Institute of Solar Research

OptiRec - 2nd generation sun simulator for the characterization of optical efficiency of parabolic trough receivers

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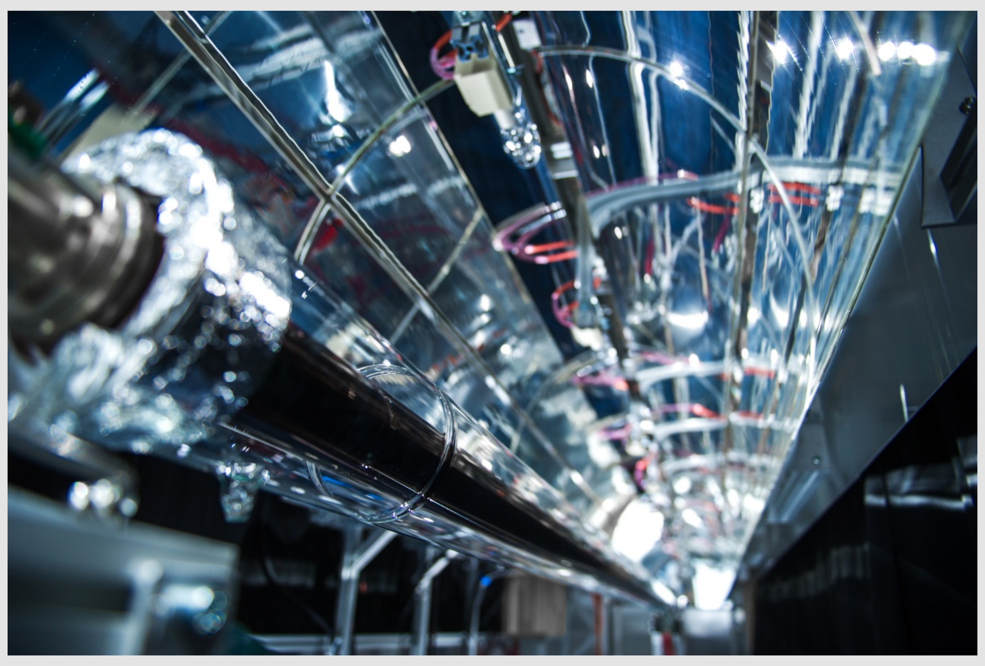

Fig. 1: Test receiver mounted in the OptiRec test bench

Calorimetric performance measurements in sun simulators are an established method to determine the optical efficiency of parabolic trough receivers, an important performance parameter of this parabolic trough key component. To this end, a second generation linear sun simulator, the OptiRec test bench, has been developed at DLR's QUARZ Center. It is optimized for high accuracy, high repeatability as well as reduction of required testing time, improved operation and long-term stability.

The test bench consists of a mirrored elliptical trough with flat end mirrors concentrating the radiation of 6 metal-halide lamps with a total power of 15 kWe on a parabolic trough receiver. The absorbed power of the receiver is determined calorimetrically by measuring mass flow rate and the enthalpy increase of water pumped through the receiver at room temperature. The ratio of the power absorbed by a sample receiver to that of a reference receiver yields the relative optical efficiency of the sample receiver.

Major improvements in the OptiRec test bench compared to the predecessor are:

- the use of glass mirrors instead of aluminum mirrors which reproduce spectral parabolic trough conditions well and therefore increase the significance of measurement results
- the implementation of two receiver measurement positions enable to monitor lamp stability with a reference receiver and allow the exchange of receivers during lamp operation
- the water circuit itself, providing highly stable mass flow rate and water inlet temperature in the receiver and a reduction of the displacement body's heat capacity in order to accelerate steady state and therefore measurement frequency
- the optimization of the assembly process for high repeatability as well as fast receiver exchange.

These measures reduce the duration of a single measurement in the OptiRec test bench by a factor of 4 compared to the ElliRec test bench and thus enable repetitions of sample measurements in order to increase repeatability.

The repeatability of the OptiRec test bench was characterized by a measurement series conducted over 5 testing days. In conformity with the ElliRec measurement method, the absorbed power of a receiver was measured repeatedly in receiver position A, including reassembly.

A reference receiver was measured in receiver position B without reassembly. Figure 2 shows the results of the test series. For receiver position A, the repeatability is **0.13%**, which is distinctively lower than the analogously measured repeatability of approximately 0.2% in the ElliRec test bench.

For receiver position B, repeatability is 0.10%. The deviation between both series quantifies the influence of reassembly. Thus, further optimization of the assembly process is not considered necessary.

With the OptiRec Test bench, the optical efficiency of parabolic trough receivers can be determined faster, with a higher repeatability and lower effort than it was already possible in the ElliRec test bench. Measurement results of both test benches will be compared in a round robin campaign.

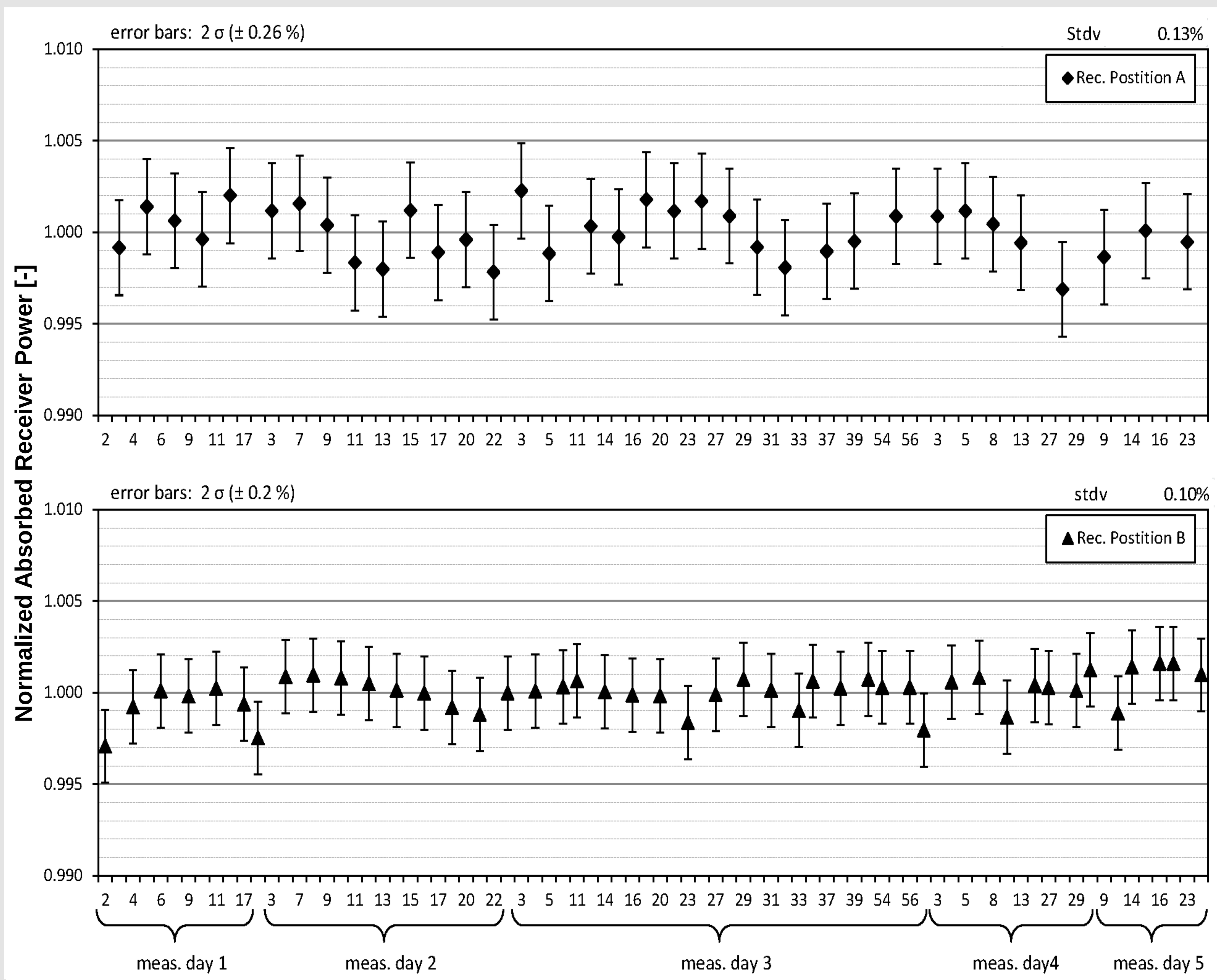

Fig. 2: Repeatability testing series of the OptiRec test bench; receiver position A: reassembly included, receiver position B: without reassembly

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Supported by:
Federal Ministry for Economic Affairs and Energy
on the basis of a decision by the German Bundestag

Deutsches Zentrum für Luft- und Raumfahrt