Objectives

1. Why optical system is required in solar cells?
2. Ray tracing optics
3. Ray tracing software
4. Introduction to OSLO
5. Limitations of our free version of OSLO
6. Design a simple optical system
7. Design further to optimize parameters

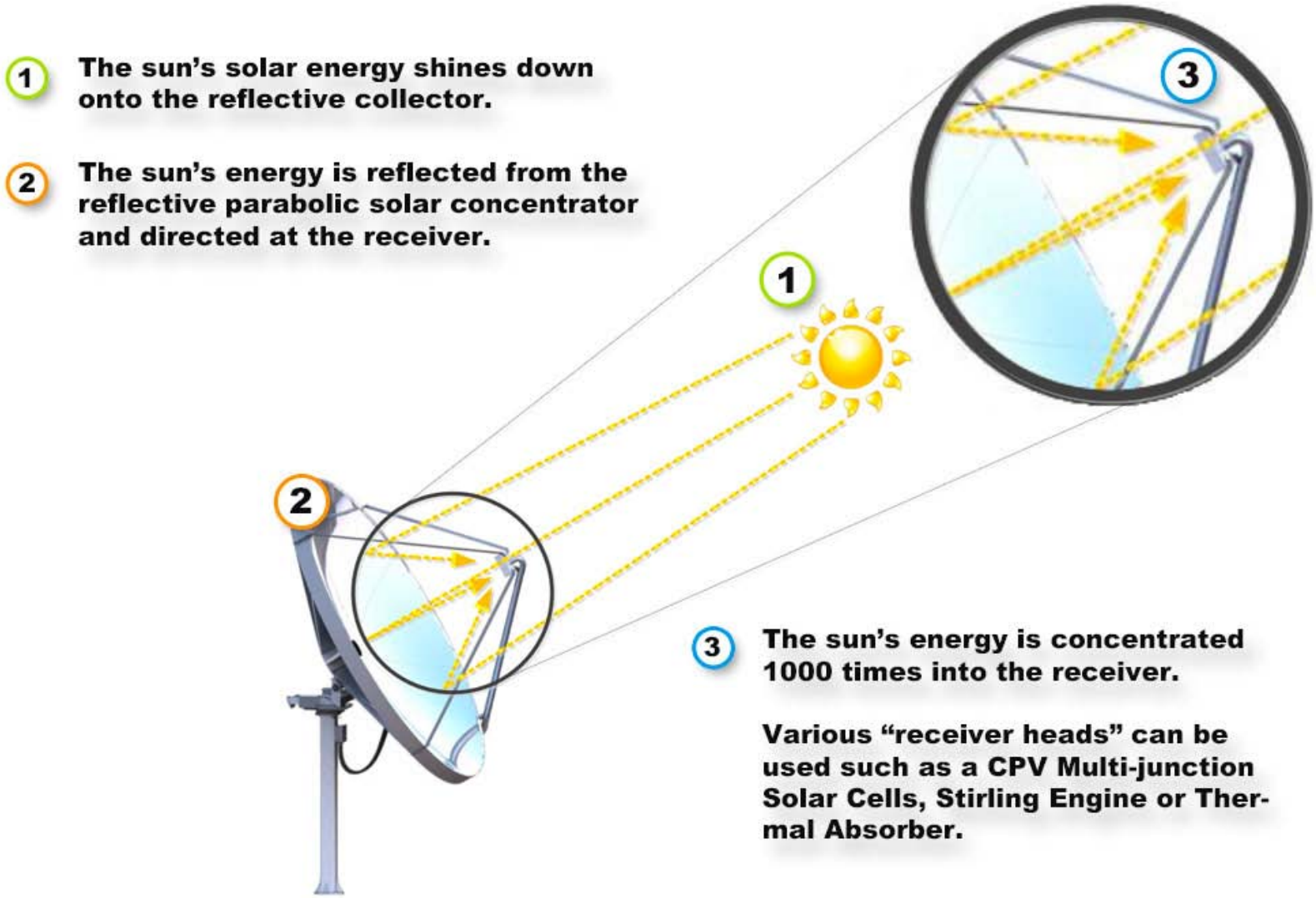
Concentrated solar power

- Mirrors or lenses are used to concentrate a large area of sunlight, or solar thermal energy, onto a small area

- Electricity is generated when the concentrated light is converted to heat, which drives a heat engine connected to an electrical power generator

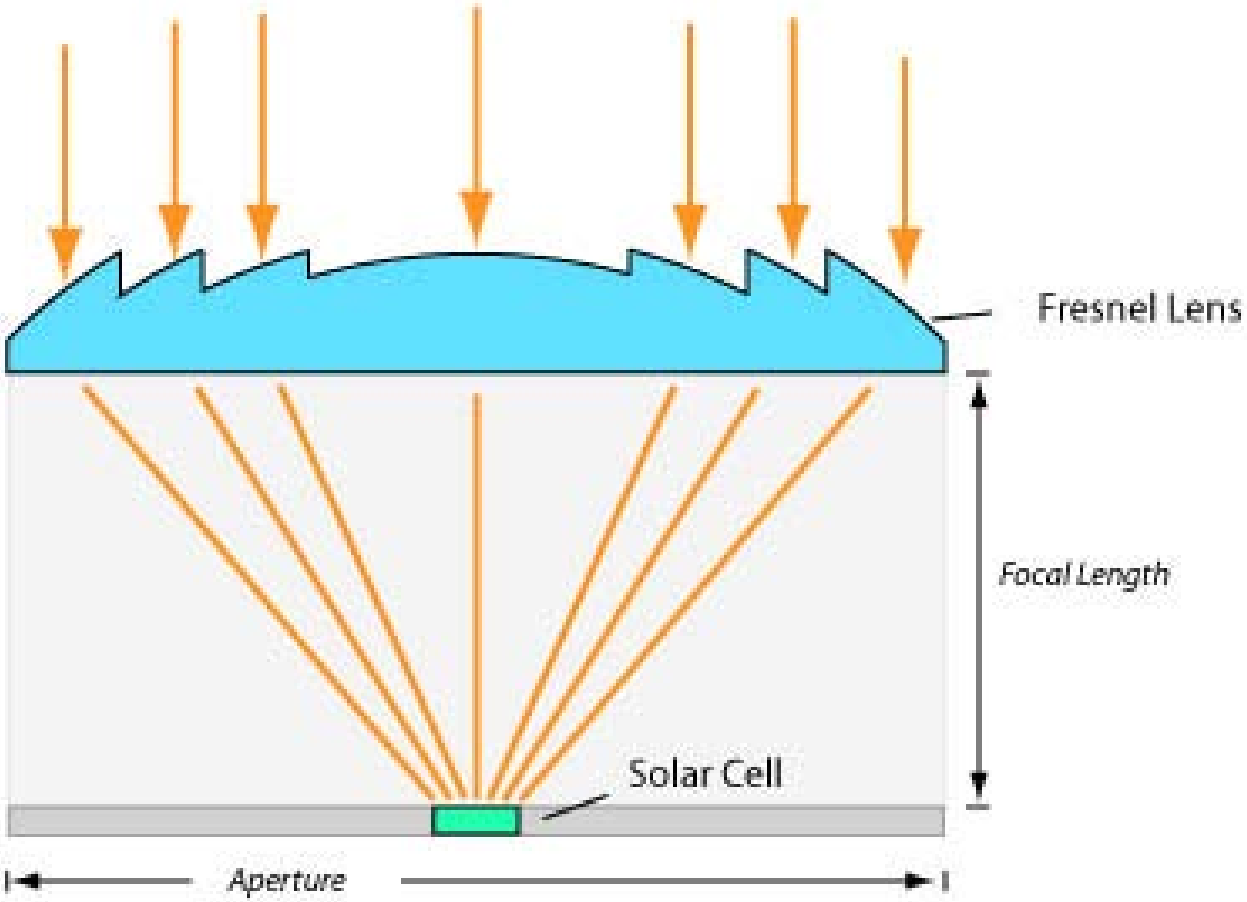
http://www.seia.org/policy/solar-technology/concentrating-solar-power

Parabolic Dish



http://www.solartronenergy.com/solar-concentrator/how-does-a-solar-concentrator-work/

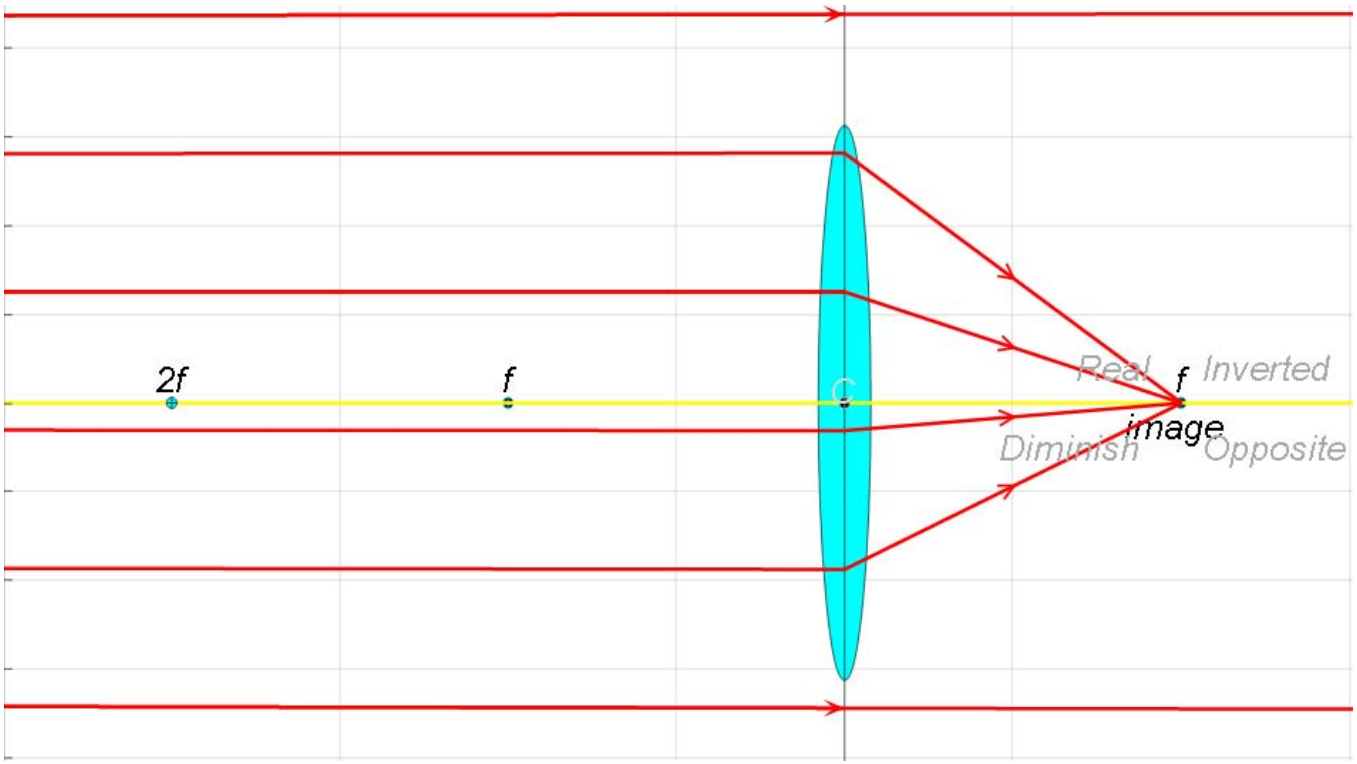
Fresnel Reflector



http://www.greenrhinoenergy.com/solar/technologies/pv_concentration.php

Ray Optics

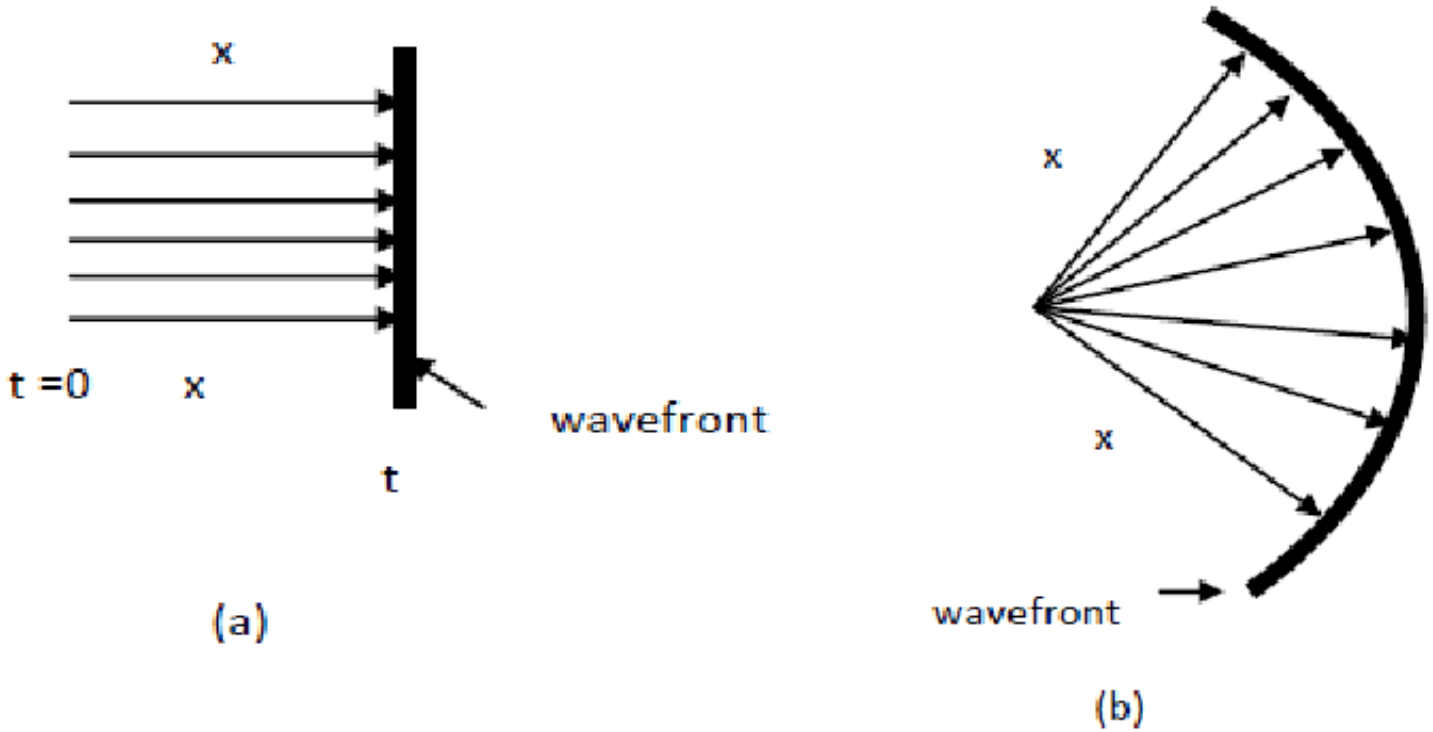
Ray optics, describes light propagation in terms of rays



*wikipedia

Planar wave or Collimated light source

Light coming from source located at infinity is planar wavefront

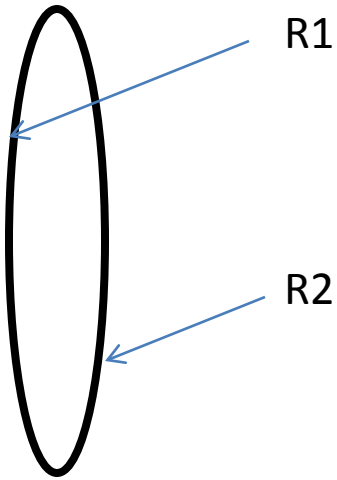


https://www.researchgate.net/publication/268293990_A_Flatbed_Scanner_Based_Wavefront_Sensing_Unit_for_Optics_Quality_Control/figures?lo=1

Two Important Equations

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Lens maker's equation



$$\frac{1}{o} + \frac{1}{i} = \frac{1}{f}$$

$$\frac{1}{\text{object distance}} + \frac{1}{\text{image distance}} = \frac{1}{\text{focal length}}$$

Common Ray Tracing Softwares

1. Zemax
2. OSLO
3. Optix

We will use OSLO, It has free version for light use, OSLO EDU

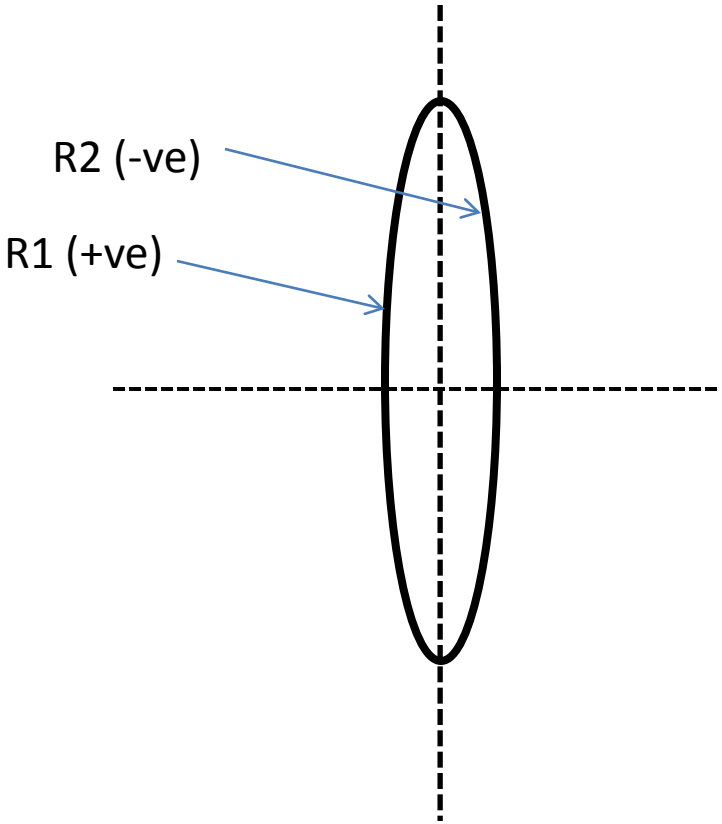
You can download OSLO LITE, this version has more flexibility. Please email them Your course syllabus and they will “hopefully” allow you to download LITE version

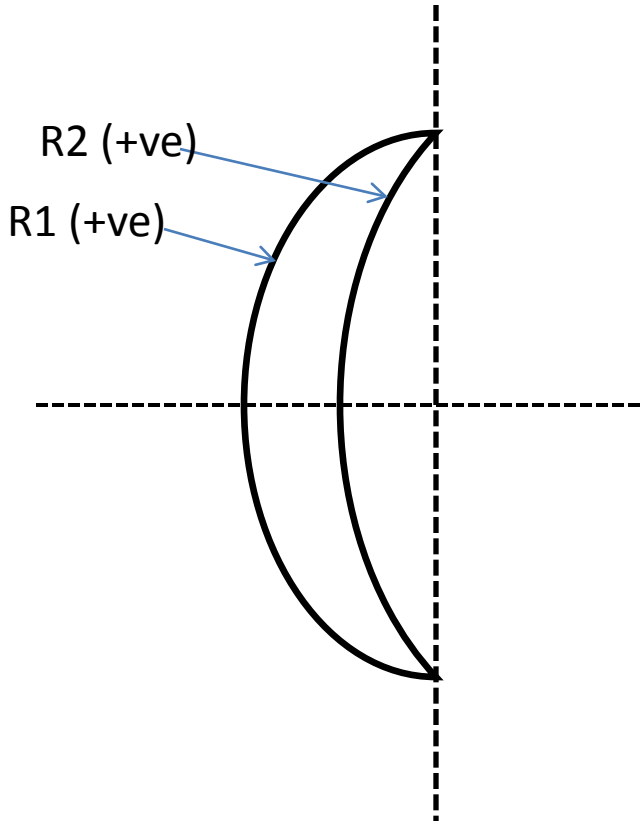
Let’s start how to design lens/optical system with OSLO

Install

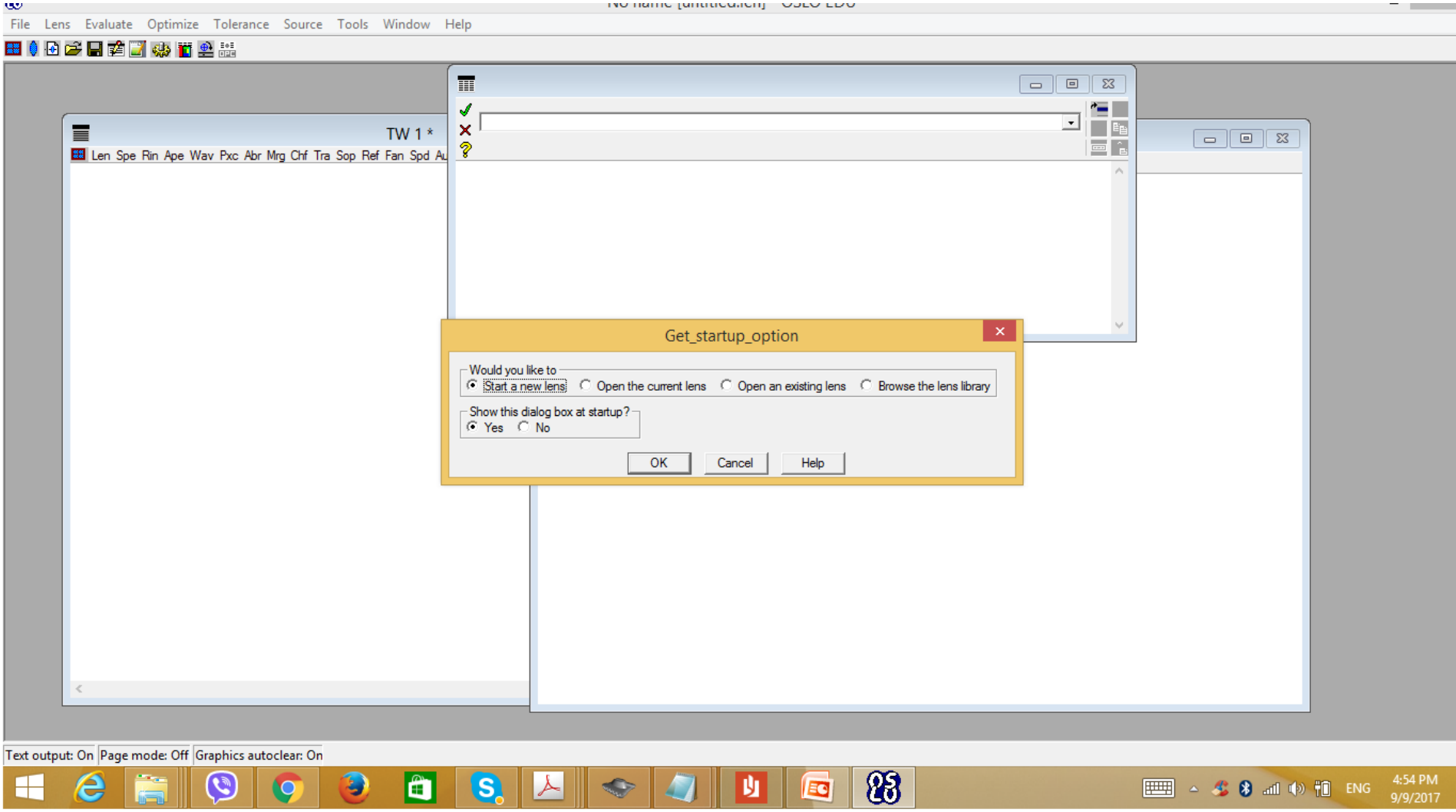
1. Go to website
   https://www.lambdares.com/support/5900/
2. OSLO EDU is the free version
3. Download it, approximately 28 mb

Sign Convention

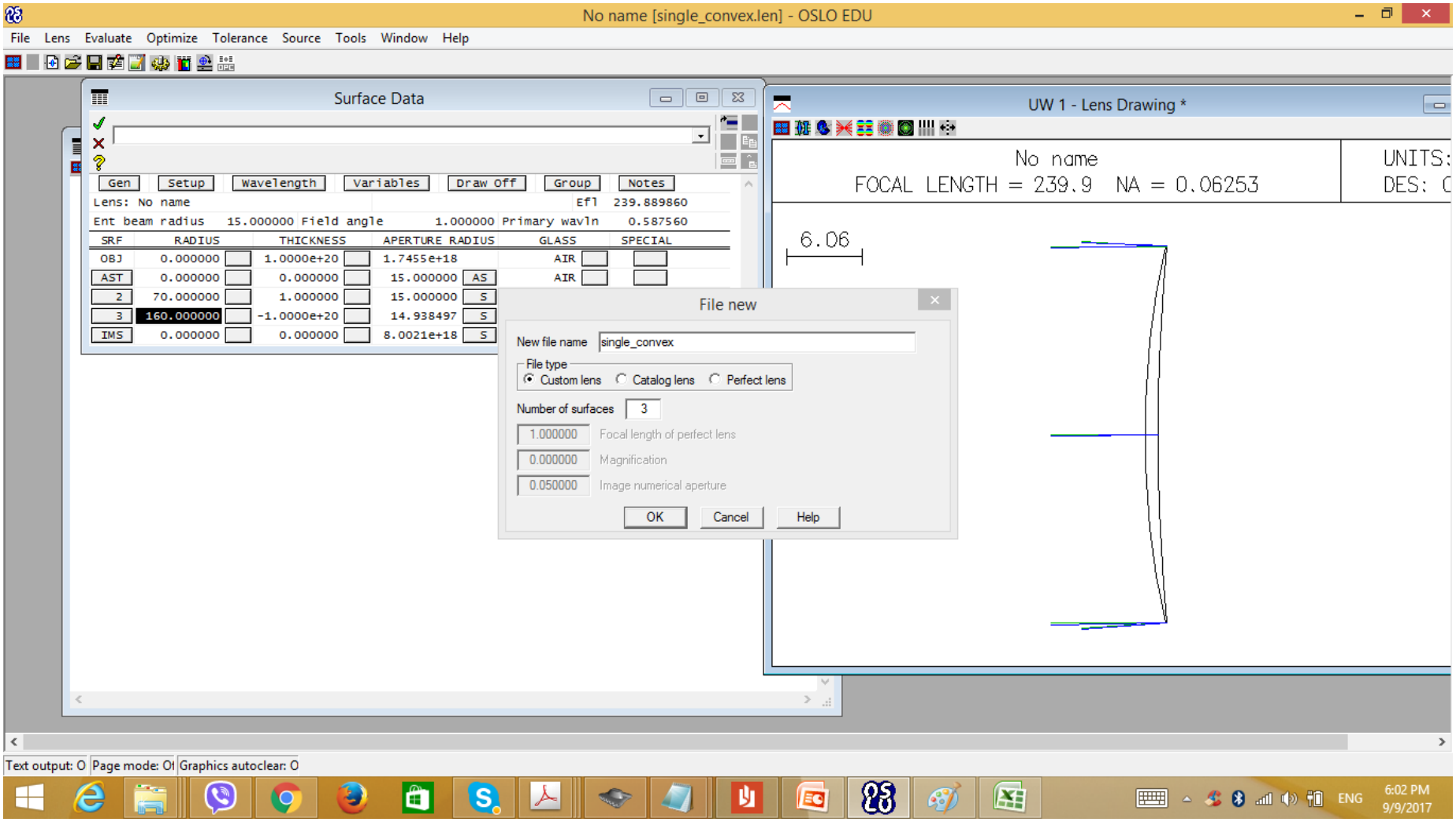


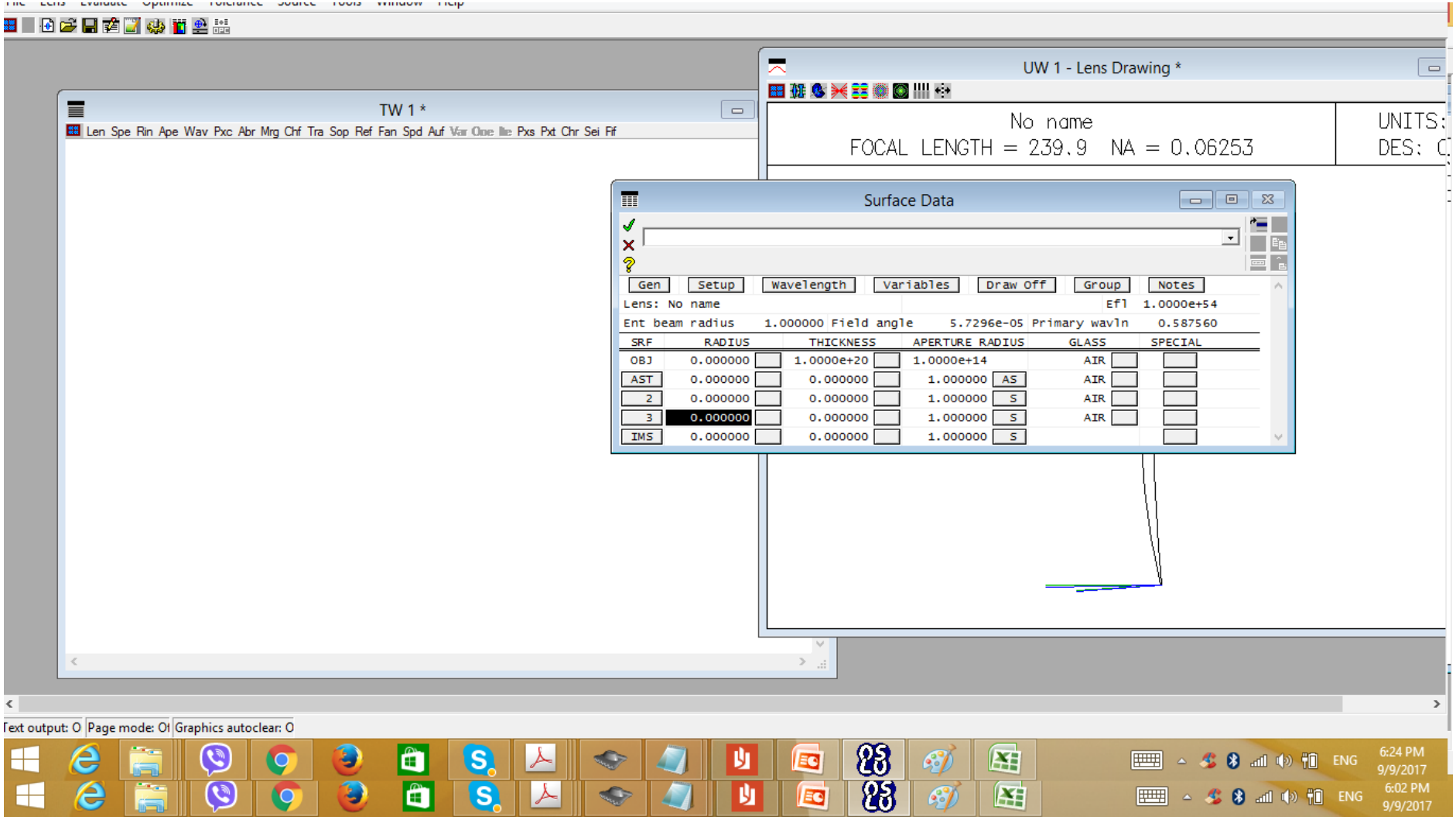


Single Convex/concave lens design



1. File -> new lens
2. New file name: single convex
3. Custom lens tick
4. Surface 3 (two surfaces for the lens and one is aperture stop)
5. done




TW 1 *
Len Spe Rin Ape Wav Pxc Abr Mrg Chf Tra Sop Ref Fan Spd Auf Var Opt Ite Pxs Pxt Chr Sei Fif
UW 1 - Lens Drawing *
No name
FOCAL LENGTH = 239.9 NA = 0.06253
UNITS:
DES: C
Surface Data
Gen Setup Wavelength Variables Draw Off Group Notes
Lens: No name
Efl 1.0000e+54
Ent beam radius 1.000000 Field angle 5.7296e-05 Primary wavln 0.587560
SRF RADIUS THICKNESS APERTURE RADIUS GLASS SPECIAL
OBJ 0.000000 1.0000e+20 1.0000e+14 AIR
AST 0.000000 0.000000 1.000000 AS AIR
2 0.000000 0.000000 1.000000 S AIR
3 0.000000 0.000000 1.000000 S AIR
IMS 0.000000 0.000000 1.000000 S
Text output: O
Page mode: O
Graphics autoclear: O
ENG
6:24 PM
9/9/2017
ENG
6:02 PM
9/9/2017

All units are in millimeters

1. Enter beam radius 15
2. Filed Angle 1 (deegre)
3. Object thickness is the distance of the object from aperture stop surface
4. Surface 2 radius 100
5. Surface 3 radius -100
6. Select wavelength
7. Thickness is after the surface
8. Ast is aperture stop, select that
9. Put tick after every selection and value
10. Select material BK7 for surface 2

No name [single_convex.len] - OSLO EDU

File Lens Evaluate Optimize Tolerance Source Tools Window Help

Surface Data

15.0

Gen | Setup | Wavelength | Variables | Draw Off | Group | Notes

Lens: No name Efl 97.580389

Ent beam radius 15.000000 Field angle 1.000000 Primary wavln 0.587560

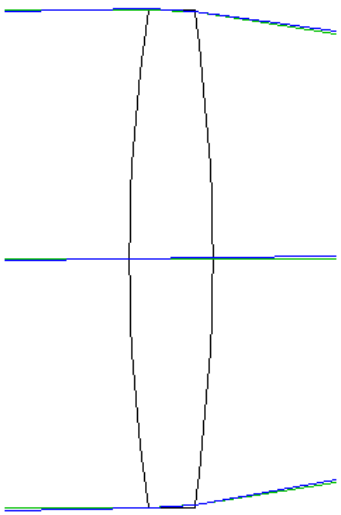
SRF	RADIUS	THICKNESS	APERTURE RADIUS		GLASS		SPECIAL
OBJ	0.000000	1.0000e+20	1.7455e+18		AIR		
AST	0.000000	0.000000	15.000000	AS	AIR		
2	100.000000	5.000000	15.000000	S	BK7	C	
3	-100.000000	1.0000e+20	14.802001	S	AIR		
IMS	0.000000	0.000000	1.7088e+19	S			

UW 1 - Lens Drawing *

No name
FOCAL LENGTH = 97.58 NA = 0.1537

UNITS: MM
DES: OSLO

6.06



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