described by A. Ferriere & al. [5]. It consists in a CMOS camera offering a high picture frame rate (up to 163 fps), a high resolution (1920x1200 pixels) and a high dynamic (16-bit). The camera records pictures of a scanning bar (shown in Fig. 2) that travels from East/West to West/East in front of the aperture of the receiver cavity at a velocity of 2 m/s. The scanning bar has a black stripe on each side to create contrast in the bright pictures. An algorithm using a spatial derivative approach results in the reconstruction of the intensity distribution. Finally, a fast response heat flux sensor installed on this bar calibrates the intensity distribution into a flux distribution.

Fig. 2: Picture of the scanning bar (surrounded in red) installed at the receiver aperture before the installation of the receiver

## 4. Comparison and discussion

Fig. 3 shows the simulated and experimental flux distribution given by a single heliostat at the aperture of the receiver. The slope error is set to 1.7 mrad.




(a) (b)

Fig. 3: (a) Simulated and (b) measured flux distribution at the aperture of the Next-CSP solar receiver with one heliostat

The shape of the heliostat focal spot is very similar between the simulation and the measurement. The higher flux density observed in the simulated flux distribution is likely due to some dust on the heliostat mirrors decreasing their reflectance. Further comparisons with more heliostats will be performed when operating the solar receiver and be presented in the final paper.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