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INSTITUTE OF ENGINEERING; UNIVERSITY OF ALGARVE; CAMPUS DA PENHA; FARO-PORTUGAL

## **Thermo-optical performance of a solar funnel cooker**

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# The study

Funnel solar cookers are simple, effective and have multiple advantages

But there is limited data available in scientific literature about their thermo-optical performance

Study parts:

1-Analyze the optical performance (Antonio Carrillo's presentation)

2-Thermal model (work in progress)

**3-Experimental study**

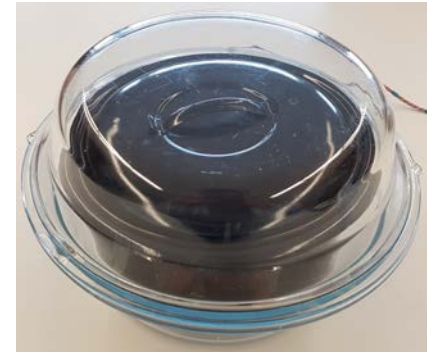
## Experimental setup: Funnel solar cooker



3 identical solar cookers



Panels-Funnel

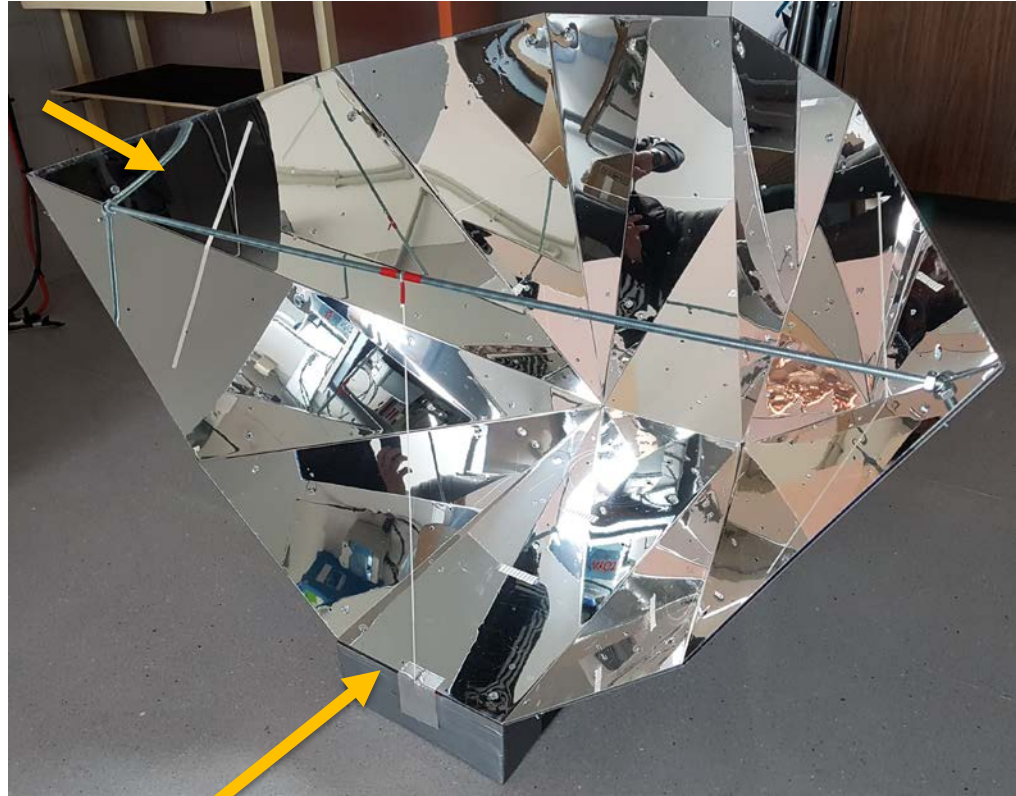


Receiver

## Experimental setup: Panels-Funnel

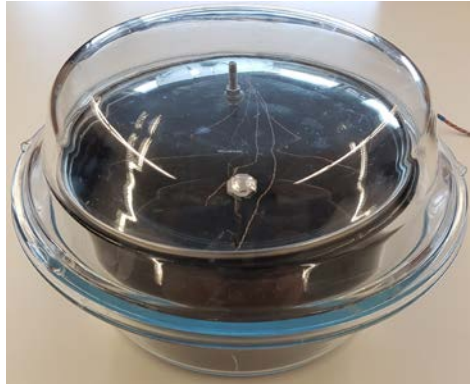
Material:

- Aluminium composite panel
- Reflectance: 0.85



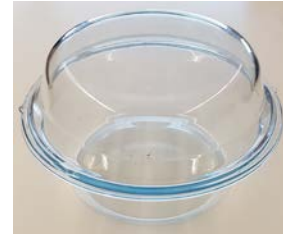
8cm thickness XPS insulator

## Experimental setup: Receiver



Optical properties (Work in progress)

- Emissivity
- Absorptivity
- Reflectance
- ...



Washing machine  
door glass  
Mass: 2239g



Pot  
Mass: 580g  
Height:10cm  
Diameter:20cm  
Capacity:2,5l



Metallic pot cover  
Mass: 252g



Glass pot cover  
Mass: 372g

# Materials and methods: Instrumentation



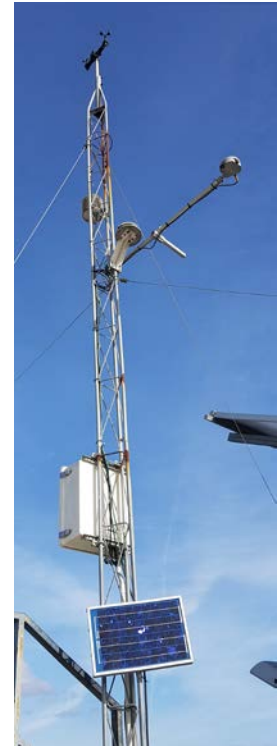
**Temperature measurement sensors**

- 5 Thermocouples in water
- 1 TC air
- 3 TC pot
- 1 TC pot cover



**Local weather station**

- Horizontal global radiation pyrometer
- 40° global radiation pyrometer
- Ambient thermometer
- Anemometer



**Weather station**

## Materials and methods: methods

Standard: ASAE S580 (Ref. Funk 2000)

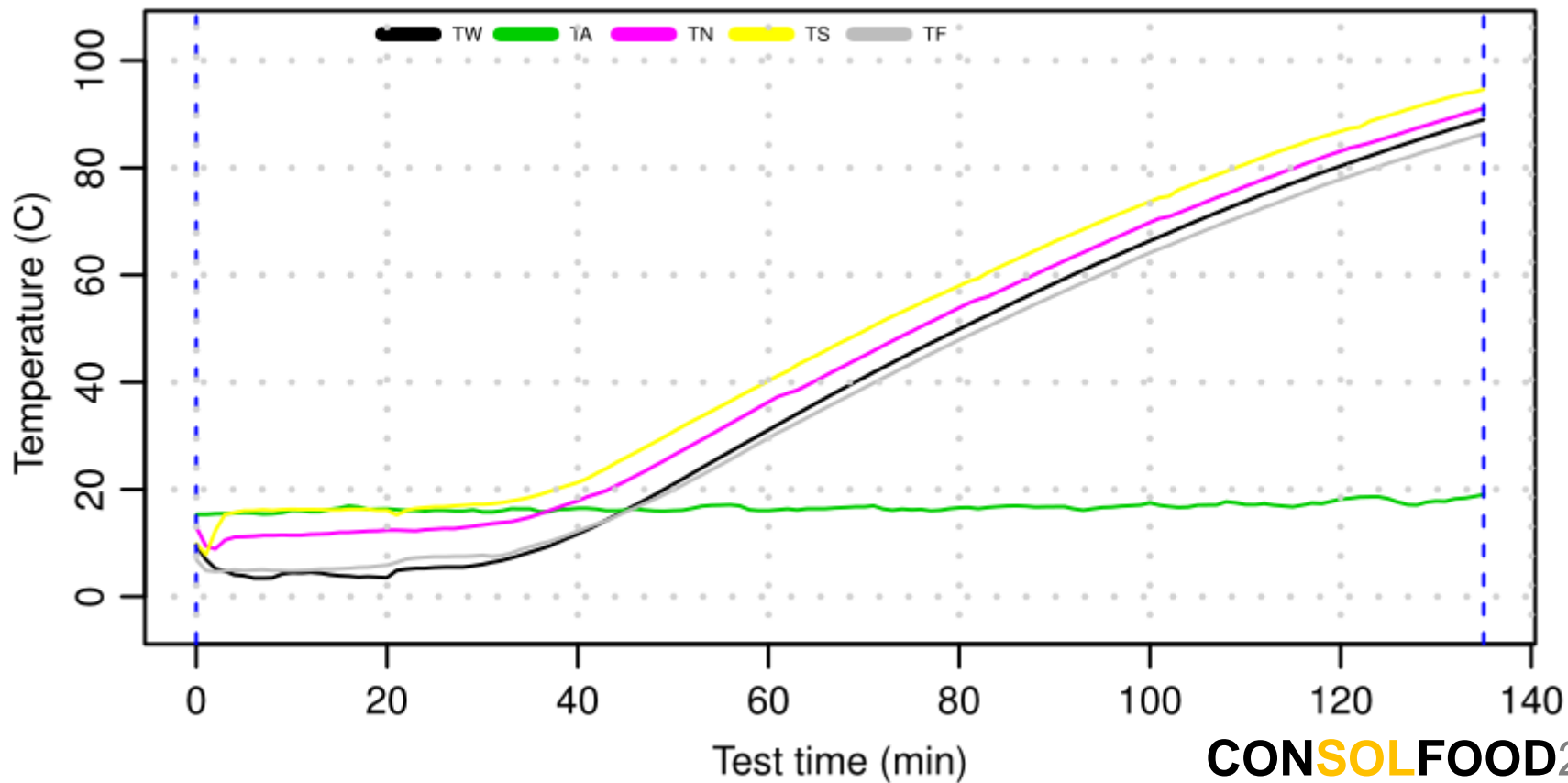
Most Important variables

Uncontrolled (weather) variables

- Wind (avg. less than 1.0m/s & max less than 2.5m/s)
- Insolation (between 450W/m<sup>2</sup> -1100W/m<sup>2</sup> & variation less than 100W/m<sup>2</sup> during a 10-min)
- Solar altitude and azimuth (between 10:00 and 14:00 solar time)

## Materials and methods: test data

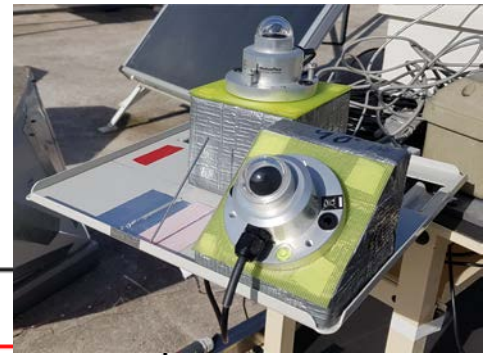
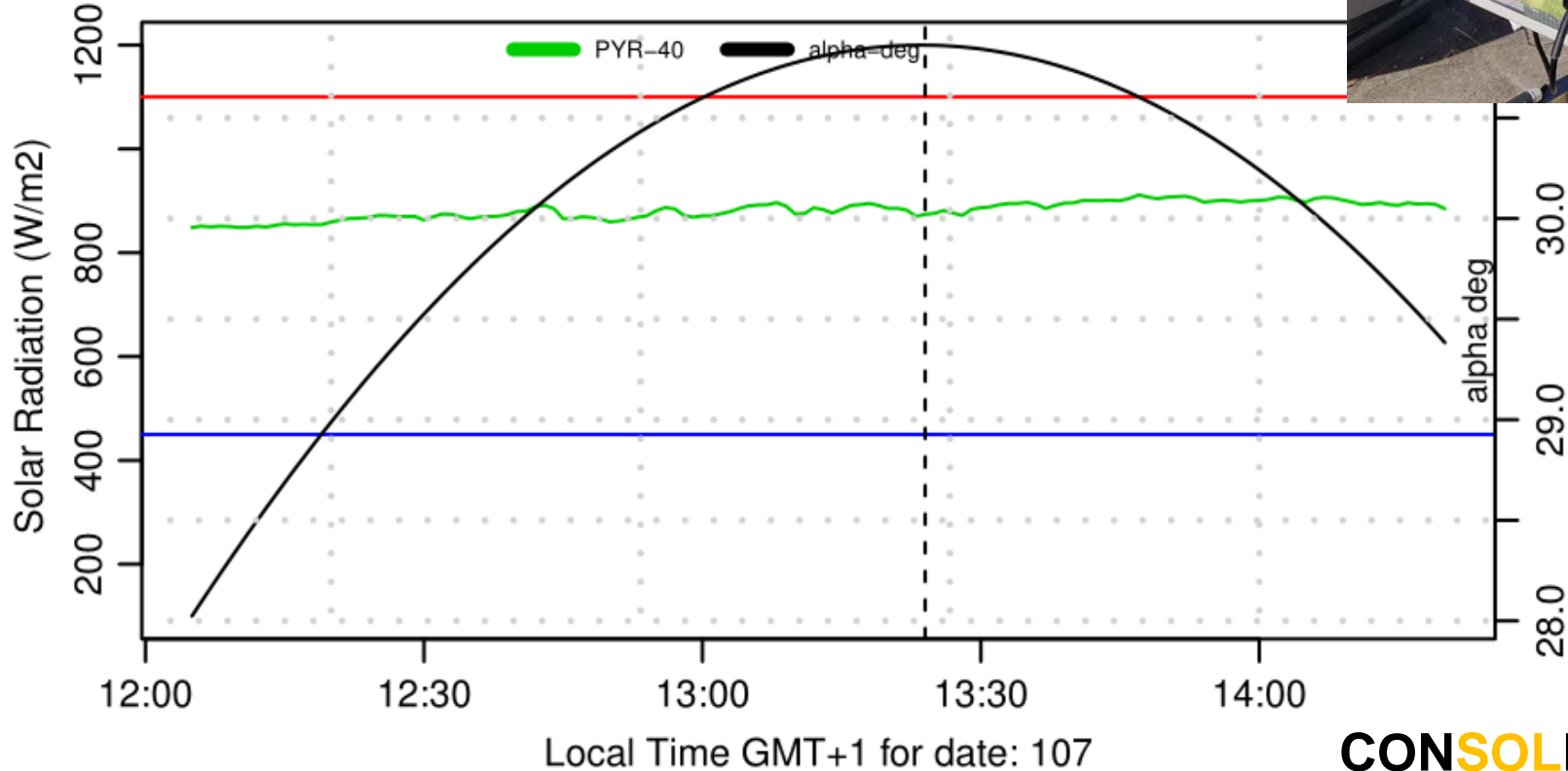
### E 57 CSR01 Temperature water-air-pot





# Materials and methods: test data

## E 57 Solar Radiation 40deg



## Materials and methods: test analysis

Analyze of the results according to the standard (ASAE S580, Ref. Funk 2000)

- Calculating cooking power

$$P_i = \frac{T_2 - T_1}{600} * m * C_{pw}$$

- Standardizing cooking power (to be corrected to standard insolation of 700 W/m<sup>2</sup>)

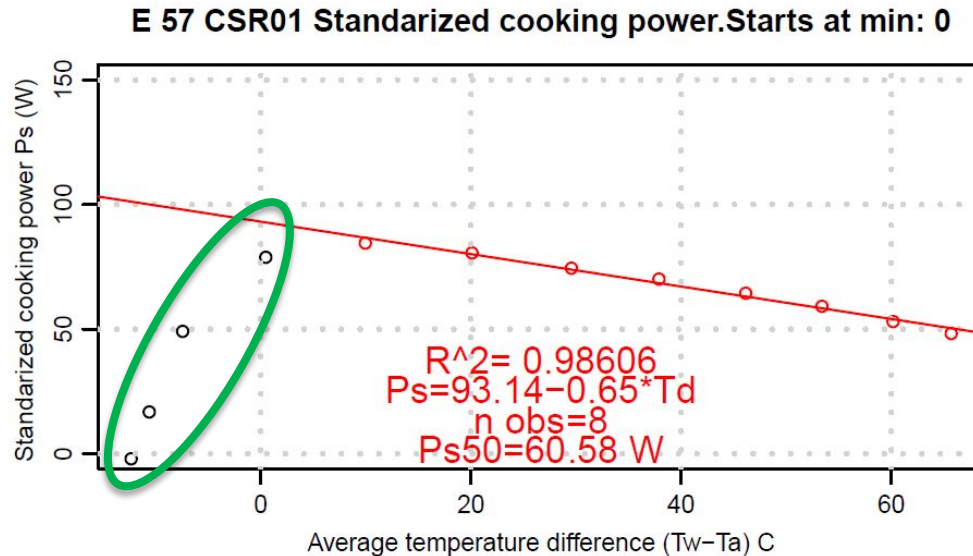
$$P_{si} = P_i * \frac{700}{G_i}$$

$G_i$  : average insolation i ( $\frac{W}{m^2}$ ).

# Materials and methods: test analysis

Protocol: ASAE S580 (Ref. Funk 2000)

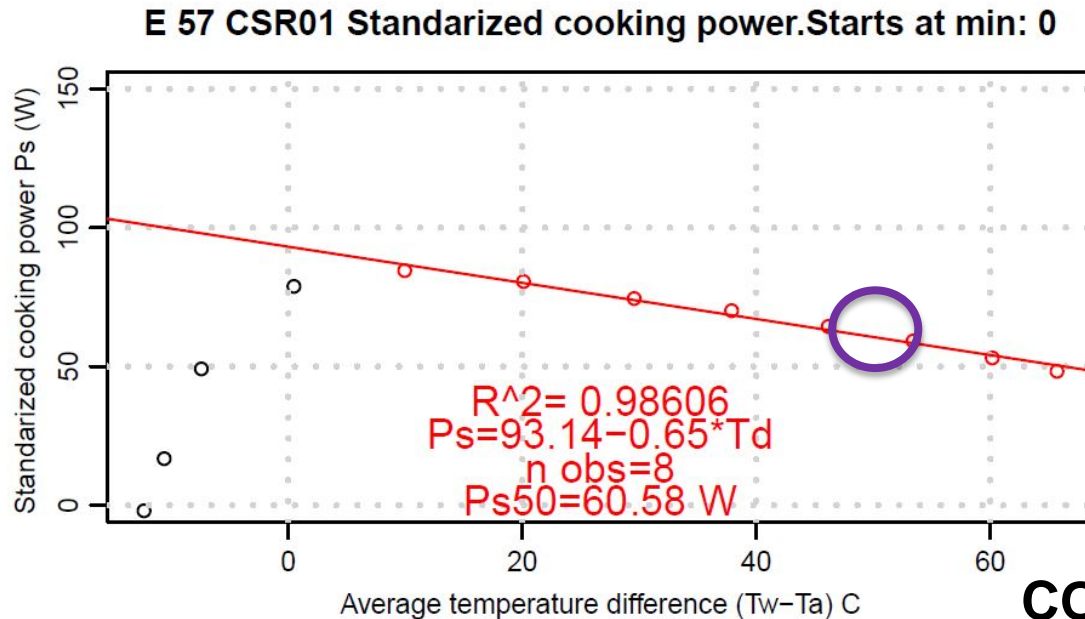
- Plotting (The standardized cooking power (W) is to be plotted against the temperature difference (°C))
- - A linear regression



# Materials and methods: test analysis

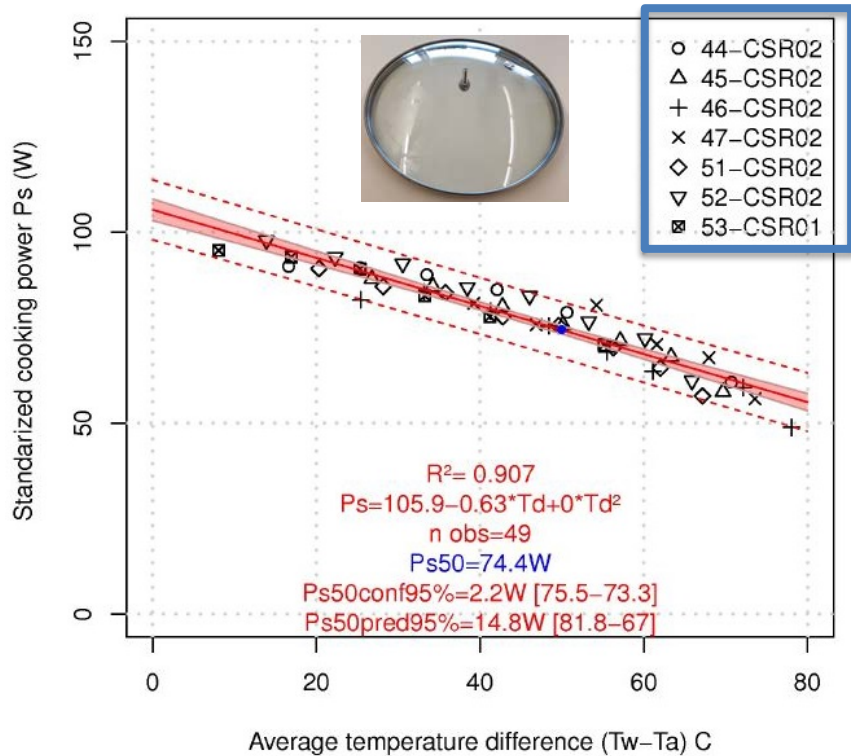
Protocol: ASAE S580 (Ref. Funk 2000)

- Single measure of performance (The value for standardized cooking power (W) is to be computed for a temperature difference of 50°C)

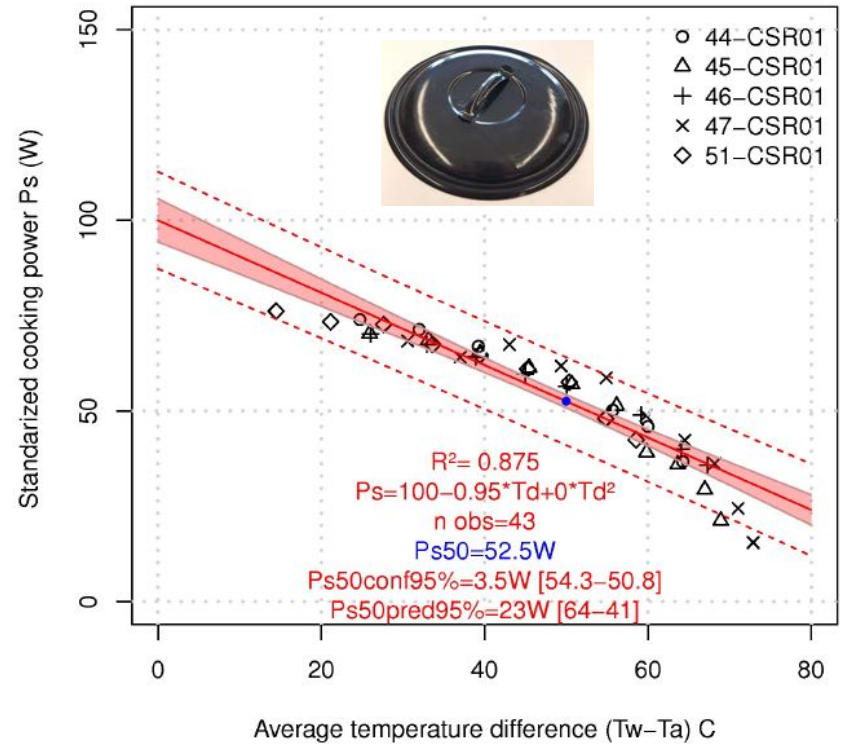


# Experimental Results

## Standardized cooking power Glass e=0cm

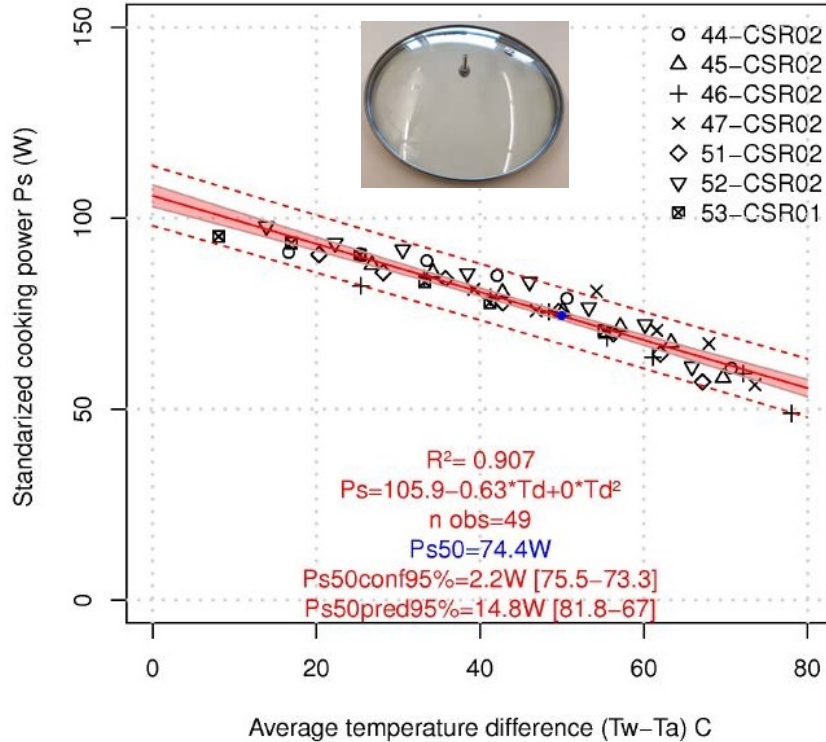


## Standardized cooking power Black metal e=0cm

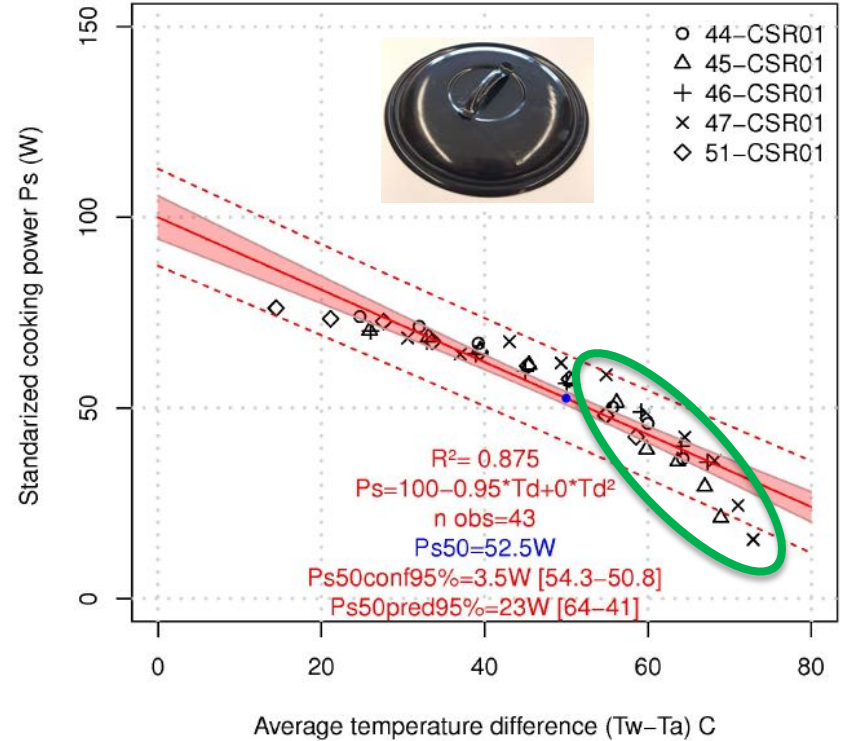


# Experimental Results

Standardized cooking power Glass e=0cm



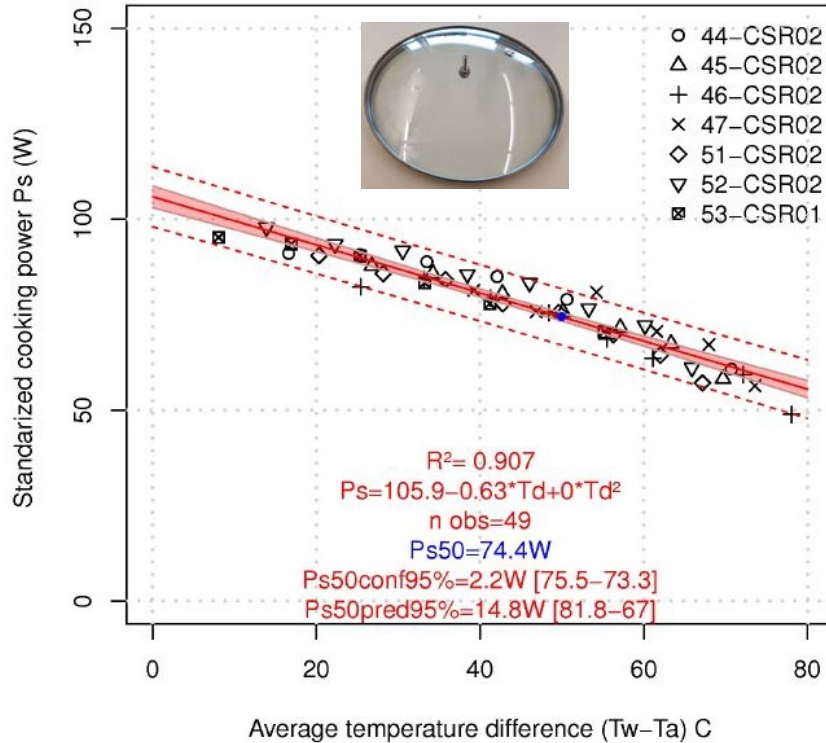
Standardized cooking power Black metal e=0cm



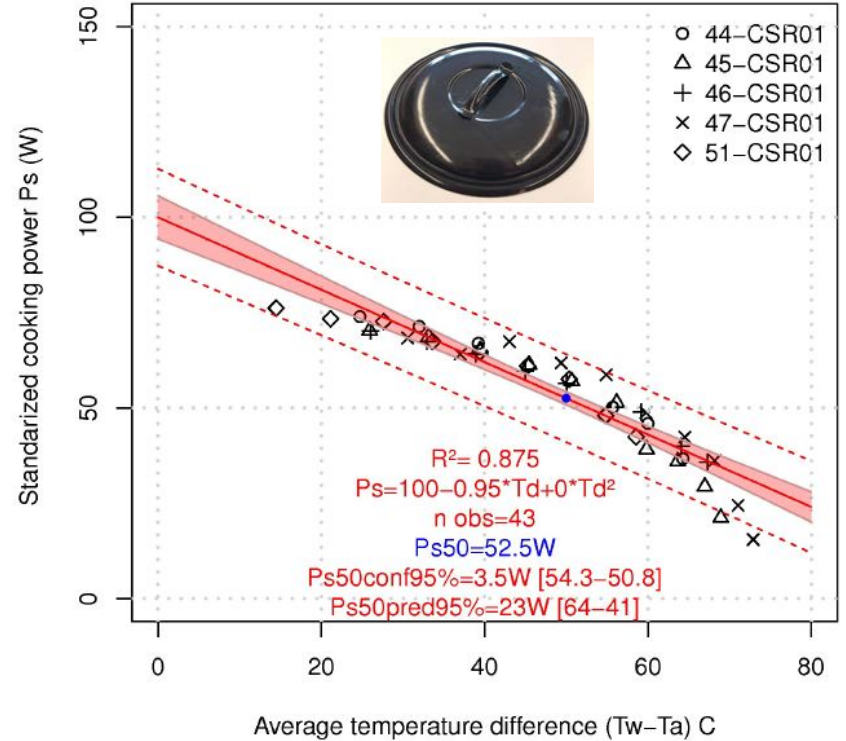


# Experimental Results

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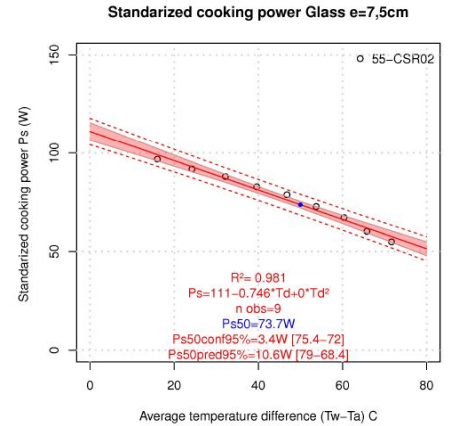
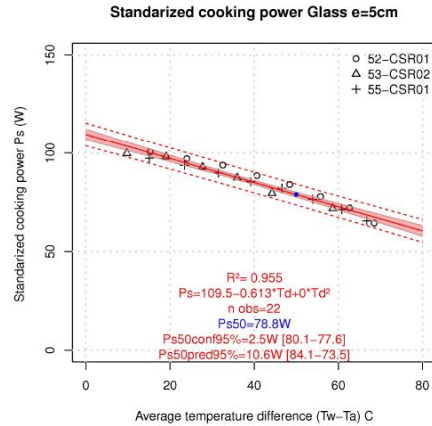
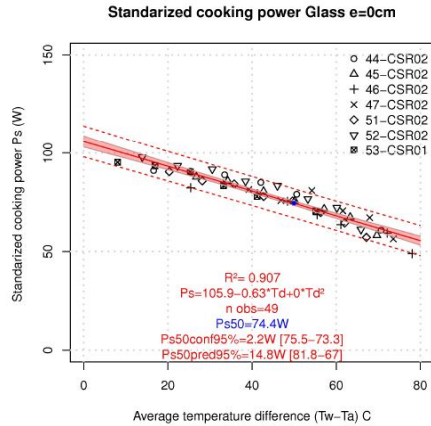


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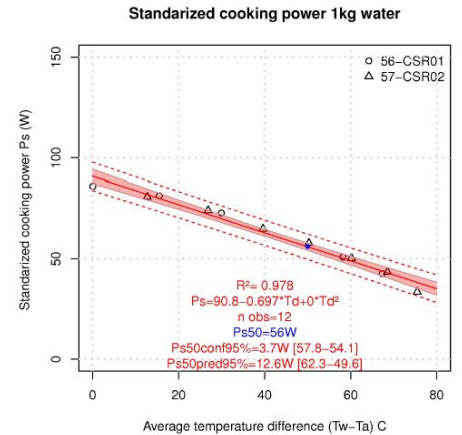
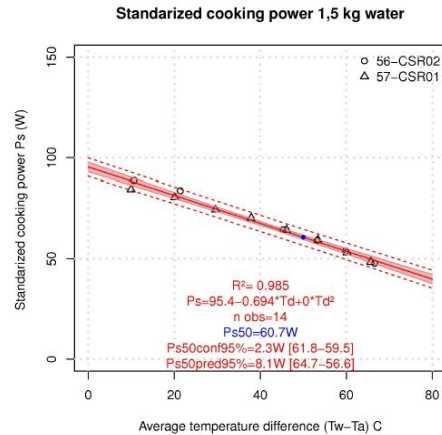
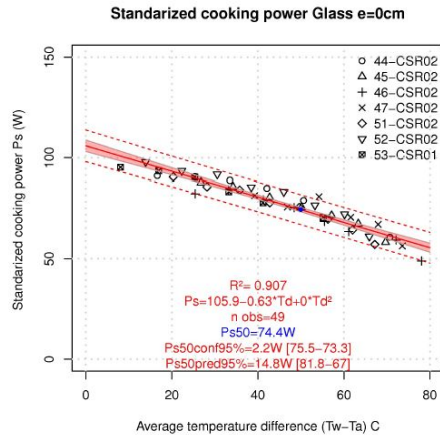


# Experimental Results

Receiver s have  
been raised



Different water  
loads





## Conclusions and perspectives

- Thermal performance parameters for several configurations of a typical solar funnel cooker have been determined following standard ASAE S580.
- Results are robust and repeatable
- Configuration with glass cover and elevated receiver performs better
- Thermal performance is better with high water load
- Future work: characterize other configurations such as summer configuration, different fluids, receivers, reflector area, materials, etc.