



High-Temperature Distributed Measurements Based on Femtosecond Fiber Bragg Gratings

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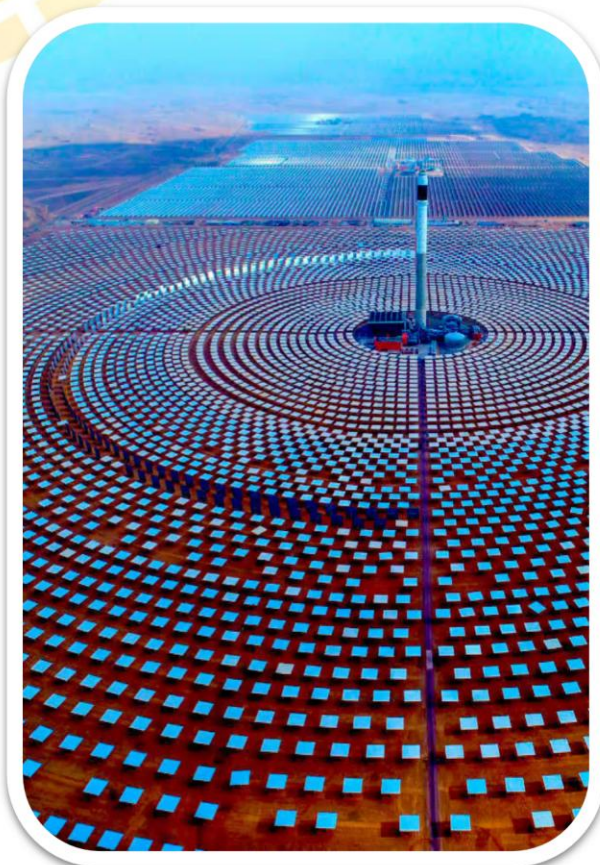


CONCLUSIONS

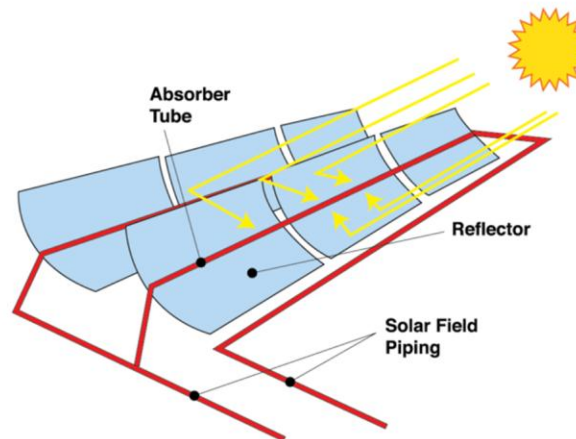
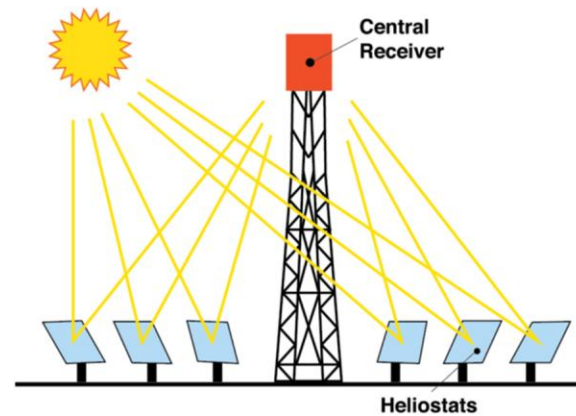


INTRODUCTION

CSP Status



Ouarzazate, Morocco, 2018



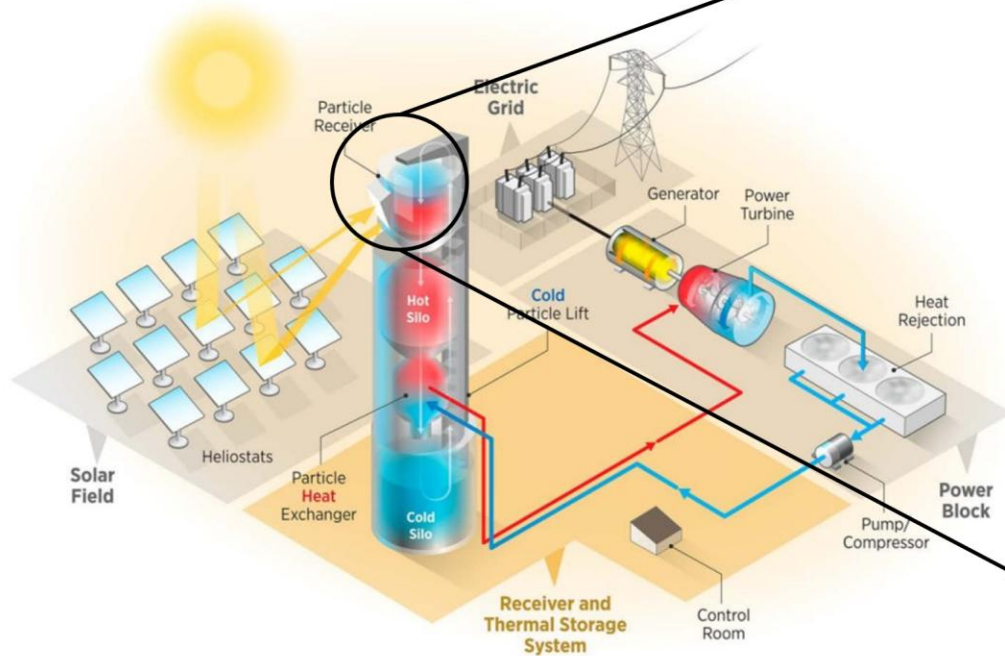
Thermal storage

Up to 7GW worldwide

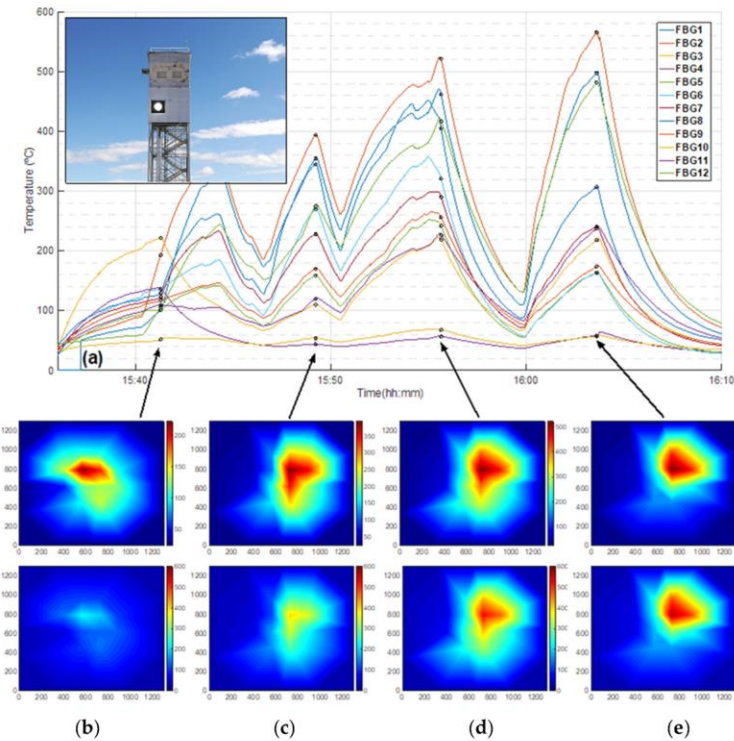
\$8.1B Market Size (2024)

Grand View Research (GRV)

CSP Efficiency Criticality



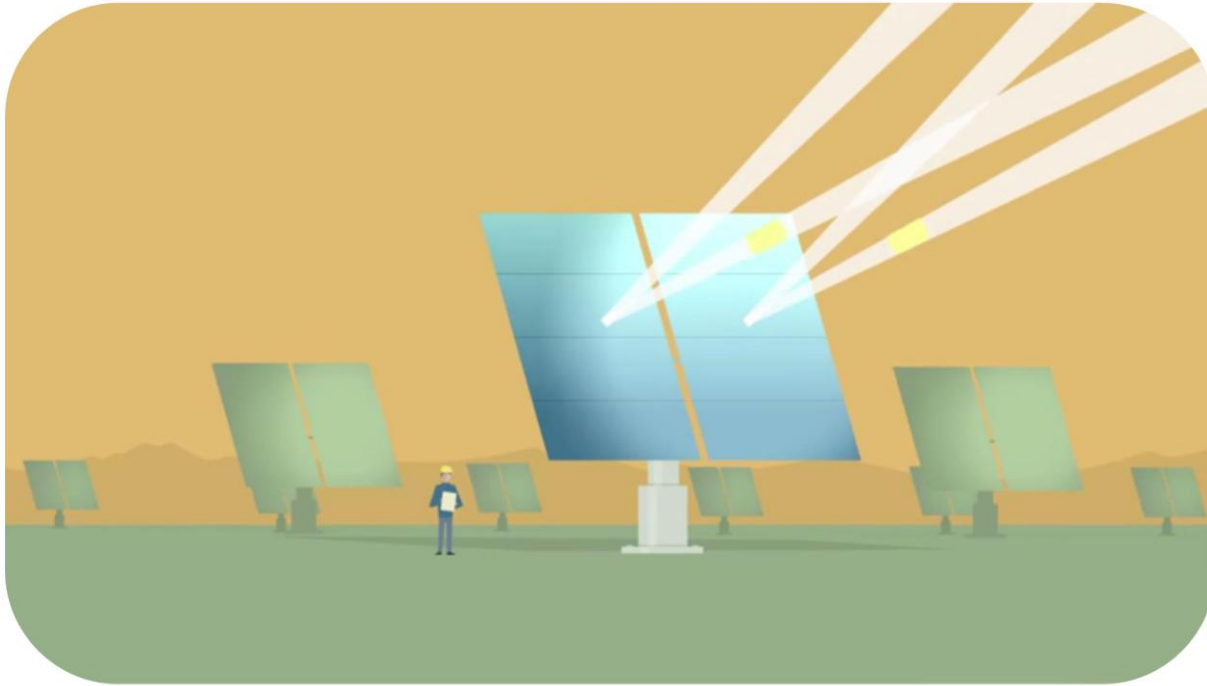
Temperature Distribution (1)



Key Magnitude

1 High-Temperature Monitoring in Central Receiver Concentrating Solar Power Plants with Femtosecond-Laser Inscribed FBG. Roberto Rodríguez-Garrido et. al.

Temperature Measurement Benefits



Material degradation prevention



Efficiency increase



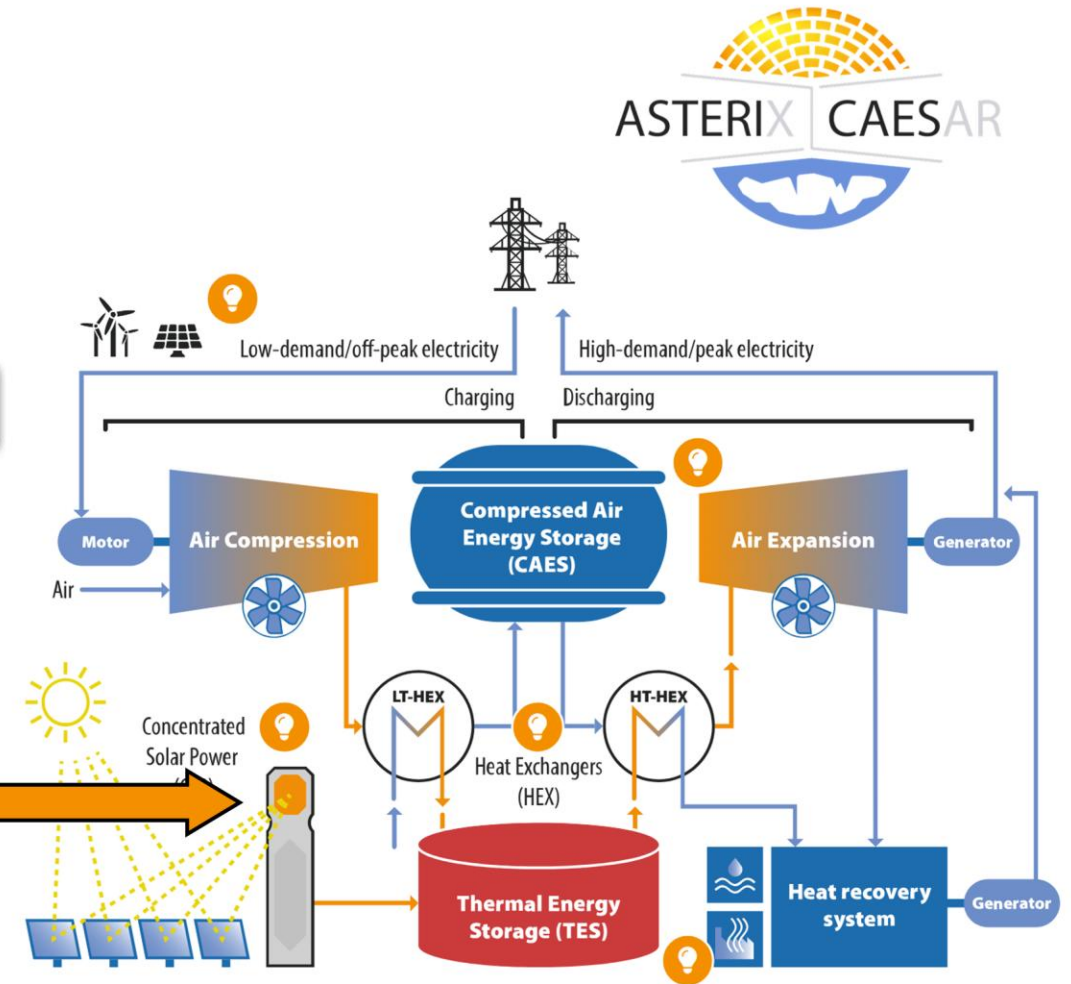
Dangerous gradients and peaks identification

The ASTERix-CAESar Project

Hybrid CSP – CAES configuration

Temperature distribution measurement

Up to 800 °C



Conventional Thermoelectric Technology

High Temperature

- ❌ **EMI Immunity**
- ❌ **Radiation Independence**
- ❌ **Spatial Practicality**
- ❌ **Scalability**



Thermocouples (K-type)

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 and scalability

FBGs technology provide multiple sensors in a single array.

Passive components and EMI Immunity

Only fiber cable is needed: Easier assembly and maintenance



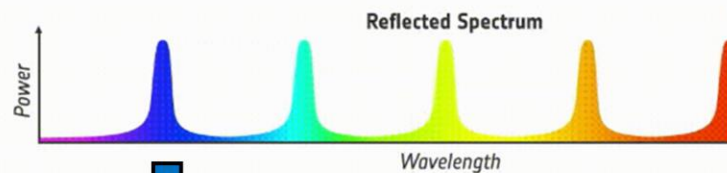
SYSTEM DESCRIPTION

High-Temperature Measurement – Principle of Operation

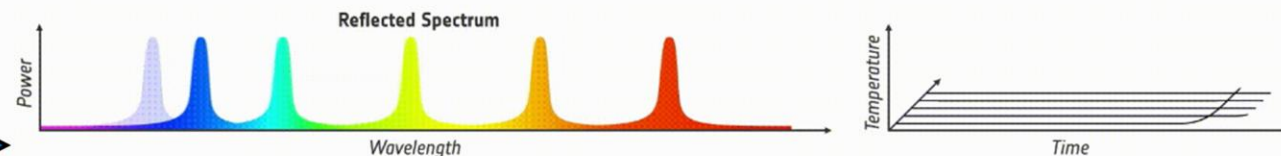
Objective: 800 °C

$$T(\lambda) = c_5 \cdot \left[\frac{(\lambda - \lambda_{Ref})}{\lambda_{Ref}} \right]^5 + c_4 \cdot \left[\frac{(\lambda - \lambda_{Ref})}{\lambda_{Ref}} \right]^4 + c_3 \cdot \left[\frac{(\lambda - \lambda_{Ref})}{\lambda_{Ref}} \right]^3 + c_2 \cdot \left[\frac{(\lambda - \lambda_{Ref})}{\lambda_{Ref}} \right]^2 + c_1 \cdot \frac{(\lambda - \lambda_{Ref})}{\lambda_{Ref}} + c_0$$

Multiplexed Temp



Multiplexed Temperature sensing



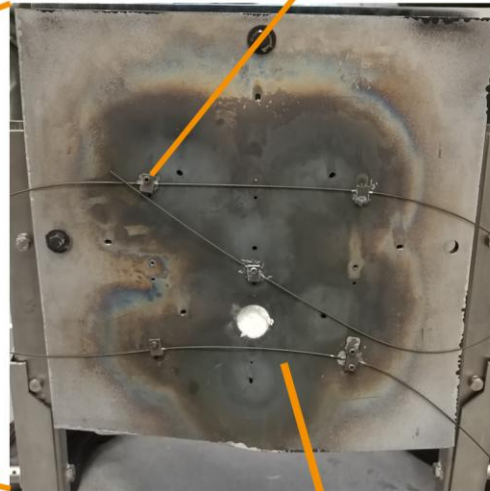
High-Temperature Measurement – System Description

Objective: 800 °C

Tower Receiver



*Punctual FBGs for
Temperature Measurement*

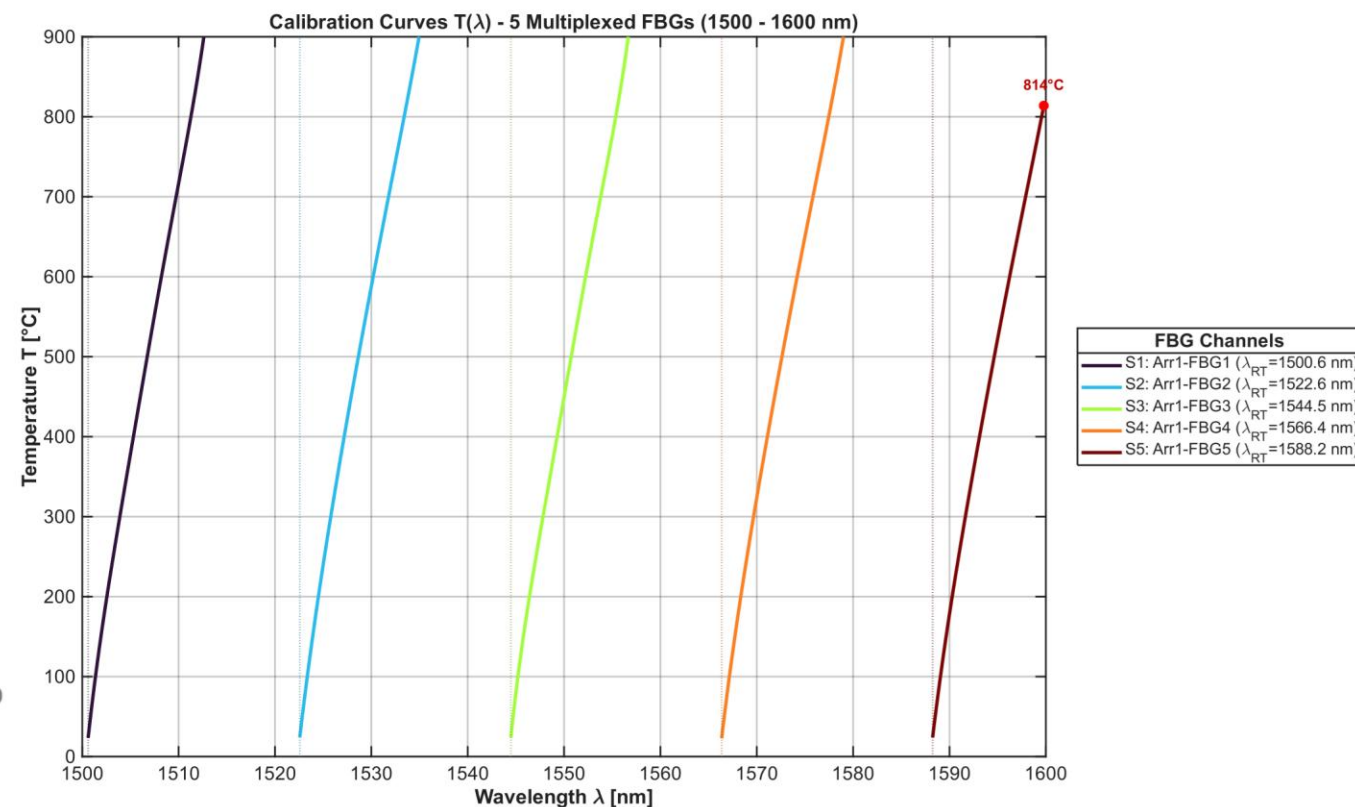
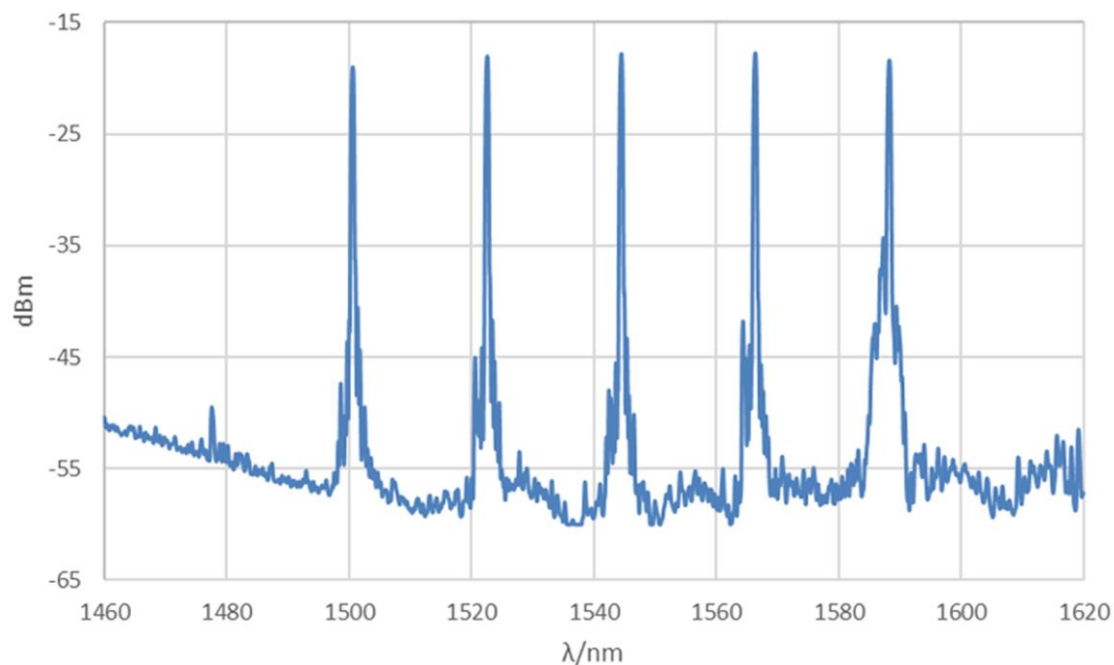


Optical Fiber



High-Temperature Measurement – System Description

Objective: 800 °C





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



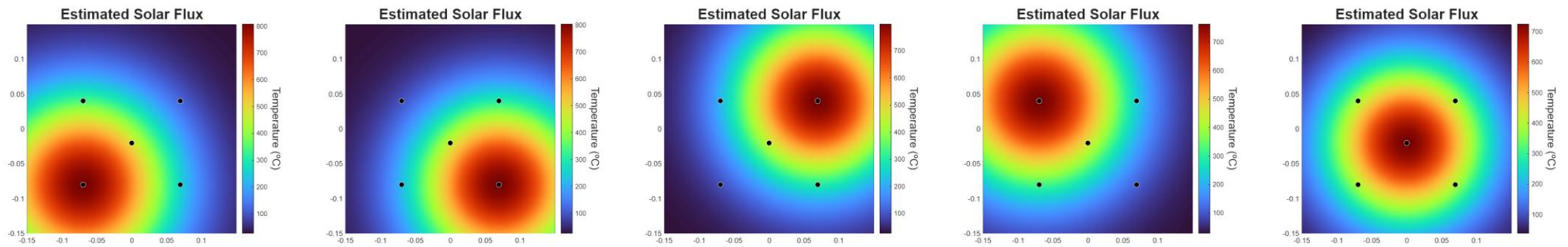
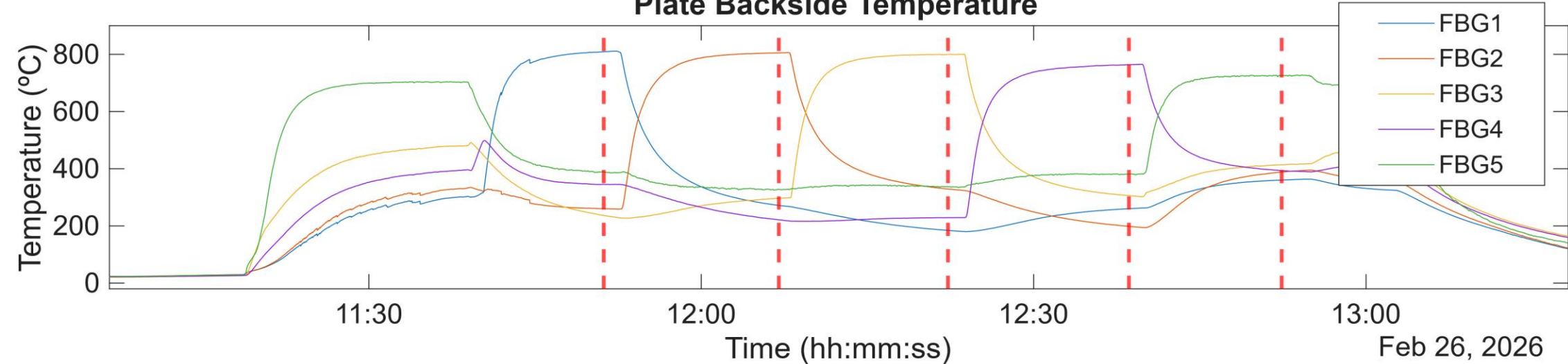
Relevant Results

Gardon: 312 kW/m²

Up to 800 °C

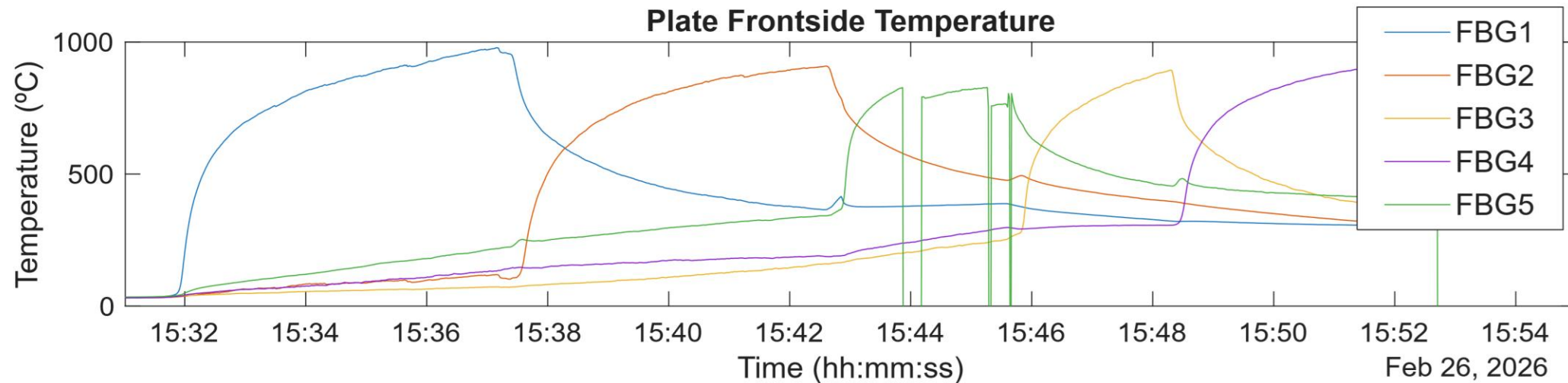
High Temperature Measurement

Plate Backside Temperature



Relevant Results

High Temperature Measurement



Gardon: 312 kW/m²

Peaks of 1000 °C



CONCLUSIONS

Conclusions – High Temperature

Measuring high temperature with fs-FBGs is feasible

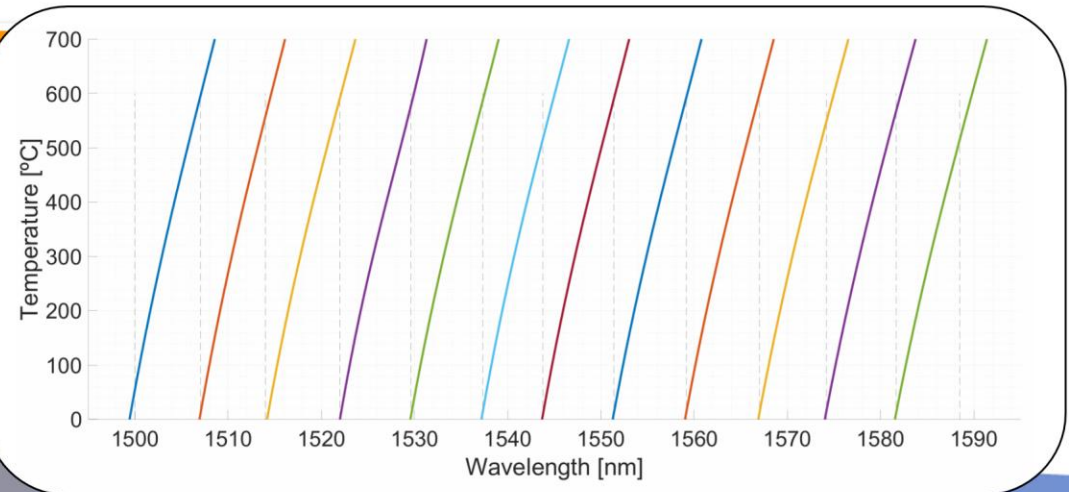
Excellent resilience to different ambient conditions

Compact, robust and efficient

Some issues

Calibration Range up to 700 °C

Sufficiency of Spectral Range



Conclusions: Current and future work

New designs for PSA assembly

New configuration

Special installation procedure

Future Experiments

Different spectral configuration

Higher temperatures

Calibration duties





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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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