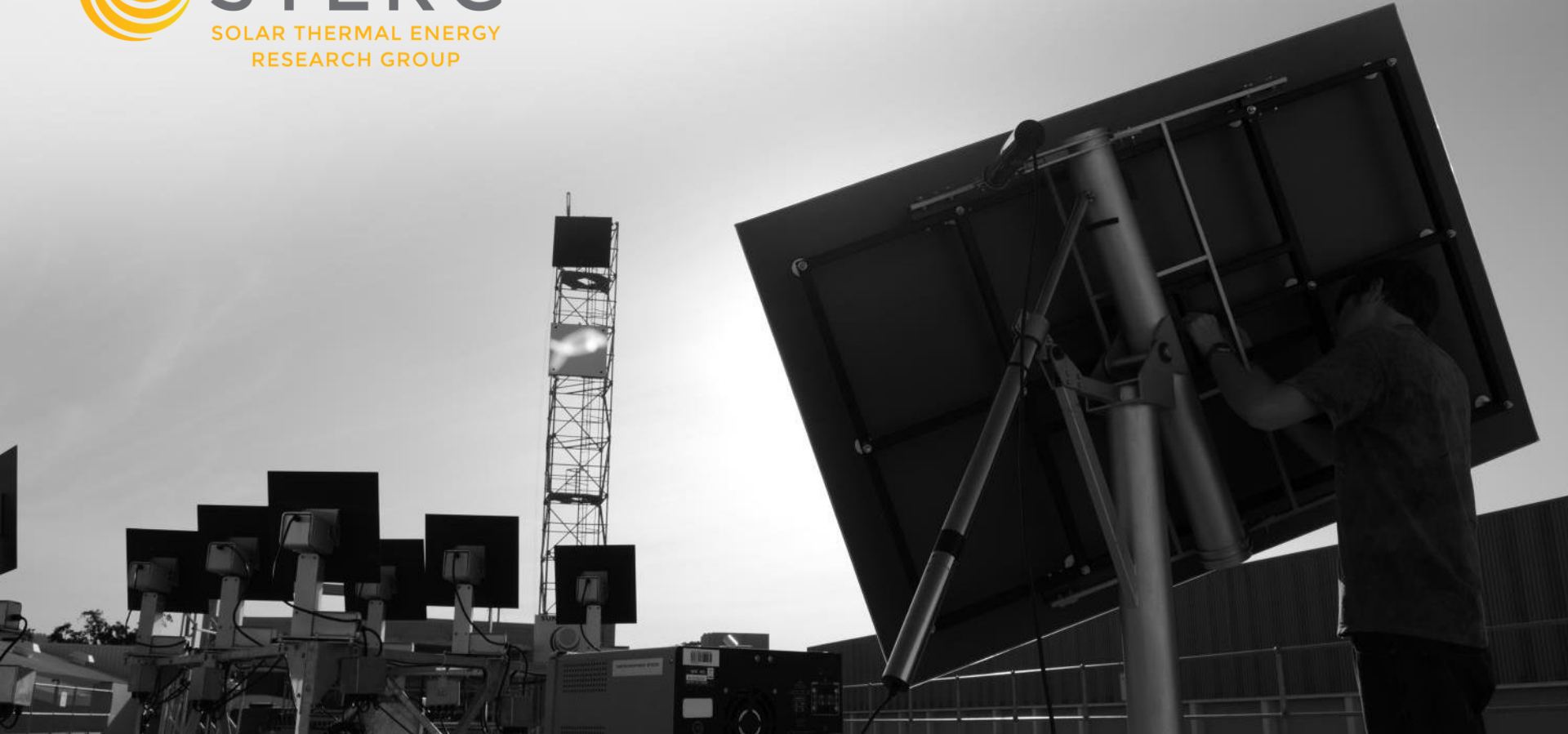




# STERG

SOLAR THERMAL ENERGY  
RESEARCH GROUP



# Suitability of STERG's HelioPod for AZELIO's CSP tower

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AZELIO Performance Analyst Intern



AZELIO  
SOLAR POWER WHEN YOU NEED IT



6<sup>th</sup> Annual STERG  
Symposium  
STELLENBOSCH, SOUTH AFRICA  
18 - 19 JULY 2019



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# STERG's Heliostat Technology



## HelioPod

- Developed through a TIA funded innovation initiative
- Six heliostats sharing a common structure
  - Modularity
  - Re-deployability
  - No need for ground preparation
- Fully autonomous with wireless communication
  - Fast integration
  - No need for cabling
- Excellent optical performance



The technology was demonstrated at 200 kW<sub>th</sub> pilot plant “Helio100” in Stellenbosch.

# AZELIO

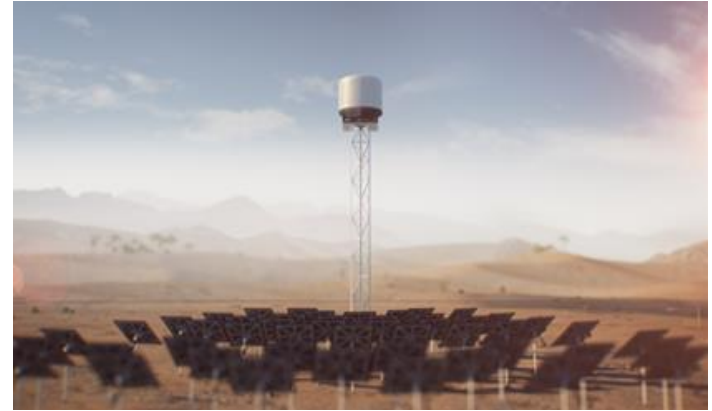
## TES technology

- Supply reliable electricity to off-grid area
- Dispatchable and distributed
- Small scale power generation (0.1 MW - 10 MW)
- Long-term storage up to 13 hours

### Interest:

Investigate suitability of the HelioPod for Azelio's tower

- Able to provide the nominal heat flow rate
- Able to comply the requirements to suit the tower
  - Short tower
  - Small cavity aperture area



# Objective & Methodology

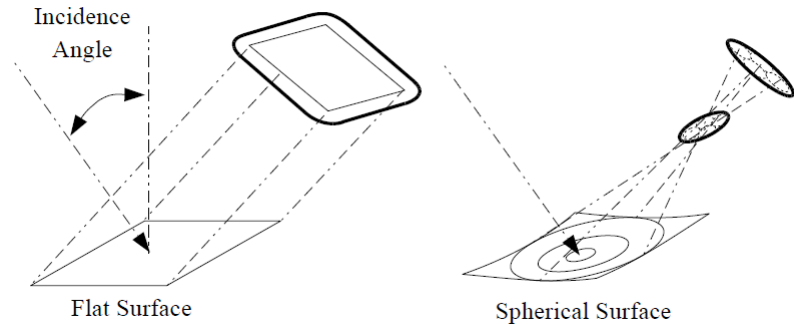
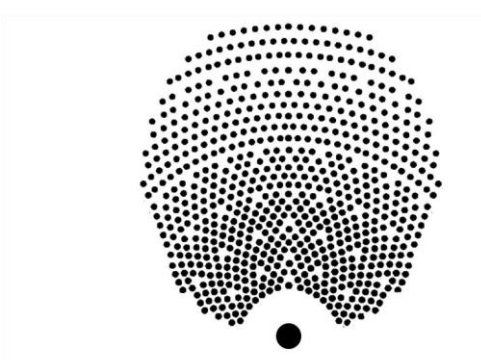


## Objective

Model the performance assessment of Heliopods with facet modifications.

Two analyzed variables:

- Heliostat field layout
- Focal length



# Objective & Methodology



## Objective

Model the performance assessment of HelioPods with facet modifications.

Two analyzed variables:

- Heliostat field layout
- Focal length

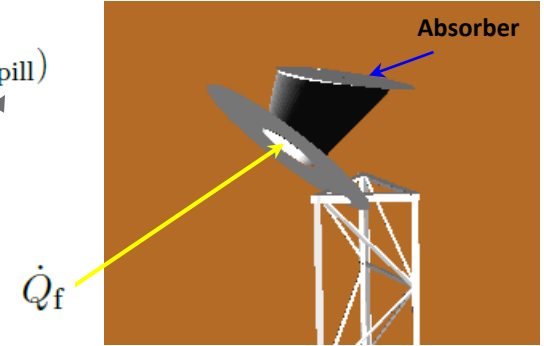
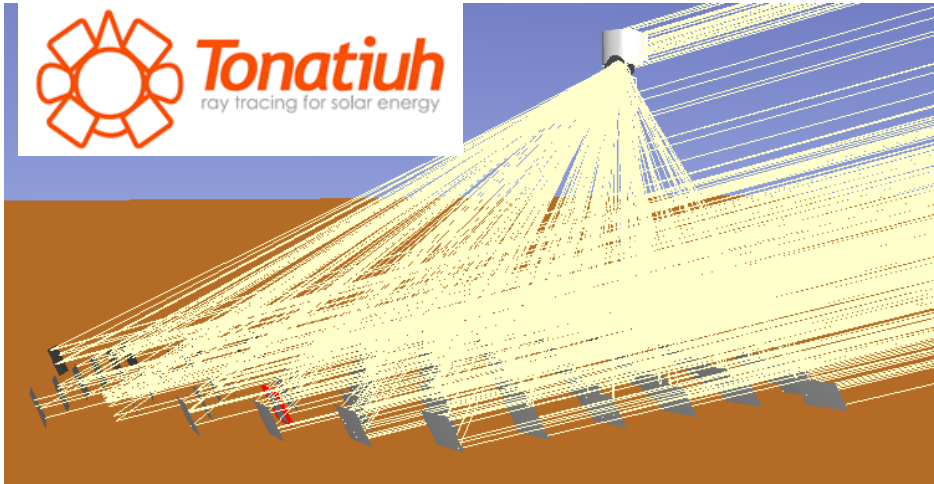
## Methodology

- Development of ray-tracing model
  - Design of heliostat field layout
- Identification of suitable facet focal lengths

# Ray-tracing model



$$\dot{Q}_f \doteq \sum_h^f \dot{Q}_h \doteq \sum_h^f A_h DNI \varepsilon_{\text{surf}} \varepsilon_{\text{cos}} (1 - f_{\text{shad}}) (1 - f_{\text{block}}) (1 - f_{\text{att}}) (1 - f_{\text{spill}})$$

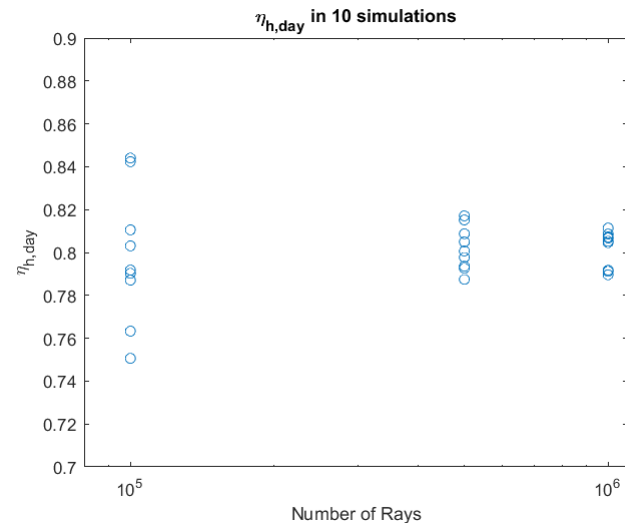
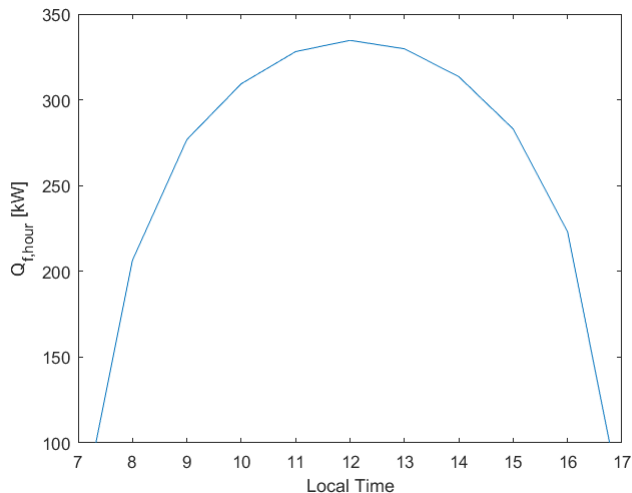
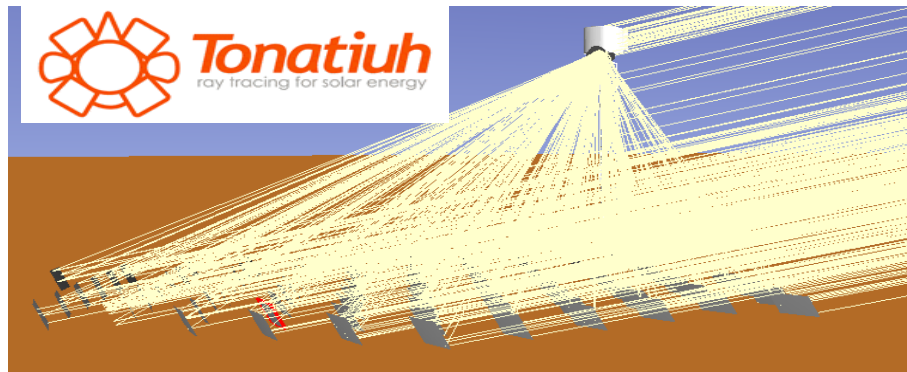


Challenges for a first-time user:

- Performance of the overall field
- Reliability of the results
- Long computational time

# Ray-tracing model

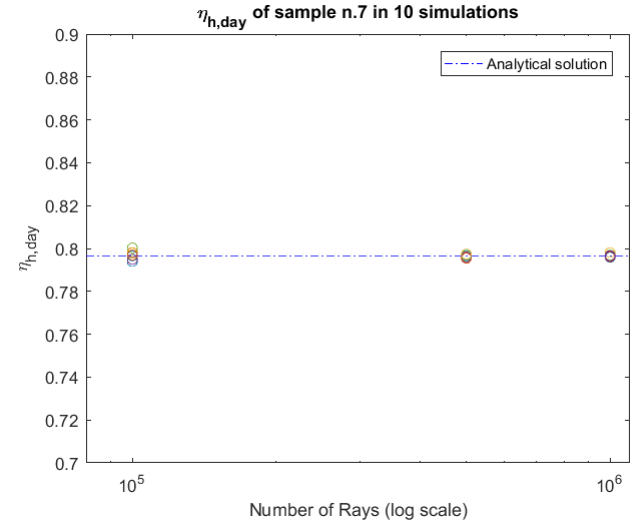
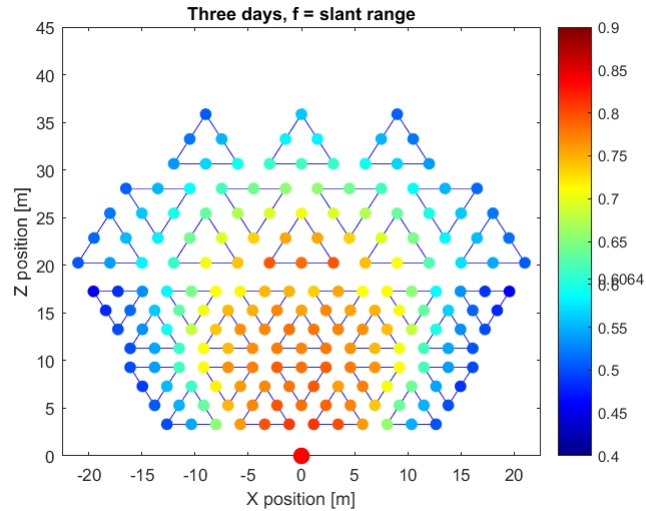
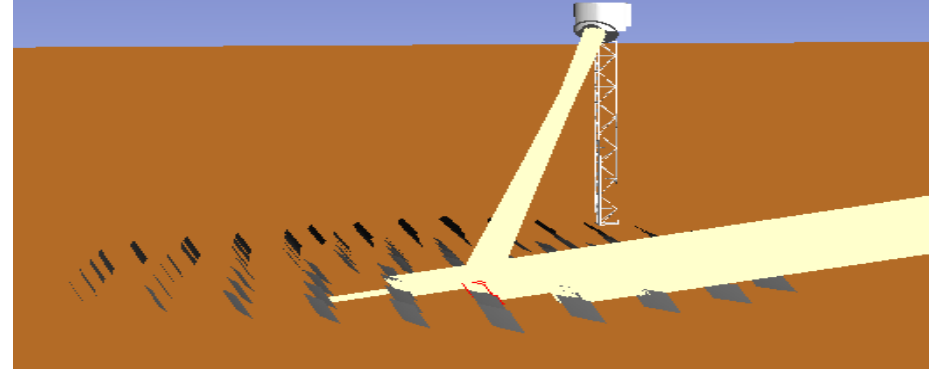
## Challenges





# Ray-tracing model

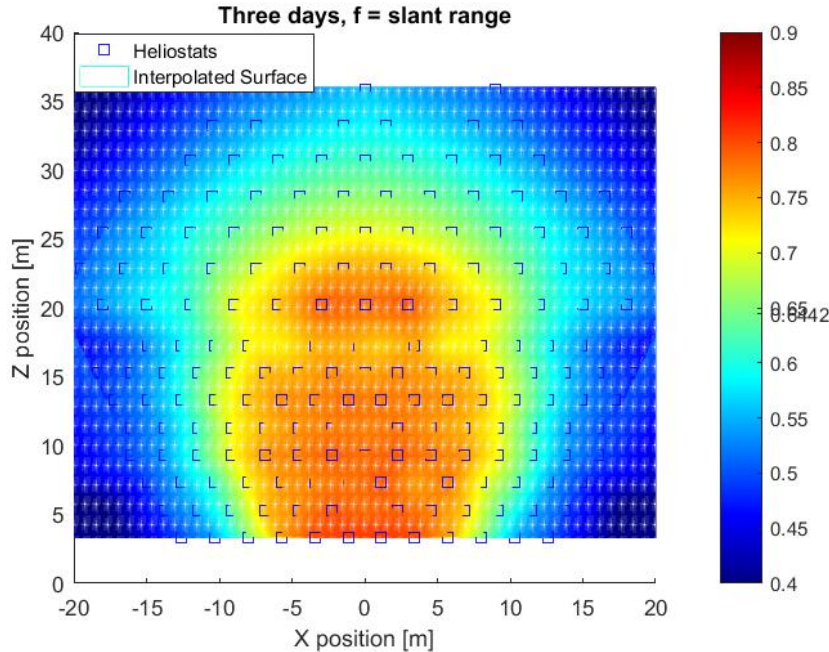
## Solution



# Design of the Heliostat Field Layout

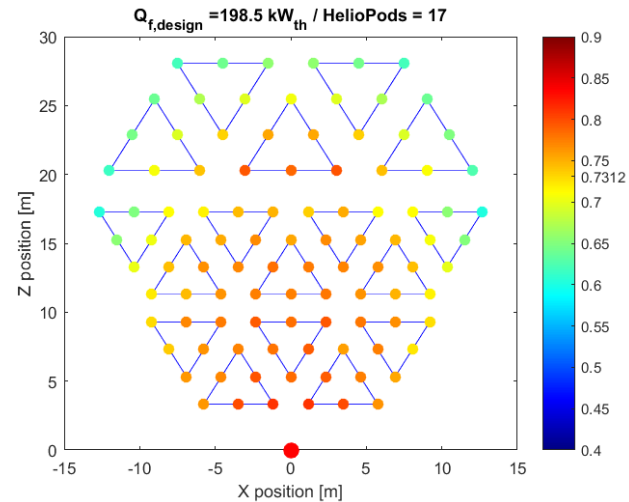
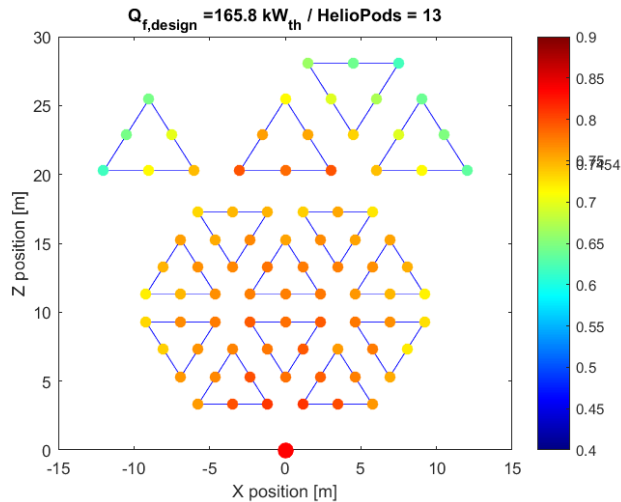
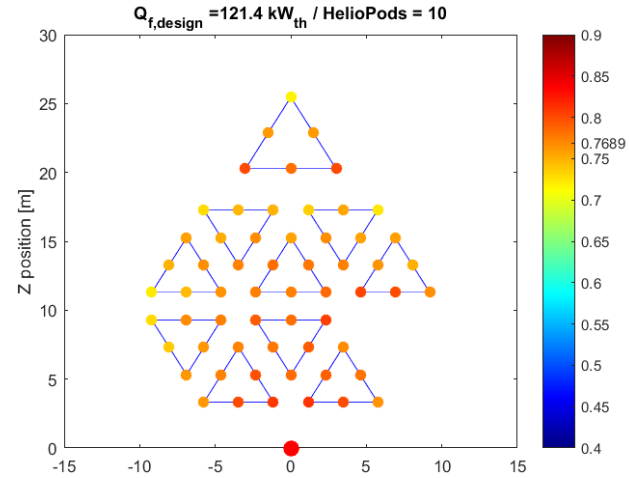
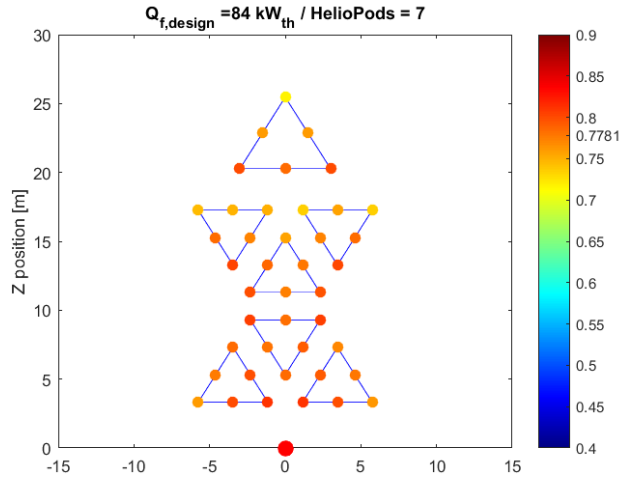


## AZELIO's receiver requirements



- AZELIO's receiver demands for a compact field close to the tower.
- Due to the cavity, only heliostats on limited field area can effectively hit the absorber
- Suitability condition:  
Heliostat technology is suitable if it is able to provide the nominal heat flow rate with a layout within the limited field area

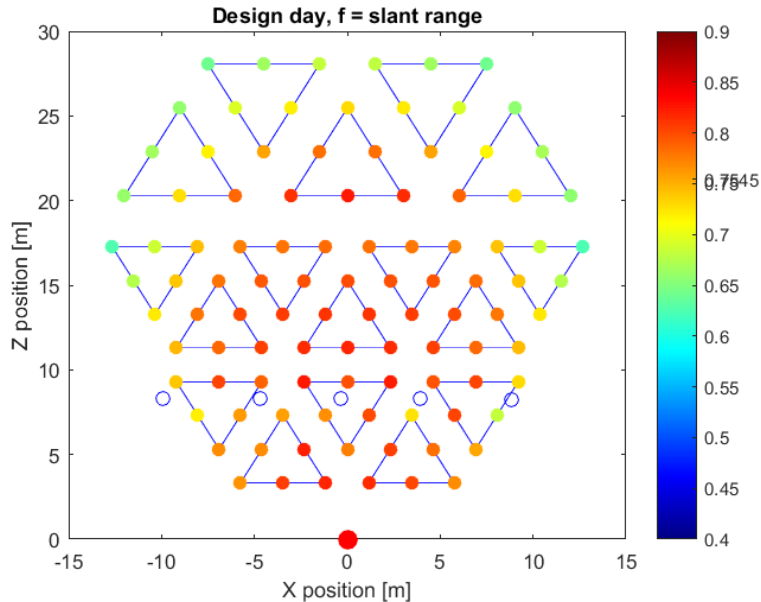
# Dedicated Heliostat Field Layout



# Performance Assessment



## Provide indications of achievable outcomes



Theoretical assumption of adapting the focal length of every heliostat

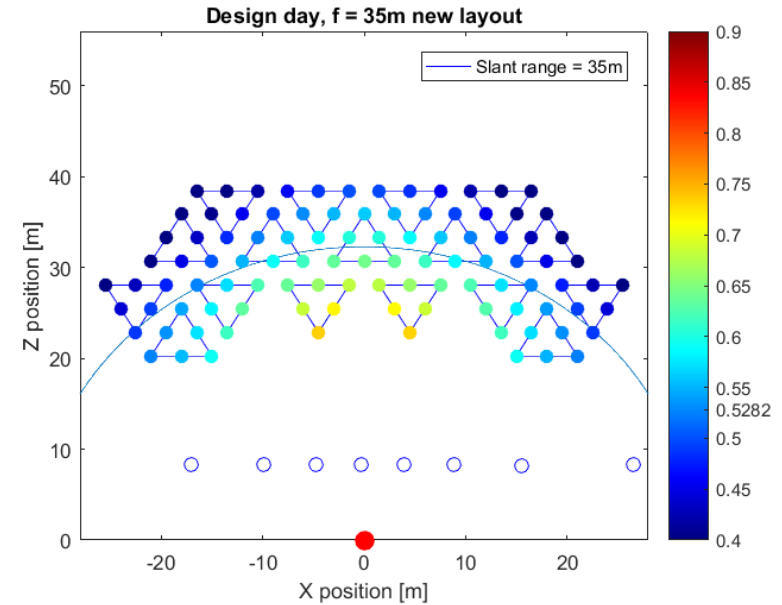
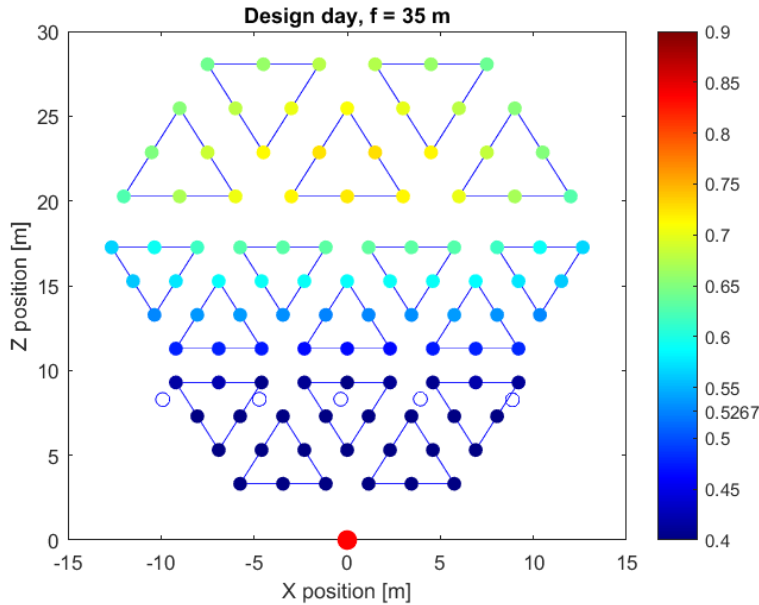
Performance assessment with current HelioPod facet

Identification of a set number of facet focal length

# Facet Adaptation



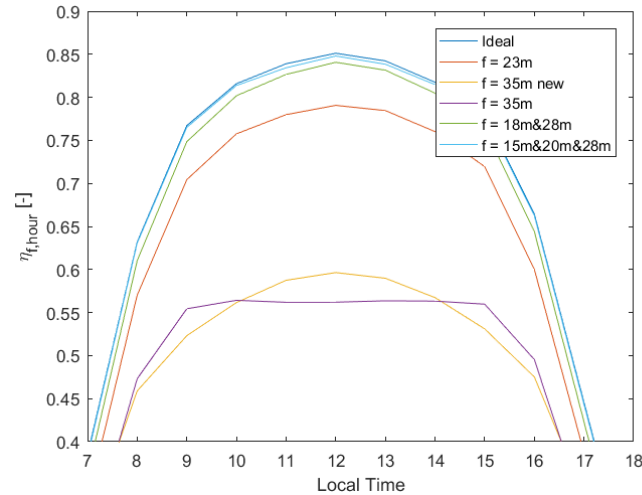
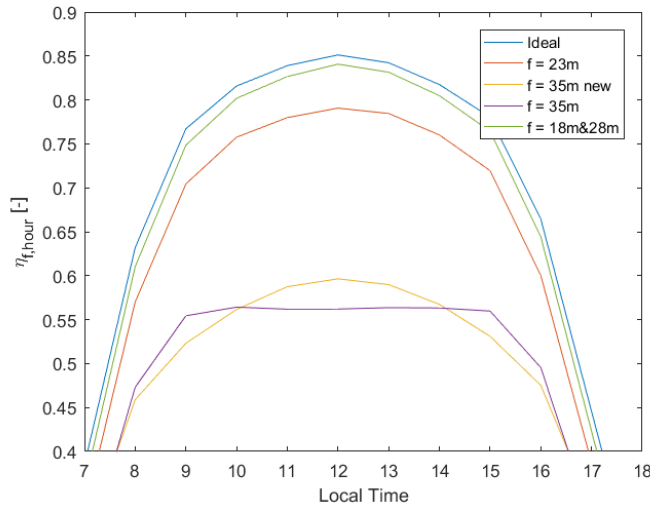
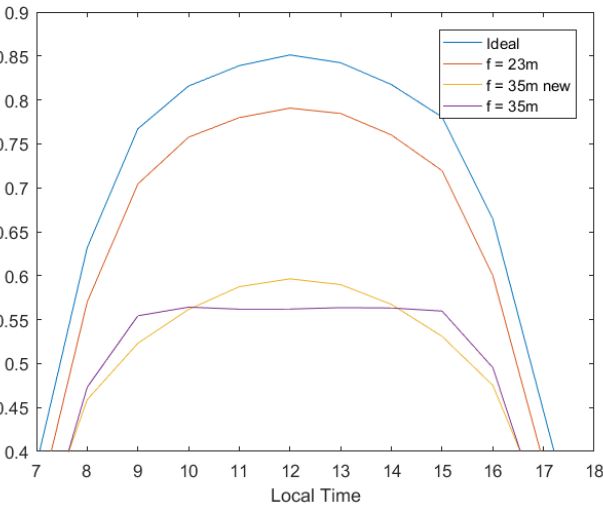
## Suitability of Current HeliPod facet



# Facet Adaptation



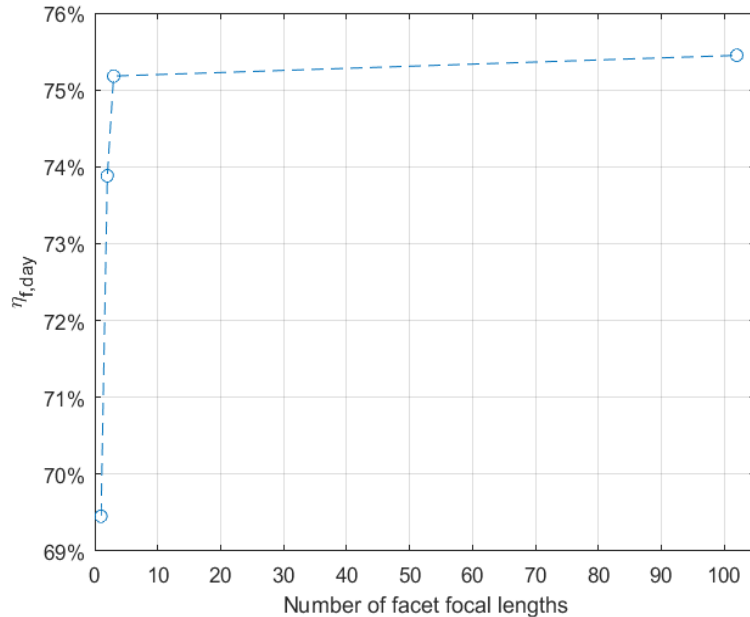
## Identification of facet focal lengths



# Facet Adaptation



## Identification of facet focal lengths



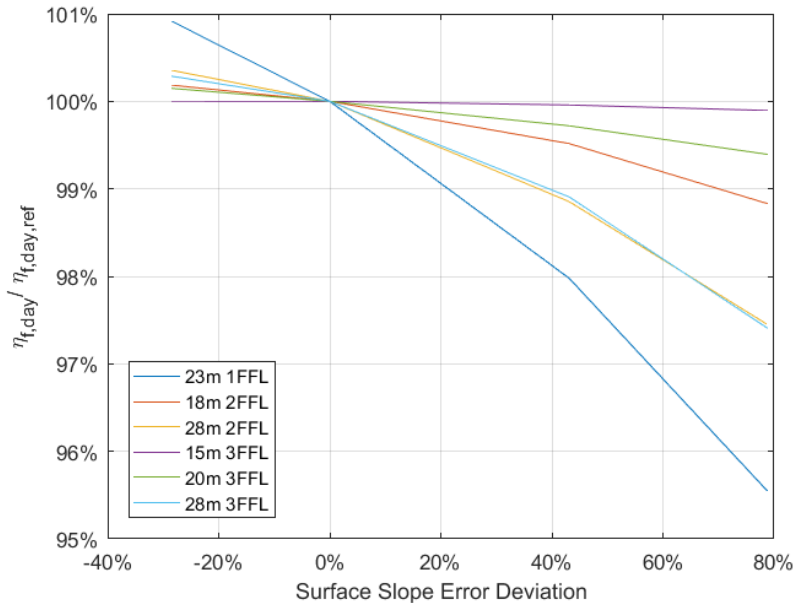
HelioPod technology fulfils the AZELIO requirements with good optical efficiency if:

- 2/3 new facets are developed

# Facet Adaptation



## Sensitivity analysis on surface slope error



HelioPod technology fulfils the AZELIO requirements with good optical efficiency if:

- 2/3 new facets are developed
- Facet surface accuracy respect a limit

Interesting finding:  
Impact of short FFL inaccuracy is marginal.



# Future Work



Facets with large curvature are an unexplored field

- Model the manufacturing process for evaluating feasibility
- Producing a prototype

# Thank you for your attention!

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## ACKNOWLEDGEMENTS:

Dr. Matti Lubkoll

AZELIO

## Questions?

## CONTACT DETAILS:

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# Back Slides

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# Design of the Heliostat Field Layout



## Methodology

