

Heliostat Soiling Rate Study under Realistic Tracking Conditions

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Introduction:

The soiling of solar mirrors has been an important focus of research during the last years due to its potential impact on the optical efficiency of Concentrating Solar Thermal (CST) Technology projects. **Soiling reduces the reflectance** of the mirrors and thus **lowering the overall yield** and introducing important O&M costs due to cleaning. A variety of parameters influences the severity of the problem, such as site characteristics, mirror materials, position of facet surfaces, etc. The here presented campaign focuses of the **influence of the night time stow position** of heliostats on the soiling rate.

Figure 1: CESA1 heliostat at Ciemat-PSA, Tabernas, Spain, after cleaning lower facets, evaluated facets marked in red



Campaign setup:

- 6 week campaign (Spring 2023), 2 heliostats of the CESA1 solar field at the Ciemat - Plataforma Solar de Almería (PSA)
- Tracking from sunrise to sunset (analog to operation in commercial plants)
- Night time stow horizontally, one heliostat facing the mirror front side upwards (labelled 6H20) and the other downward (labelled 6H18)
- Commercial state-of-the-art 4-mm silvered-glass mirrors
- Every 2 weeks, the mirror facets were washed (using a brush and demineralized water)
- Monochromatic near-specular reflectance measurements D&S 15R-USB handheld reflectometer $\rho_{\lambda,\phi}(660nm;15^\circ;12.5mrad)$ before and after cleaning
- 20 measurements per facet, average value taken as the facet reflectance
- 4 facets per heliostats were measured at 2 heights to evaluate influence of soiling, see Figure 1 above

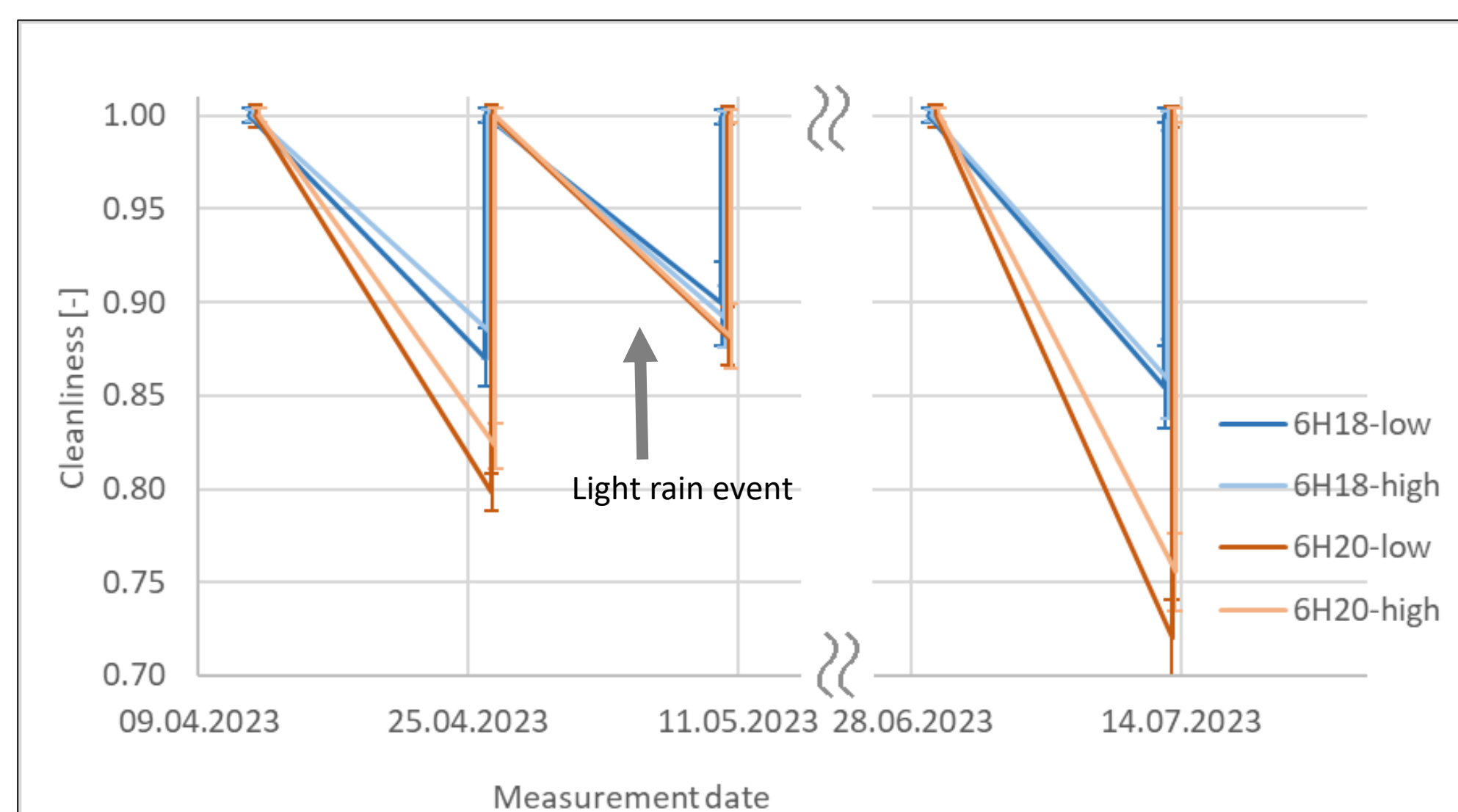


Figure 2: Cleanliness (with standard deviation) of heliostat facets over time

	Face up	Face down
Minimum cleanliness [-]	0.738	0.857
Mean soiling rate [pp/day]	1.6	0.9

Table 1: Cleanliness and soiling rates during measurement campaign

Results:

- Light rain occurrence during second half of first month, 2 weeks added to evaluate dry conditions
- Initial reflectance of the facets was 0.937
- Cleanliness over time in Figure 2. Soiling reduces cleanliness (stronger for the up-facing heliostat) and is restored by washing
- Minimum cleanliness for the up-facing heliostat considerably lower than down-facing one (0.738 compared to 0.857)
- Mean soiling rates are 1.6 and 0.9 pp/day for face-up and -down, respectively
- Results in an **average difference (up-down) in cleanliness of 0.093**
- Precipitation event showed that light rain during daytime led to similar soiling patterns (see Figure 3) on both heliostats, resulting in a considerably smaller difference in cleanliness (0.014)
- Smaller differences in soiling behavior detected due to height above ground. Soiling is stronger closer to the ground with average **differences between the 2 measured heights of 0.020**

Conclusion and Outlook:

- Strong influence of night time stow position on soiling behavior (**10.7 % stronger soiling for face up stow**)
- Stronger soiling closer to the ground

Future work:

- Evaluate long term campaign for a whole year of measurements
- Study overall benefits of including face-down stow capabilities in heliostat design



Figure 3: Soiling pattern on one facet after light rain