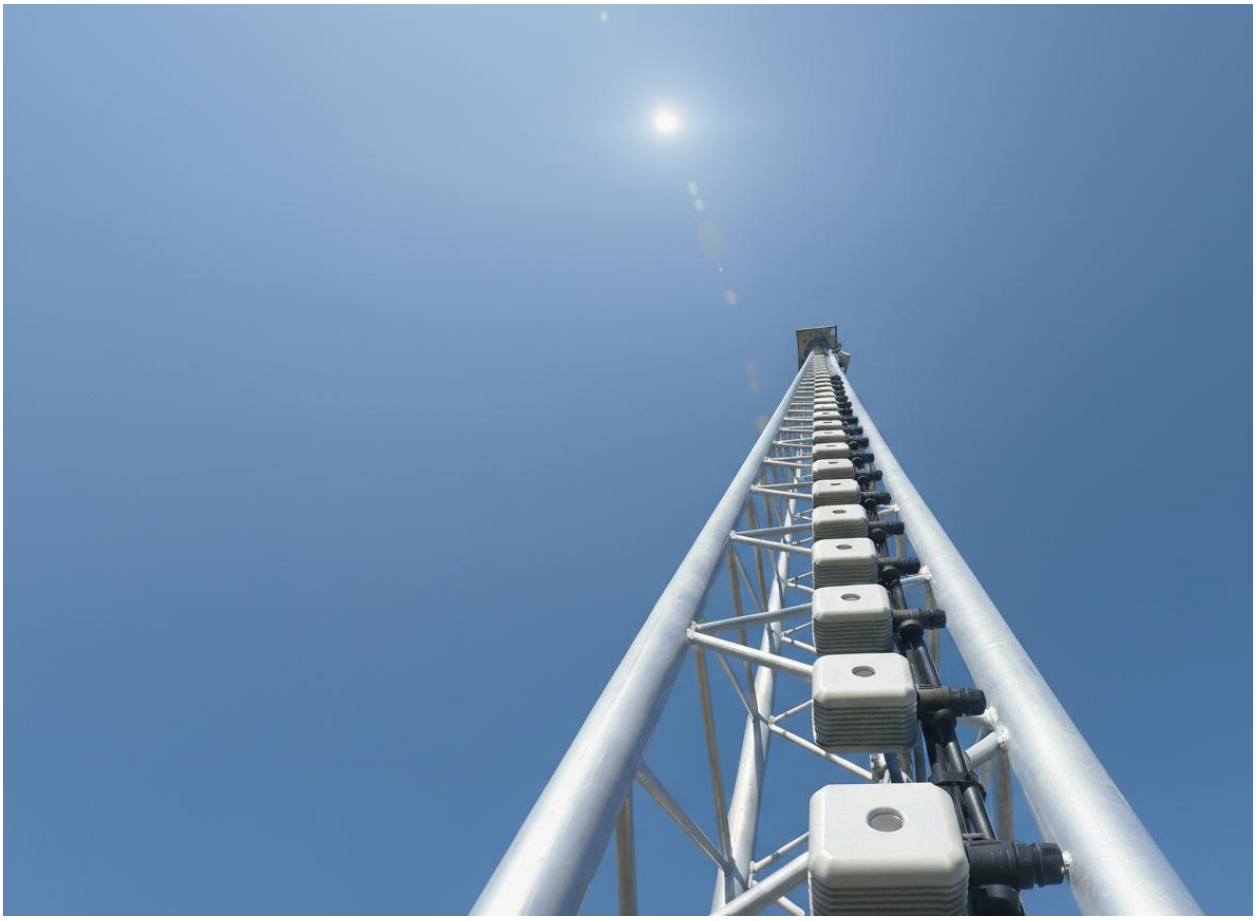
Helioschar+

Advanced Heliostat Optical Characterization System

Technology Transfer and Licensing Opportunity for China



Prepared for discussions with potential industrial partners in China. The proposed route is technology transfer and patent/know-how licensing to a local partner that can complete industrialization and commercial exploitation; it is not positioned as a long-term service model delivered by CENER in China.

Executive summary

Helioschar+ is an advanced measurement system for the optical and geometrical characterization of heliostats in solar tower plants. It was developed to overcome the practical limitations of the conventional target-camera method, especially for distant heliostats, small heliostats, low-flux beams or large reflected spots that exceed the size of the Lambertian target.

The system combines vertically distributed optoelectronic light detectors and cameras. The heliostat remains static while the apparent motion of the sun sweeps the reflected beam through the detector array. Detector signals and camera images are processed to reconstruct the beam shape, optical quality and surface/slope deviation of the heliostat with high fidelity.

For China, the proposed commercialization route is technology transfer and licensing to an industrial partner able to complete product adaptation, industrialization, manufacturing and local commercial exploitation. CENER is not seeking to provide characterization services in China.

Technology type	Patented heliostat characterization system for solar tower plants
Core measurement principle	Direct scanning of reflected beam using optoelectronic detectors and cameras
Target maturity	Validated advanced prototype / demonstrator; further industrialization required
Commercialization route	Patent/know-how licensing and technology transfer to a Chinese partner
Strategic China fit	Quality assurance, commissioning and performance optimization in large tower heliostat fields

Why heliostat characterization matters

In a solar tower plant, the solar field is one of the most critical and capital-intensive subsystems. Plant performance and receiver integrity depend on the ability of each heliostat to concentrate and direct solar radiation according to the required aiming strategy. Heliostat quality is not a single parameter: it combines beam quality, surface slope errors, facet canting, alignment and pointing/tracking performance.

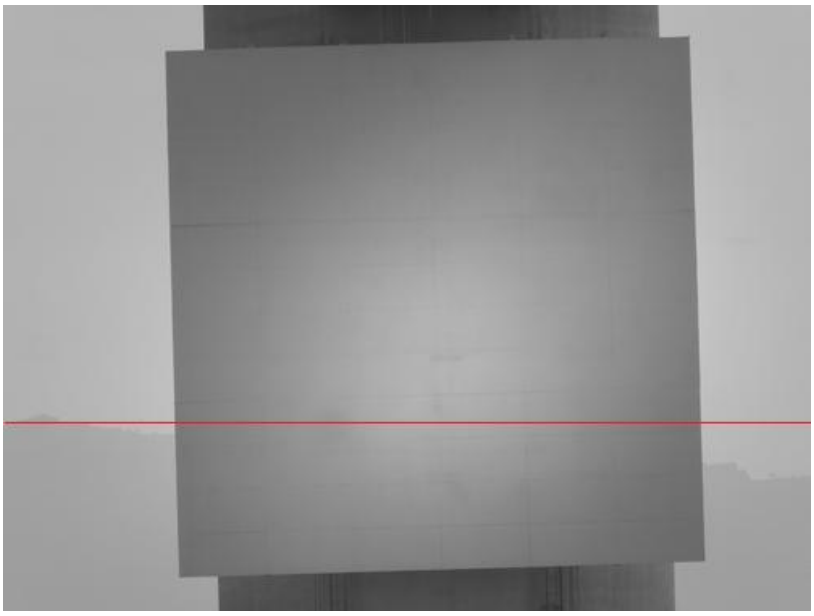
- Poorly characterized heliostats increase uncertainty in the real flux delivered to the receiver.
- Unknown optical quality forces operators to use conservative aiming strategies, reducing plant output.
- Receiver damage risk increases when local flux peaks are not well understood.
- Commissioning and quality assurance become more complex as fields grow larger and heliostats are located farther from the tower.

Prototype/device concept images for Helioschar+ detector units.

Limitations of the target-camera method

The conventional method projects each heliostat beam onto a Lambertian target and observes it with a camera. This method is useful in R&D centres and small fields, but it becomes less reliable in commercial-scale fields. Non-linear camera response, limited dynamic range, lens distortions, non-uniform target reflectance, dirt, edge effects and target degradation add uncertainty. For distant or small heliostats the reflected beam may have low flux density, poor contrast and a spot size that exceeds the target.

- Target-camera measurements may contain high noise caused by the target and camera chain.
- The flux shape often needs smoothing, background removal and partial reconstruction, which can reduce fidelity to the real beam.
- The method is barely parallelizable and therefore difficult to scale to large fields.
- At long distances, the reflected beam may overflow the target and become unsuitable for accurate characterization.

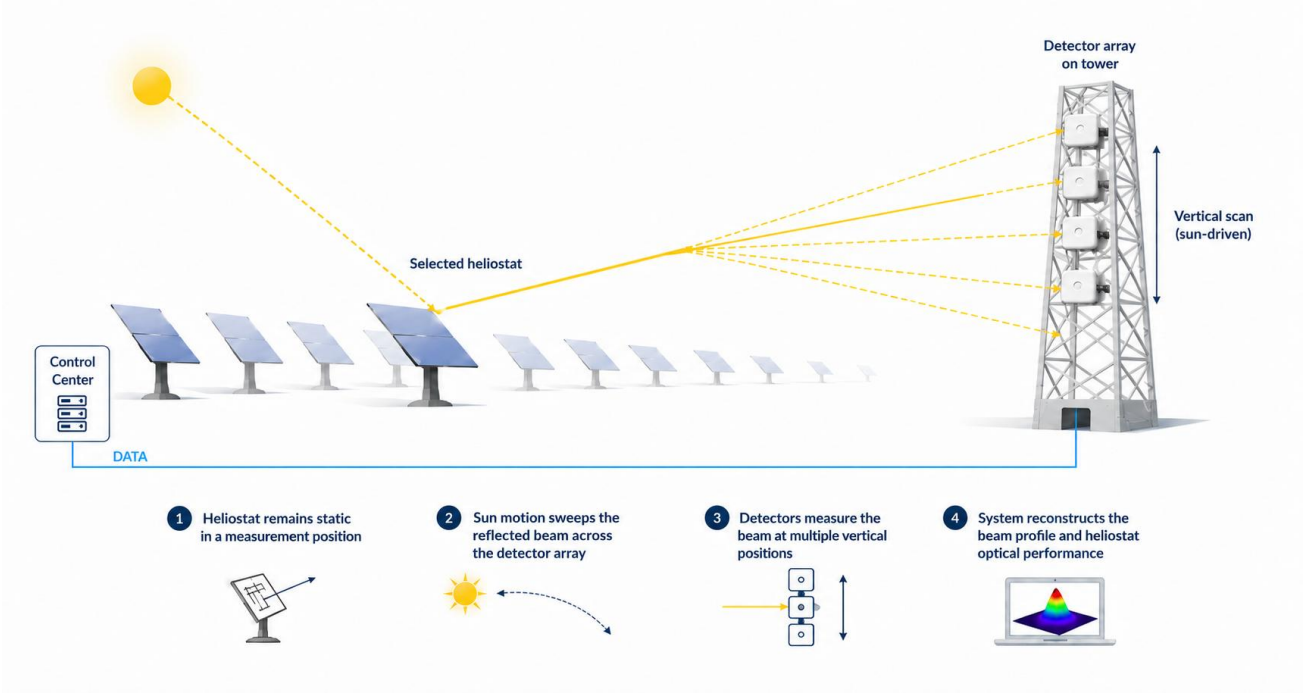


Example of target-camera image quality issues: non-uniform target, processing and partial reconstruction.

The Helioschar+ solution

Helioschar+ replaces the indirect target-camera dependency with direct optoelectronic scanning. An array of incident-radiation detectors measures the reflected beam with adaptive electronics and automatic variable gain. Embedded optical lenses increase useful signal and reduce the influence of background light. Cameras placed next to the detectors provide complementary images of the heliostat, enabling reconstruction of surface normal vectors and optical-geometrical characterization.

The measurement is scanner-based: the heliostat is fixed in a chosen position, and the sun acts as the driving mechanism. As the sun moves, the reflected spot sweeps across the detector array. The system captures and normalizes detector signals and camera images to reconstruct the beam and infer optical quality parameters.



Simplified Helioschar+ measurement principle: the sun sweeps the reflected spot through the detector array while the heliostat remains static.

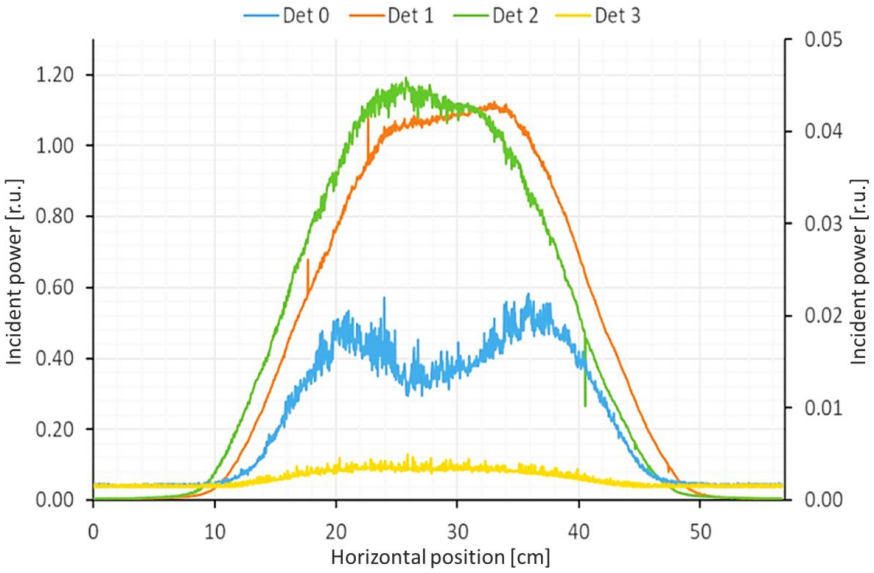
Capability	Benefit
Universal applicability	Designed for different heliostat sizes, positions and distances within the field.
High sensitivity	Detector-based measurement reduces noise and improves signal-to-noise ratio.
Parallel potential	Several systems can be installed to characterize multiple heliostats or field sectors.
Advanced characterization	Supports reflected beam characterization and surface/slope deviation analysis.
Low plant intrusion	Portable and easy to integrate in new or existing solar tower plants.

Validation and development status

Available materials report successful validation activities and advanced development. Earlier validation used CENER heliostat testing facilities at Tudela with a 9 m², nine-facet heliostat approximately 200 m away. Detector signals were corrected for DNI variability, sun movement and cosine effects, and results showed higher sensitivity, lower noise and smoother, more reliable flux shapes than target-camera measurements.

The internal development documentation states that the system achieved the precision KPI for optical-geometrical characterization, with a target below 0.1 mrad. It also records several demonstration routes and projects, including LEIA, Chloe, Cation and Sun-DT, with potential industrial users/advisors such as ACCIONA, COX and ACWA involved in related activities. The technology is available for technology transfer and licensing to an industrial partner capable of completing product adaptation, industrialization and commercial deployment in the Chinese market.

Item	Status
Precision KPI	<0.1 mrad optical-geometrical characterization target reported as achieved
Demonstrators	Demonstration activities secured through multiple projects
Commercial status	Patented technology available for technology transfer and licensing in China.
Remaining step	Industrial partner required for final product engineering and market exploitation



Example comparison showing detector-based characterization versus target-camera limitations.

Intellectual property and licensing opportunity

The technology is protected by patent rights. Available asset documentation identifies the international patent reference WO/2020/021147 for Helioschar+. For China, the relevant national publication is CN112442253A, also identified as CN112442253B after grant in some records. The Chinese title is 根据反射的光束表征反射元件的方法, translated as “Method for the characterization of reflective elements from their reflected light beams”. The publication date in China is 2 March 2021, and the applicant/assignee is Fundación CENER (National Renewable Energy Centre). The appropriate commercial proposition for China is licensing and transfer of the current technology package, including know-how and technical documentation, to a qualified industrial partner able to complete product adaptation, industrialization and commercial exploitation.

The ideal partner would have capability in one or more of the following areas: solar tower EPC or developer activity, heliostat design/manufacturing, optical instrumentation, solar field control and diagnostics, local manufacturing, integration in utility-scale CSP plants, and access to Chinese CSP developers/operators.

- Complete industrial design and product adaptation for Chinese plant requirements.
- Manufacture or subcontract manufacturing locally.
- Integrate the system into Chinese solar tower plants, test facilities or heliostat supply chains.
- Exploit the technology commercially in China and potentially other agreed markets.
- Work with CENER during a defined technology-transfer phase.

Conclusion

Helioschar+ addresses a key bottleneck for the next generation of large solar tower plants: knowing the real optical quality of heliostats at scale. Its detector-and-camera approach can provide more robust and detailed characterization than conventional target-camera techniques, particularly for distant, low-intensity or large-beam heliostats. For a Chinese industrial partner, it offers access to a protected European technology that can be industrialized locally for quality assurance, commissioning and performance improvement of large heliostat fields.