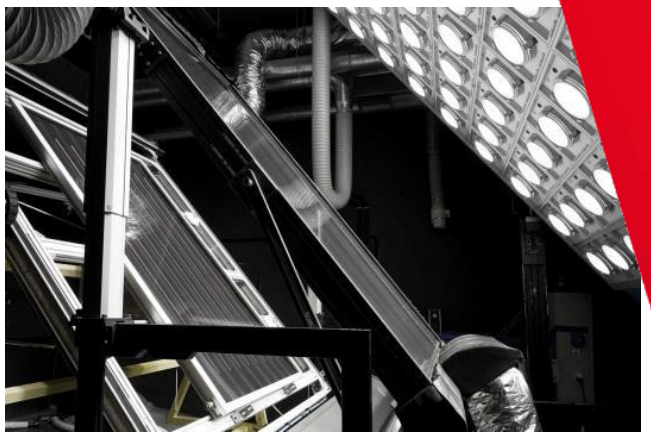





# INNOVATIVE HELIOSTAT CHARACTERIZATION SYSTEM
# SOLARCONCENTRA 27/03/2019

CENER | NATIONAL RENEWABLE ENERGY CENTRE
ADItech

GOBIERNO DE ESPAÑA
MINISTERIO DE ENERGÍA, TURISMO Y AGENDA DIGITAL
MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD

Ciemat

# INTRODUCTION

# INTRODUCTION

HELIOSTAT QUALITY = BEAM QUALITY + POINTING ERROR

BEAM QUALITY

↓

Concentrator's quality

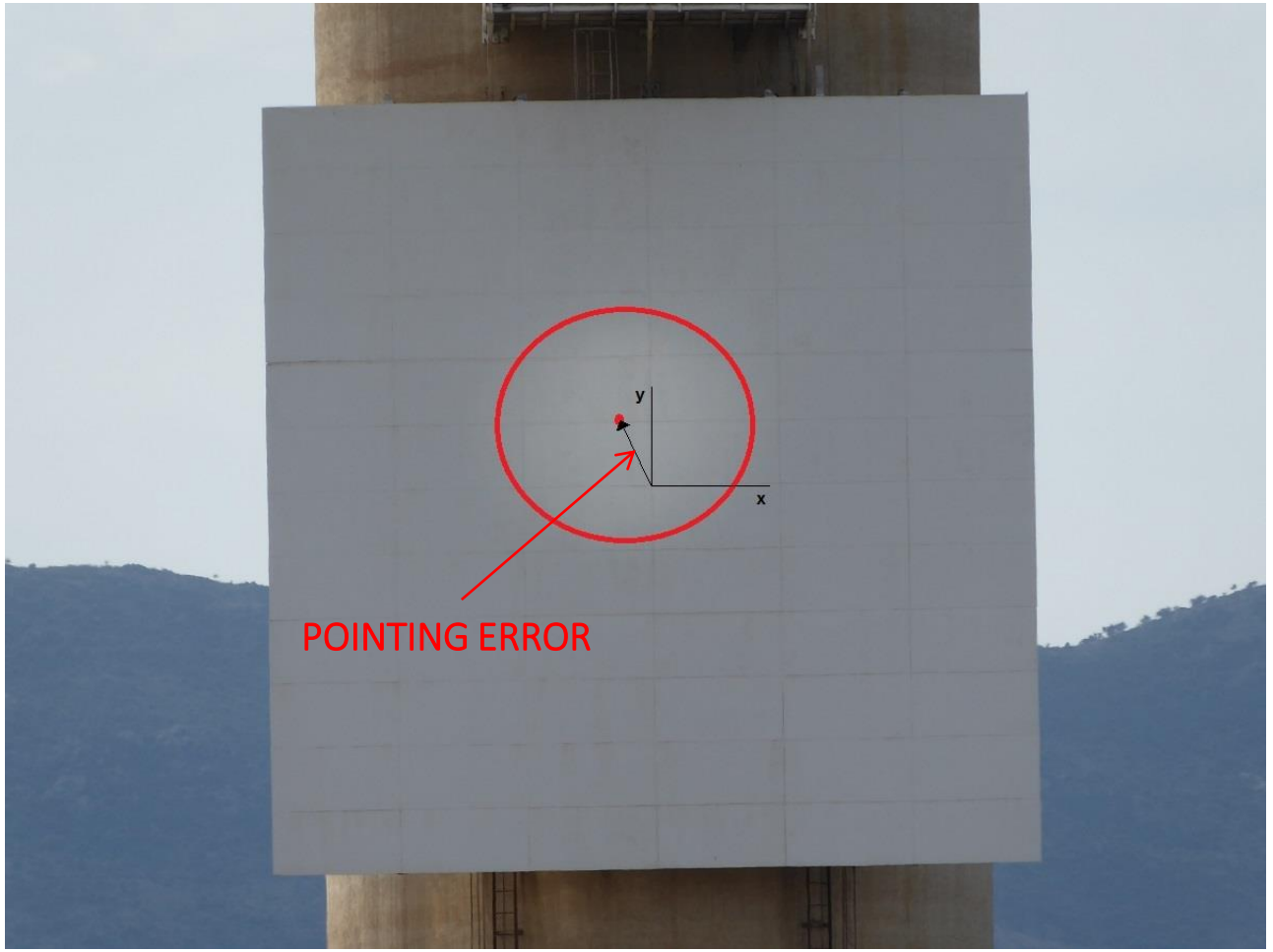
↓

Surface error

POINTING ERROR

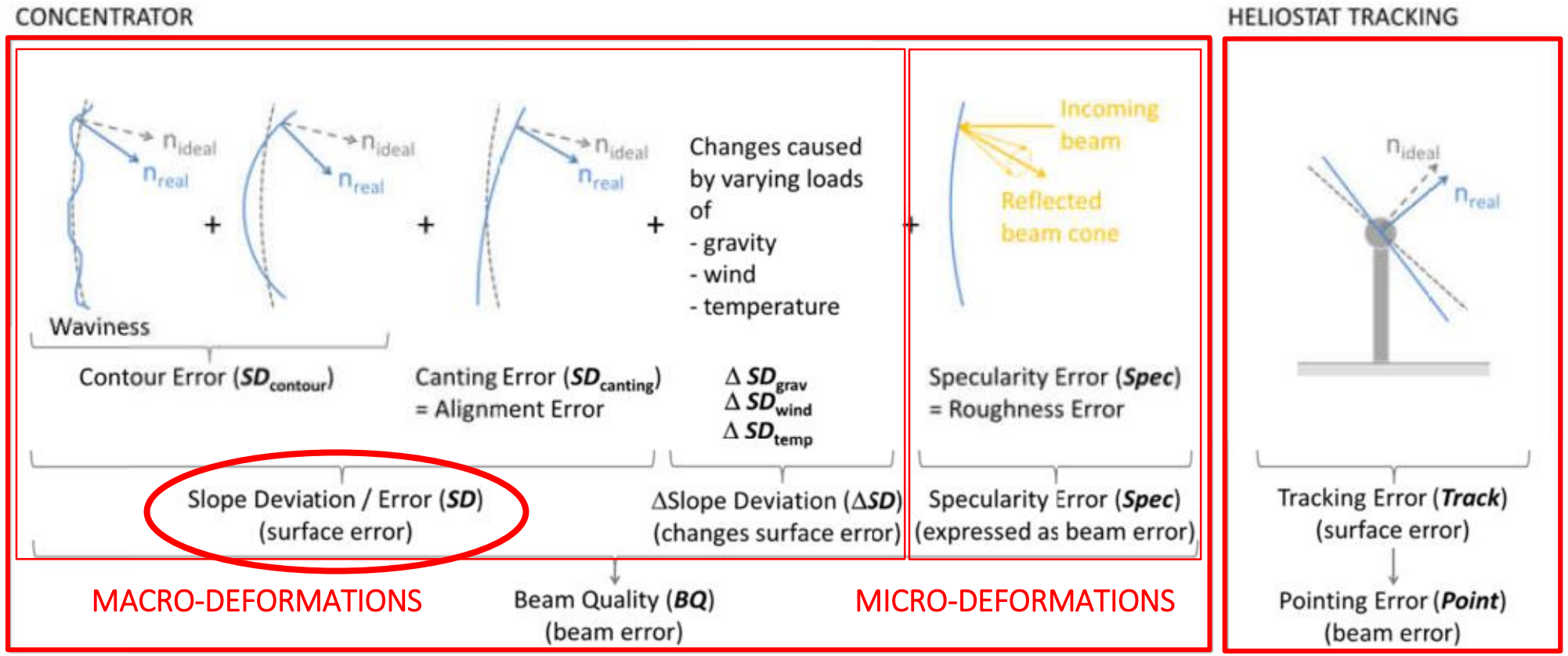
↓

Tracking error



# INTRODUCTION

HELIOSTAT QUALITY = BEAM QUALITY + POINTING ERROR




CHARACTERIZATION METHODS

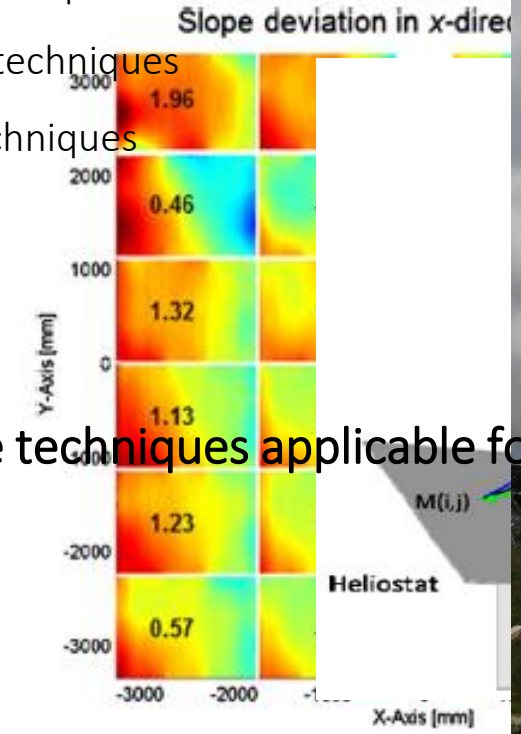
CALIBRATION METHODS

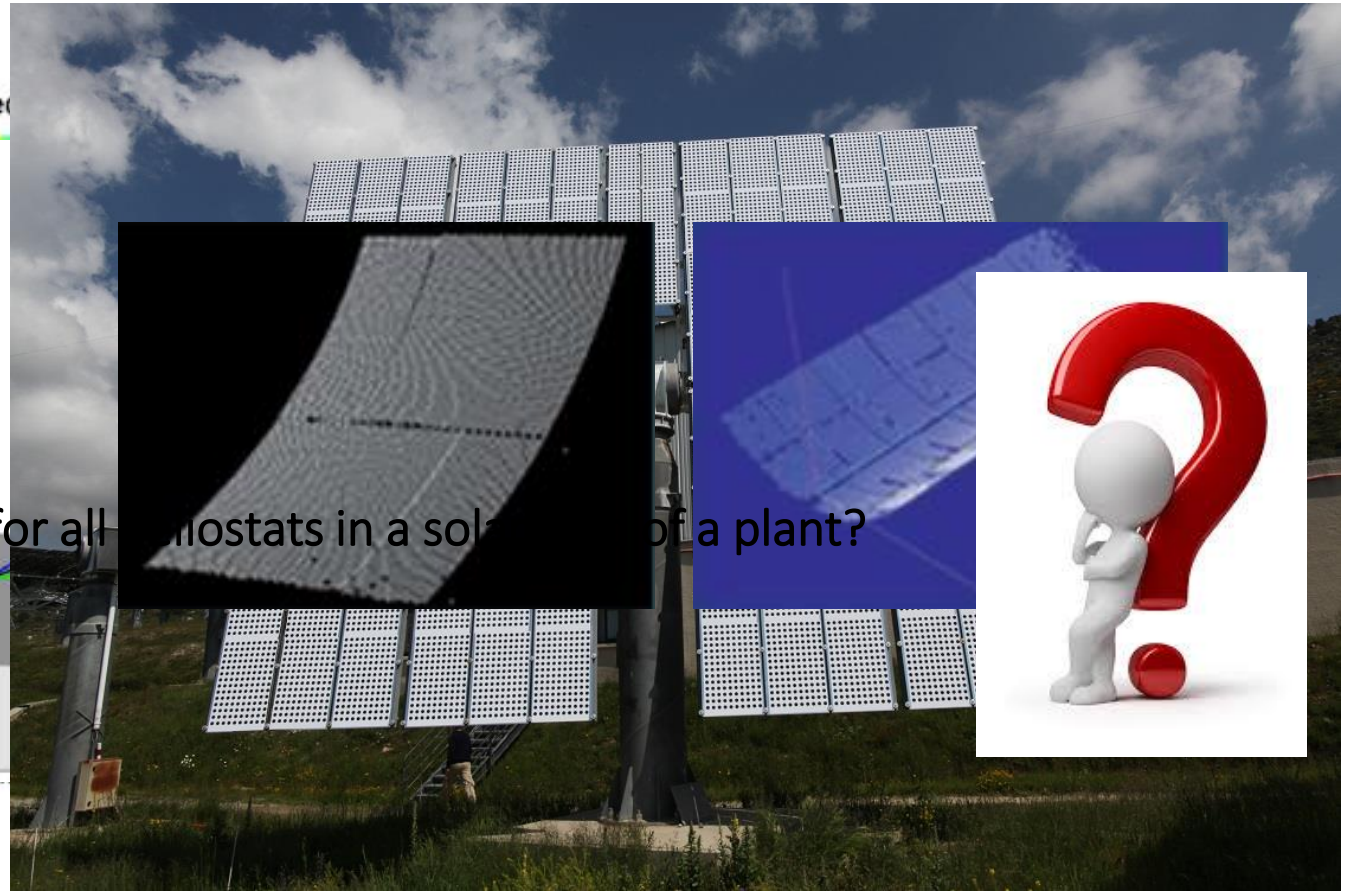
# INTRODUCTION

## STATE-OF-THE-ART

Objective: knowing the exact shape of the concentrator or the deviation from the ideal shape

- Deflectometry techniques
- Photogrammetry techniques
- Laser scanning techniques
- Etc.

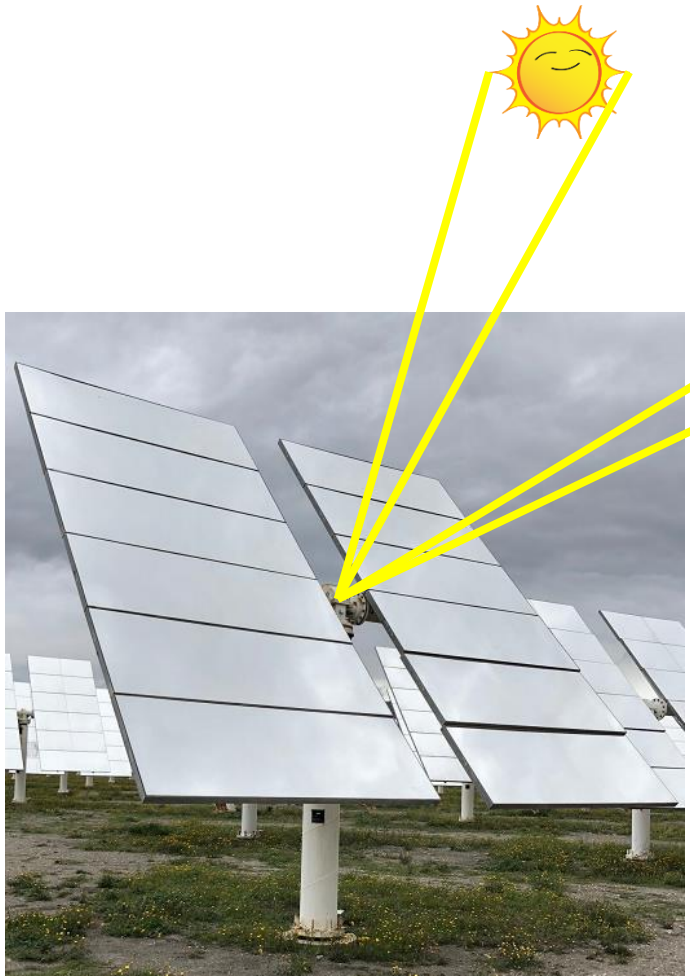


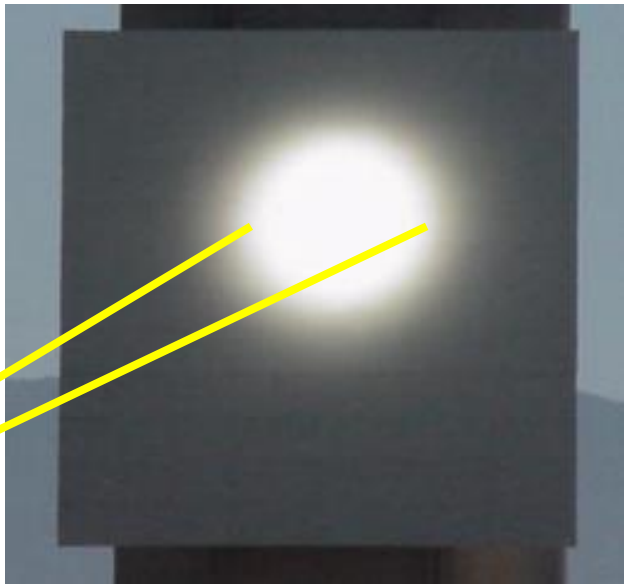



Is any of these techniques applicable for all heliostats in a solar field of a plant?

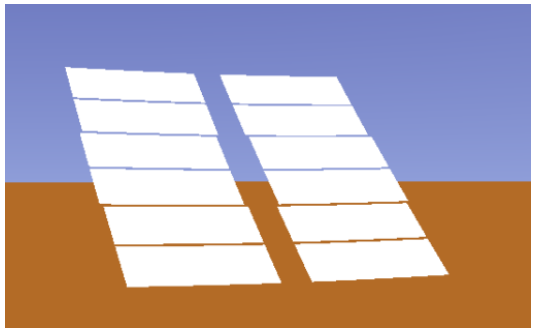
# INTRODUCTION

## STATE-OF-THE-ART: The most extended method

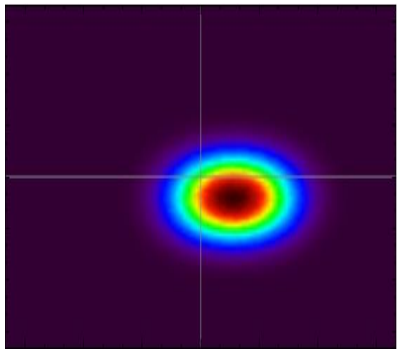


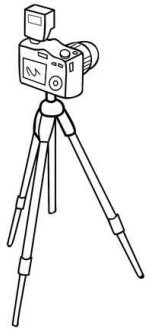


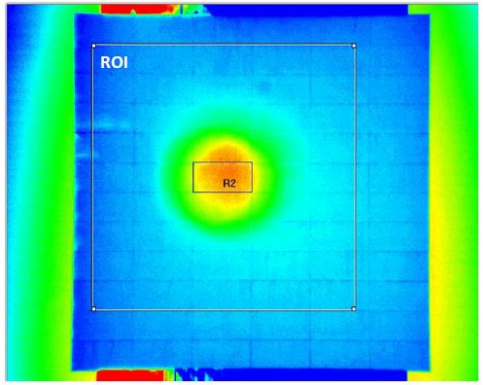
Ray-tracing model

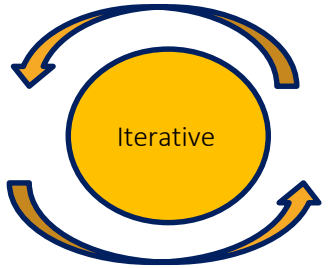


f(BeamQuality)








BeamQuality

# INTRODUCTION

## STATE-OF-THE-ART: Shortcomings

Non-linear response and low range of the camera, etc.

Non-uniform lambertian target, peeling and chipping of the paint, etc.

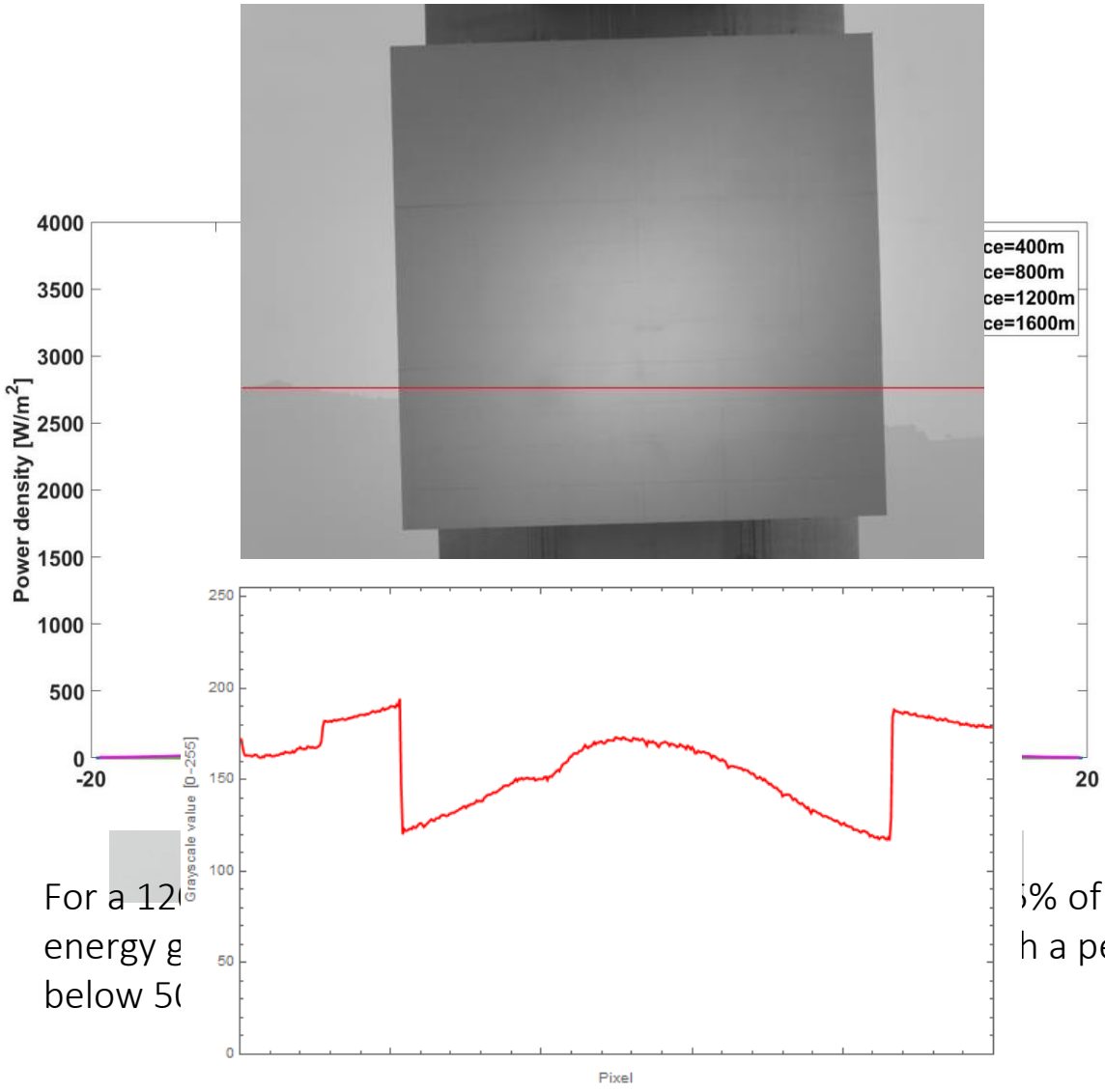
The reflected beam overflows the target

Poor contrast and low quality signal-noise ratio if density flux values are low

Deformed images, loss of data and generalized impoverishment of characterization quality

Non-viable for small and/or far heliostats

Barely parallelizable

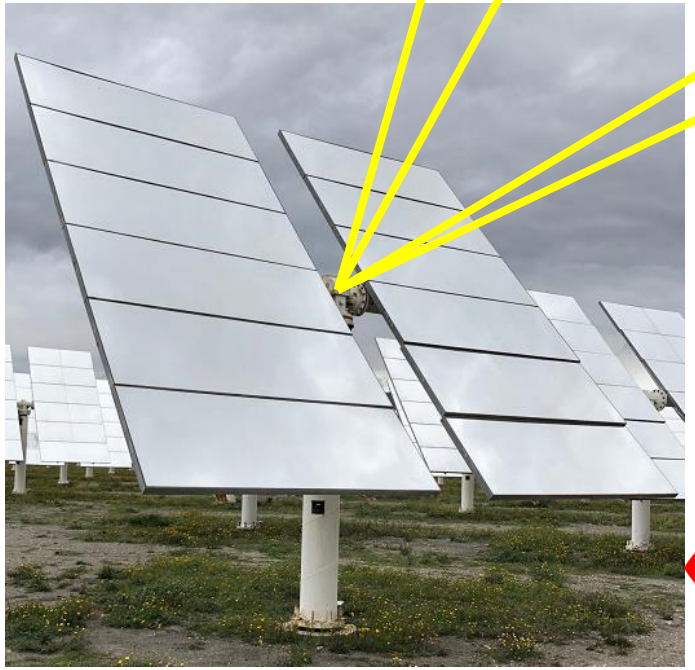


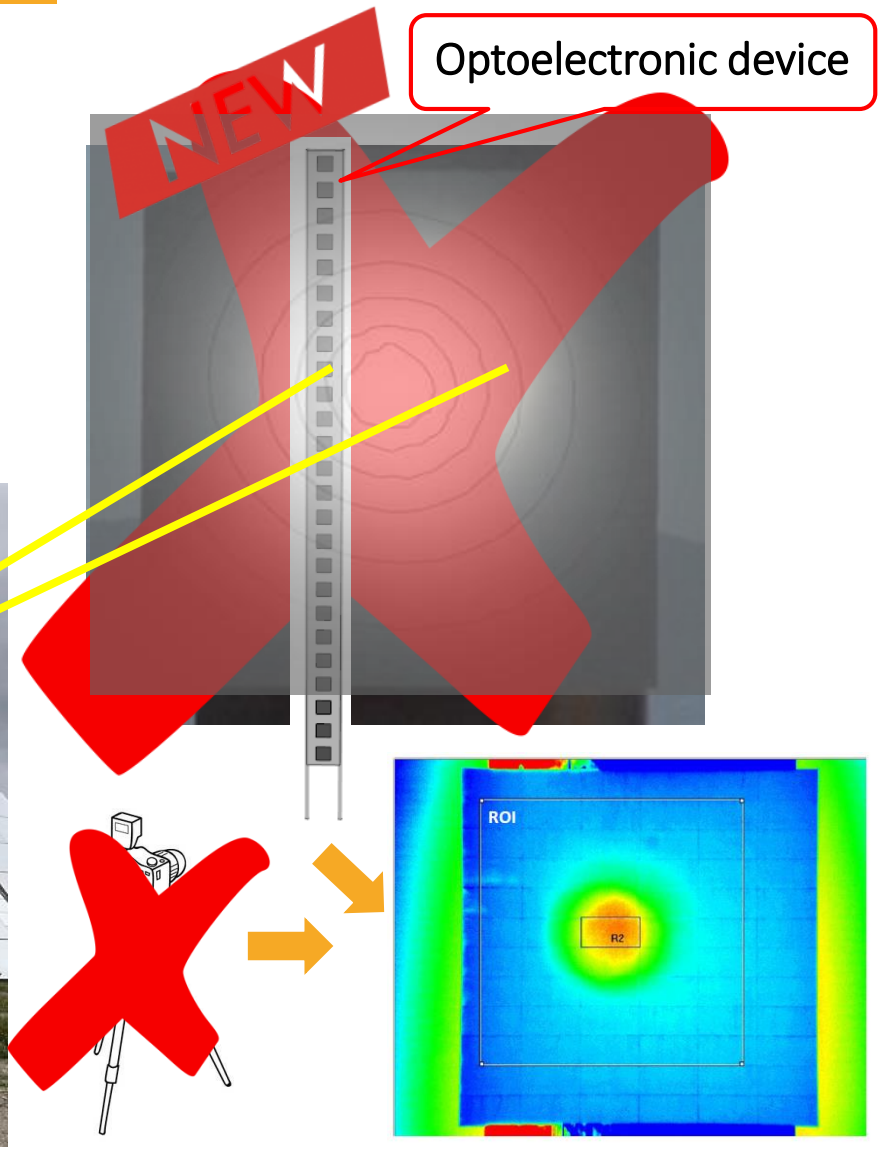

For a 12 % of the energy g h a peak below 5(

# INNOVATIVE APPROACH

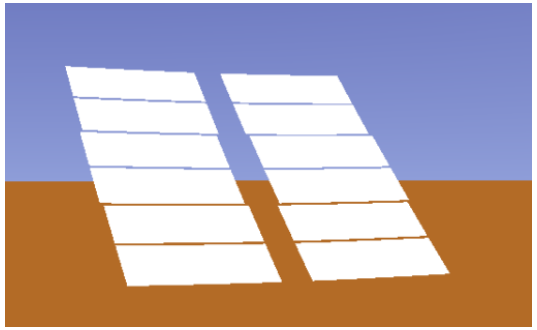
# INNOVATIVE APPROACH

## The basis

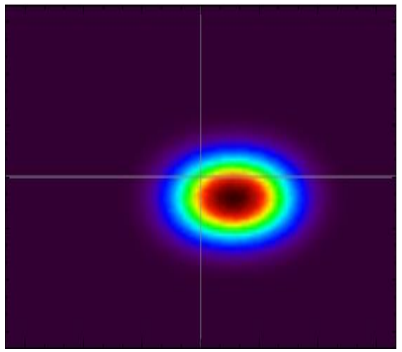


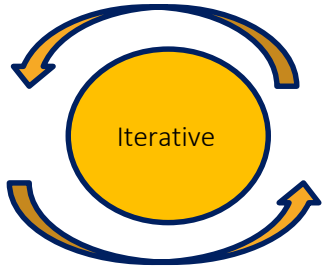



Ray-tracing model



f(BeamQuality)

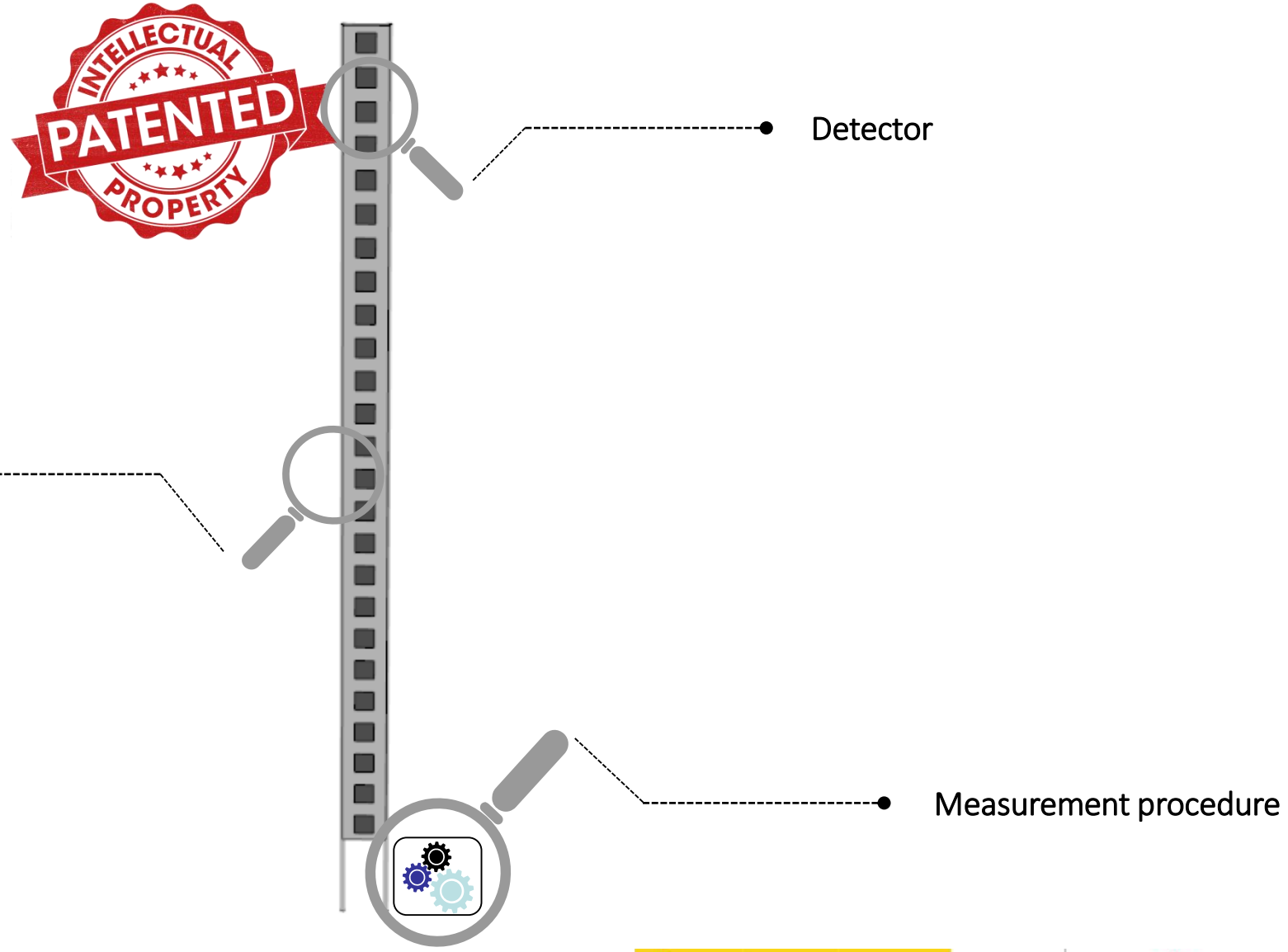





BeamQuality

# INNOVATIVE APPROACH

Detail view

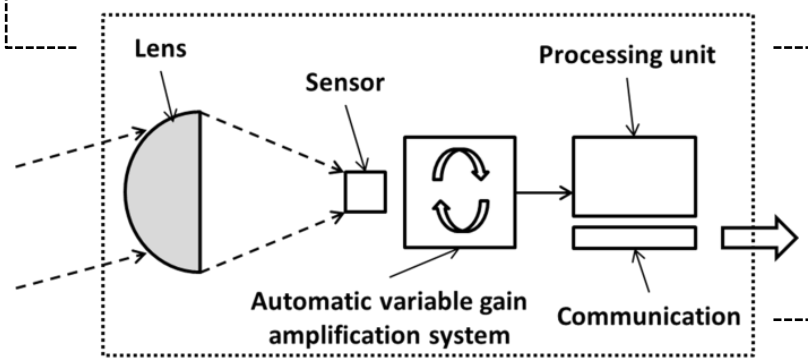


# INNOVATIVE APPROACH

## Detail view: Detector

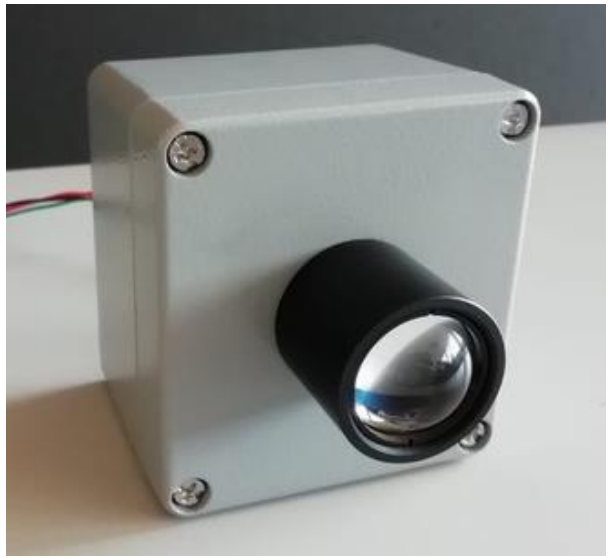
Large area silicon photodiode

Enhancement of optical signal, signal-noise ratio improvement factor in the range 20-100




Includes temperature sensor to prevent measurement deviations

Coordination among detectors to capture the signal at once



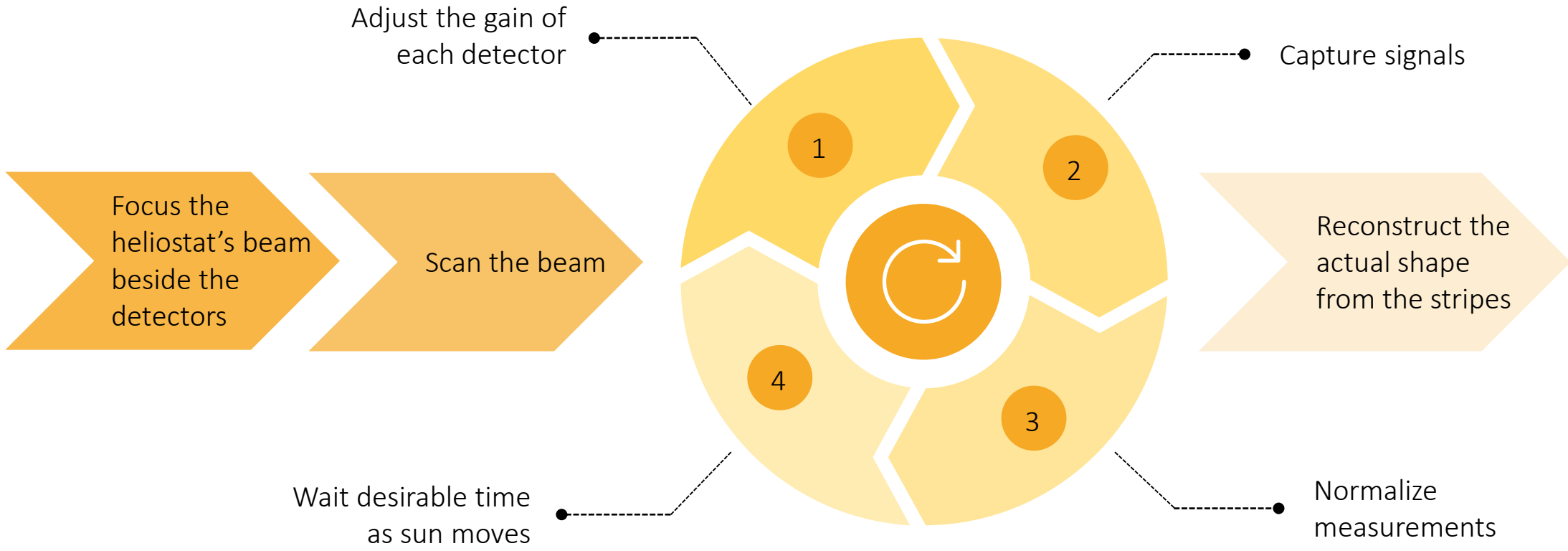
Adapts the measurement range according to the incident radiation

Metal enclosure box (IP68) that ensures the perfect alignment of the optic elements

# INNOVATIVE APPROACH

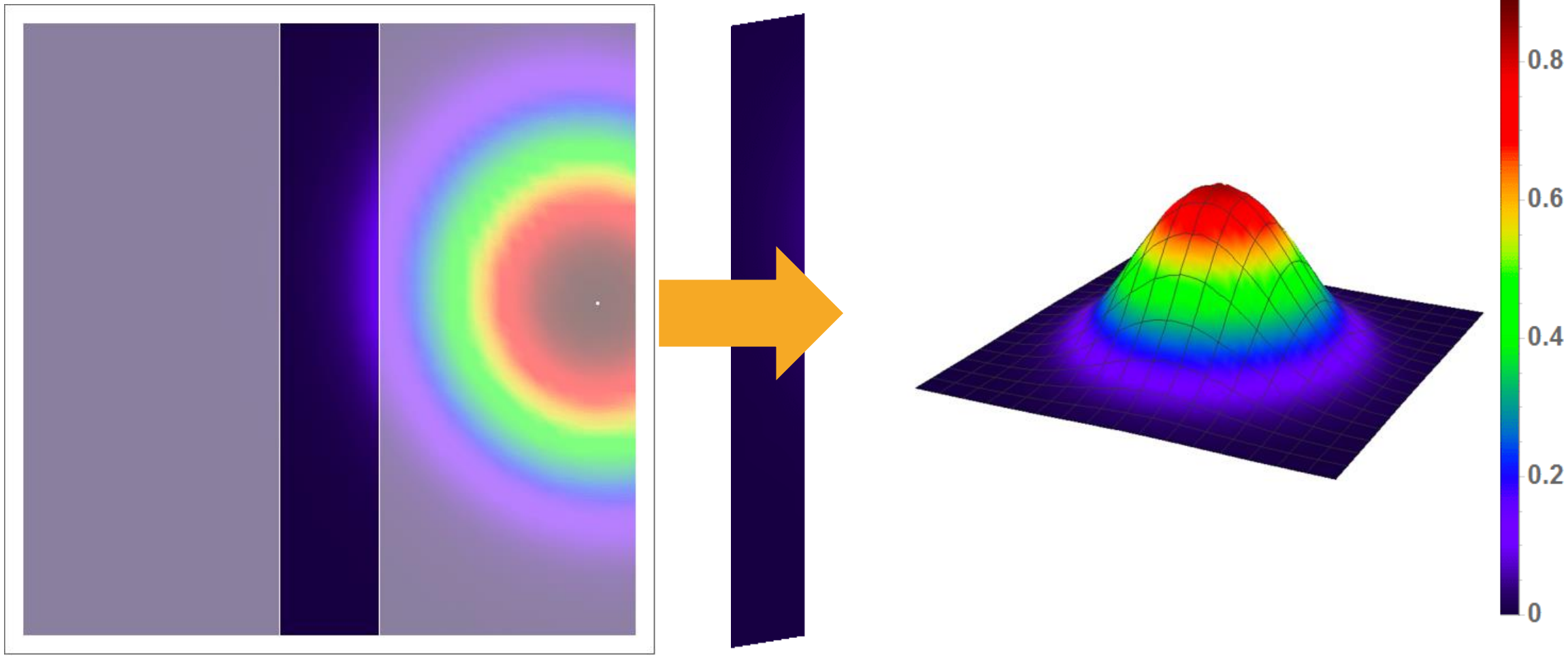
## Detail view: Measurement procedure

A scanner-based measurement system in which the sun actuates as the driver mechanism whilst the heliostats remains static



# INNOVATIVE APPROACH

Detail view: Measurement procedure



# INNOVATIVE APPROACH

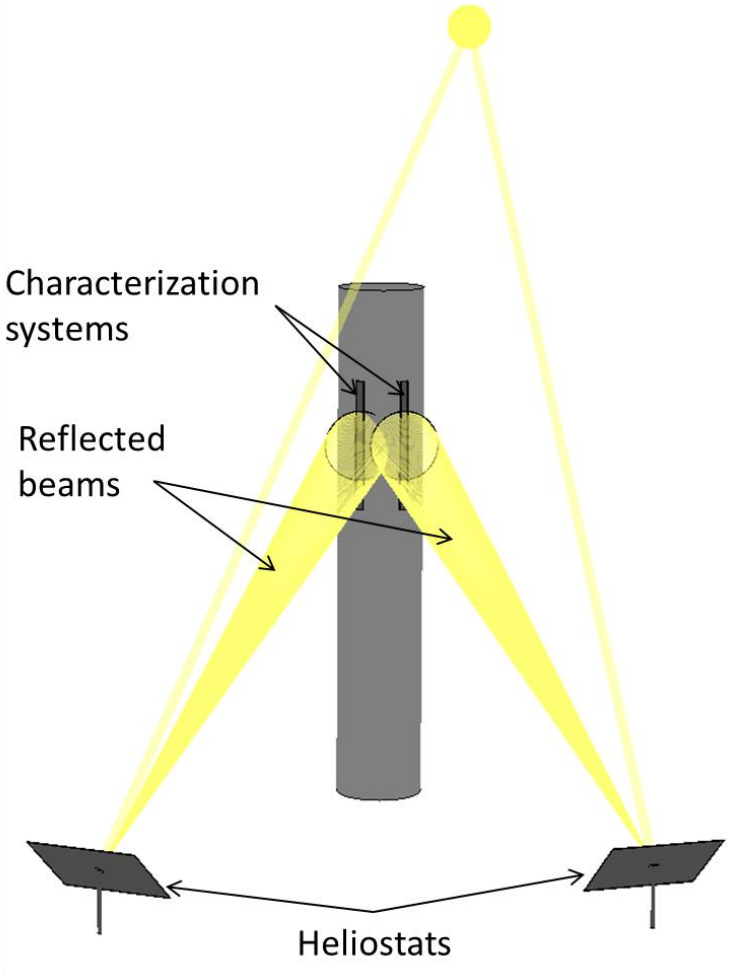
## Detail view: Support structure

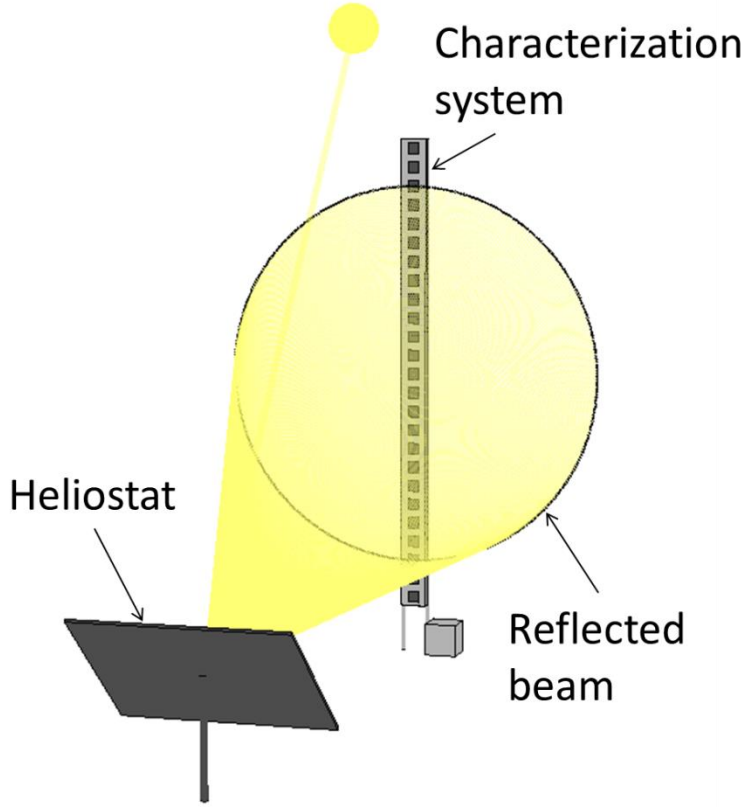
### Features

- Portable
- Versatile length
- Easy to integrate in existing plants or in the surroundings of a heliostat field

### Applicability lines

- Attaching several systems to the tower allowing the simultaneous characterization of heliostats
- As the quality control system during heliostat manufacturing, assembling and commissioning



# CURRENT STATUS & CONCLUSIONS

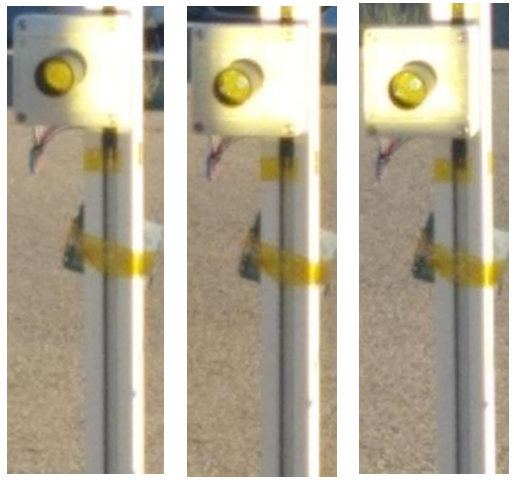
# CURRENT STATUS

Design → Build → Verification → Validation Evaluation → Market

10-15m length

25-30 detectors

Once capture each few seconds



Validation against state-of-the-art methods at in-house facility

Accuracy limits

Summer 2019

# ADVANTAGES

Direct measure of the reflected beam, no lambertian target and no camera, increasing the quality of the measurements

A suitable resolution along any flux density profile

Using a lens reduces the acceptance angle of the incident beam allowing

- An improvement of signal-to-noise ratio of the measurements
- The simultaneous characterization of heliostats working in parallel with several systems radially distributed and at different levels
- Removing the direct sun contribution when characterizing the South-East-West heliostats (if in the North hemisphere) when the sun is off of the reflexion plane

Easy to install in already operational or new power plants

Reduction in costs, no lambertian target and its maintenance

# CONCLUSIONS

An innovative solution for heliostat characterization applicable to any heliostat, breaking the current state-of-the-art shortcomings and making a step-forward in heliostat characterization

An optoelectronic device composed by vertically-aligned detectors with automatic gain adjustments and embedded lens that scans heliostat's reflected beam using sun's movement

High accuracy even with low density flux, lowering ambient noise, removing heliostat movement impact and allowing simultaneous characterizations with multiple devices

The system is portable, versatile and easy to integrate in any solar tower plant for periodic heliostat characterizations and as a quality control during assembling and commissioning

A prototype in last stages of validation and evaluation

Joint development from CENER and UNIZAR, under patent application (P2018/30756)

CENER


CONTACTO:
Ciudad de la Innovación, 7
31621 Sarriguren, Spain
T: +34 948 25 28 00

C/ Isaac Newton,
Pabellón de Italia
41092 Sevilla, Spain
T: +34 902 25 28 00

info@cener.com

www.cener.com



Iñigo Les
iles@cener.com

Marcelino Sanchez
msanchez@cener.com

# THANK YOU FOR YOU ATTENTION

CENER | NATIONAL RENEWABLE ENERGY CENTRE
ADItech

GOBIERNO DE ESPAÑA · MINISTERIO DE ENERGÍA, TURISMO Y AGENDA DIGITAL · MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD

Ciemat

Nafarroako Gobernua | Gobierno de Navarra