

Lecture 2 What is Zemax?



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Zemax OpticStudio (www.zemax.com)

Zemax OpticStudio is a software for designing optical system. It is used to analyze <u>imaging system</u> and <u>non-imaging system</u>.

Zemax is based on **Ray Tracing**. Namely, it models propagation of rays via optical system. Ray tracing is practical only for paraxial analysis. However, computing aberrations and diffraction effects are time consuming. Hence, Optical Designers need software such as:

- Zemax OpticStudio
- Code V
- TracePro
- > OSLO

which help characterize and optimize the design.

Zemax OpticStudio

- models the effect of optical elements (like lenses, aspheric surfaces, mirrors and diffractive optical elements)
- produces standard analysis diagrams (such as spot diagrams and ray-fan plots).
- simulates coatings on optical surfaces.
- has a tolerancing capability and thus makes it possible to analyze production and assembly faults.
- has optimization tools.







Zemax

Zemax helps optical designer evaluate complicated optical calculations!



Zemax

What if there is no program such as Zemax?

Consider the following exercise.

We have 4 rays separated by 5 mm. Calculate the intersection of each ray with the optical axis after refracting the plano convex lens. Wavelength: 632.8 nm Glass: BK7 (n = 1.5151) (Use Snell's Law of refraction)



Zemax Modes

Zemax allows you to use two modes:



- Sequential mode: In this mode, rays propagates from one surface to another sequentially to produce image. An integer number is assigned to each surface. We need 3 surfaces at least; Object, Stop and Image. Rays starts from Object plane and ends at the Image plane. This mode is usually used in imaging systems.
- Non-sequential mode: In this mode, Light can be reflected, refracted or scattered from a surface many times. The rays are collected by a dectector. This mode is usually used in non-imaging systems.

Lens Data Editor (LDE)

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- An optical system can be formed by using LDE.
- In Zemax, many operations are performed by defining surfaces which can be lens, mirror, ...

LDE: Surface Type

Surface type can be:

- Standard (Spherical)
- Even Asphere
- Paraxial
- Grating
- ≻ ...

In the design, we usually prefer standard surfaces.

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LDE: Radius & Thickness

Radius

defines Radius of Curvature of the surface. Radius can be + or -

Thickness

defines the center distance between two surfaces to separate the optical surfaces. Thickness can be + or -

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LDE: Material (Glass)

Material is used to input optical material.

It can be written manually of selected from Library.

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LDE: Coating

It allows you to select a coating material to apply on the surface.

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LDE: Clear Semi-Diameter

The size of Clear Semi-Diameter defines the effective optical area where light passes through the surface. This surface is polished and maybe coated.



LDE: Mechanical Semi-Diameter

Mech Semi-Diameter is related to diameter where light does not pass through the surface. By default, it is equal to the Clear Semi-Diameter.

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LDE: Chip Zone

The chip zone is simply an extension of the clear aperture, usually meant provide extra space for mounting the lens so that the mounting assembly doesn't block light through system.



LDE: Conic

Optical systems comprise lenses and mirrors made with precise surfaces. Optical surfaces can be divided into spherical and aspherical surfaces.

In Zemax, you can form different types of surfaces by using conic constants (K). It can be used to assign an aspherical property to the standard surface.



Why do we need Conic Surface?

For a given image quality, the choice of optical surfaces has a major impact on the packaging and cost of a lens system. In general,

conic surfaces improves the optical performance of the system.



Zemax Training

https://www.zemax.com/pages/training

https://www.youtube.com/c/DesignOpticsFast

https://www.youtube.com/user/opticsrealm

http://www1.gantep.edu.tr/~bingul/opac202

Defining a Simple Lens in Zemax

Now we will see very simple application in Zemax; adding a single lens. Consider the following lens.

Diameter = 25 mm, λ = 0.65 µm and SFOV = 0° and 10°. (Namely, FOV = 20°).





System Performance

Analysis	Description
	A layout may be opened by navigating to AnalyzeSystem ViewerCross-
Lavout	Section. The Cross-Section option plots a YZ cross section through the lens, and is
Layout	only valid for rotationally symmetric, axial systems. A layout diagram is always a
	useful visual representation of the current optical system.
	A spot diagram may be accessed by navigating to AnalyzeSpot Image
	QualityRays & SpotsStandard Spot Diagram. The spot diagram gives indication
Spot Diagram	of the image of a point object. In the absence of aberrations, a point object will
	converge to a perfect image point. By default, OpticStudio plots the spot diagram
	for each field point.
	The Optical Path Difference (OPD) fan can be opened by selecting
	AnalyzeImage QualityAberrationsOptical Path. The OPD fan is a plot of the
OPD Fan	optical path difference as a function of pupil coordinate. In a perfect optical
	system, the optical path of the wavefront will be identical to that of an aberration-
	free spherical wavefront in the exit pupil.
	The Ray Fan plot in OpticStudio may be opened by selecting AnalyzeImage
	QualityAberrationsRays Aberration. The Ray Fan plots ray aberrations as a
Pay Fan	function of pupil coordinate. Generally, a given ray which passes through the
Kay Fall	optical system an onto the image surface, its point of intersection falls on some
	small but nonzero distance away from the chief ray. Once again, in a perfect
	optical system, the ray aberrations should be zero across the pupil.

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Example Performance Data & Plots

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Setting Index of Refraction of a Material

In Material column, you can also set the index of the glass instead of glass name. For example, to add a material whose index is n = 1.5

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