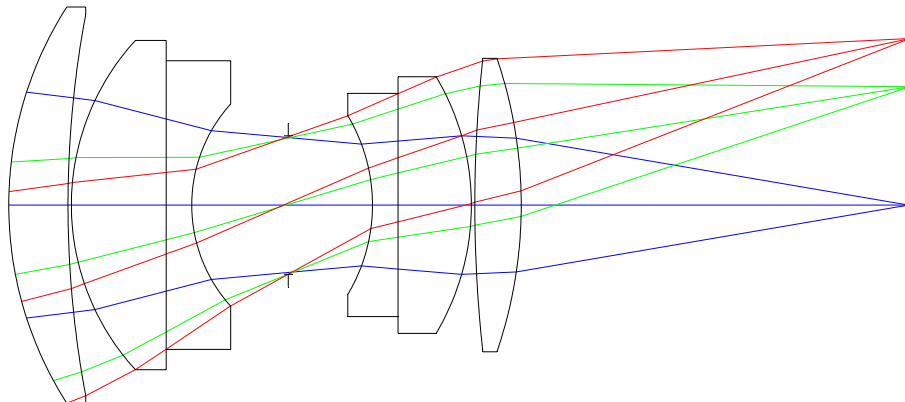


# Zemax Intro

- Basic ray tracing practical only for paraxial analysis
  - Aberrations are time consuming to calculate
  - Diffraction (learn about this later) also tough
- Computer Aided Design (CAD)
  - Use commercial tools to do all of the number crunching
  - Popular software packages
  - Code V, Zemax, OSLO
- CAD tools do not automatically design the lenses, they only help characterize and optimize *your* designs

# What do CAD tools do?

- Computer-aided *sequential* lens design
  - rays are traced from one surface to the next in the order in which they are listed
- Example
  - A ray starts at the object surface
  - The ray is traced to surface 1, then to surface 2, and so on
  - A ray cannot skip a surface... e.g., not from 2 to 6
  - A ray cannot go back... e.g., from 3 to 1

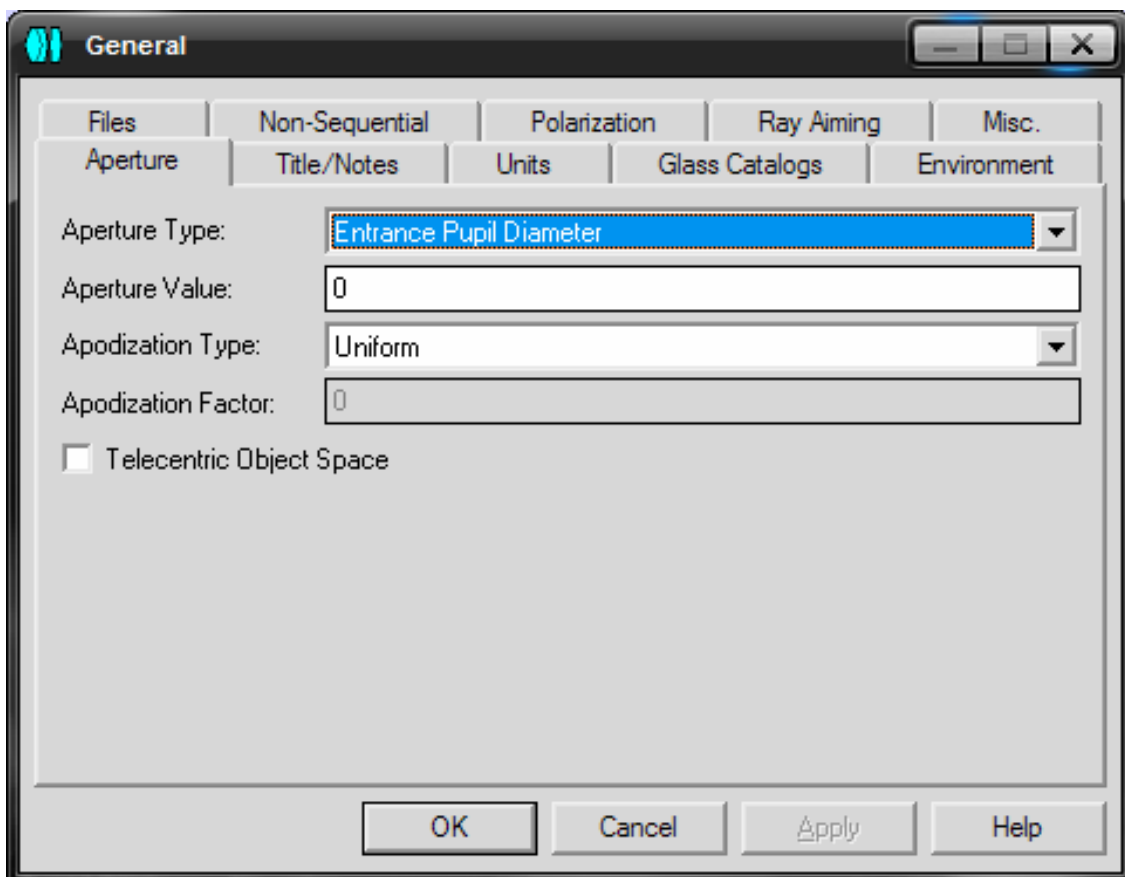


# Getting Started ...

- Determine your design parameters
  - Project variable will determine
- Enter the design into Zemax
  - Lens Data Editor
- Use the analysis tools to characterize and optimize!
  - Use “solves”
  - Merit function based optimization
- Today
  - Enter a singlet lens into Zemax
  - Enter a spherical mirror

# General Parameters

- Object is at infinity
- Focal Length = 100mm
- Wavelength: 632.8nm
- Center Thickness (*c.t.*) of the singlet:  $2\text{mm} < c.t. < 12\text{mm}$
- Edge Thickness (*e.t.*) of the singlet:  $e.t. > 2\text{mm}$
- Beam Diameter:  $f/\# = f/D$



# Wavelengths

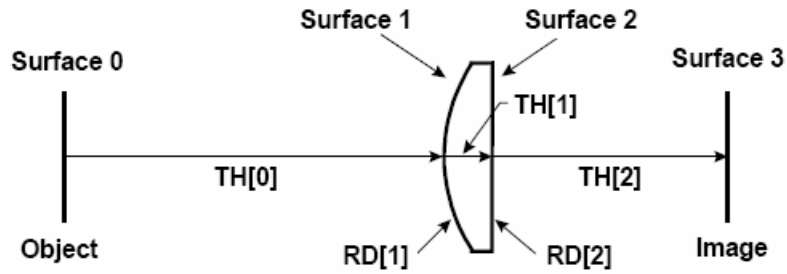
Use	Wavelength (µm)	Weight	Use	Wavelength (µm)	Weight
<input checked="" type="checkbox"/>	0.48613270	1	<input type="checkbox"/>	0.55000000	1
<input checked="" type="checkbox"/>	0.58756180	1	<input type="checkbox"/>	0.55000000	1
<input checked="" type="checkbox"/>	0.65627250	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1
<input type="checkbox"/>	0.55000000	1	<input type="checkbox"/>	0.55000000	1

Select -> F, d, C (Visible) Primary: 2

OK Cancel Help Save Sort Load

- Select wavelengths
  - Visible, IR, UV
  - Weight (importance)

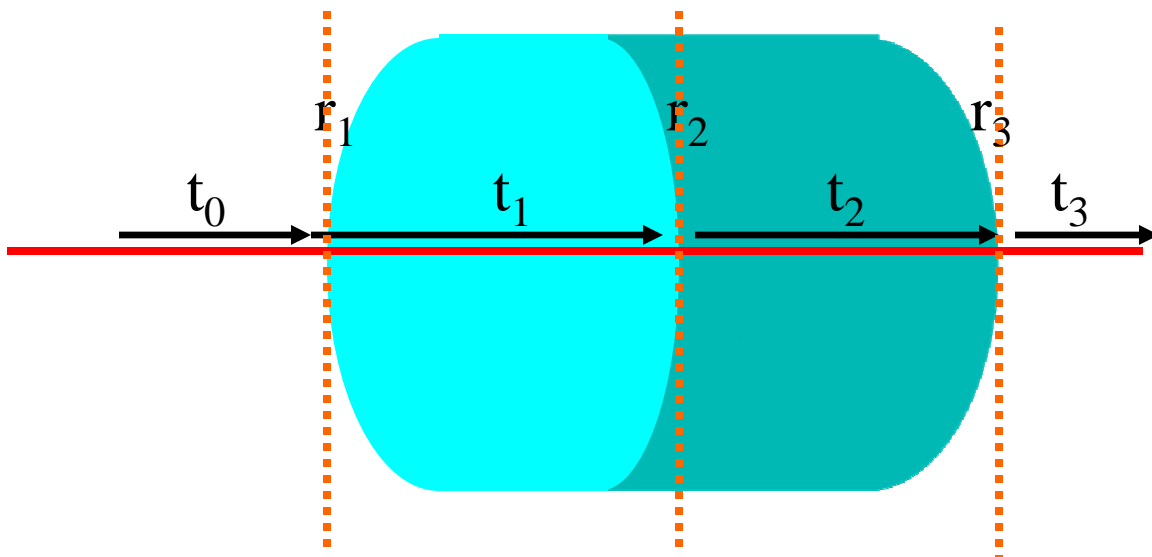
# Lens Data Editor



Lens Data Editor

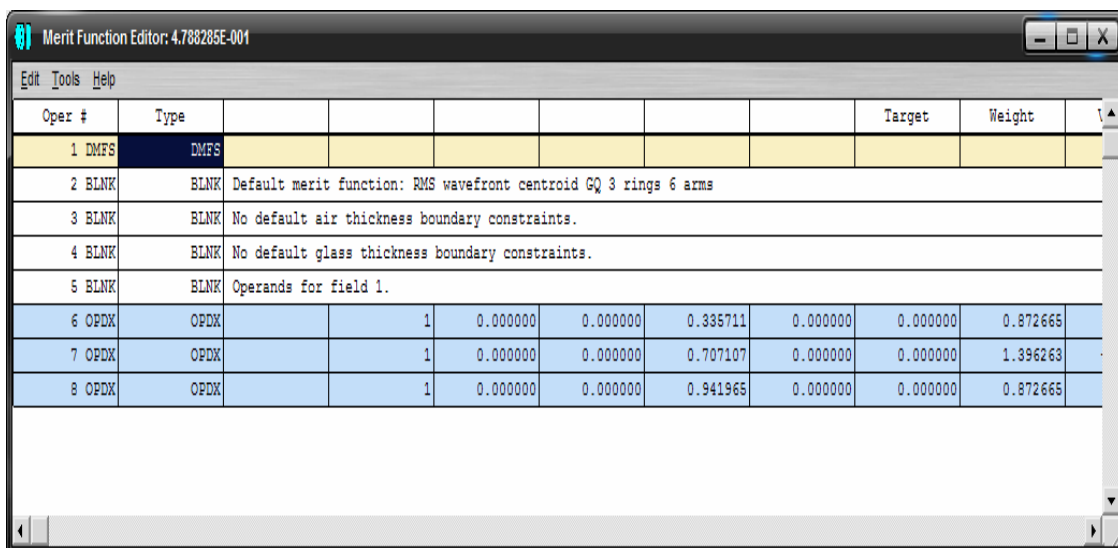
Edit Solves Options Help

Surf	Type	Comment	Radius	Thickness	Class	Glass
OBJ	Standard		Infinity	Infinity		
STO+	Standard	AC254-100MM-B	66.680000	4.000000		LAKN22
2*	Standard	AC254-100MM-B	-53.700000	1.500000		SFL6
3+	Standard	AC254-100MM-B	-259.410000	0.000000		
4	Standard		Infinity	0.000000		
IMA	Standard		Infinity	-		



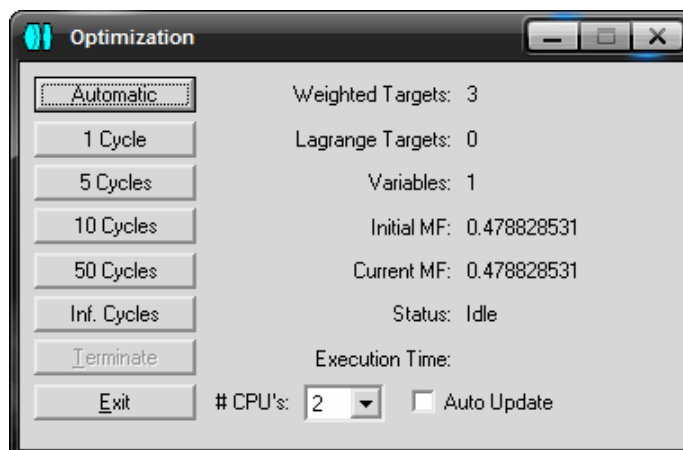
# Merit Function

- Equation which evaluates the performance of the lens
  - Editors->Merit Function
    - Manually constructing a merit function is tough
    - Use defaults
- Start the optimization
  - Tools->Optimization->Optimization



Merit Function Editor: 4.788285E-001

Oper #	Type							Target	Weight	
1	DMFS	DMFS								
2	BLNK	BLNK	Default merit function: RMS wavefront centroid GQ 3 rings 6 arms							
3	BLNK	BLNK	No default air thickness boundary constraints.							
4	BLNK	BLNK	No default glass thickness boundary constraints.							
5	BLNK	BLNK	Operands for field 1.							
6	OPDX	OPDX		1	0.000000	0.000000	0.335711	0.000000	0.000000	0.872665
7	OPDX	OPDX		1	0.000000	0.000000	0.707107	0.000000	0.000000	1.396263
8	OPDX	OPDX		1	0.000000	0.000000	0.941965	0.000000	0.000000	0.872665

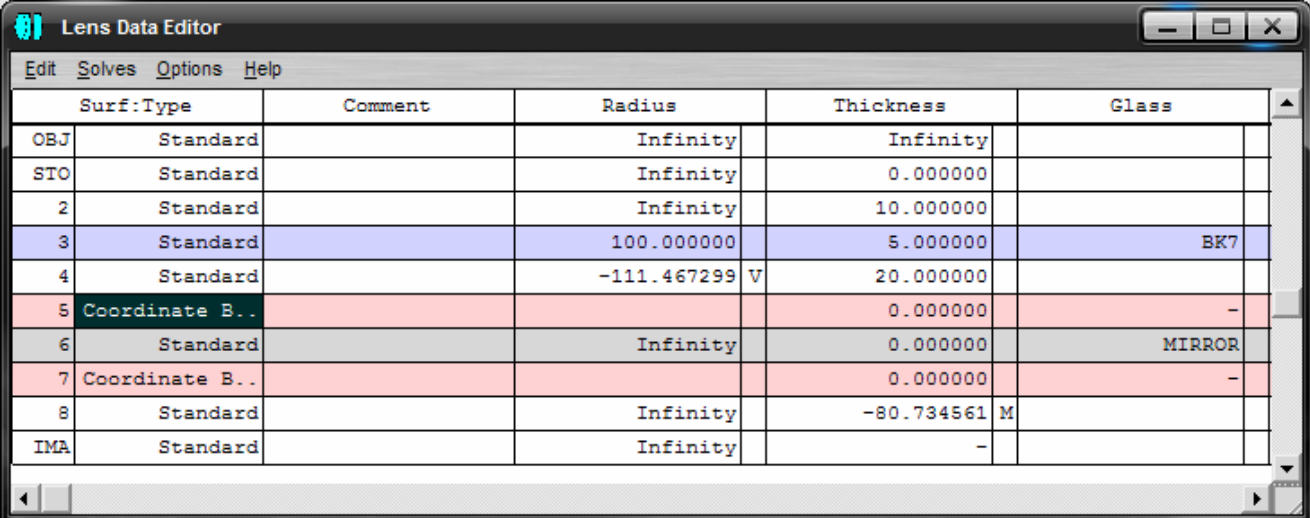
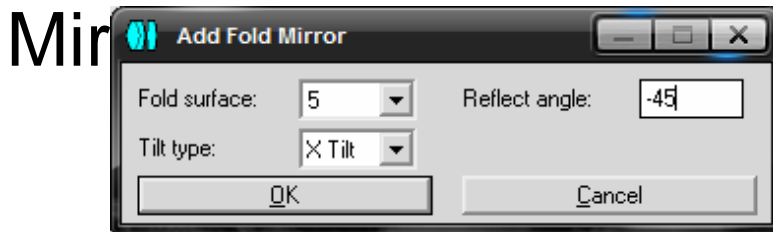


Optimization

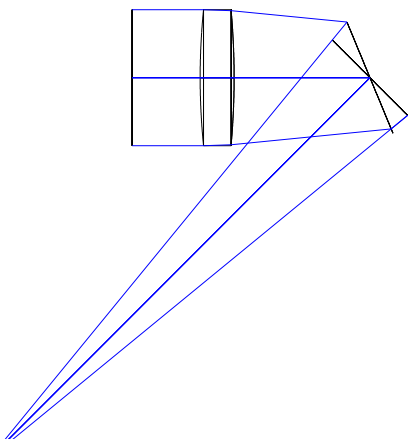
     Weighted Targets: 3  
      Lagrange Targets: 0  
      Variables: 1  
      Initial MF: 0.478828531  
      Current MF: 0.478828531  
      Status: Idle  
      Execution Time:  
      # CPU's: 2       Auto Update

# Mirrors

- Use the Tools Menu to add a fold mirror
  - Tools->Fold Mirror->Add Fold Mirror



Surf	Type	Comment	Radius	Thickness	Glass
OBJ	Standard		Infinity	Infinity	
STO	Standard		Infinity	0.000000	
2	Standard		Infinity	10.000000	
3	Standard		100.000000	5.000000	BK7
4	Standard		-111.467299 V	20.000000	
5	Coordinate B..			0.000000	-
6	Standard		Infinity	0.000000	MIRROR
7	Coordinate B..			0.000000	-
8	Standard		Infinity	-80.734561 M	
IMA	Standard		Infinity	-	



Also  
make  
spherical  
mirrors



# Analysis Tools

- Spot Diagrams

