Development of AR light guide

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Motivation

It is believed that these devices will not only be used for entertainment but will also play a central role in education, medicine and communication.

VR optics shuts out the outside world from the user, hence the need for AR which superimposes the virtual images while permitting the user to continue viewing the real world

System Performance

-Light weight
-Compact and manufacturable (The mechanical assembly must be easy to put together)
-Have a good field of view, not exceptional
-Low F-number
-Good image quality with essentially low distortion

| System Performance Table	Specification (minimum)	Specification (maximum)	Reference design	DesignWK10_S1	DesignWK10_S2	DesignWK10_S3
Field of View	10	70	NA		34	36
Image Quality	NA	NA	NA	Average	Average	Better
Weight in grams	10	200	NA	82.148	36.78	185.88

Aberration Coefficients

% Date   Mar 29 2020, 15:25
% Table   Table 1 - Aberration Evaluation 1

% Radial index	Meridional index	Zernike coefficient
0	0	-1.54E-19
1	-1	1.74E-19
1	1	-5.52E-20
2	-2	-5.37E-20
2	0	-9.39E-20
2	2	6.64E-23
3	-3	1.88E-19
3	-1	6.69E-21
3	1	-2.11E-20
3	3	-4.91E-20
4	-4	-9.95E-21
4	-2	-5.73E-22
4	0	-3.65E-21
4	2	1.25E-21
4	4	6.13E-22
5	-5	-1.08E-20
5	-3	-1.41E-19
5	-1	-1.18E-19
5	1	4.92E-20
5	3	3.95E-20
5	5	-5.84E-20

Designs
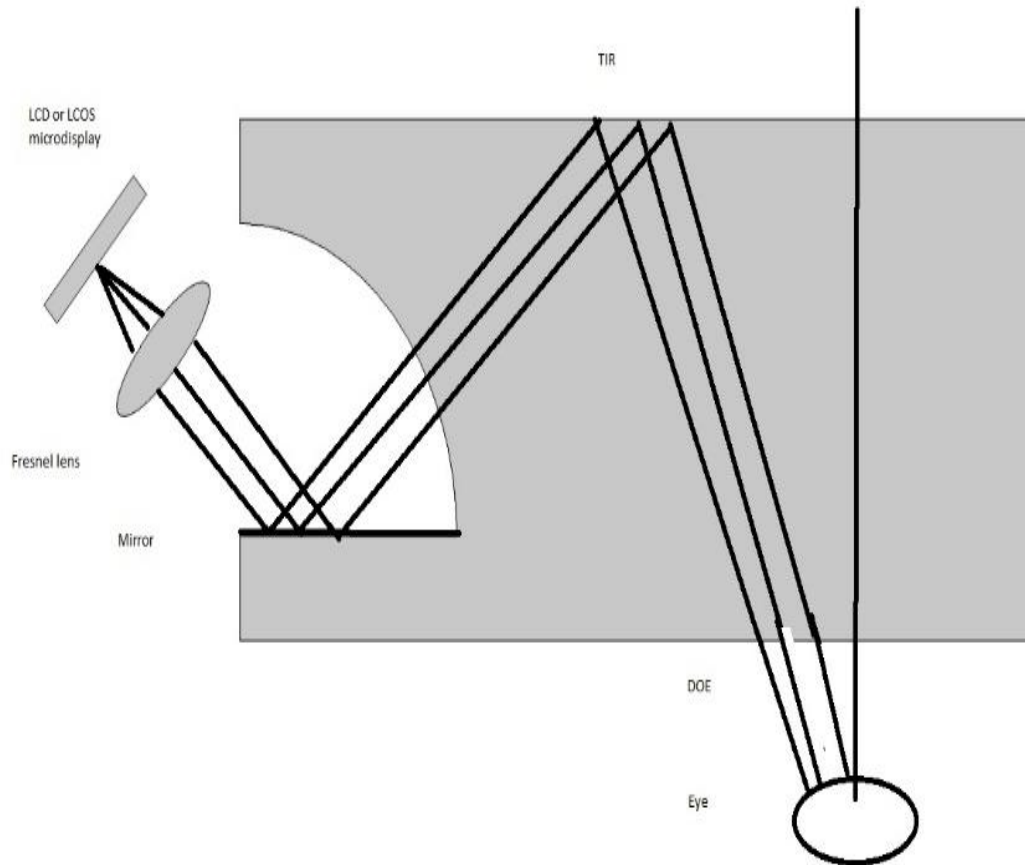
$$n_\beta \sin(\beta_m) - n_\alpha \sin(\alpha) = m\frac{\lambda_0}{d}$$

where the diffraction order m (dimensionless) is an integer.
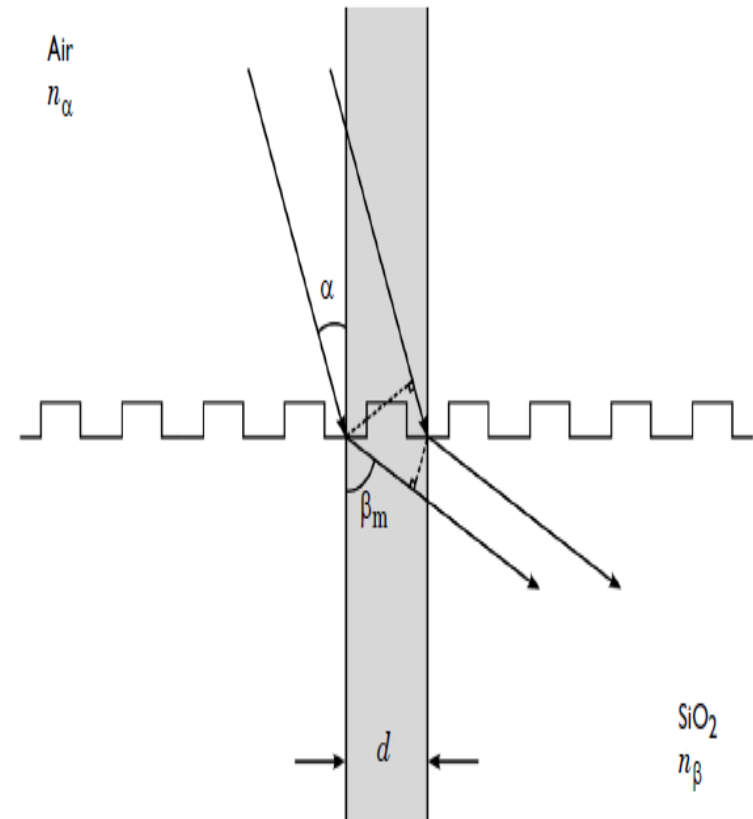
Design 1
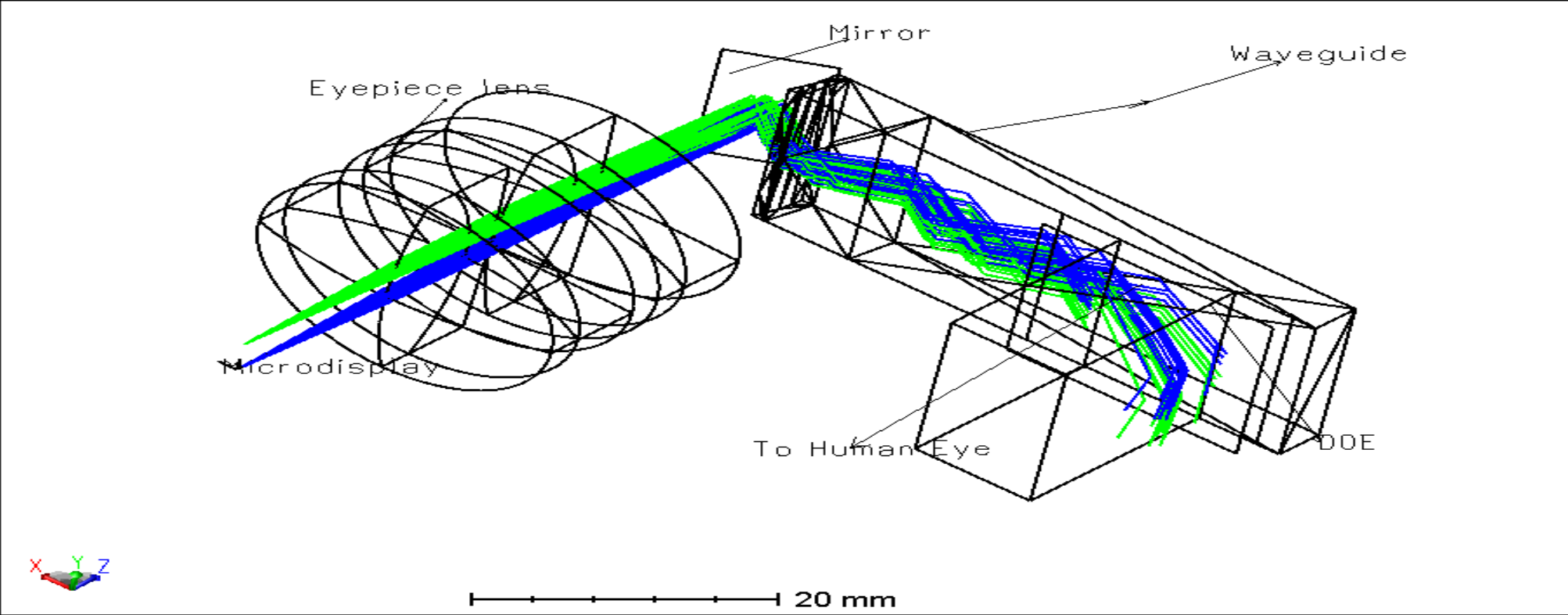
Design 2

200 lines/um

M=1

FRP0510 (Ideal modeling of a Fresnel lens)
3/29/2020

3D Layout

50 mm

Mirror

Lens

Diffraction grating

Zemax
Zemax OpticStudio 18.4.1

DesignWK10_S2.zmx
Configuration 1 of 1
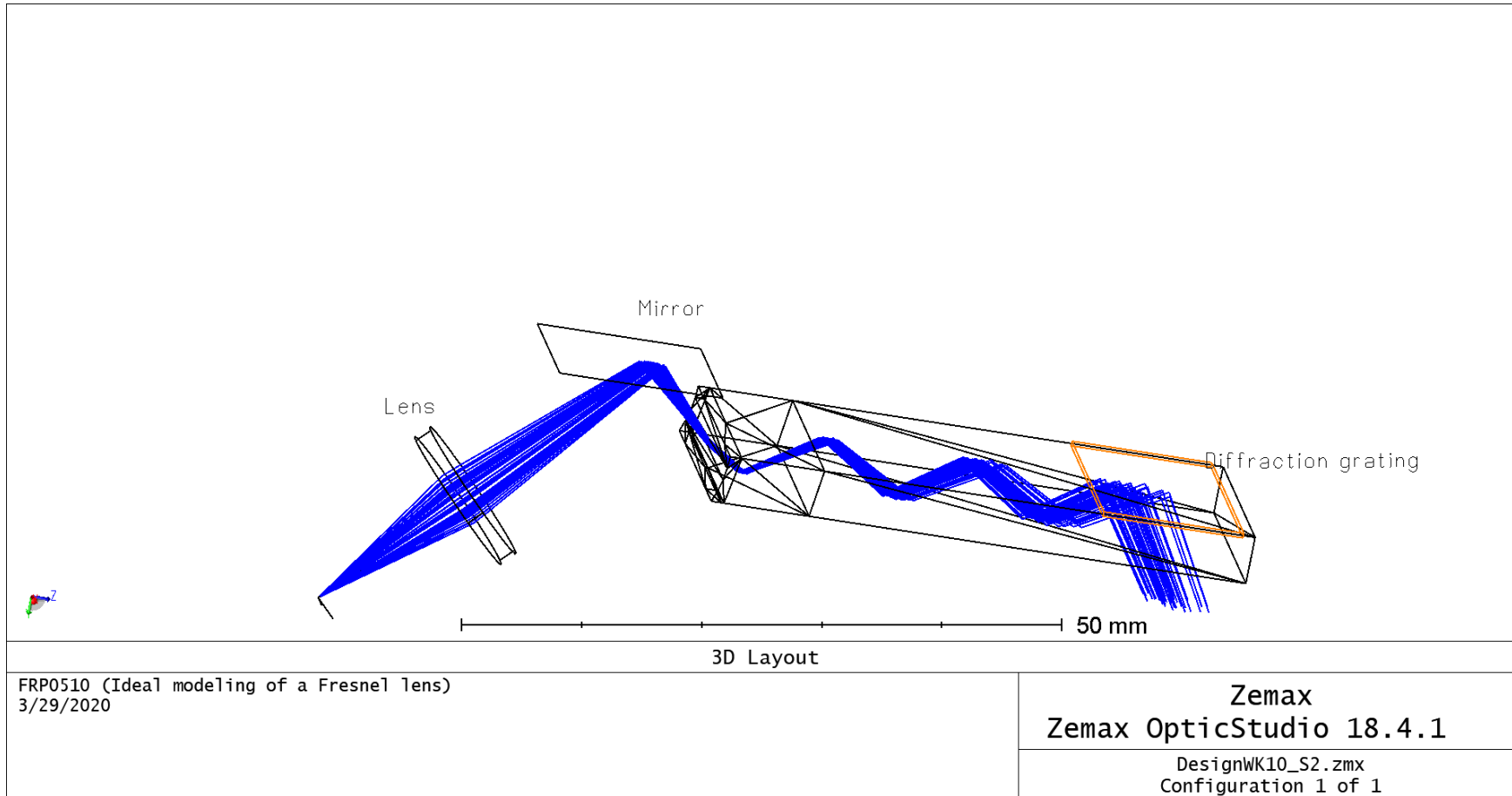
Design 3

d=600nm=
2.5e6
lines/m

Manufacturability

The eye piece lenses is from Thorlabs catalog AC 254-060-A, AC 508 -060-A and FP510
the mirror could made of a thin piece of glass with some silver coating,

The waveguide is rectangular box of K5, BK7 or PMMA glass which will have some DOE written on one side of it.

To make the DOE should be challenging 2.5e6lines/ meter

DesignWK3_S3b.mph - COMSOL Multiphysics

File   Home   Definitions   Geometry   Materials   Physics   Mesh   Study   Results   Developer   Temperature (ht)

Plot   Plot In

Volume   Slice   Line   Arrow Line   Color Expression   Selection   Evaluate Along Normal   Cut Line Direction   Second Point for Cut Plane Normal
Arrow Volume   Isosurface   Contour   Mesh   Deformation   Export Expressions   First Point for Cut Line   Cut Line Surface Normal   Cut Plane Normal
Surface   Arrow Surface   Streamline   Annotation   Filter   Second Point for Cut Line   First Point for Cut Plane Normal   Cut Plane Normal from Surface
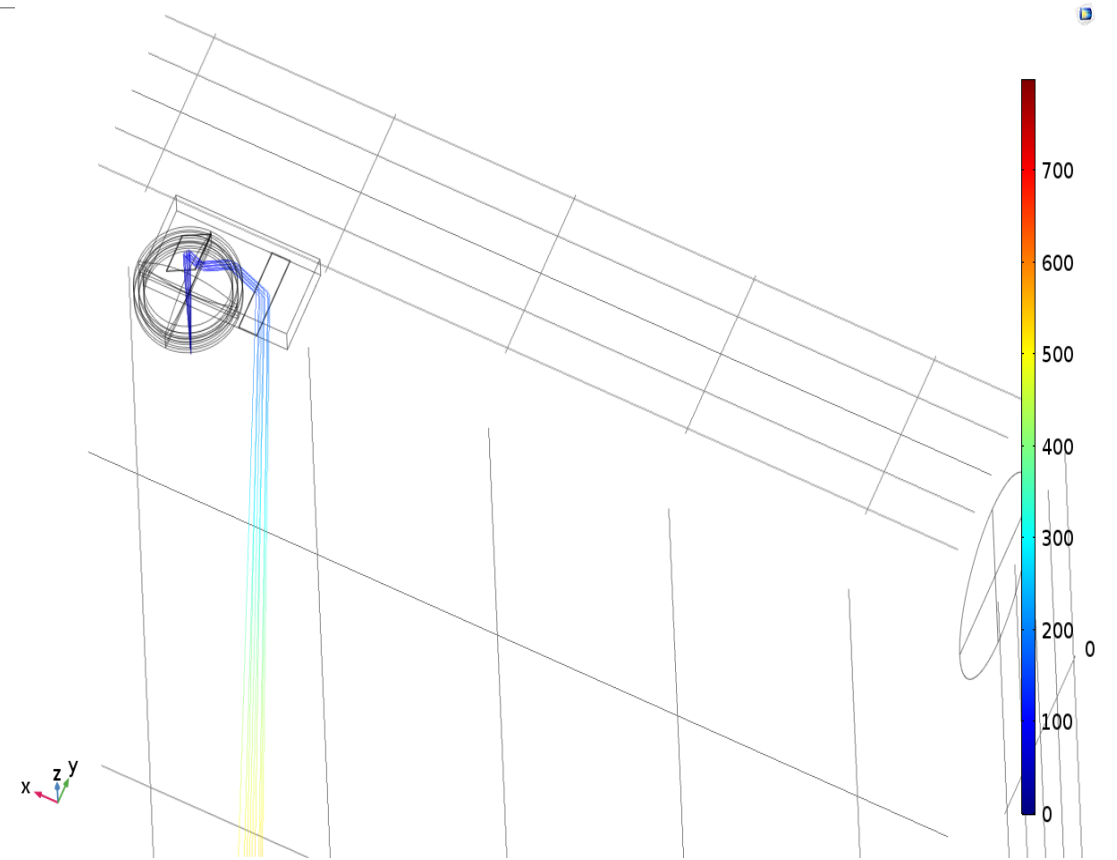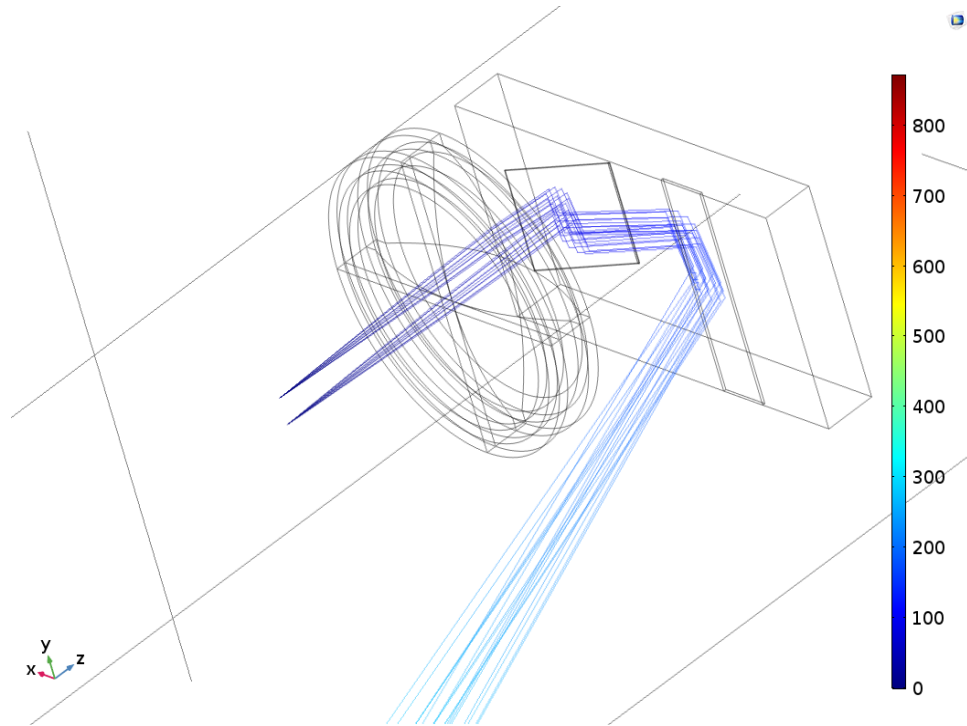
More Plots

3D Image   Animation

Plot   Add Plot   Attributes   Select   Export

Model Builder

Medium Properties 1
Material Discontinuity 1
Ray Properties 1
Release from Grid 1
Lens Obstructions
Image Plane
Mirror 1
Release from Grid 2
▷ Grating 1
▽ Heat Transfer in Solids (ht)
Solid 1
Initial Values 1
Thermal Insulation 1
Heat Flux 1
Initial Values 2
Multiphysics
▷ Mesh 1
Study 1
Step 1: Ray Tracing
▷ Solver Configurations
Study 3
Study 4
Step 1: Time Dependent
▽ Solver Configurations
▽ Solution 2 (sol2)
Compile Equations: Time Dependen
▷ Dependent Variables 1
▷ Time-Dependent Solver 1
▽ Results
▷ Data Sets
Views
▽ Derived Values
Aberration Evaluation 1
Global Evaluation 1
Ray Evaluation 1
▷ Tables
▷ Ray Diagram 1
▷ Ray Diagram 2
Spot Diagram
▷ Ray Trajectories (gop)
▽ Temperature (ht)
Surface
▷ Isothermal Contours (ht)

Settings

3D Plot Group

Plot

Label: Temperature (ht)

▽ Data

Data set: Study 4/Solution 2 (sol2)
Time (s): 8E-9

▷ Title

▽ Plot Settings

View: Automatic
☐ Show hidden entities
☐ Propagate hiding to lower dimensions
☑ Plot data set edges
Color: Black
Frame: Material (X, Y, Z)

▽ Color Legend

☑ Show legends
☐ Show maximum and minimum values
☐ Show units
Position: Right
Text color: Black

▷ Number Format

▷ Window Settings

Graphics   Convergence Plot 1   Convergence Plot 2   Ray Diagram 1

Time=8E-9 s   Surface: Temperature (K)

0
-100
mm
-200

-300

-400

40
20
0
-20
-40

mm

40 60 80 100 120
mm

350
300
250
200
150
100
50
0

Messages   Progress   Log   Table 1

2.27 GB | 3.4 GB

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7:24 PM
3/29/2020

Optical Aberrations

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Conclusions

-Demonstrated the design of AR Device
- Need to have started with Sequential Ray tracing in order to evaluate image quality
- Quantify the weight of device, based weight of lenses and waveguide
- Calculate FOV using laws of reflection and diffraction equation
- Characterized rise in Temperature for Design 3
- Used Zemax and COMSOL back and forth (Somethings I could not do in Zemax, I could do with COMSOL)
- Had some trouble with the DOE in Zemax
- Should be able to refine the simulations