SOLSTICE	Name of the PhD candidate: **Pierre-Henri DEFIEUX** Title of the PhD thesis: **Hybrid optical method for characterizing a heliostat field in a concentrated solar power plant.** Dates (start/end): 29/09/2017 – 28/09/2020
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Other contributor	Co-funding European project Next-CSP & SOLSTICE

Context and objectives

The efficiency of a concentrated solar power plant depends on the capacity of his reflective surfaces to focus the sun light on a receiver. This property must be checked regularly during the plant operation and, if possible, without stopping the operation. Achieving this objective is possible by developing a method of characterization of mirror canting. The backward-gazing method with four cameras, patented in 2015, was proposed. The paper Ref [1] provides the description of the method. It allows determining the mirrors that must be adjusted and their curvature. This results in optimizing the concentration and the homogeneity of the focal spot on the receiver. The method is non intrusive and is adapted to solar power plant in operation. It requires five cameras including one for the sun characterization (Fig. 1). The images' treatment is necessary to retrieve the slopes of the mirrors shape errors. The objective of this thesis is to optimize the method and combine it with fluxmetry on white diffuse target.

Approach

The sun backward gazing method with multiple cameras for characterizing solar concentrators includes a $2N\times2M$ matrix of cameras (with N and M natural numbers greater than or equal to 1). Using more than four cameras particularly allows capturing higher shape errors, by covering a bigger surface in the image frame (Fig. 1).

Main results

A measurement campaign was carried out in November 2017 at the THEMIS solar tour, in Targasonne. These acquisitions are used for the optimization of the data treatment. The heliostat E06 was chosen for experiments and set in Sun-tracking mode. Measurements were done without voluntary mechanical defects entered, then with the defects. The comparison of these two acquisitions allows to estimate the entered defects on mirrors shape by the backward-gazing method. The slopes errors of the heliostat shape are retrieved from the data treatment. The absolute value of the entered defects is 0,92 mrad. By considering errors of the order of one milliradian, the simulations showed that the method can theoretically reconstruct heliostat shape errors at 200 meters, with an accuracy of 0,1 mrad. With the present experiment the defects retrieved by the backward gazing method were lower than expected of about 20-30%. The quality and the accuracy of results can be improved by optimizing the acquisition device. The data treatment must be enhanced to extract the slopes more accurately.

The backward-gazing method with four cameras is under optimization. The hardware and the data treatment must be improved to increase the results' accuracy and reliability. The method is adapted to low shape defects of heliostats and will be complemented with a fluxmetry method on scattering target. The hybrid method will be able to measure a large shape defects range.

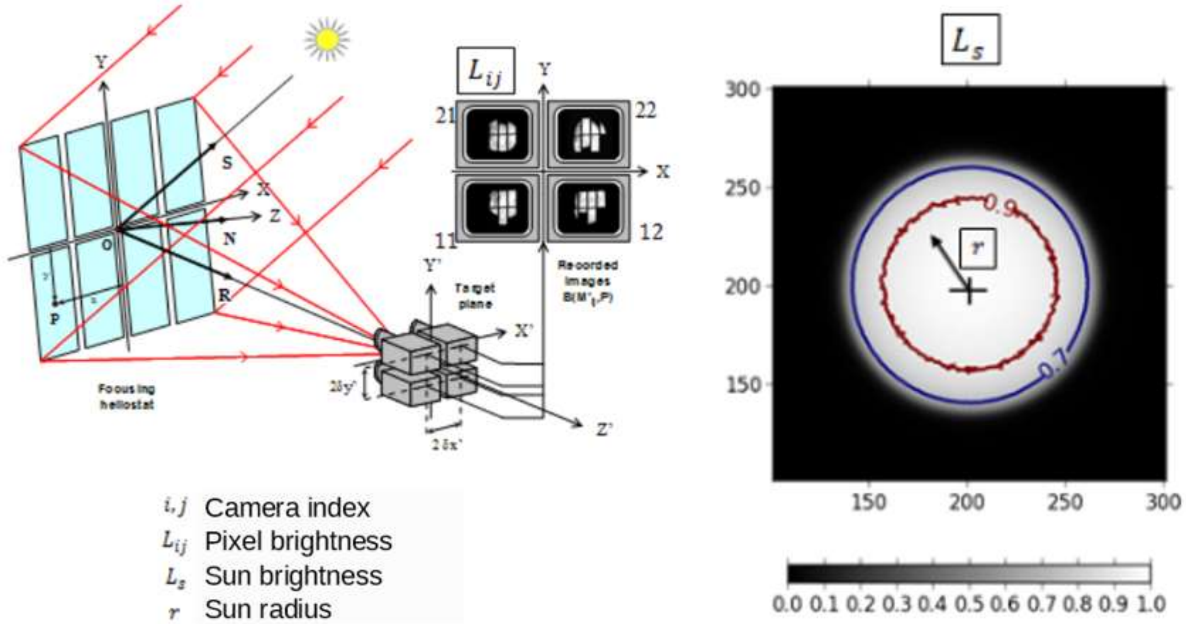

Figure 1: Backward-gazing method principle (left) and Sun characterization by the fifth camera (right).

References

[1] Coquand M, Henault F, Caliot C. "Backward-gazing method for measuring solar concentrator shape errors". Applied Optics, 2017, vol 56(7), pp 2029-2037