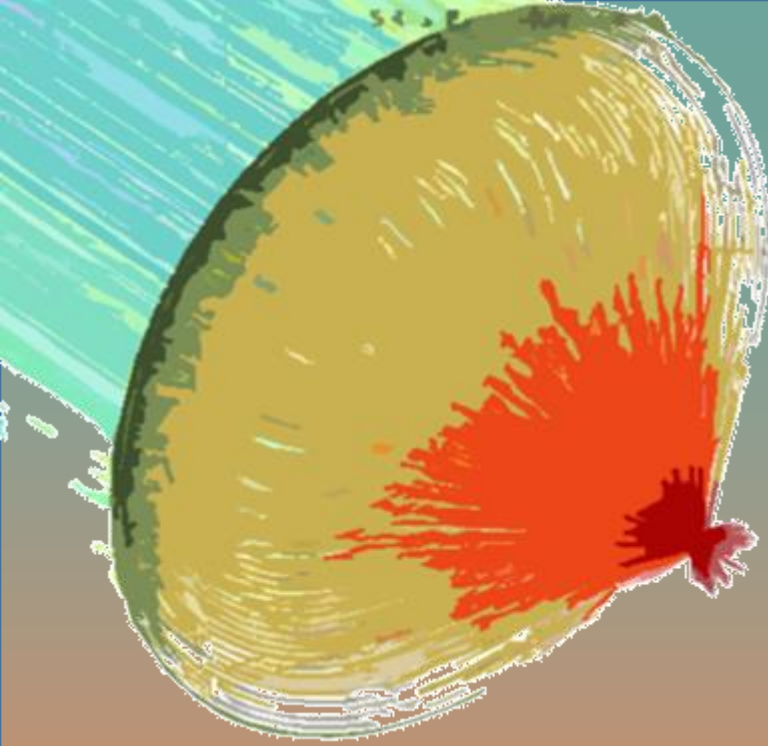


NAAAEA Technical Conference 2018

November 9, 2018 Richardson, TX



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

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Dep. of Mechanical & Energy Engineering

College of Engineering

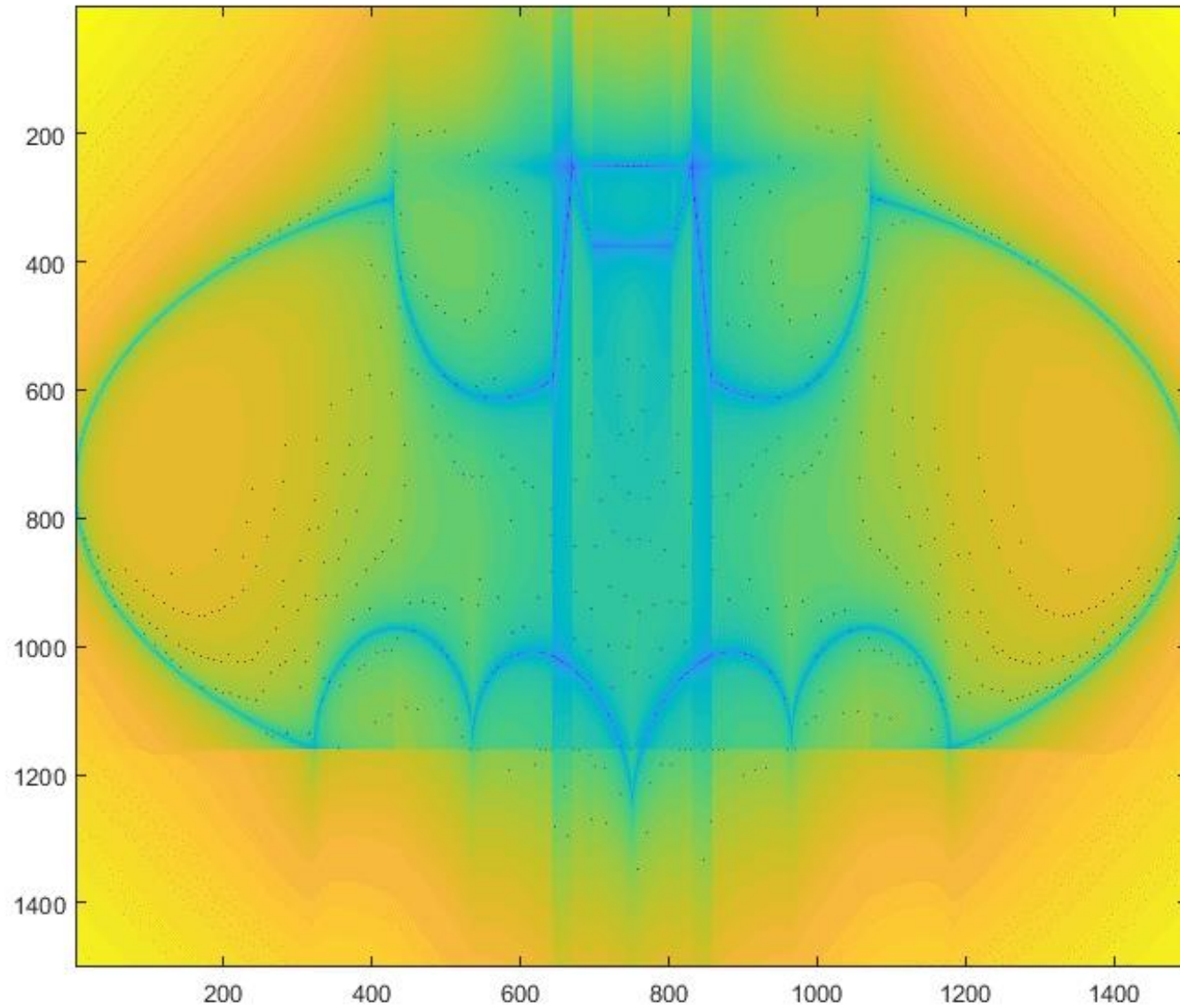
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DEPARTMENT OF
MECHANICAL &
ENERGY ENGINEERING
College of
Engineering

UNT

The BATMAN CODE!



Founders



History

**PROFESSIONAL MATH,
LINEAR ALGEBRA,
AND MATRIX
COMPUTATION
WITH PC-MATLAB
ON YOUR IBM-PC...**

PC-MATLAB is an interactive program for your IBM-PC that serves as a convenient "laboratory" for computations involving matrices. It provides easy access to matrix software developed by the LINPACK and EISPACK projects. The capabilities range from standard tasks such as solving simultaneous linear equations, inverting matrices, and eigenvalue problems, to fairly sophisticated matrix tools such as the singular value decomposition.

The Standard
The original mainframe version of **MATLAB** is currently used for research and classroom teaching at several hundred leading universities worldwide. It has become the standard instructional tool used in introductory courses in applied linear algebra, as well as more advanced courses in numerical analysis, matrix theory, statistics, and applications of matrices to other disciplines.

Integrated Analytical Computation
PC-MATLAB is more than just a matrix laboratory—it is an integrated program for all your numerical analysis needs. **PC-MATLAB** includes complex and polynomial arithmetic, FFT's, digital filtering, and multivariate statistics. The precision 2-d and 3-d graphics, data manipulation facilities, and extensibility features will meet all your professional analysis and reporting needs.

Easy-to-use
This we guarantee. Matrix calculations are indicated to **PC-MATLAB** in a manner not unlike how they are written on paper. Finally you'll have a program with a "modern" user interface to mathematically sophisticated calculations!

Free Literature
Call or write us for a free pamphlet. We'll show you how **PC-MATLAB** can help you with your teaching and research.

The MATH WORKS Inc.

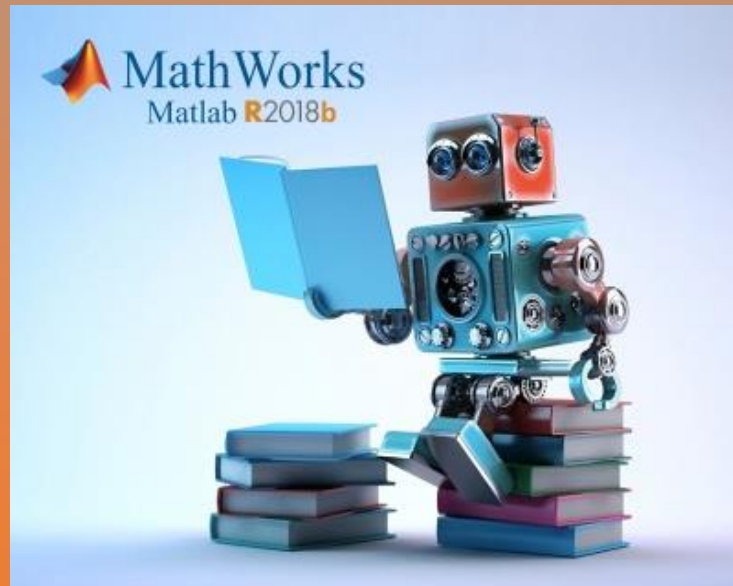
Applications:

- Numerical analysis.
- Matrix theory.
- Statistics.
- Data analysis.
- Control theory.
- Signal processing.
- Applied matrix computations in many disciplines.

124 Foxwood Rd.
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Benchmarks

Calculation	PC-MATLAB with 8087	VAX/11/780 MATELAB with FPA, VMS	Ratio PC/VAX
50 x 50 real matrix multiply	10.1 s	12.5 s	0.8
50 x 50 real matrix inverse	23.6 s	11.6 s	2.1
50 x 50 complex matrix inverse	69.9 s	16.3 s	4.3
25 x 25 real eigenvalues	25.7 s	10.5 s	2.4
2048 point complex FFT	5.5 s	1.4 s	3.9
25 x 25 3-D plot	14.2 s	42.2 s	0.3



Company



Revenue

\$ **900** million in 2017

>60% from outside the US

People

4,000

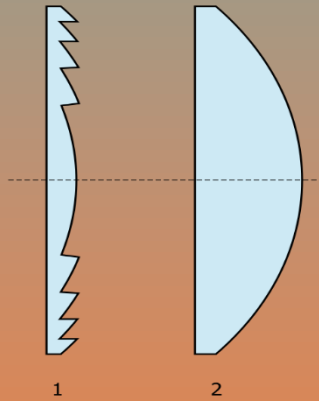
>30% outside the US

Users

> **3,000,000**

worldwide

History



Applications



Advantages

Compact

Thicknesses < 1mm

Light-weight

1 m² lens ~ 1.5 kg

Higher

Concentration

As high as 2000x (GCR)

Shorter

Focal Length

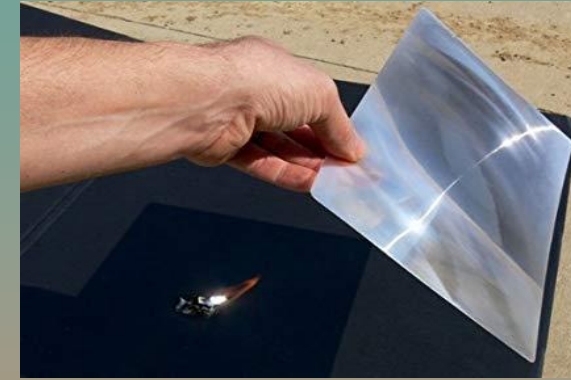
Based on prism shapes

Design Flexibility

Compared to parabolic troughs

Lower cost

Normally PMMA



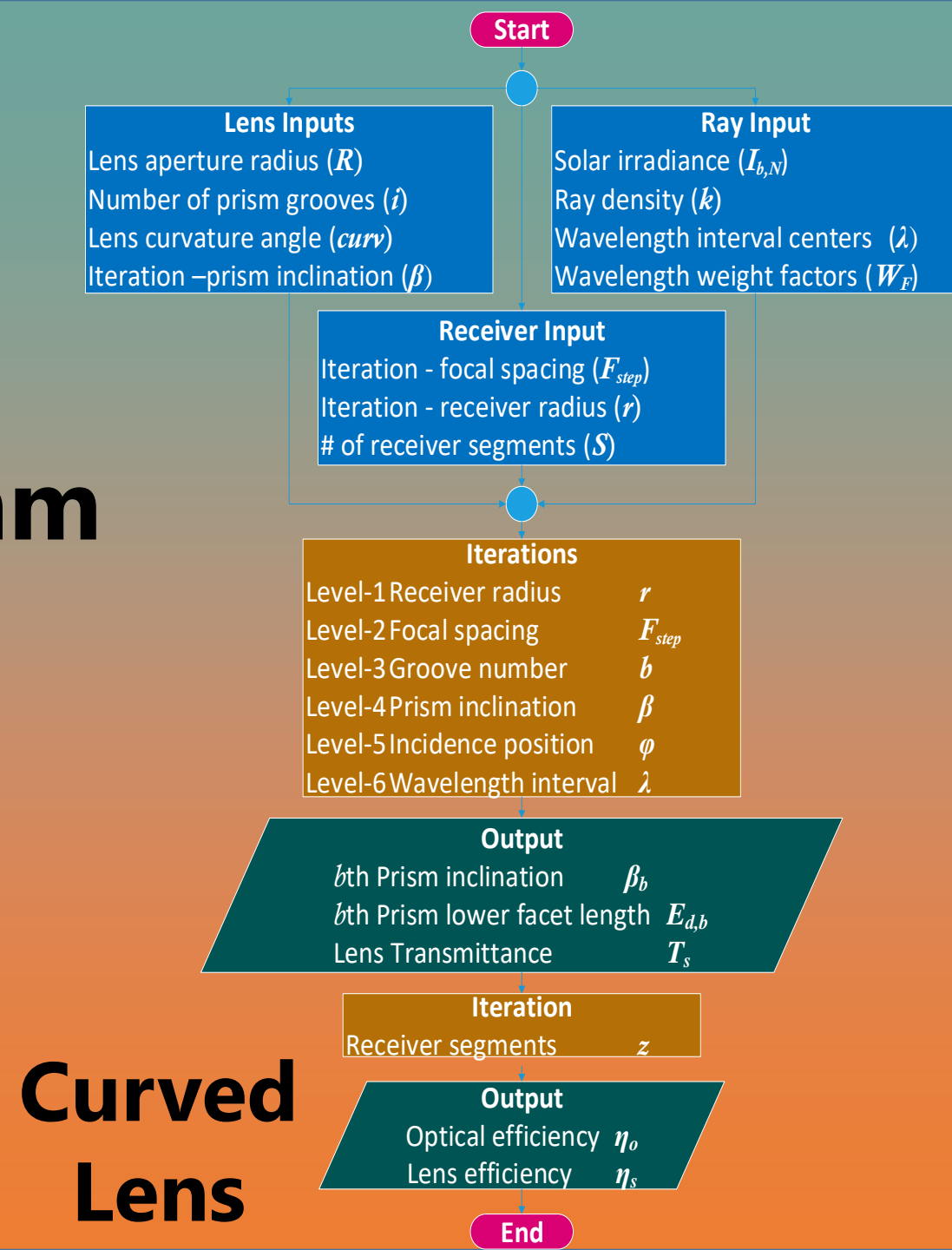
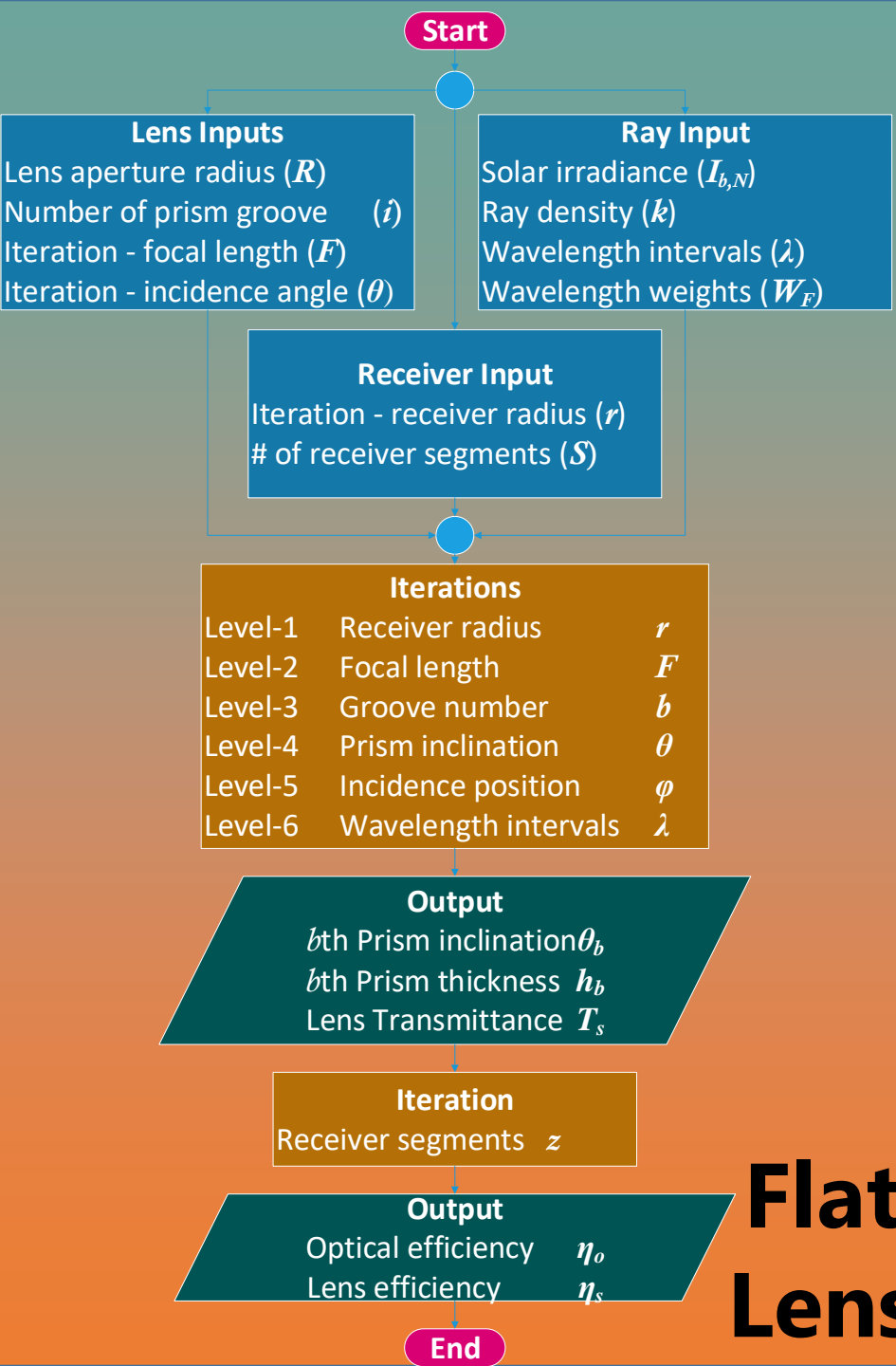
The Design Concept

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



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)

What are you trying to do?

Design a lens based on application?
1

Test an existing lens design?
0

OK Cancel

> **1,500** lines

> **1,000** lines

Sample Lens Design

```
>> 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
#####
```

Code Output

Desired system description

while running the code!

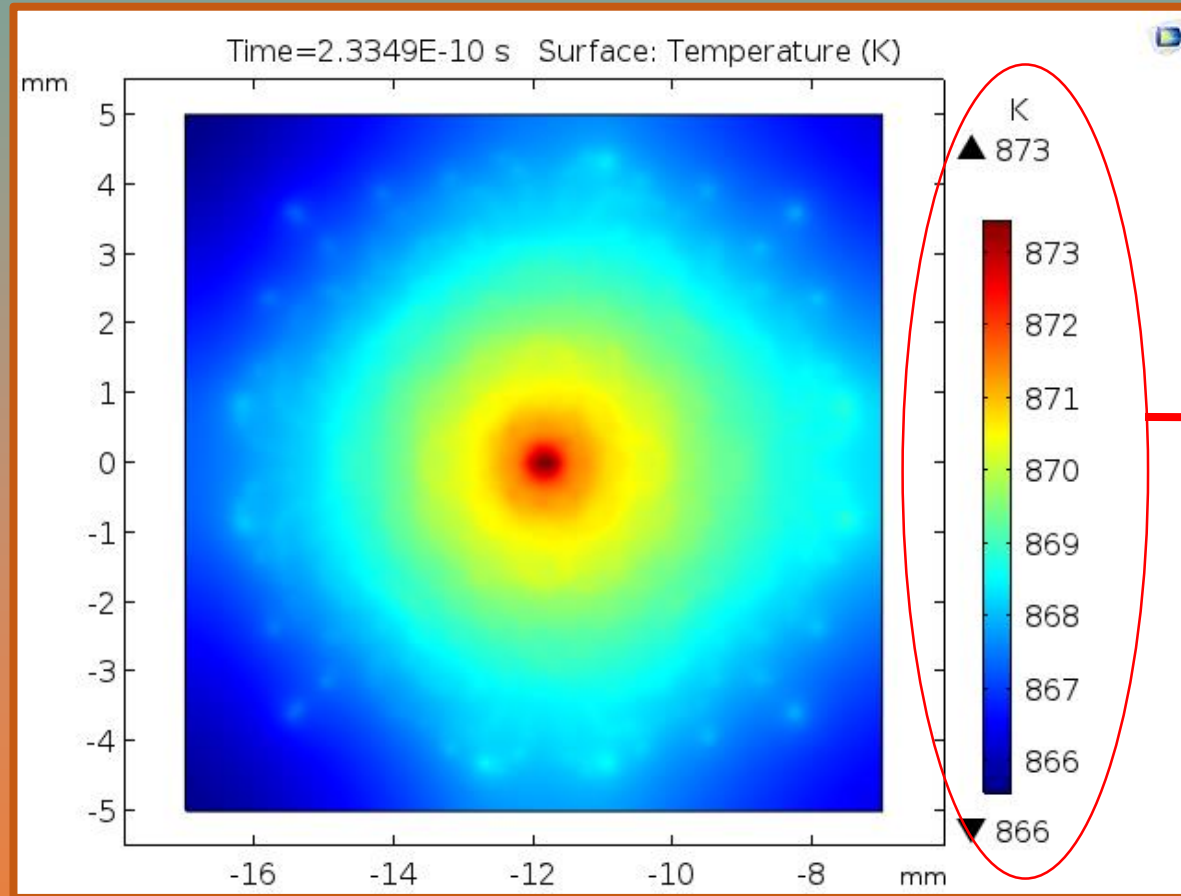
Total of **3.44 W** needed with convective and radiative losses

Estimate of **7 cm** of lens diameter needed

Iterate system dimensions to meet total needed power

Lens Diameter Groove Count Focal Length

Sample Lens Design



Maximum and minimum temperatures are within the required 625°C

Simulated Temperature Distribution
at the focal area

THANK YOU

QUESTIONS?