



Concentrated Solar Flux Measurements Based on Optical Fibers and Multiple Photodetectors

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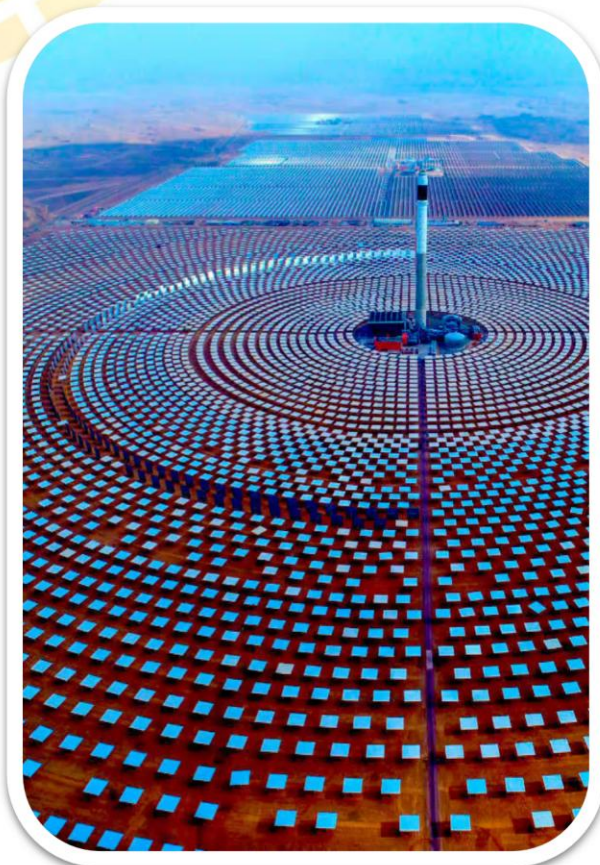


CONCLUSIONS

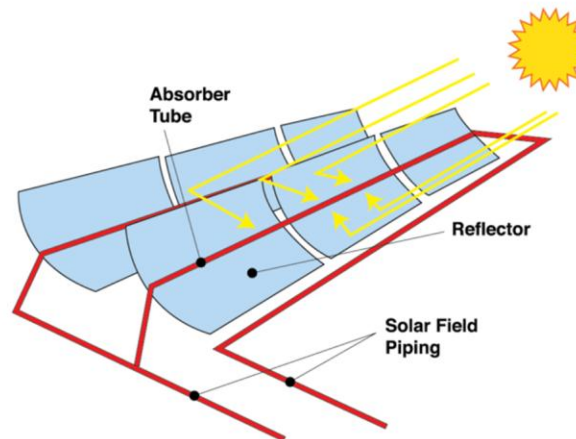
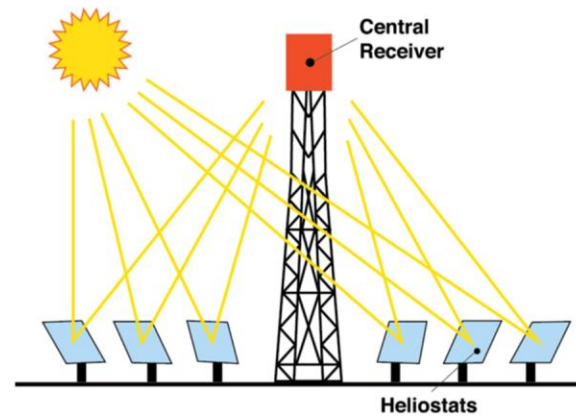


INTRODUCTION

CSP Status



Ouarzazate, Morocco, 2018



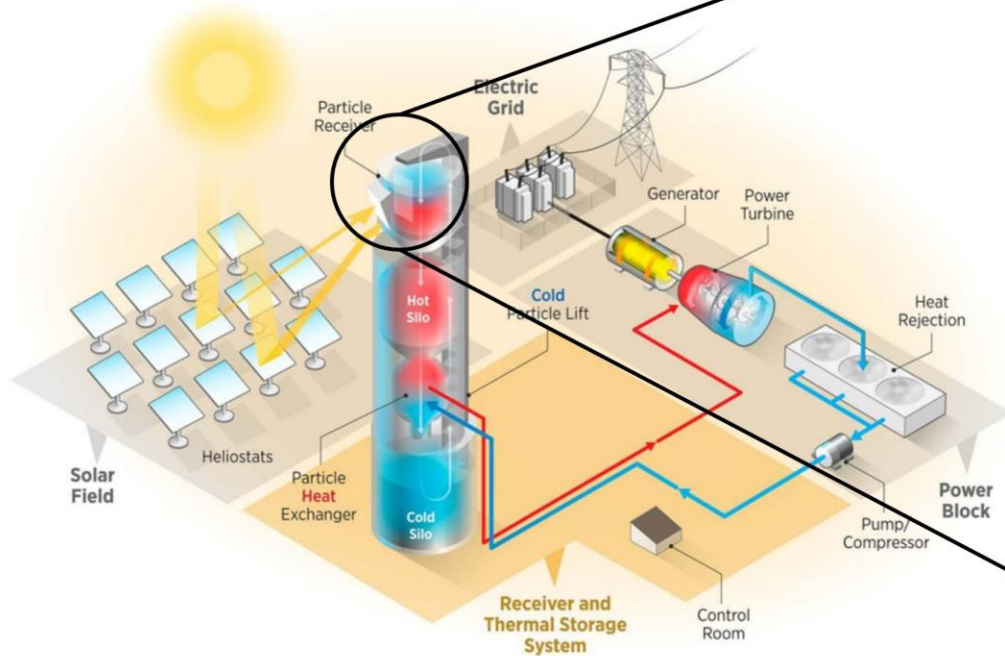
Thermal storage

Up to 7GW worldwide

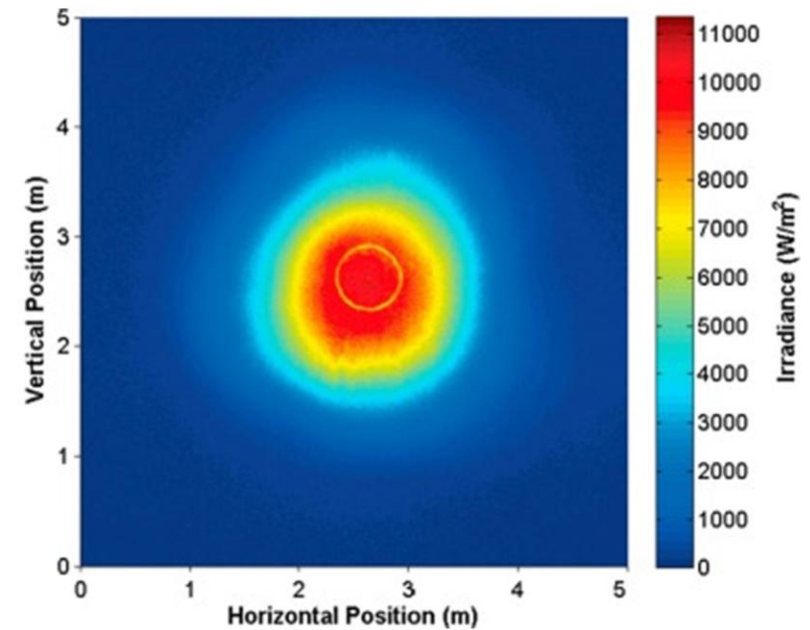
\$8.1B Market Size (2024)

Grand View Research (GRV)

CSP Efficiency Criticality



Concentrated Solar Flux Distribution (1)



Key Magnitude

1 Review of the solar flux distribution in concentrated solar power: Non-uniform features, challenges, and solutions. Ya-Ling He et. al.

5

Concentrated Flux Measurement Benefits



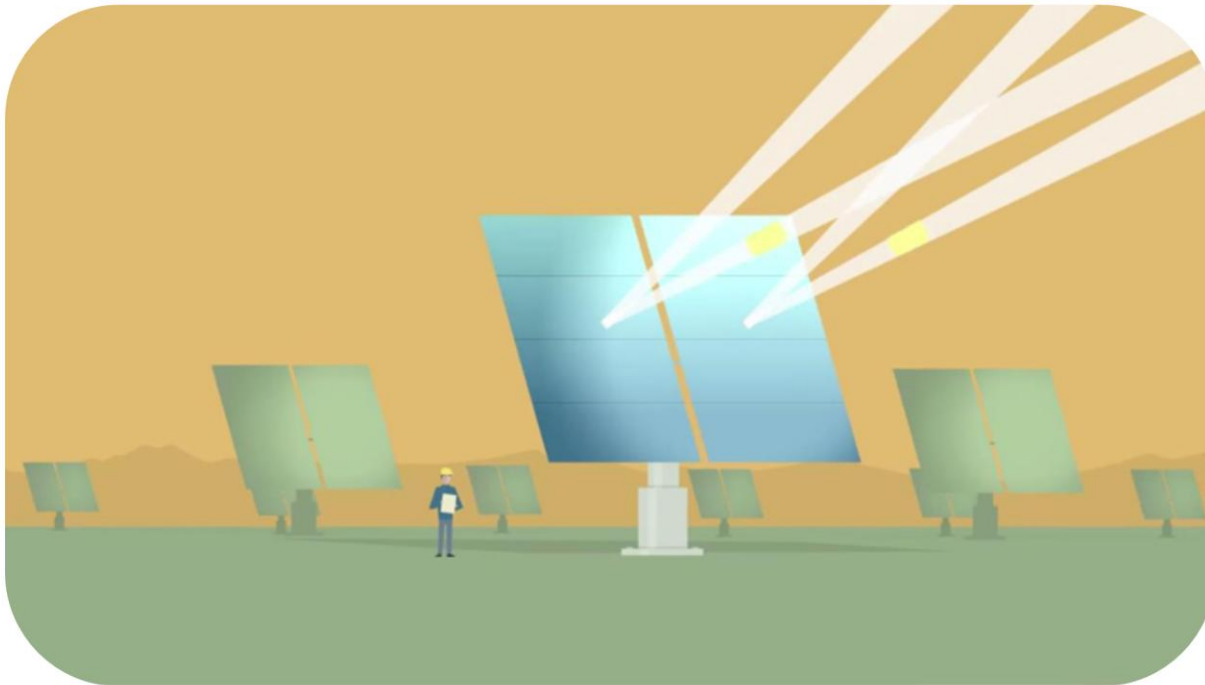
Heliostats deviations and flaws



Obstacles and atmospheric events



Dangerous gradients and peaks

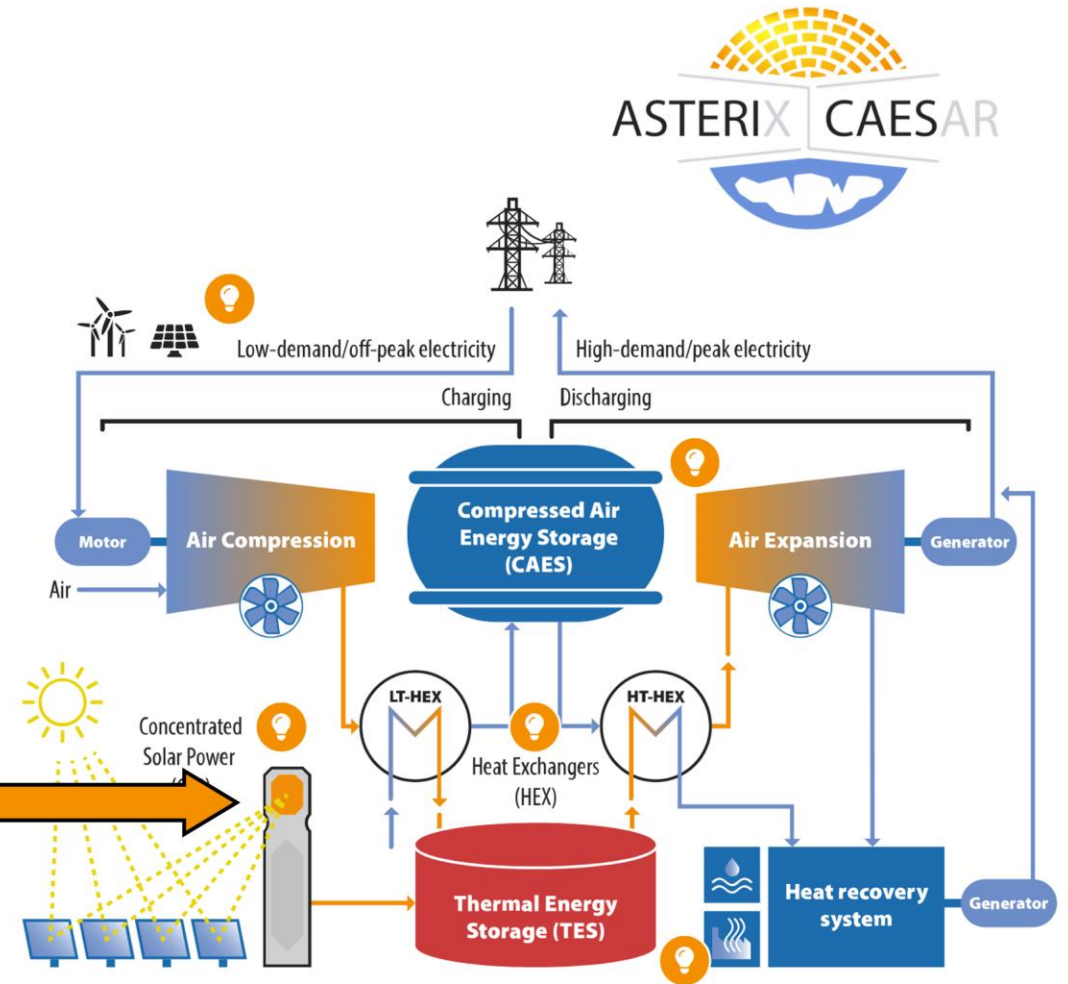


The ASTERix-CAESar Project

Hybrid CSP – CAES configuration

Concentrated solar flux measurement

Up to 1.5 MW/m^2



Conventional Thermoelectric Technology

Concentrated Solar Flux

- ❌ EMI Immunity
- ❌ Scalability
- ❌ High Spatial Resolution
- ❌ Passive Device



Gardon Radiometer

Optical Technologies



CSP specific advantages

Spatial decoupling

Light is captured and guided towards a safe space for measurement
Radiation does not affect the measurement components.

Spatial efficiency

Optical guided components such as optical fibers have 2mm diameter

Passive components and EMI Immunity

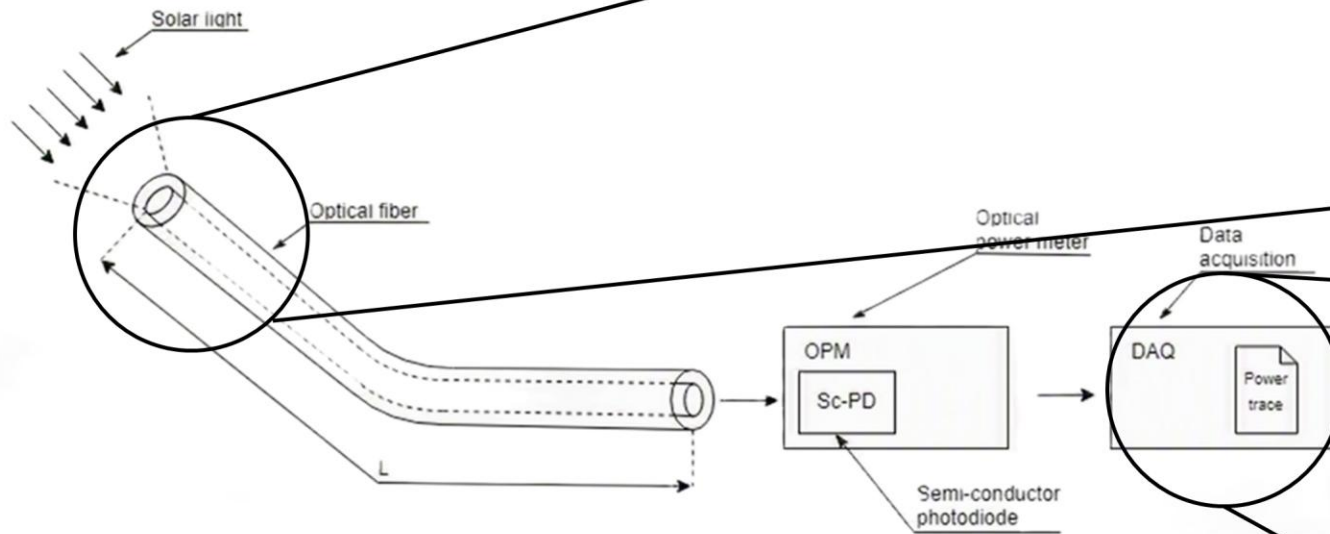
Only fiber cable is needed: Easier assembly and maintenance



SYSTEM DESCRIPTION

Concentrated Solar Flux Measurement

Objective: 1.5 MW/m²



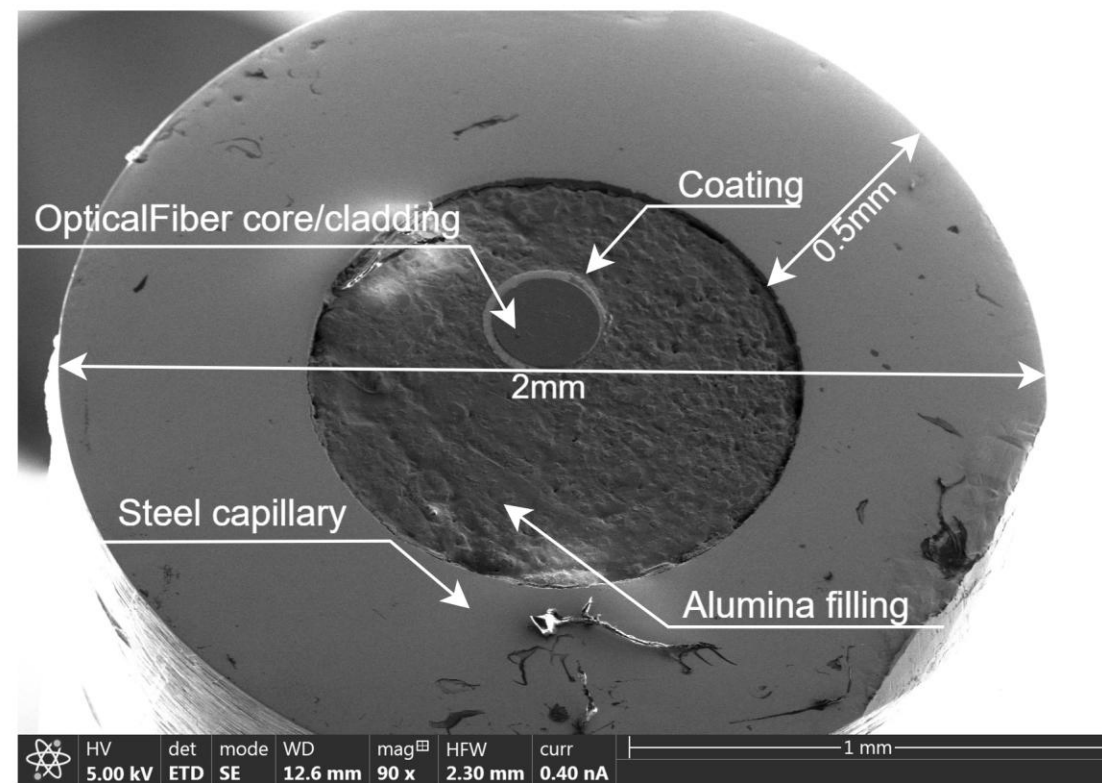
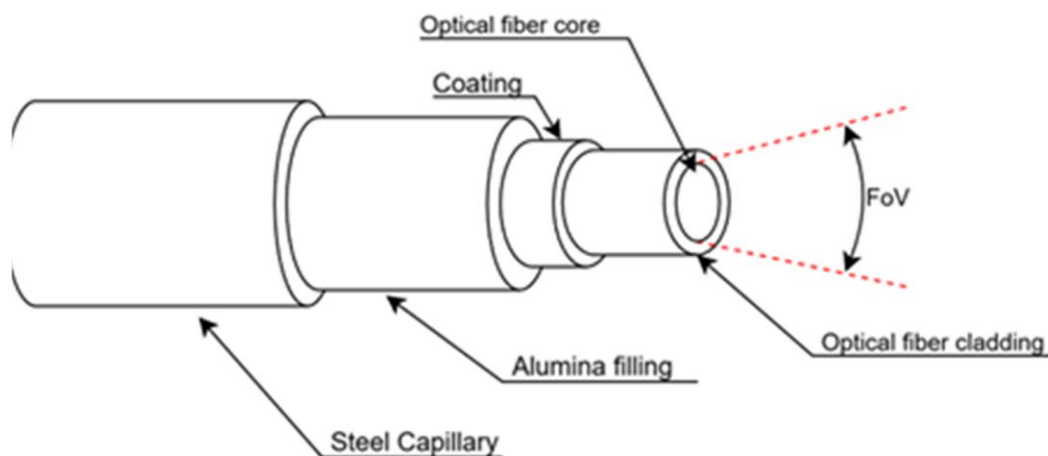
Concentrated Solar Flux Measurement – Optical Fiber

Objective: 1.5 MW/m²

Special designs for CSP purposes

Stable operation up to 700 °C

Gold/polyimide coating



Concentrated Solar Flux Measurement – Photodetectors

Objective: 1.5 MW/m²

Integrating Sphere Photodiode



- S140C
- Power Sensor Head with Silicon Detector

Thermal Power Sensor



- S401C
- Surface Absorber with Background Compensation



RESULTS

Testing Campaign

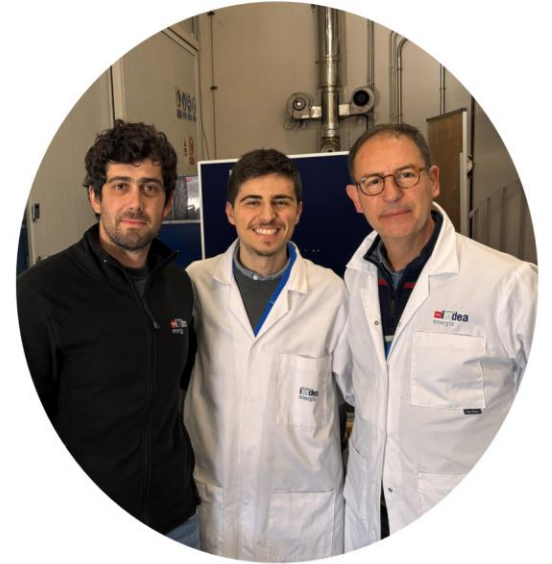
Móstoles, Spain (2026-02-23 to 2026-02-27)



KIRAN-42, 7
Xenon arc lamps

Up to 3 MW/m²
flux

Temperatures
higher than 1000 °C



Relevant Results

Concentrated Flux Measurement – S401C (Photodiode)

Gardon: 312 kW/m²

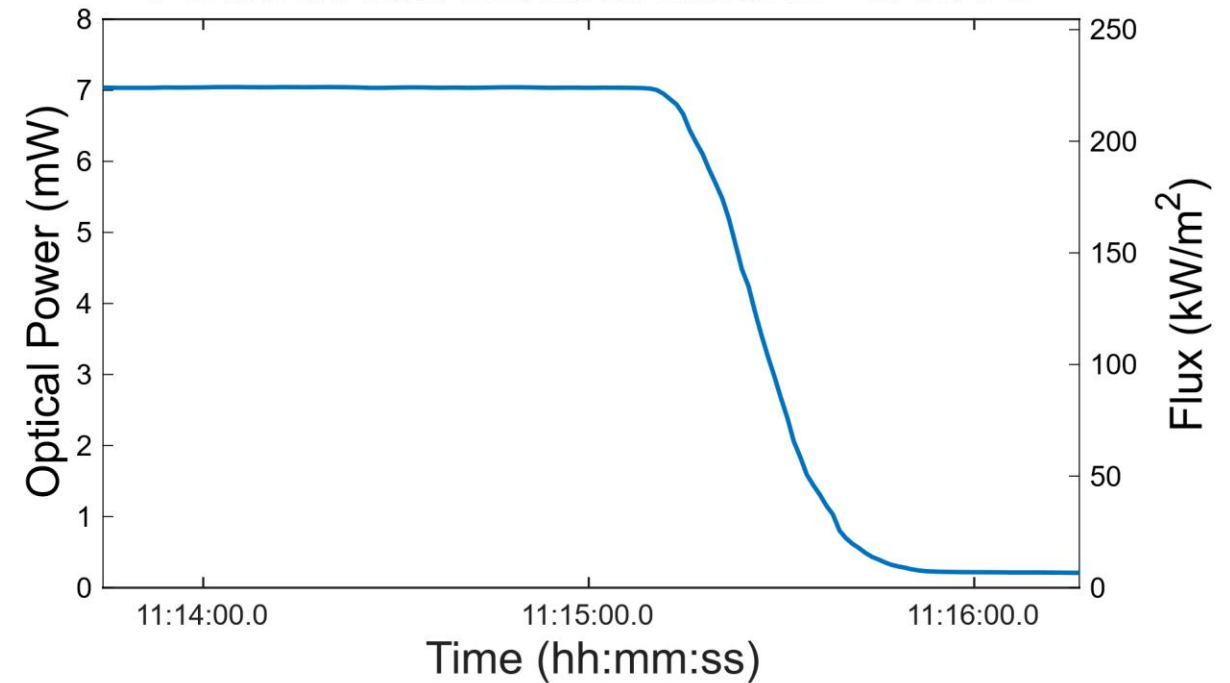
Fiber: 222,8 kW/m²

Direct incidence

Slow response

Low sensitivity

Power/Flux Measurement - S401C



Relevant Results

Concentrated Flux Measurement – S140C (Thermal)

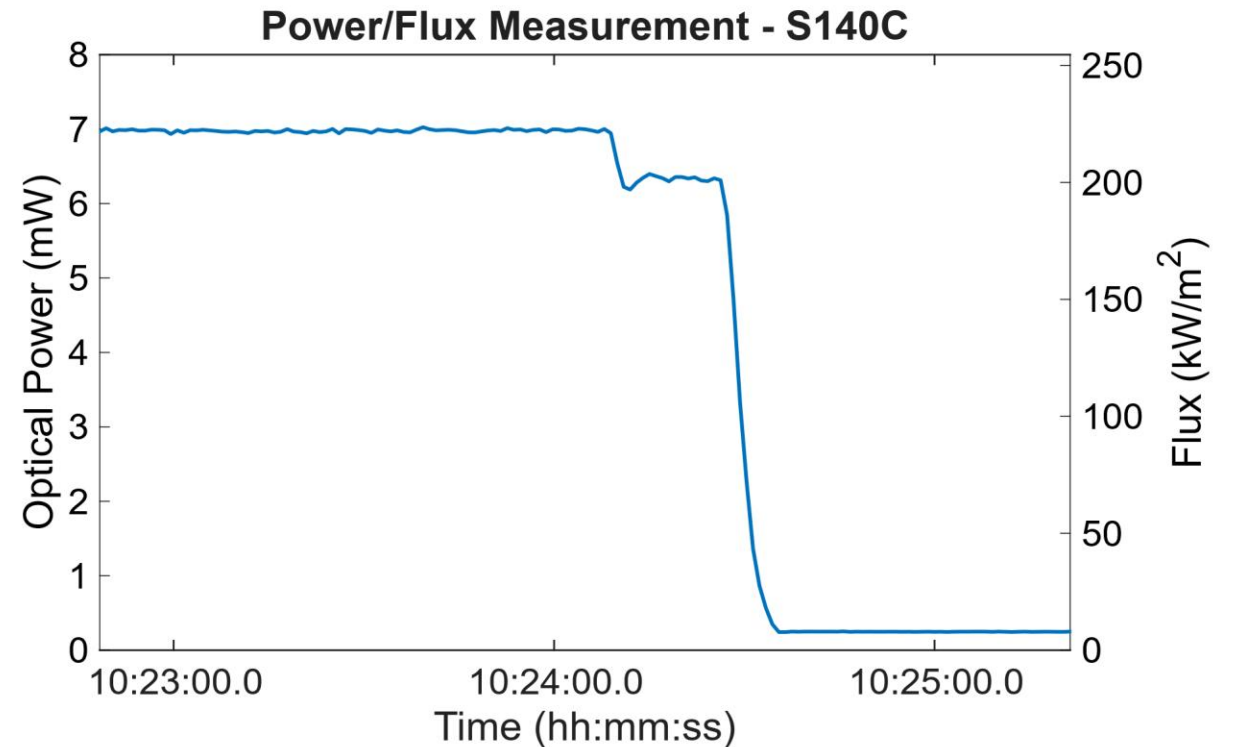
Gardon: 312 kW/m²

Fiber: 222,8 kW/m²

Direct incidence

Fast response

High sensitivity



Relevant Results

Concentrated Flux Measurement

Gardon: 357 kW/m²

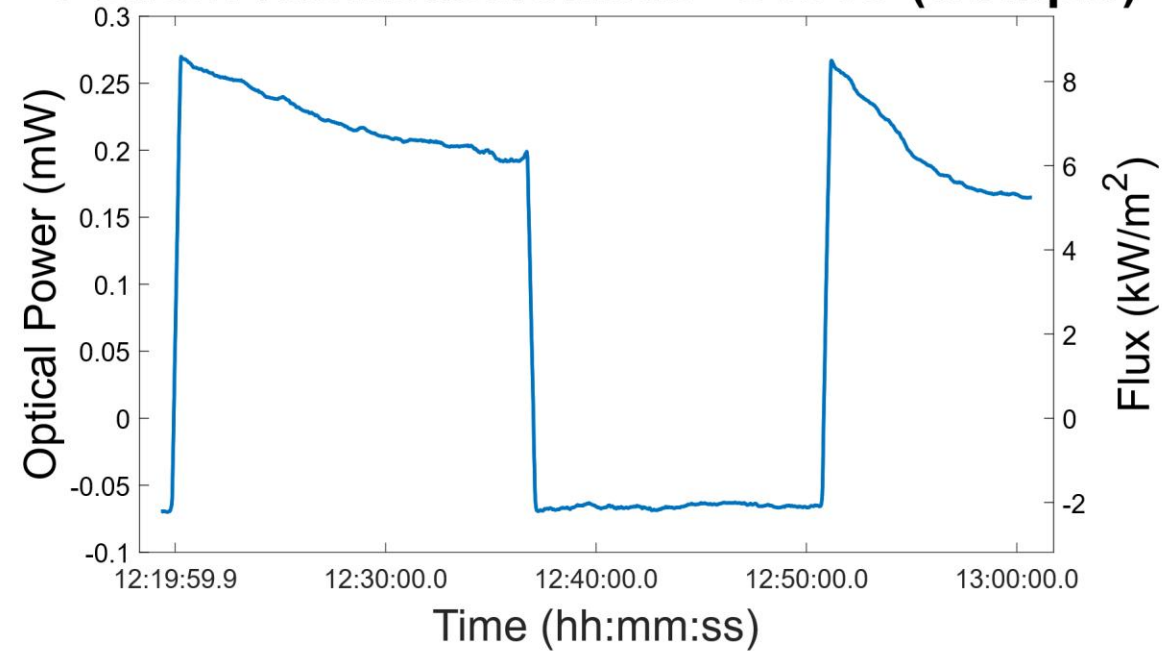
Fiber: 8,9 kW/m²

Oblique incidence

2.4% light captured

Degradation and lack of FOV

Power/Flux Measurement - S401C (Oblique)





CONCLUSIONS

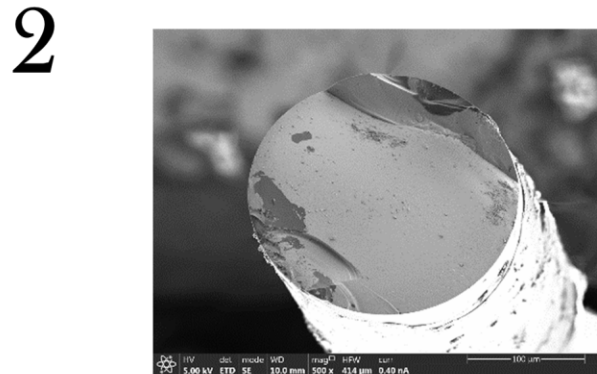
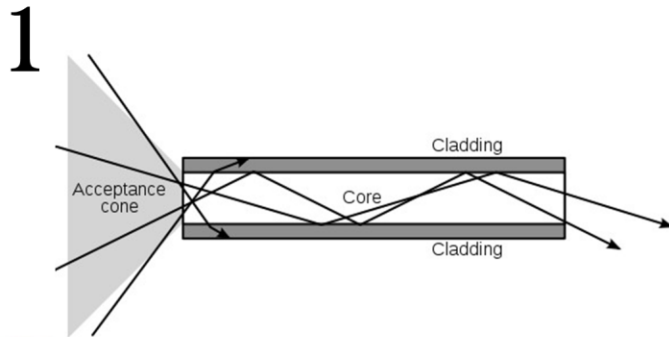
Conclusions – Concentrated Solar Flux

Measuring concentrated solar flux with optical fibers is feasible

Practical, easy configuration and installation

Repetitive measurements, consistency

Three main issues were identified. Future Challenges

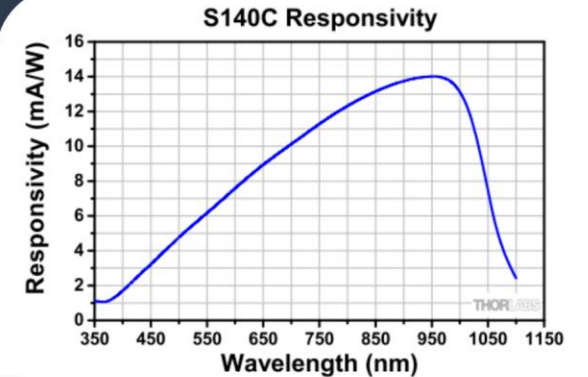


Conclusions: Photodetectors

Photodiodes

Higher Sensitivity and Faster Time Response

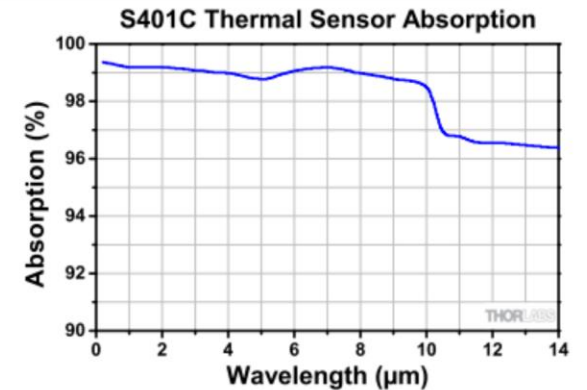
Limited Spectral Bandwidth – Calibration Factor



Thermal Sensors

Lower Sensitivity and Slower Time Response

Full Spectral Bandwidth – No Calibration Factor



Conclusions: Current and future work

New designs for PSA assembly

High-temperature optical fibers

Water-cooling

Use of reinforcements

Enhance FoV

Reduce angle dependence

Protection window and temperature mitigation





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Thank you!



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Views and opinions expressed are those of the authors only and do not necessarily reflect those of the European Union, UKRI, or SERI. Neither the European Union nor the other granting authorities can be held responsible for them.



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