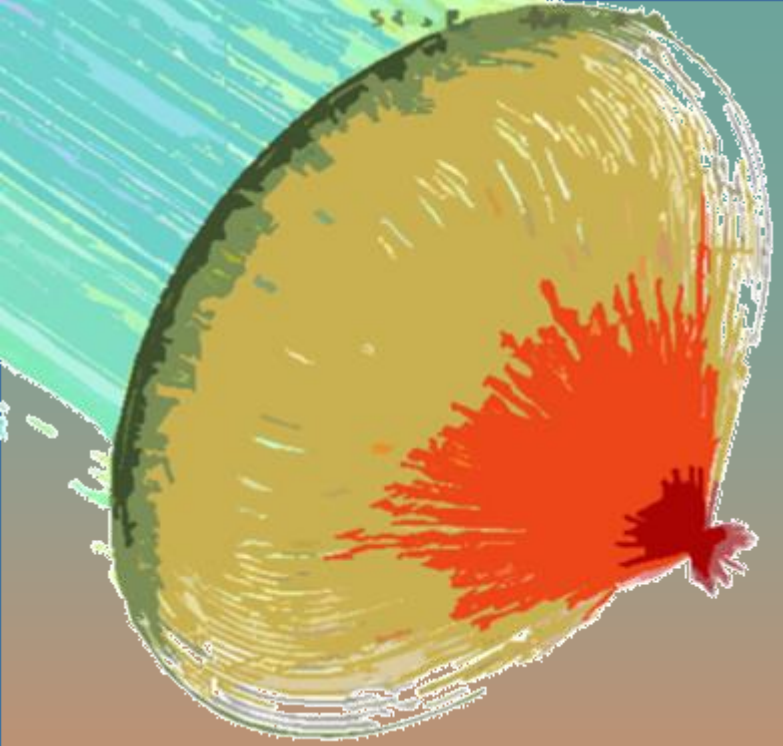

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Using MATLAB® for the Design and Evaluation of the Fresnel-Lens Based Solar Concentrator

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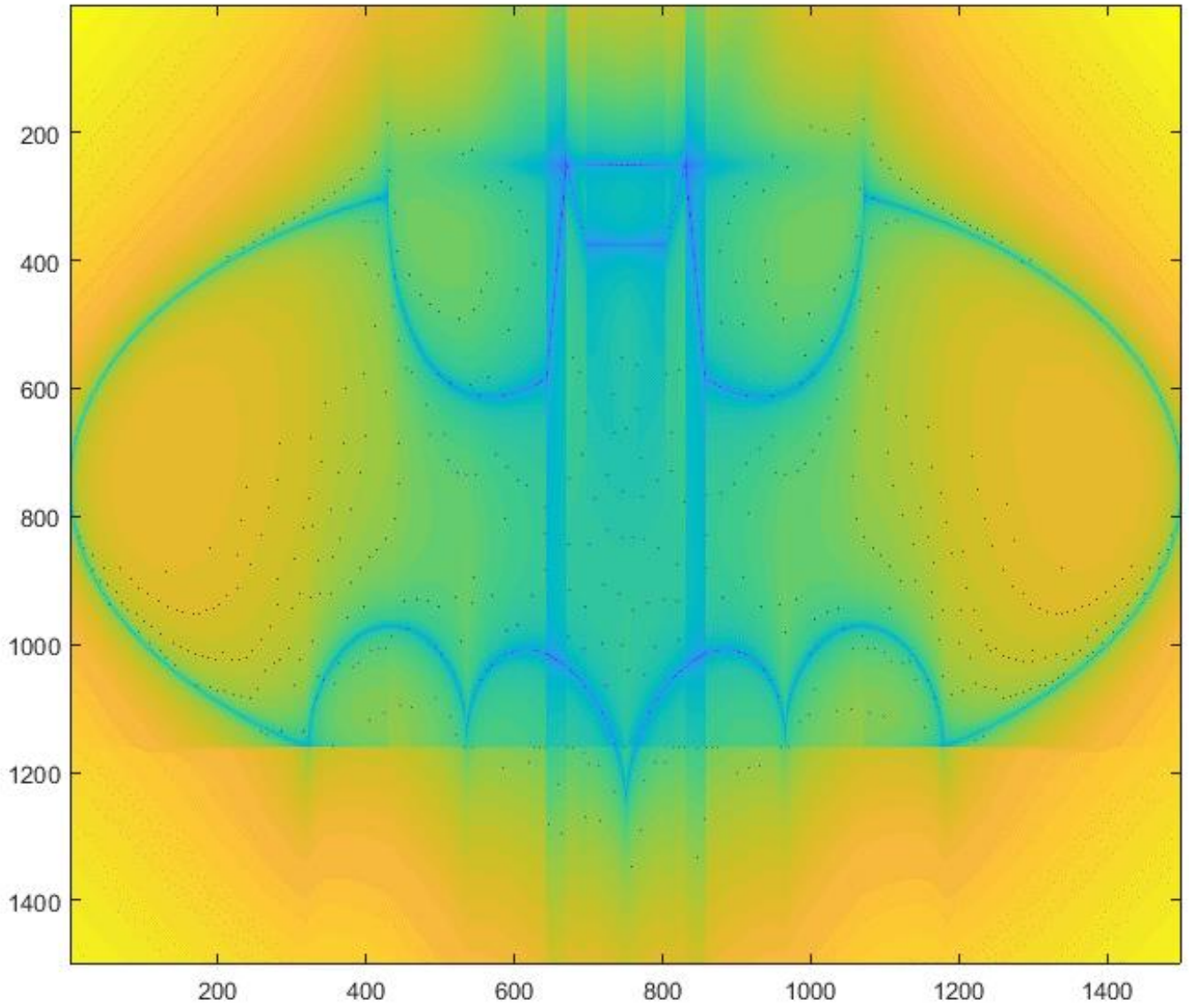
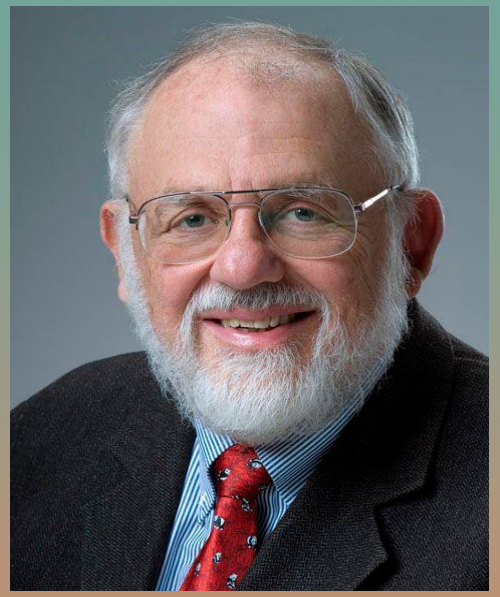
UNT

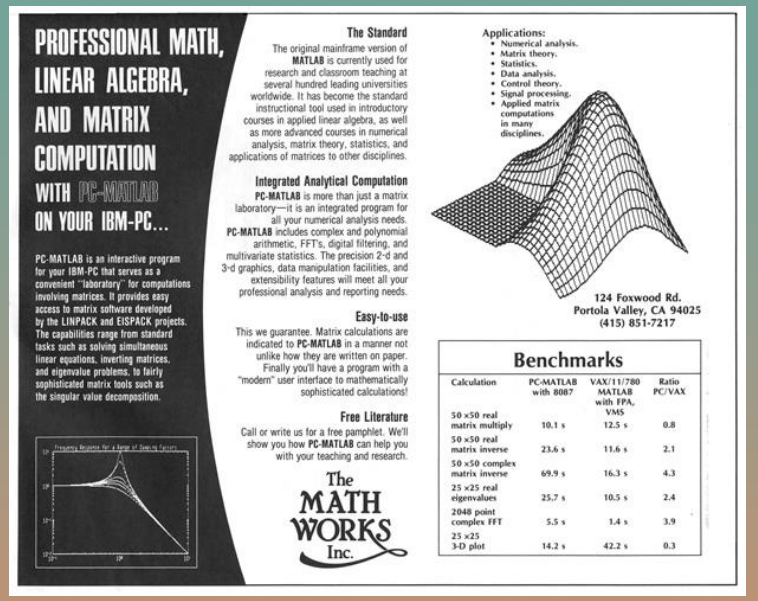
The BATMAN CODE!

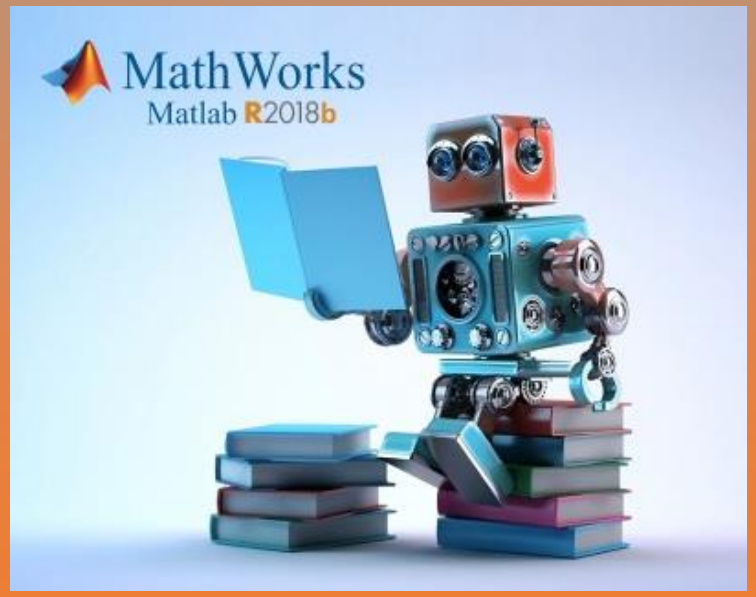


Founders



History





Company

MathWorks®

Revenue

$900 million in 2017

>60% from outside the US

People

4,000

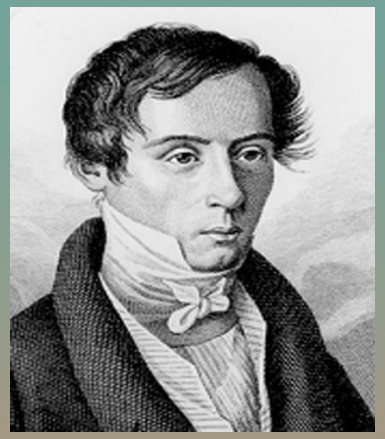
>30% outside the US

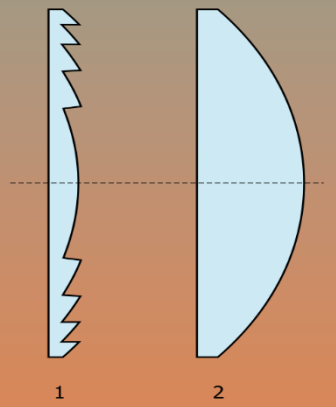
Users

>3,000,000

worldwide

History





Applications

Advantages

Compact
Thicknesses <1mm

Light-weight
1 m^2 lens ~ 1.5 kg

Higher Concentration
As high as 2000x (GCR)

Shorter Focal Length
Based on prism shapes

Design Flexibility
Compared to parabolic troughs

Lower cost
Normally PMMA

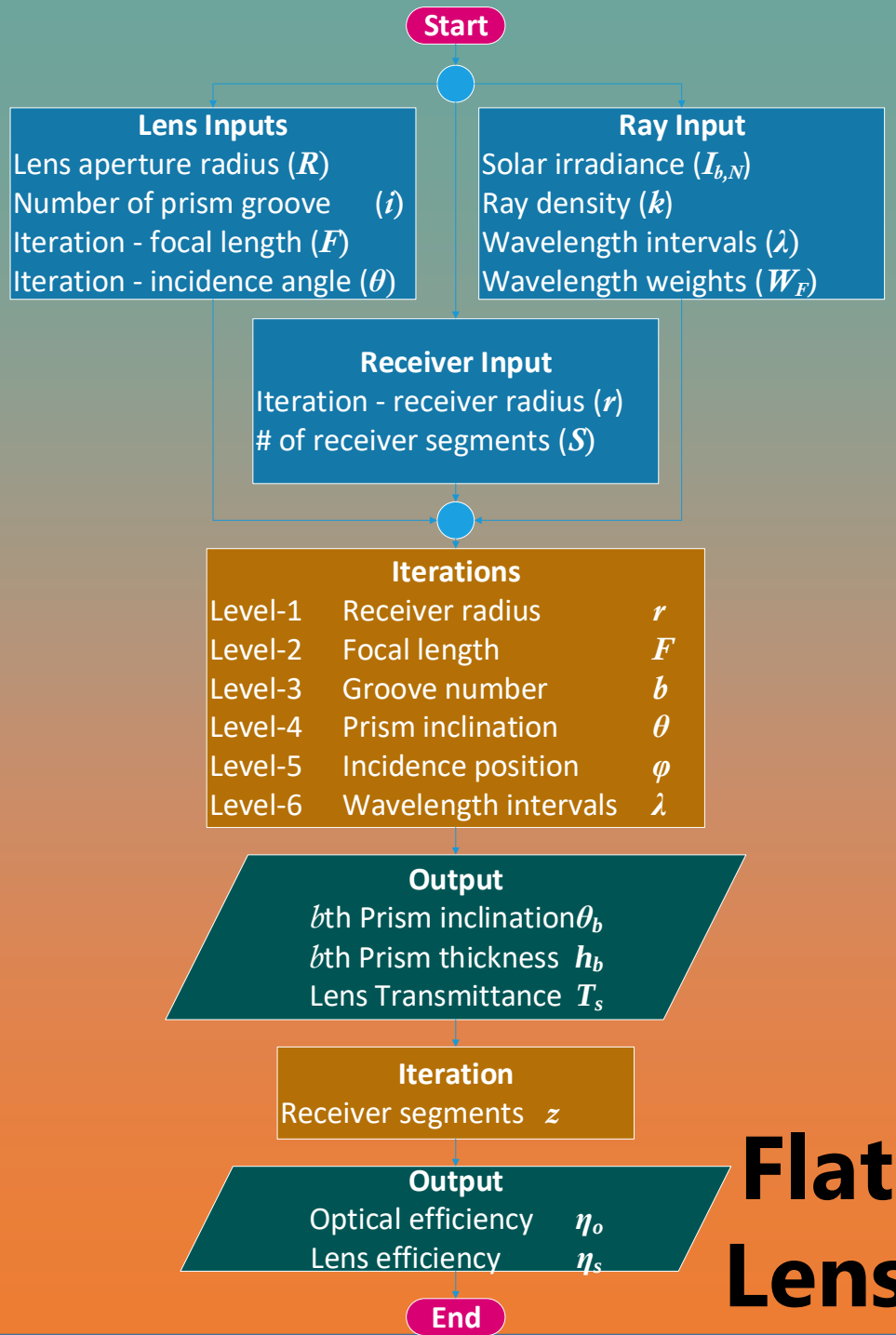
The Design Concept

Count all successful **ray arrivals** at the different incidence conditions

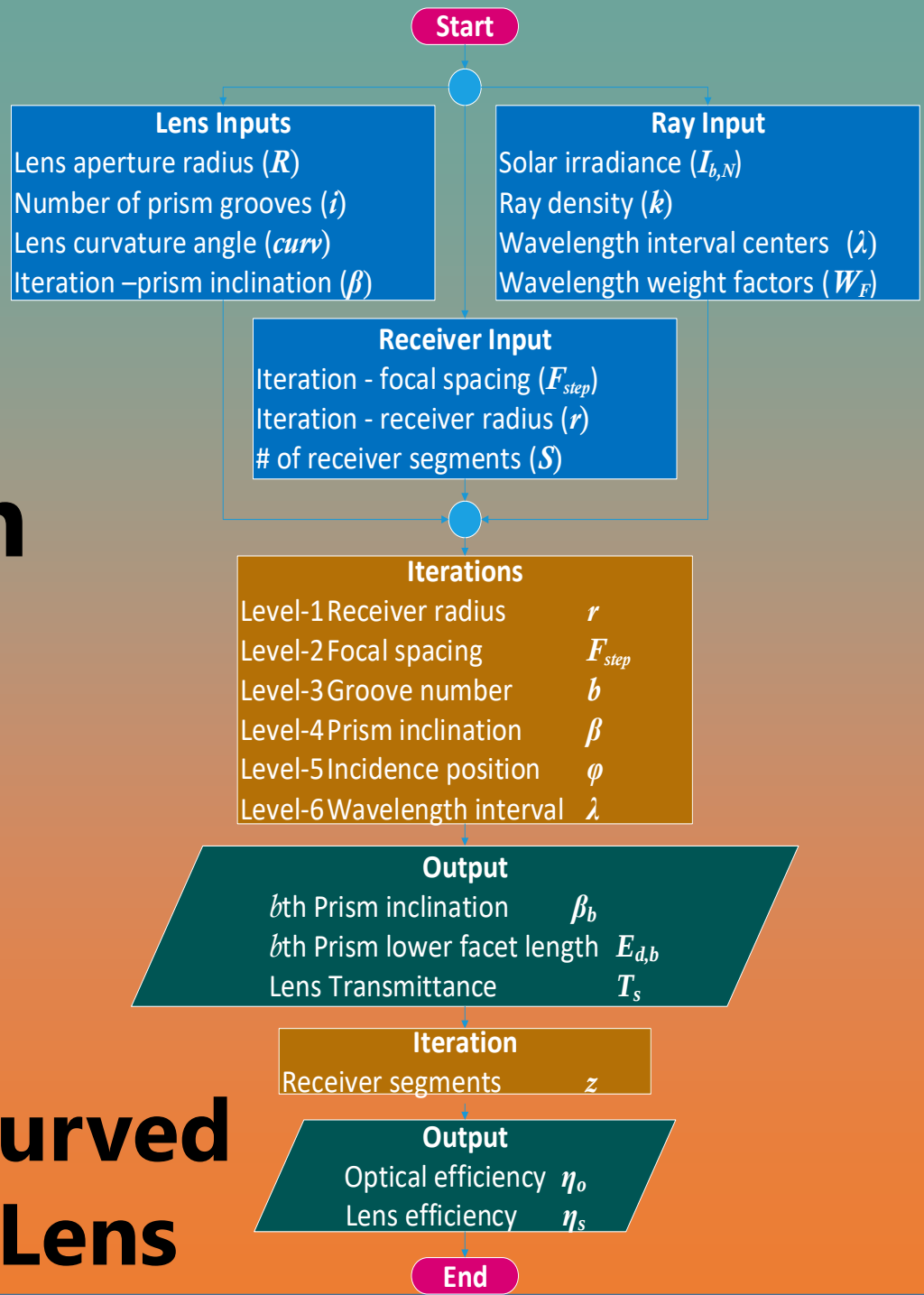
Convert the successful ray arrivals at the focal receiver **into CDF** cumulative distribution function

Transform the statistical distribution **into heat** and **flux** distributions

The Algorithm Flow



Flat Lens



Curved Lens

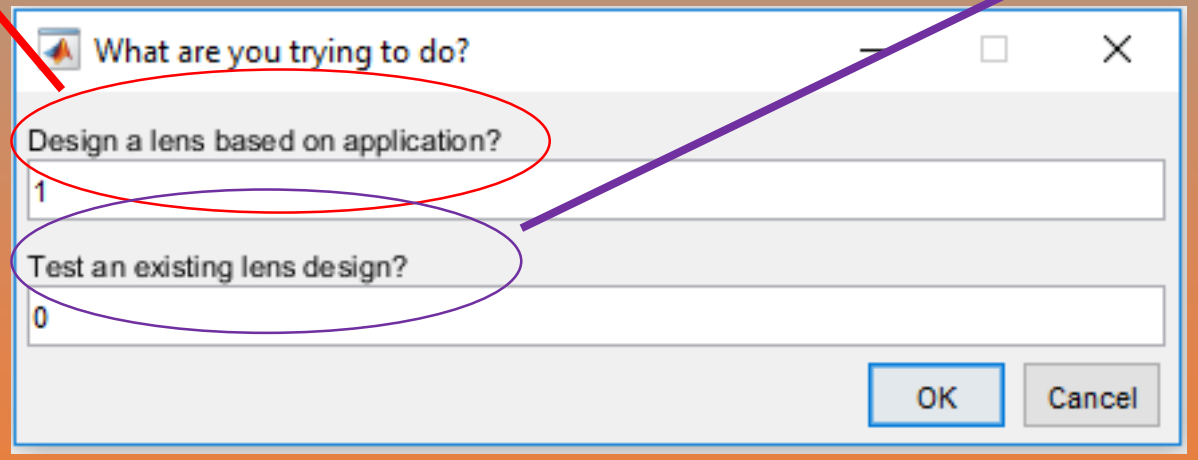
The Code

Design a Lens

Based on application
(Find the lens parameters to achieve a predefined T)

Test a Lens

Based on an existing design
(Generate a heat and flux plots of the receiver)



> **1,500** lines

> **1,000** lines

Sample Lens Design

Total of 3.44 W needed with convective and radiative losses

Estimate of 7 cm of lens diameter needed

Iterate system dimensions to meet total needed power

```
>> Main_run_file
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Study type: Design a lens based on application
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Lens type: Flat-Spot
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Receiver radius (r) : 5.640000e+00 mm.
Desired surface temp. (Ts) : 900 K.
Heat Loss (Qloss) : 3.261132e+00 W.
Heat Required (Qreq) : 3.436132e+00 W.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Estimated required lens diameter : 7.174316e+01 mm.
Recommended lens-aperture interation limits are within 20% of the estimated value
Recommended lens-aperture interation limits are based on 85% lens efficiency
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Variables being tested now
     a           g           f          TotE
   68.0000    34.0000    25.0000     3.0655

   68.0000    34.0000    30.0000     3.4163

   68.0000    34.0000    35.0000     3.3096

   68.0000    34.0000    40.0000     3.4739

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

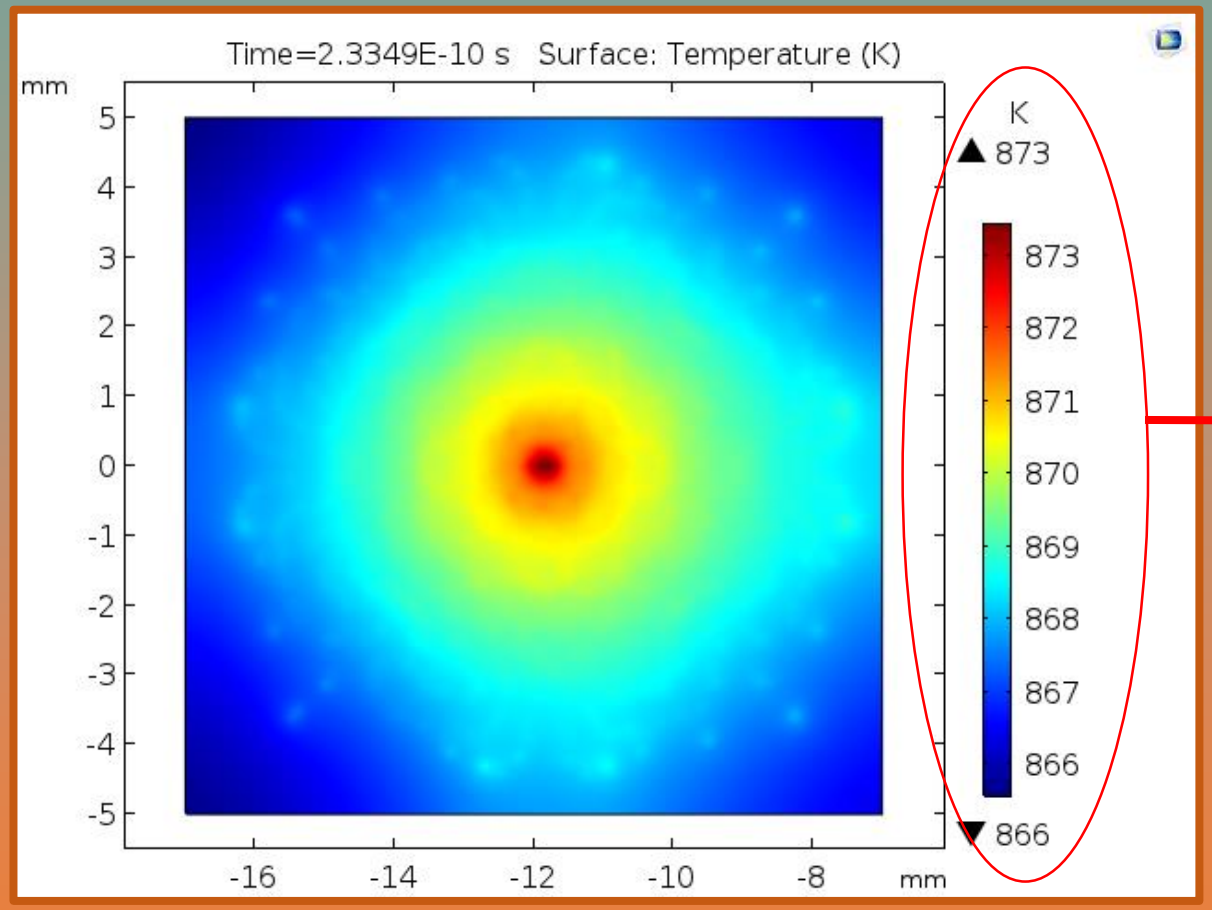
Lens Diameter **Groove Count** **Focal Length**

Code Output

Desired system description

while running the code!

Sample Lens Design



Maximum and minimum temperatures are within the required 625˚C

Simulated Temperature Distribution

at the focal area

THANK YOU

QUESTIONS?