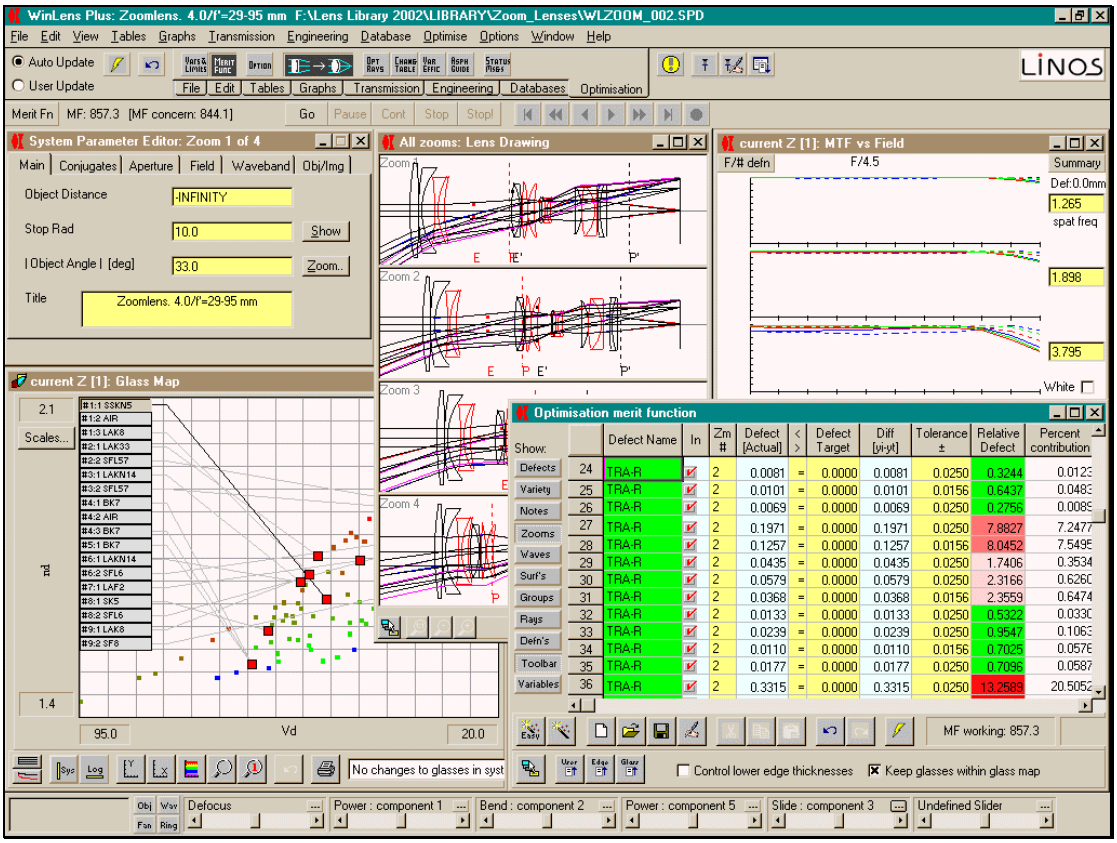
LINOS

WinLens

Optical Design Software

users guide / introduction



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Summary

This document provides a brief introduction to using WinLens; in particular:
- what it is & some of the basic features
- setting up a very simple system
- the main editors
- graphics & tables
- using sliders to change parameters
- glasses, including the active glass map
- databases, lens library & disk file viewer

It does not attempt to cover an optical theory, or the meaning of the various graphs & tables for which there is extensive help system available.

The document applies to WinLens 4.3 and WinLens Plus. All screen dumps were taken from WinLens Plus. There are some features which are only to be found in the more advanced version. These will be shown by {plus} [for WinLens Plus only] Normally this will appear in a section title, but sometimes in the body of the text. An extensive on-line help system is also available.

New features will be shown by {vi.j.k} where vi.j.k is the version when the new feature was introduced.

Cross references are shown in ***Bold-Italics***. If you are reading this document on a PC, such cross references are hyper-linked to the relevant chapter or section.

We assume that the user:
- has a very modest knowledge of optics[1]
- is reasonably familiar with Windows

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[1] The WinLens help system contains a lot of useful background information on optical design concepts

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Author: Dr Geoff Adams

1 Introduction

- *Who is WinLens designed for?*
- *What systems can WinLens model?*
- *What can WinLens be used for?*
- *Quick guide to the manual*
- *List of new features*

"Science is a wonderful thing if one does not have to earn one's living from it."

Albert Einstein

WinLens is a program for modelling and optimising {plus} optical systems. This manual provides a simple overview to WinLens and some of the things it can do. In particular, you will find a very simple series of examples of setting up a system.

WinLens is designed to make simple tasks easy – things like reversing a component at the single click of a button, checking a melt glass or finding alternative glasses. While WinLens cannot do all things, it aims to make it simple to do the things it can do. There are no obscure command codes to learn, just a simple toolbar or menu to access the different capabilities.

1.1 Who is WinLens designed for?

WinLens is designed for people who work with optical systems with an axis of symmetry or two orthogonal planes of symmetry. It is designed for professional optical designers, for optical engineers and for students. It is designed for people who need to quickly model an optical system for themselves or to check someone else's work.

1.2 What systems can WinLens model?

WinLens is designed to handle systems which are composed of one or more optical components. These can be user defined components or LINOS parts.

User defined components can be lenses, mirrors or thin lenses[2]. A lens component can be a singlet, doublet, air-spaced doublet or cemented triplet. Naturally for these you will need to enter full details [radius, separations, glass names etc].

LINOS parts can be entered, in the component editor, by typing the part number alone, or by drag & drop from the component database. LINOS GRIN components can now be modelled {vi1.1.4}.

The optical surfaces in a component can be spherical, conic or aspheric in cross section. Usually these will be surfaces of revolution, but can also be cylindrical or toroidal in form.

WinLens can handle zoom systems, with zooming gaps between any or all components. Conjugate, aperture, field and waveband values can differ totally from zoom to zoom.

1.3 What functions can WinLens perform?

WinLens can perform in a whole series of roles [in no particular order]:

- Optimise a new or existing design {plus}
- Quickly model a chain of LINOS components for an experimental physicist
- Check data provided by an external consultant
- Import data from a CodeV, Oslo, Sigma or Zemax file
- Export data to a CodeV, Oslo, Sigma or Zemax file
- Test out ideas for a new design
- Assess the possible effects of melt glass changing on a system
- Suggest alternative glasses
- Assess the effect of LINOS coatings on the transmission of a system
- Offer alternative glasses to real or 'optimised' glasses
- Assess sensitivity[3] of aberrations to manufacture error {plus}
- Be an effective teaching tool for undergraduate/postgraduate studies

---

[2] WinLensPlus {plus} can also model **thin lenses**. These are defined as two surfaces with zero separation. The user may define power, glass and bending for such components. Raytracing thru these uses the paraxial equations. TRA calculations for these are correct, but OPD calculations may not be trusted.

To create a thin lens, simple drag & drop from the thin lens icon at the bottom of the system data editor, into the component column. Then fill in the resulting dialog.

Thin lenses are drawn as a single line with arrow heads.

[3] This is a simple paraxial/Seidels analysis. WinLens Tol is a fully featured tolerancing program with comprehensive sensitivity analyses, tolerance editors with statistical feedback, and Monte Carlo simulations

1.4 Quick guide to the manual

The manual is organised as follows:

Chapter	Purpose
Chapter 2: Examples	• Simple LINOS doublet [***sec 2.1***] • Symmetric system of two LINOS doublets [***sec 2.2***] • Simple user defined lens [***sec 2.3***]
Chapter 3: Editors	• System data editor [***sec 3.1***] • System parameter editor [***sec 3.2***] • Surface data editor [***sec 3.3***] • Zoom manager [***sec 3.4***] • Pickup editor [***sec 3.5***]
Chapter 4: Tables and graphs	• Review/change global options [***sec 4.1***] • Make multiple copies of a graph or table [***sec 4.2***] • Use zoom friendly graphs & tables [***sec 4.3***] • Freeze a graph or table for 'audit trail' purposes [***sec 4.4***] • Change format of data in tables [***sec 4.5***]
Chapter 5: Sliders	• Purpose of sliders [***sec 5.1***] • Defining a slider [***sec 5.2***] • Notes on sliders [***sec 5.3***]
Chapter 6: Glasses	• Standard, special & temporary glasses [***sec 6.1***] • Melt glasses [***sec 6.2***] • Finding an alternative glass [***sec 6.3***]
Chapter 7: Databases & Lens Library	• LINOS components [***sec 7.1***] • Optical glasses [***sec 7.2***] • LINOS thin films [***sec 7.3***] • LINOS lens library [***sec 7.4***] • Disk file viewer [***sec 7.5***]
Chapter 8: Final thoughts	• Pre-Designer [***sec 8.1***] • LINOS capabilities [***sec 8.2***] • On-line resources [***sec 8.3***] • Book recommendations [***sec 8.4***] • Journals [***sec 8.5***] • LINOS offices [***sec 8.6***]

1.5 New features {v1.1.5}

WinLens Plus and WinLens 4.3 are often updated. The table below lists the latest additions to these programs.

Version	Feature
V1.1.5 [May 2004]	**Lens drawing** {plus} -optional surface numbering -slider controlled single ray trace **Graphs** {plus} optional choice of wavelength to display, **Transmission v aperture graph** {plus} **Footprint graph** {plus} **Paraxial/Seidels tables** display values for any of the chosen [or for differences at two of those wavelengths
[WL4.3]	**Full active glass map [*Section 6.3*]** **Export to** CodeV, Oslo, Sigma & Zemax file
Other programs	*- Major update this year is the ISO 10110 drawings in WinLens Tolerancer [part of the WinLens Plus suite]* *- Also Material Editor can now create glasses which are melt derivatives of existing catalogue materials - Just use data supplied in melt sheet. These can then be used in WLP*
v1.1.4 [May 2003]	**Active Glass Map**: Custom glass map. Shows glasses in system. Allow glass update by click on map. Search for glass with particular properties. Colour code glasses by property. [For more information see ***Section 6.3***]
	GRIN: LINOS radial & slab GRIN lenses can now be analysed. These components are included in the database.
v1.1.3 [Oct 2002]	**Import** CodeV, Oslo, Sigma & Zemax files
	Export {plus} data to CodeV, Oslo, Sigma & Zemax file
	Summary tables for graphs – child tables which show data 'behind' graph. When loaded, these are utomatically refreshed when the parent graph is updated.
	Export table data to Excel or HTML file

2 How to set up a simple lens system

This chapter contains very basic information on how to actually set up a lens system in WinLens.

- *Your first lens*
- *Changing the design*
- *Making a custom component*

"The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living."

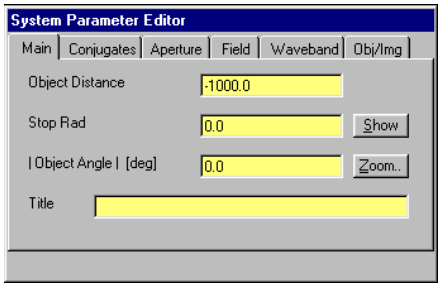
Jules Henri Poincaré

In this chapter we will walk you through the very basics of using WinLens to set up a simple system from a LINOS component. This will then be converted into a symmetric system with two LINOS components. We will then show how to make a user defined component.

When you start WinLens, the program will fill the screen. At the top is a menu and toolbar. At the bottom are sliders. You can ignore all these for the moment.

2.1 System 1: Single LINOS lens

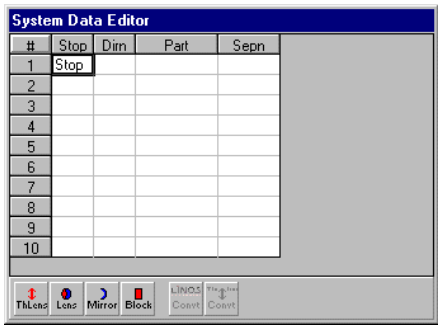
You will also see two windows:



The System Parameter Editor allows you to select the conjugates, aperture & field parameters and their magnitudes.

The 'main' page shows the current selection of the parameters, along with the values. These can be edited.

You can also specify the waveband.



The System Data Editor shows the sequence of components making up the system. These will be named in the 'Part' column.

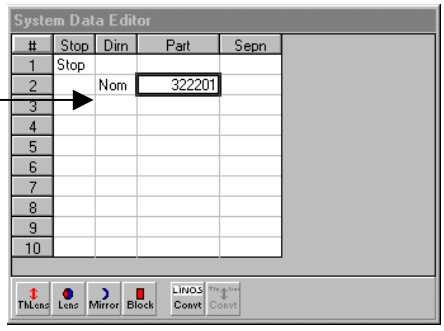
The distance between components is listed in the 'Sepn' column.

The spreadsheet will automatically grow in length if needed for more complex systems.

We will now create a system, using the LINOS component 322201 [a doublet].

When you have entered the component, try clicking on the 'dirn' cell, marked 'nom' to change the orientation of the lens.

[Note: you can also drag & drop components from the component database table: see ***section 7.1***]



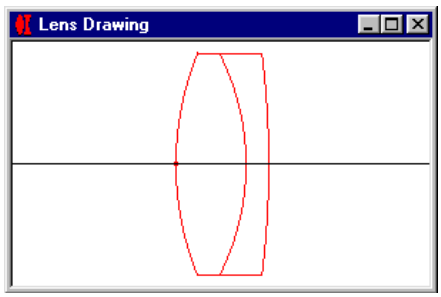
Simply type the part number [322201] into a cell in the 'Part' column. It is NOT very important which cell you use!

WinLens will get the data for this component automatically from the database.

The 'Dirn' column shows the direction of the component:

- 'Nom' - normal
- 'Rev' – reversed

Click to change component orientation

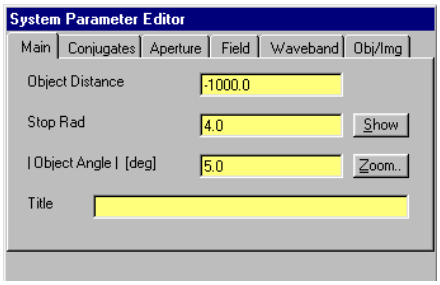


The lens drawing will automatically appear when you load a system or enter the first component of a new system.

Note: you can change the properties of this drawing by:

- right click the drawing, then
- choose '*Select local options for this drawing…*' from the popup menu

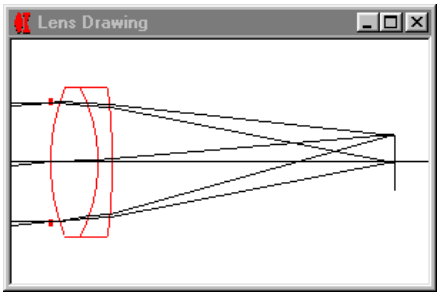
This is simple so far, but the system has an aperture size of zero, so no light will get through. It also has a zero field size. We need to enter some values for both.



We will specify that the system has:

- Stop radius of 5mm
- Object angle of 5deg

Simply type the values into the fields shown in the System parameter editor.



This shows the lens drawing for the new stop and aperture setting.

Note that the image surface and extreme rays in the fan are drawn.

To choose these or other options:

- right click the drawing, then
- choose '*Select local options for this drawing…*' from the popup menu

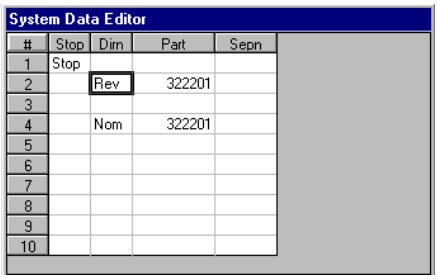
A tabbed dialog contains the choices.

At this point you might want to load other graphs & tables, such as the Seidel aberrations table, the spot diagram or transverse ray aberration plot. These can be accessed either from the 'tables' or 'graphs' menu, or via icons in the 'tables' or 'graphs' section of the toolbar directly under the menu

Try reversing the component several times and see how the diagrams are automatically updated. Note how you can instantly see that this component has a 'right' and a 'wrong' direction!

2.2 System 2: Two LINOS lenses

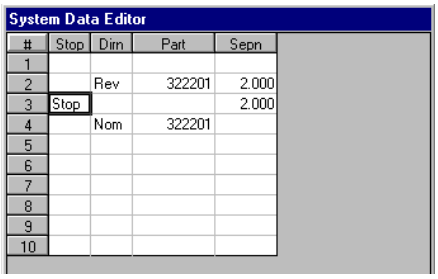
In this example we are going to make the lens into a symmetric system with unit magnification [mag = -1]. The system will be composed of two LINOS components with a central stop. First we will enter the components:



Add another 322201 part after the first.

Make sure there is a cell free between the two! [the stop is going to go here]

Reverse the FIRST component

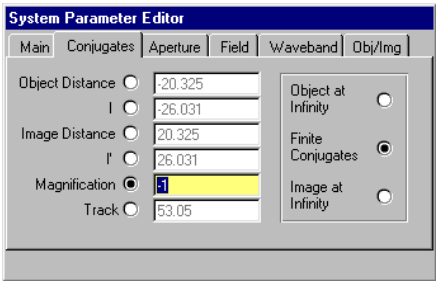


Now add in two separations of 2mm, as shown

At the moment the stop is right at the front of the system.

So finally, position the stop between the two components by clicking the cell in the 'Stop' column between the two components.

Now we need to change the conjugate from controlling object distance to controlling magnification

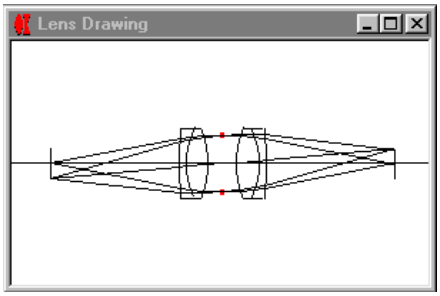


Select the 'conjugate' tab in the system data editor. Here you may choose the independent parameter.

Click on the 'Mag' option & enter a value of –1

Note how the other dependant parameters are automatically updated

If you now look at the 'Main' tab, note that 'Mag' has replaced 'Stop Rad'



Here we see the final lens drawing of the symmetric system.

Note that we have again changed the drawing options to include the object plane.

Now reverse both components to see the huge increase in spherical aberration!

There are two comments to make:

1. You can do this in any order, e.g. set magnification first.
2. So far we have been dealing on a component level. However there is a spreadsheet editor which will allow you to see the system on a surface by surface basis. [see ***section 3.3***]

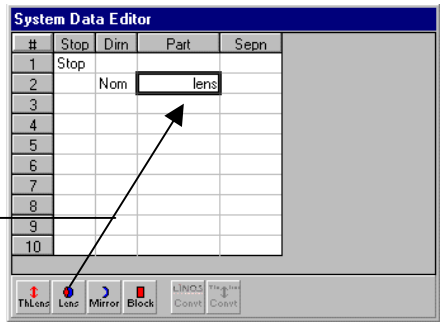
2.3 System 3: User defined lens

In this example we are going to create a system from a user defined plano convex lens.

First, lets clear the last system. Pull down the 'File' menu and click on the 'New' option. It is up to you whether you save the old system!

In the System Parameter Editor, set the stop radius to 4mm and the object angle to 5deg.

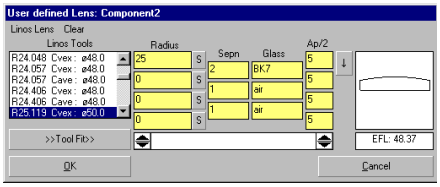
Alternatively, drag & drop from the lens icon, to the desired cell in the 'parts' column *{plus}*



Type the word 'lens' in a cell in the 'Part' column, end press the enter key.

This tells WinLens that you want to create a user defined lens.

WinLens will launch a simple lens editor.

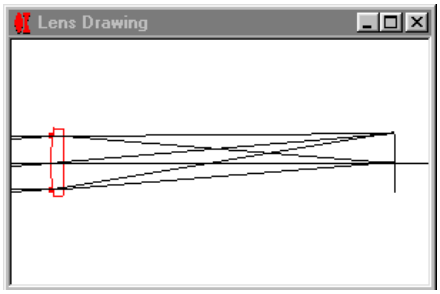


In this editor, set:

- first radius to 25mm
- first separation to 2mm
- first glass to BK7

click on the OK button

note that the lens can be a singlet, a cemented doublet, an air spaced doublet or a cemented triplet.



This shows the resulting singlet – the right way round, given the distant object.

If you reverse the lens, the performance does drop off, though it is not so obvious from the lens drawing. You would need to look at the TRA curves.

If you wish to re-edit the lens then either:

1. Double click on the 'lens' in the 'part' column of the System Data Editor
2. Use the surface editor [see section 3.3]

The former allows you to edit this lens only, but you can make it into a doublet or triplet. The later allows you to edit surface data for the whole system, but does not allow you to insert surfaces or components.

3 The editors

WinLens contains a number of different editors.

- *System parameter editor*
- *System data editor [component level view]*
- *Surface data editor [surface by surface view]*
- *Zoom manager*
- *Pickup editor*

"*Nothing tends so much to the advancement of knowledge as the application of a new instrument. The native intellectual powers of men in different times are not so much the causes of the different success of their labours, as the peculiar nature of the means and artificial resources in their possession.*"

- *Sir Humphrey Davy*

WinLens contains a number of editors for different purposes. You have already met the System Data Editor and the System Parameter Editor. In this chapter we will provide more information on these and some others

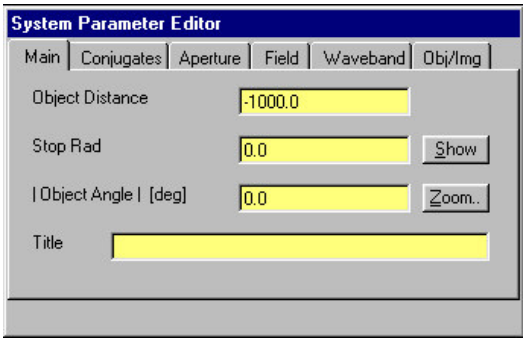
- System parameter editor
- System data editor [component level view]
- Surface data editor [surface by surface view]
- Zoom manager
- Pickup editor

3.1 System parameter editor

Whatever system is designed, whether simple singlet or complex zoom system, you will need to specify, in some way, where the object is, what size it is and the aperture of the system. You will also need to specify the waveband in which the system is operating.

These may all be selected in the system parameter editor, a tabbed form which is permanently loaded.

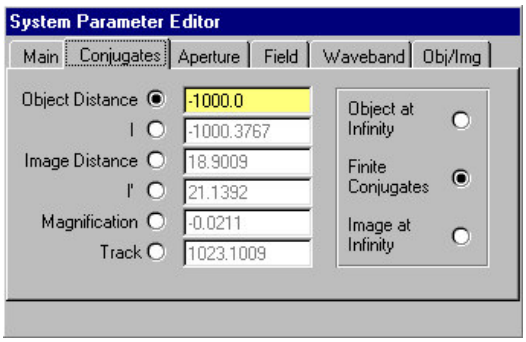
This is permanently loaded



There are several ways of controlling conjugate, aperture & field size. For example, conjugates might be expressed in terms of object distance from first surface, image distance from last surface, magnification etc.

For each class [conjugate, field & aperture] one of these options is the current selection. This is shown on the 'main' tab.

All other options [which are controlled by that choice] are shown on the appropriately named tab.



On these other tabs, you can only change the value of the selected option [the dependant parameters will be updated automatically]. To change selection, click on the option button for the choice appropriate to your system.

Zoom systems. This editor always shows the parameters for the **current zoom**. Both values and options can change from zoom to zoom.

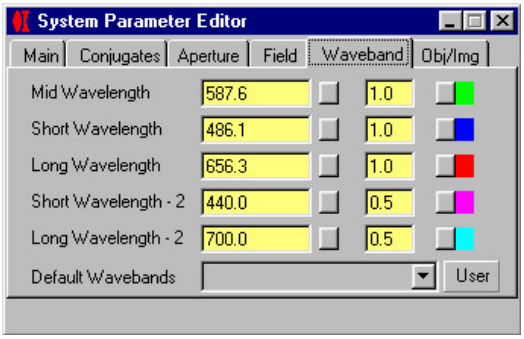
To create a zoom system, insert/delete a zoom, or look at the parameters for all zooms, simply click the 'Zoom' button. This will load the 'Zoom Manager', which is discussed in ***section 3.4***.

3.1.1 Wavelength definition

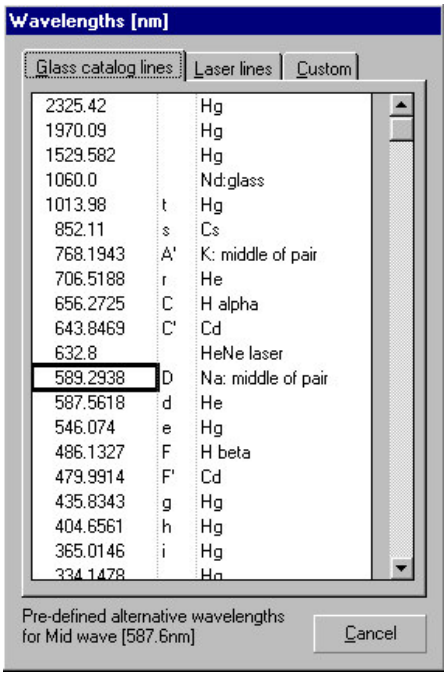
Since refractive index of any material varies with wavelength, the wavelengths required for analysis must be defined.

You may specify up to 5 wavelengths in any one zoom. The mid wavelength is the primary wavelength for analysis.

You may also define a colour for each wavelength. These colours will be used in the various graphs for identification. To define the colour simply click on the button beside the colour sample area at right for the wavelength of interest.



To define the wavelength you may type in a value [in nm] in the text box. Alternatively {plus}, WinLensPlus maintains a list of standard wavelengths. To access this list, click on the button beside the text box, and you will see:



Simply click on the wavelength you want, and it will appear in the wavelength text box.

This form is split into several tabs. The first contains standard glass catalogue wavelengths. The second, a long list of laser wavelengths. The final tab contains any custom wavelengths.

These custom wavelengths are defined in a simple text file [WaveLen.LST], which lives in the UserData subdirectory.

Each wavelength is defined in a single line. An example of 3 wavelengths is shown below:

1060.0| 1060.0
t| 1014.0
s| 852.1

Note the first part is the 'name', and ther second part [after the '|' character] is the actual value.

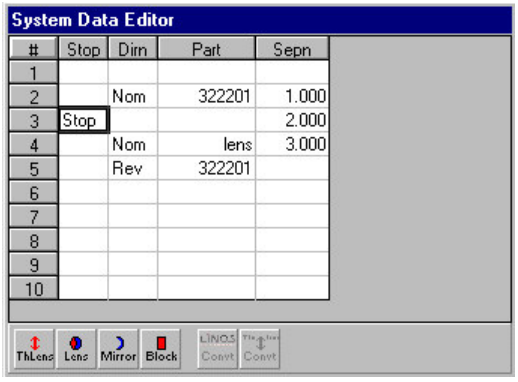
WinLens also contains a few standard wavebands. You can select these from the drop down list at the bottom of the system parameter editor, in the waveband tab. This will set the wavelengths appropriately.

Alternatively, you may set up a custom set of wavelengths, and then define these as the 'user' waveband. Simply click on the button beside the list. These may then be recalled by selection from the list at a later date.

3.2 System data editor

As noted in the examples, this editor allows you to specify/edit the basic structure of the system in terms of components and separation between components.

This is permanently loaded



In this illustration, the system consists of:

- LINOS doublet #322201
- Stop in air
- User defined lens
- LINOS doublet #322201 [reversed]

The stop is 1mm after the first doublet, and is in turn 2mm before the user-defined lens. Following the user lens is a 3mm gap before the final LINOS doublet

3.2.1 System data editor icons

You can use the left hand block of icons if you want to create a user defined thin lens, lens, mirror or block. Simply drag & drop from the icon into the desired cell in the 'part' column. WinLens will then load a dialog, to enable you to define that component

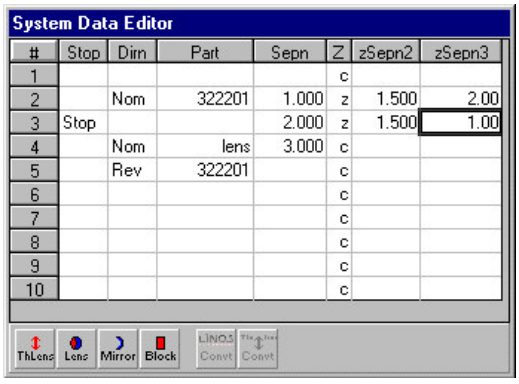
The right hand block of buttons are for conversion:

1. Conversion of a LINOS component into a user defined component [with same parameters, but editable]
2. Conversion of a thin lens into a user defined lens

3.2.2 System data editor and zoom systems

In WinLens all gaps between components can be made zoom-able, i.e. have different values for the separation in each zoom. These separations are shown in the system data editor.

If we make the system shown above have three zooms [see ***section 3.4***], then the system data editor will have some extra columns, to display the zoom separations. we might end up with:



First note the new thin column to the right of the 'Sepn' column. Each cell has one of two possible codes:

- 'z' for zoom-able
- 'c' for constant [i.e. same for all zooms]

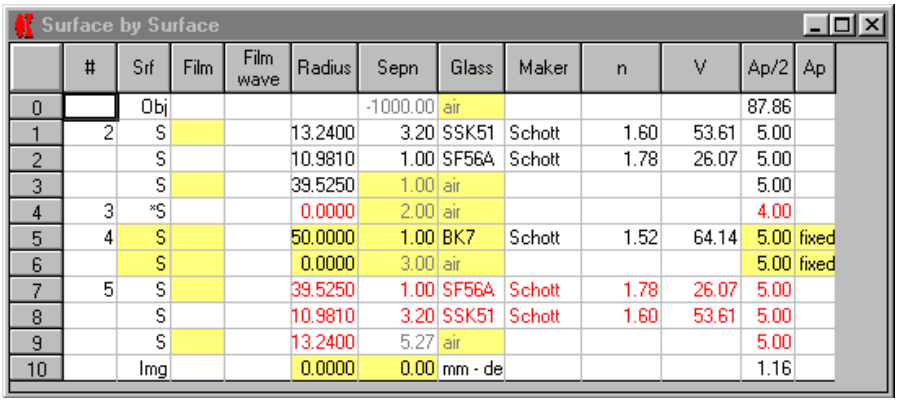
Click to toggle between these two states.

Once a gap is marked as zoom-able, you may enter values for the separations in the extra zooms in the space provided. Thus here, the gap between the first LINOS doublet, 322201, and the stop has the value of 1.0mm in zoom 1, 1.5mm in zoom 2 and 2.00mm in zoom 3.

3.3 Surface data editor

To load, either:
- Select 'Surface' from the 'Tables' menu
- Click 'Surf Data' icon in the 'Tables' tab of the main tool bar

On many occasions it is convenient to see all the component data [radii, separation, glasses, apertures etc] in one spreadsheet. This view is provided by the Surface data editor. Here we show the editor for the system outlined in section 3.2



	#	Srf	Film	Film wave	Radius	Sepn	Glass	Maker	n	V	Ap/2	Ap
0		Obj				-1000.00	air				87.86	
1	2	S			13.2400	3.20	SSK51	Schott	1.60	53.61	5.00	
2		S			10.9810	1.00	SF56A	Schott	1.78	26.07	5.00	
3		S			39.5250	1.00	air				5.00	
4	3	*S			0.0000	2.00	air				4.00	
5	4	S			50.0000	1.00	BK7	Schott	1.52	64.14	5.00	fixed
6		S			0.0000	3.00	air				5.00	fixed
7	5	S			39.5250	1.00	SF56A	Schott	1.78	26.07	5.00	
8		S			10.9810	3.20	SSK51	Schott	1.60	53.61	5.00	
9		S			13.2400	5.27	air				5.00	
10		Img			0.0000	0.00	mm - de				1.16	

There are many thing to note:

1. Data for surfaces & spaces inside a component are colour coded. Thus the first, third, fifth etc. components will be black. Data for the second, fourth, sixth etc, component will be in red. The stop [if in air] counts as a component.
2. The first column [headed #] shows the row number of the parent component, in the systems data editor [see ***section 3.2***]
3. Data for spaces between components [separations & materials] will be in grey.
4. Editable data is shown by cells with a yellow background [please note: LINOS components cannot be edited unless they are first converted[4] into user components]
5. Films can be entered from the LINOS film database, either by name or by drag & drop from the thin film database form[5] into the film column.
6. Entering a value of zero for the radius defines a plane surface.
7. Separations are for distance after the surface.
8. Separations shown are for the current zoom [see section 3.4]
9. To change an editable glass either type its name or drag & drop from the glass database. This form is searchable and can be sorted in many ways.
10. You can enter materials between components.
11. Apertures on editable surfaces can either be fixed or variable. If variable, then the aperture will be adjusted[6] to allow the passage of all rays from each object point, given the system stop and other fixed apertures. To toggle between the two states, simply click on the cell. *{plus}*
12. If the system contains toroid/conic or aspheric surfaces then extra columns will appear at the right of the form

3.3.1 Hidden features

There are a number of hidden features to this editor. You may find these useful. All can be accessed by clicking on particular cells.

1. Surface dialog to change surface type: click an editable cell in the 'Srf' column
2. Melt glass entry: click in the 'Maker' column for an editable glass. All you need is the melt glass index at two wavelengths.
3. List of indices at the waveband wavelengths. Click on a glass cell in the 'n' or 'V' columns.

[4] To convert a LINOS component into an editable user lens, simply select the component in the system data editor and press F12. Alternatively, click the conversion icon at mid bottom of the system data editor.

[5] The various databases can be easily displayed. Either select an option from the 'Database' menu or click on icon in the 'Database' tab in the main toolbar.

[6] Various options are available for this procedure, e.g. rounding, extra space etc. To see these options, select 'Aperture control' from the 'options' menu.

3.4 Zoom manager

This editor has one purpose only – to allow you to create and specify zoom systems.

In WinLens a zoom system usually [but not always] has one or more spaces whose separation changes with the zoom number. However, you can also have completely different:

- conjugates [object/image distance]
- field size
- aperture size
- wavebands

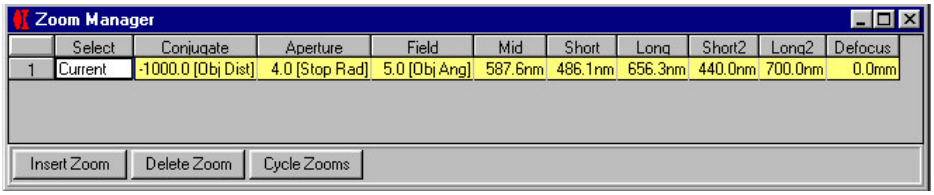
for each zoom.

Lets make a single zoom system. To load the Zoom Manager, either:

1. Click on the 'zoom…' button on the System parameter editor
2. Pull down the 'tables' menu and select the 'Zooms' option
3. Click the 'Zoom' icon in the 'tables' tab of the main toolbar

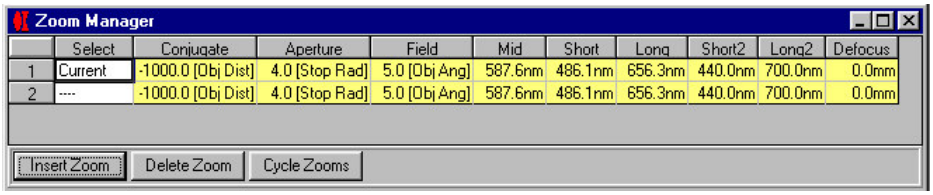
You will see something like:

To load either:
- Select 'Zooms' from the 'Tables' menu
- Click 'Zoom' icon in the 'Tables' tab of the main tool bar
- Click 'Zooms…' button on the System parameter editor



There is just one row, for the single zoom. In it are the editable parameters for that zoom. You can change the values [but not the parameter types] here.

To add a zoom, simply click the 'Insert Zoom' button.



Now there are two zooms. Initially the new zoom is a copy of the previous zoom, in terms of system parameters. As explained above, you can edit the values here, or change the parameter types for the 'current' zoom in the System parameter editor.

Initially graphs and tables[7] show data for the current zoom, when the current zoom is changed, these will be updated accordingly.

The current zoom is shown by the word 'current' in the 'Select' column. To change the current zoom, simply click on a cell in the that column

To change the parameter types you must use the System parameter editor, where you can change the parameter types for the current zoom – for example, you could control object distance in zoom1 and magnification in zoom 2.

We have already shown how the zoom separations are entered [see ***section 3.2.2.***]

[7] We will discuss how to make graphs & tables show data for any specific zoom whether or not, or even for multiple zooms! [***See sections 4.2 & 4.3***]

3.5 Pickup editor

Pickups are ways of enforcing permanent links between data. For example, you may wish to ensure that two separations are kept at identical values, no matter what happens.

WinLens has a number of pickups, ranging from single parameter pickups, such as separation and glass, through surface pickups, to complete component pickups.

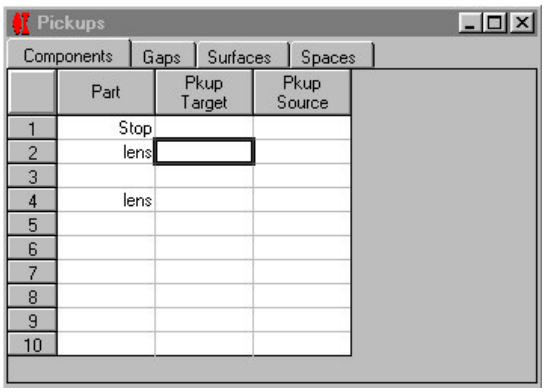
Each pickup has a master or source component/parameter and a slave or target component/parameter. Changes in the master are automatically repeated in the slave. The master component/parameter is always 'earlier' in the optical chain than the target.

Most pickups, with the exception of glass, can have a scale factor. For example, if two components are linked, you may force the target component to be twice the size of the source pickup. A component scale factor of –ve, means that the the component is rotated [mirrors excepted!]

Finally, you can build chains of pickups! Thus one component may be master to another, which is in turn master to a third and so on. Pickups do not have to be between 'adjacent' components. This chaining can be very useful when dealing with systems with repeating modules.

Here we see the pickup editor, for a system with two components.

To load either:
- Select 'Pickups' from the 'Tables' menu
- Click 'Pickup' icon in the 'Tables' tab of the main tool bar



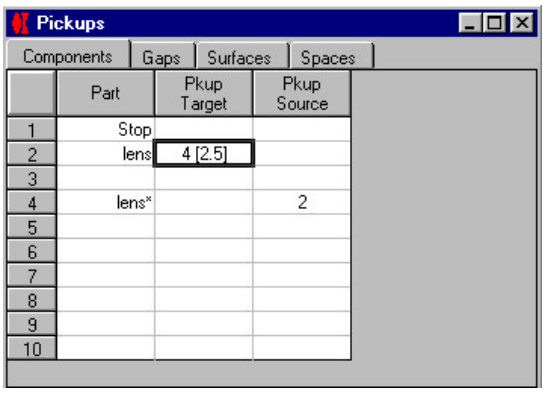
To make a pickup, simply drag from the 'Pkup Target' column and drop into the 'Pkup Source' column.

Naturally, you must drag from the cell in the row of the source component [in this case row 2]

Equally naturally you must drop in the row where the target component should be

if you do not drop it in row of an existing component [row 4 in this case], then it will create a linked component in that target row!

When you drop, you will be asked to enter the scale factor [unless this is a glass pickup]. After the link is made you will see:



The value in the 'Pkup target' column (*4[2.5]*) tells you that lens in cell 2 is the master component in a link to the lens in row 4, with a scale factor of 2.5

The value in the 'Pkup source' column (2) tells you that lens 4 is the slave or target in a link from component 2.

Note that the slave component's name has changed to 'lens*'.

To edit the pickup scale factor or delete it, simple click on the cell in the 'Pkup target column'. A value of zero will delete the pickup.

WinLens will perform checks to make sure that pickups are valid and comply to the rules!

4 Graphs & tables

How to:

- *Review/change global options*
- *Make multiple copies of a graph or table*
- *Use zoom friendly graphs & tables*
- *Freeze a copy of a graph or table for 'audit trail' purposes*
- *Change format of data in tables*

"*There are many examples of old, incorrect theories that stubbornly persisted, sustained only by the prestige of foolish but well-connected scientists. ... Many of these theories have been killed off only when some decisive experiment exposed their incorrectness. .. Thus the yeoman work in any science, and especially physics, is done by the experimentalist, who must keep the theoreticians honest.*"

- Michio Kaku

Editors allow you to make changes to the optical system and its environment. Graphs and tables show you the effects, mainly optical, of those changes.

In this section, we are not going to discuss individual graphs & tables, instead we shall look at some generic items of interest. We shall see how to:
- Review/change global options
- Make multiple copies of a graph or table
- Use zoom friendly graphs & tables
- Freeze a copy of a graph or table for 'audit trail' purposes
- Change format of data in tables

These are all things which will be useful, but are not immediately obvious.

4.1 Review/change global options

Local options[8] apply to a single graph or table and will be located in clear view on that graph or table. For example the scale of the spot diagram can be edited by directly typing into a text box on the spot diagram graph.

Global options apply to several graphs. This includes things like:
- number of wavelengths at which to trace rays
- number of rays in a fan for TRA, OPD, Longitudinal aberrations etc
- number of ray rings for spot diagrams, MTF's etc

To review and edit such global options, either:
- **Select 'Options' from the main menu**
- **Right click a graph/table and select 'Global parameters, from the popup menu**

Any changes will be applied straight away to all appropriate graphs/tables.

4.2 Multiple copies of a graph or table

Some times it can be very useful to have multiple copies of a graph or table. For example, you might have one lens drawing showing the entire system, while another shows the small portion round the stop or is zoomed in to the image plane.

Most graphs and tables can be 'cloned'. **To clone a graph/table, right click on that form and select the option '*Make another graph [table]*' from the popup menu**. WinLens will then create a new graph/table as appropriate.

Once 'cloned' the new graph/table is independent of its parent. You may then change its scales & local options independently. For zoom systems, you may get the cloned graph/table to show results for a different zoom [discussed below]

This has an important consequence for graphs. Because we want to maintain this independence of local scales for a graph, any changes to scales do NOT automatically become the new default scales for that graph type. You must deliberately choose to do this.

To force local set of options to become the new defaults, right click on the form and select the '*Make local scales the new defaults*'.

On the other hand, if you wish to reset the graph to the old defaults, right click on the form and select the '*Reset local scales to defaults*'

4.3 Zoom friendly graphs & tables

All graphs & tables can be set to show the data for one zoom – the current zoom or a specified zoom. When the current zoom is changed in the Zoom manager [Section 3.4], the graphs & tables will be automatically updated.

[8] The exception to this rule is the lens drawing. Here there are so many options that they have been collected into a dialog. To access this dialog [as we have seen in the examples [Ch 2], right click on the drawing and choose '*Select local options for this drawing*'.

A few tables [the paraxial system data table and the Seidels table] can be set to show data for one zoom or all zooms. The options are directly visible on the form and so will not be discussed further.

Most graphs, including the lens drawing' can be set to show data for one, several or all zooms simultaneously.

To change the zoom[s] displayed, right click on the graph and select the '*Change zoom for graph [table]*' option from the popup menu. A dialog will appear with the choices available for that form.

One final note, for the lens drawing, when showing multiple zooms, you may choose which datum the graphics may be aligned to. The choices include:

- Object or image
- Any physical surface in the system
- One of the optical points, such as principle planes, object or entrance pupil etc.

This can look particularly neat when the zooms are drawn one beneath the other [as on the front cover to this document]. These choices are held in the lens drawing option dialog. Right click the lens drawing and choose the 'Select local options for this drawing' item

4.4 Freeze a graph or table

Sometimes you may want to have a copy of a graph or table, to compare with the results for a modified system later on. You could print out the table/graph. Alternatively, you can 'freeze' a copy of the form.

Once frozen the graph/table will no longer be updated by any changes to the system. Its caption will note the time of freezing.

Please note that you can load further unfrozen copies of that form using the normal menu or icon.

To freeze a from, right click on the form and select the 'Freeze' option from the menu.

4.5 Change format of data in tables

All tables show numerical data in spreadsheet form. Sometimes the number of decimal places in a particular column does not need to vary. But sometimes you may wish to see more or less information.

To change the number of decimal places in a column, right click the spreadsheet and select the 'Change column formats' option.

WinLens will launch a dialog showing all columns in the source spreadsheet. Underneath the caption for each column, you will either see a '$' or a number. The '$' sign means that column is in alphanumeric format and is fixed. However any number can be edited. Thus 2 means two decimal places. You could then change this to 4 and then see 4 decimal places in that particular column.

5 Sliders

How to use sliders to rapidly change variables over a range of values

- *Purpose of sliders*
- *Defining a slider*
- *Notes on sliders*

"The labelling of any engineering project with the epithet `simple' is more often than not the result of the feeling of confidence that springs from inadequate comprehension of the situation".

- SubG

- Purpose of sliders
- Defining a slider
- Notes on sliders

5.1 Purpose of sliders

In the last chapter we saw how the editors could be used to alter parameters. This is quite alright, but can be very time consuming, when making repeated adjustments to one or two variables.

To help with this task, sliders have been introduced to WinLens. Sliders can now be 'linked' to parameters of your choice, for example, the power of a particular component, the radius of a surface or the space between two surfaces. Here we see two sliders, one linked to the radius of curvature of the third surface.



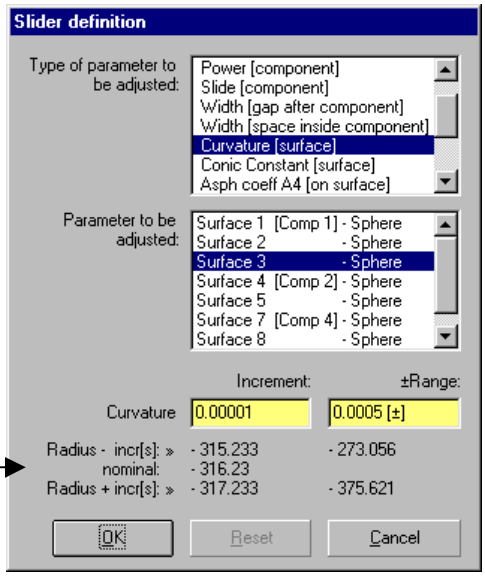
As the slider position is altered, so the parameter is updated along with all visible graphs and tables. This allows for rapid adjustment of a variable, with increments chosen by you.

Quite often, optical design requires the alteration of one parameter followed by some compensatory adjustment of another. In such a case, simple define as many sliders as are required. There is no restriction on the order in which sliders may be used.

5.2 Defining a slider

A number of sliders are located in a bar along the bottom of WinLens. Obviously these are initially undefined, i.e. not linked to any specific parameter.

To define the purpose of the slider [i.e. link it to a parameter], click on the '…' button at top right of a slider. You will see the slider definition dialog appear.



This area shows the change in the parameter resulting from:

- ±1 increment
- ±50 increments [entire range]

Because this area is intended to make clear the effect of a change, the data displayed may not be quite the same as the chosen parameter. For example, for curvature changes, the effect on radius is shown. While for an aspheric coefficient, the effect on surface sag is shown.

To define the slider:

1) Select type of parameter to be used, from the top most list.
2) Once this is selected, all available options[9] for the particular parameter will appear in the list below.
3) Select the exact parameter to be adjusted from the second list.
4) Enter either the parameter increment, or the range that you want.
5) Click the OK button.

The dialog will disappear. Now if you drag the slider bar, that parameter will be incremented and the graphs & tables updated accordingly.

To alter the definition or reset back to the starting position, simply click on the '…' button again, and the dialog will reappear, but showing the current definition.

[9] The options will depend upon the parameter type, AND the specific system. Thus if you have chosen radius, the second list will display all surfaces whose radius can be altered. LINOS components are fixed and therefore surfaces from LINOS components will NOT appear in the list.

It is easy to convert a LINOS component into 'user' defined component, which will be listed and can be adjusted by slider. Simply select the component in the System Data Editor and press F12

5.3 Notes on sliders

In this section, we discuss various aspects of sliders in more detail.

5.3.1 Rules on 'availability'

When you select a particular parameter type, you may wonder why some components or surfaces are not available. The following rules may help.

- LINOS components have a fixed design and therefore you cannot alter power, bending, curvatures, aspheric or internal separations.
- Blocks must have plane surfaces and therefore you cannot alter power, bending or curvatures
- Mirrors have a single surface and therefore you cannot alter power or bending. Alter curvature instead.

5.3.2 Setting slider increments

This is a powerful tool, and can, if not used with some care, make massive changes to a system! Therefore be careful in your choice of increment/range.

The effect of some parameter changes is immediately obvious, such as a change in width. However others, such as power or bending, are not so obvious. The following table therefore defines the various types of adjustment possible.

Parameter Type	Action	Notes	Trial increment size
Bend	Add increment value to curvature of all surfaces in the selected component	= $[C_f + C_l]/[C_f + C_l]$ C_f is curve of first surface C_l is curve of last surface	.01 - .0001
Power	Add equal and opposite increment to curvature of first & last surfaces of the selected component	Power is 1/focal length of the component in air	.01 - .0001
Slide	Add [subtract] increment to space **before** component] & Subtract [add] increment to space **after** component]		.1
Width [gap after component]	Add increment to space after component.		.1
Width [space inside component]	Add increment to a space inside component		.1
Curvature	Adds increment to the curvature of the selected surface	Curvature is 1/ radius of the selected surface	.01 to .0001
Conic constant	Adds increment to the conic constant of the selected surface		.01
Aspheric Coefficient A4 -A12	Adds increment to the nominated aspheric coefficient of the selected surface		Small!
Defocus	Adds increment to the defocus of the system		.1

When specify the parameter increment or range, look carefully at the effects displayed underneath. These will give you a clear indication of the scale of the effects, especially for items like power, curvature, conic constants & aspheric coefficients.

Note that the effects may not be the same as the parameter type, but some dependant quantity that is more obvious. Thus when altering the curvature, we

show the effect of adding curvature increments on the radius of the surface. Similarly for aspheric coefficients and conic constants, we show the impact on the surface sag. This gives a much clearer idea whether these changes are massive or insignificant – this is especially important since both cases are very likely to occur when manipulating aspheric coefficients!

5.3.3 Unlinking sliders

You can unlink a slider manually, by selecting the 'Undefined slider' from the parameter type list in the slider definition dialog.

WinLens also automatically unlinks sliders on various occasions. These include:

- Creating a new lens [all sliders]
- Loading a lens from disk [all sliders]
- Deleting a component [sliders relating to that component]
- Inserting a blank row in the system data editor
- Inserting a component [group of components]
- Reversing a component [group of components]

So don't be surprised if a slider you have defined clears after you have done some editing in the system data editor. In general, this occurs after structural changes to the lens.

5.3.4 Automatic re-centering

Please note, any changes you make to the data in the surface data editor will not clear the slider [provided they do not alter the structure of the lens, which can sometimes happen if you change a glass in a component to air].

However, after such an action, a slider directly linked to the edited parameter [such as a specific radius] will be 're-centered'. The slider will be returned to its central position.

After such a re-centering, the slider will then use the value that you entered as its new default or center point.

6 Optical glasses

This chapter is devoted to glasses within WinLens.

- *Standard, special & temporary glasses*
- *Melt glasses*
- *Finding an alternative glass*

"I do not know what I appear to the world; but to myself I seem to have been only like a boy playing on a seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

Sir Isaac Newton

In this chapter we shall briefly cover optical glasses and related features:
- Standard, special & temporary glasses
- Melt glasses
- Finding an alternative glass

6.1 Standard, special & temporary glasses

Standard glasses: WinLens has a large and up to date database of optical glasses from the major glass manufacturers. These are known as the standard glasses. This includes data on obsolete glasses, to help with setting up patents and finding new alternatives.

Special glasses: WinLens has a smaller database of special materials, mostly infra-red. You can add to these glasses using the material editor utility [a separate program]

Temporary glasses: there are times when you may wish to model a glass, just knowing one value of the refractive index, or the index and v-value. WinLens allows you to 'create' such glasses on the fly.

When you change a material[10] WinLens will search through the database [standard glasses first, then special glasses, then temporary glasses].

If one match is found, data for that glass is used.

If more than one match is found, then a dialog will present the options [i.e. list the makers names]. You then simply choose the appropriate make.

If no glasses match the name you supplied, then WinLens assumes that you wish to create a temporary glass, and loads a dialog. You then supply indices as appropriate.

One final note: please do replace temporary glasses with real glasses before committing a design to manufacture!

6.2 Melt glasses

Glass manufacturers provide refractive index data in great detail. However, optical glass is created in individual melts. The index will vary slightly from melt to melt. This may cause significant performance changes in some systems.

In theory you could create a special glass for each melt. However the supplied melt certificate rarely gives enough data for this.

However there is a much simpler method [technical details are given in the help system], which is based upon the fact that there is a relation between the indices of a melt glass and the catalogue values.

Using this relation, it is possible to predict melt glass behaviour, just knowing the melt index at two wavelengths. Given this, and the catalog data, WinLens can predict the indices at other wavelengths, and therefore model the effects of a particular melt.

To create a melt glass, simply click on the Maker name of the glass in the Surface Data table [***sec 3.3***]. WinLens will then launch the melt dialog. Once specified, you may choose to apply this data to the one space, or all spaces using that material [either including or excluding other melts]

Rules for melt glasses
- You cannot create melt data for LINOS components. If you wish to then you must convert the component into a user defined lens first [***sec 3.2.1***]
- You must supply index data at two wavelengths for the melt

[10] Materials are changed either in the Surface Data editor, or in the lens & block dialogs launched from the System Data editor. You may also change object and image space in the 'Obj/Img' tab on the System parameter editor.

To change a material you simply type in the name of the new material in place of the old name.

- You must supply a melt code [either official or you own invention]. This is very useful because you can apply different melts to the same material at different places in the system.

Once defined, you will see an extra column in the Surface Data table to the right of the Maker column. This melt column shows the melt code you supplied.

6.3 Finding an alternative glass

There are several circumstances in which you will want to find an alternative glass:

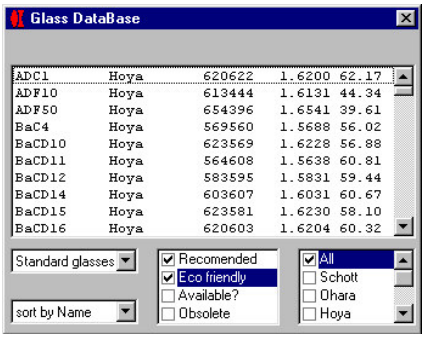
- To replace an obsolete glass
- To replace a glass with an ECO[11] friendly glass
- To replace a temporary glass with a real glass
- To replace an 'optimised'[12] glass with a real glass {plus}
- To change the performance of a system.

Obviously you could just type in a new name into the appropriate cell. However if you need a more scientific approach then WinLens can help.

There are three helpful tools:

- Glass Database
- Alternate Glass Finder
- Active Glass Map new v1.1.4

First the glass database itself. This is not just a simple list, but can be searched and sorted. It is available through the database menu, or via an icon in the database tab of the main toolbar.



You can specify which broad classes of glass [recommended, available?, ECO and/or obsolete] from one or more manufacturers are shown[13]. You can then sort this list in many ways [name, index, V-value etc].

Both this [and the tool discussed next] may be found by pulling down the 'Database' menu, or by clicking an icon in the 'Database' tab of the main toolbar.

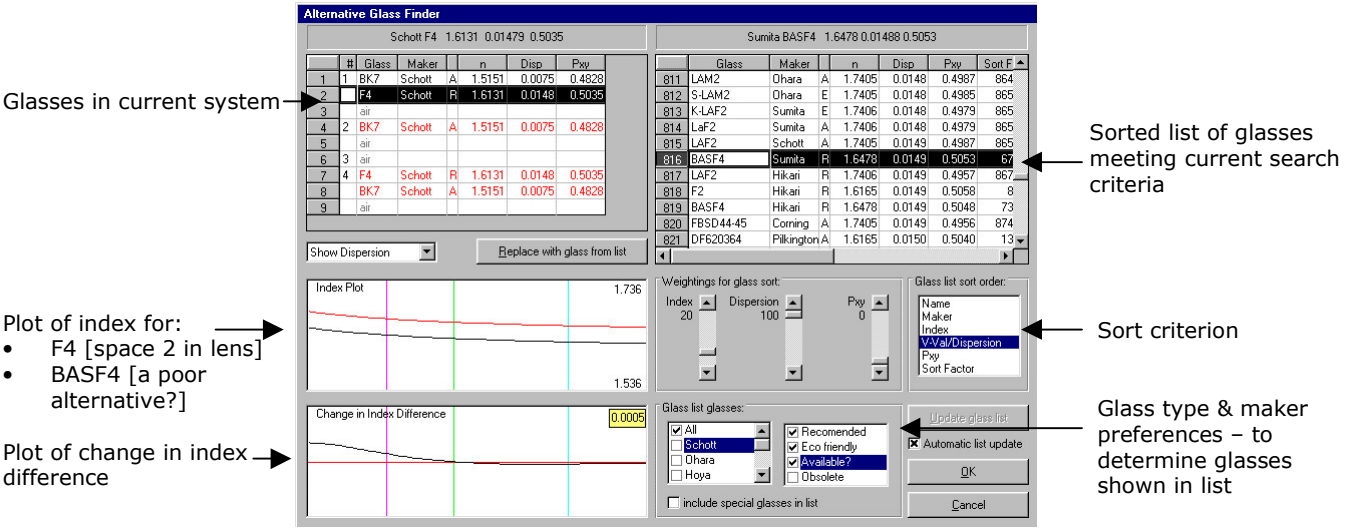
Glasses can be dragged from this to the Surface data table ['Glass column']

[11] 'ECO glass'. Many manufacturers now supply a range of eco friendly glasses which contain no lead or arsenic.

[12] 'Optimised' glass {plus}. In optimisation it is possible to make a glass into a variable. Optimisation variables require a continuous range of values.
Since there is only a finite number of real glasses, the best we can do is restrain the variable glass to lie within the real glass region, and use a glass model. After the optimisation, we will want to replace the optimised theoretical glass with the nearest real glass.

[13]These options do not limit the glasses you can use in the design! It is merely to help you list alternatives from a more focused selection.

For a more sophisticated glass replacement tool, here is also an **Alternate Glass Finder** dialog. It is also available through the database menu, or via an icon in the database tab of the main toolbar.

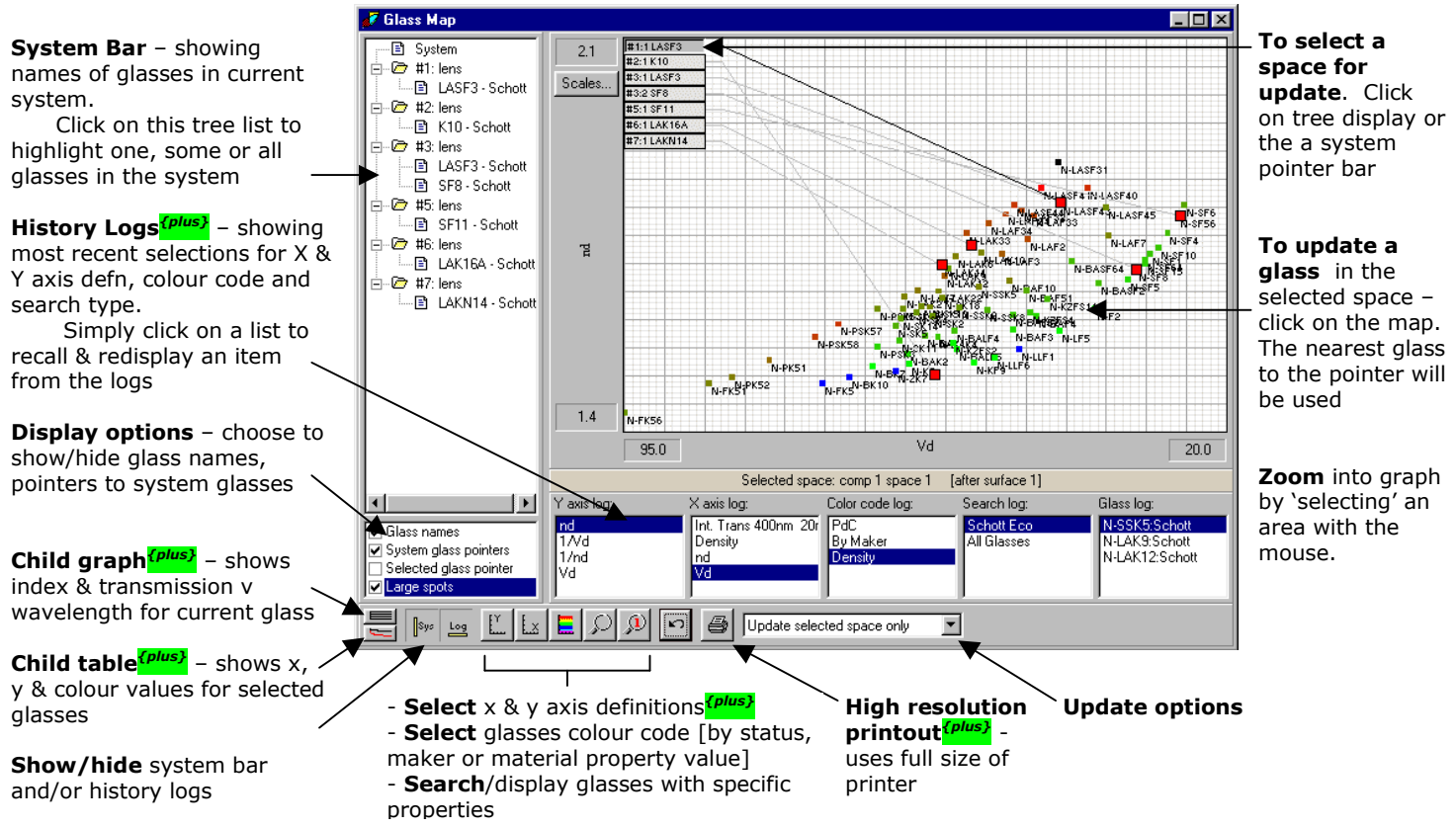


This dialog shows the current system, highlighting its glasses. Select a system glass, & the dialog can sort and search the glasses in the glass database.

If you then click on a glass in the list, you will see comparative index plots for the system glass and the alternate glass.

When you are satisfied with the match [whether by total overlay, parallelism of the two curves or merely intersection at a specific wavelength], you can then replace the glass.

Finally, there is the **Active Glass Map** *{v1.1.4}* – here we see the standard Nd-Vd plot, but with glasses colour coded for density.



7 Databases, Lens Library & Lens Files

This chapter covers the three databases within WinLens.

- *LINOS components*
- *Glasses*
- *LINOS thin films*

It also discusses the LINOS lens library and the disk file viewer [a preview option]

"Nature composes some of her loveliest poems for the microscope and the telescope."

-Theodore Roszak

In this chapter we shall look at the three databases used by WinLens, and see how they can make your work much simpler.

- LINOS components
- Glasses
- LINOS thin films

These can all be loaded by selecting an option from the 'Database' menu or clicking an icon on the 'Database' tab of the main toolbar.

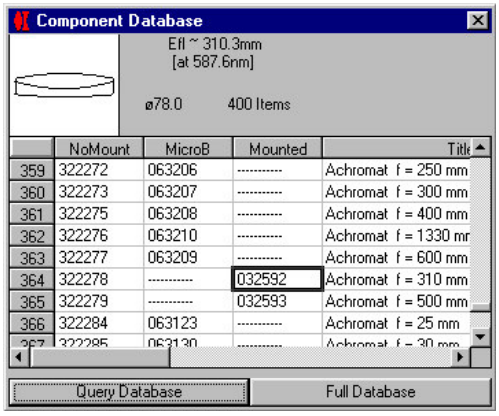
We will also mention the LINOS lens library and the disk file viewer.

7.1 LINOS components

You may want or need to model a system containing one or more of the LINOS range of components. Obviously you could type in all the parameters by hand. However that would indeed be a huge waste of time.

WinLens can access a database of the LINOS components. All you have to do is enter the part number [as illustrated in the simple example ***section 2.1***] into the system data editor. WinLens will then automatically create a lens with the correct design parameters.

If you are not quite sure which is the appropriate LINOS part to use, then view the component database form. This contains a list of the LINOS parts.



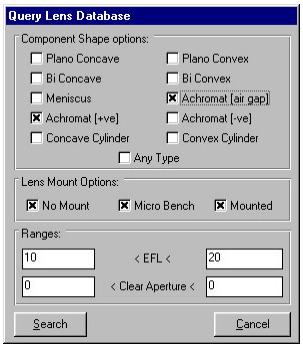
Each part has a separate row. You can see that sometimes a part has 1, 2 or even 3 part numbers.
The lens prescription is the same, but the mount type is different. From left to right, the different columns refer to:
Part#: lens with no mount
Part#: lens in microbench mount
Part#: lens in standard mount

When you click on a row, the component is drawn and details of aperture and focal length are shown in the form header.

This list can be searched by:

- type [singlet, doublet etc]
- focal length
- aperture size

To search the component database, click on the 'Query Database' button. WinLens will load a simple dialog, in which you can specify your requirements.



Toggling the 'Any Type' box will clear or check the check boxes for all other component shape options.

When your requirements have been entered, press 'OK'. WinLens will then hide the dialog, search the database and display those components which satisfy your specifications.

As before you can scroll through the list until a suitable component is found. You can then simply **drag and drop** it on the 'Part' column in the system data editor. WinLens will insert that component into your design.

One final note: obviously LINOS components cannot be edited [unlike user defined lenses]. Sometimes however, you will want to use a LINOS part as the start of a design, i.e. you will want to edit it. You can simply convert a LINOS to a 'user' lens, by:

- Select the lens in the system data editor
- Press F12

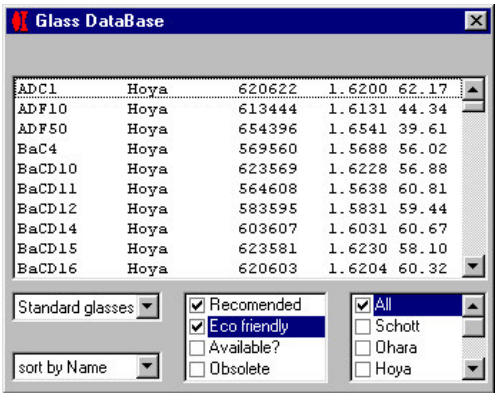
WinLens will then convert the fixed LINOS part to an editable user lens of the same prescription.

7.2 Glasses

Optical materials are a critical part of any lens design. Correct values for refractive index are crucial for correct analysis.

In the old days, each time a prescription was set up, the user had to enter the data by hand, with all the consequent possibilities for error.

In WinLens, however, all you need to do is enter the glass name in the appropriate place [see ***sections 2.3 & 3.3***]. You can either type names in directly, or drag & drop from the **Glass database form** [F4] [shown below].



As you can see, the glass database, can be searched for:

- glass category
- glass maker

And sorted by:

- name
- maker
- 6 figure code
- index [d wavelength]
- V-value [d, C, F wavelength]

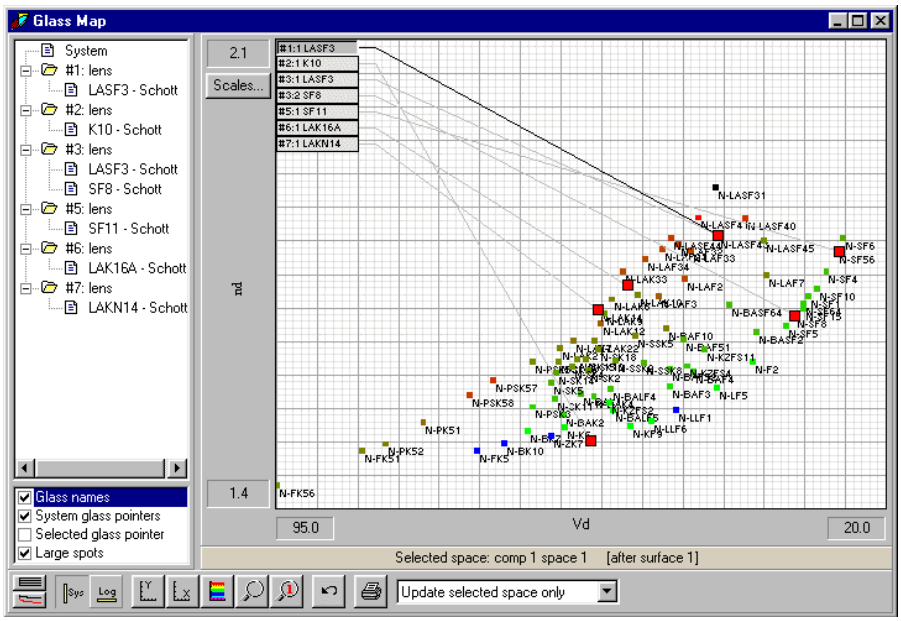
Once sorted you can simply drag and drop a glass from the database to the 'glass' column in the surface data editor.

WinLens will then directly replace/update the material data for that space.

Alternatively you may use the **Active Glass Map** {v1.1.4} [Ctrl+F4].

Glass map [new v1.1.4]

- Display current system on map
- Click on tree-view to select a space for update
- Click on map to change a glass in that space
- Custom axes from wide range of properties
- Custom colour coding of glasses
- Powerful search
- High res printout
- History logs – for axes, colour & search
- Child graph - index & trans v wavelength
- Child table with data for displayed glasses



This is a highly customisable glass map, with many useful features, which is described in more detail in section 6.3].

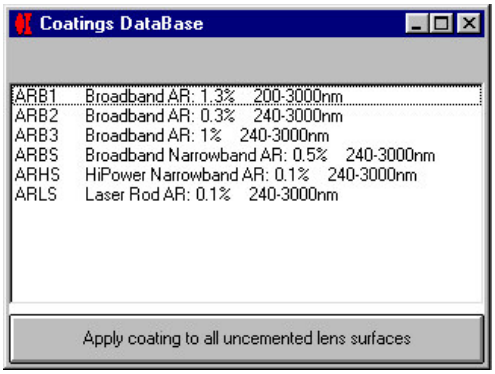
However, for the purposes of this section, a significant benefit is you can see the location of the glasses in the current system. **The main feature is that you can update a glass in that system by simply clicking on the map**.

Of course, you will want to select the space which is to be updated. This is just as simple! Either click a glass in the tree view or one of the glass pointer bars at top left of the map. The current glass has a bold pointer line, compared to the other pointer lines.

7.3 LINOS thin films

LINOS components can be supplied with or without anti-reflection coatings. These coatings do not alter the basic optical design but can make a significant improvement to the transmission of a system.

LINOS has developed a set of optimised coatings, e.g. ARB1, ARB2 etc. These coatings are listed in a simple form, which shows the Film name and some details of the film.



You can simply drag and drop a film from the database to the 'film' column in the surface data table.

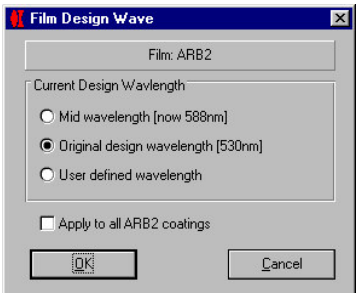
If you do this WinLens will apply the coating to that surface only.

Alternatively, you can select a coating and then click the button at the bottom of this form. WinLens will then apply that coating to all un-cemented surfaces. Pre-existing coatings on lens surfaces will be replaced.

Each film name actually refers to a family of coatings whose actual details will vary according to:

- refractive index of substrate, i.e. of the lens element
- design wavelength of the film

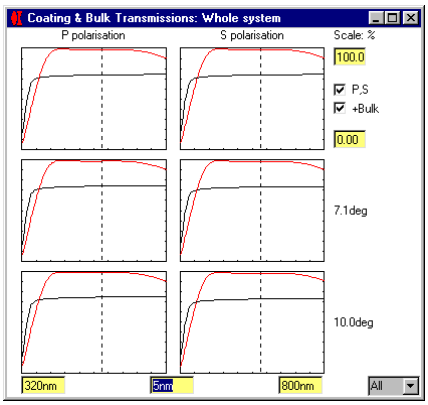
WinLens knows the refractive index of the element. However you can alter the design wavelength for the coating [this will shift the peak transmission in the waveband]. To alter the design wavelength, simply, click on the 'film wave' column in the system data editor.



WinLens will display the dialog shown left. The altered design wavelength will be applied either to:

- coating for selected surface
- all surfaces with same coating

To review the impact of coating on transmission, look at the transmission graph or table, loaded via the 'transmission' menu [or by clicking on the equivalent icon in the 'transmission' tab of the main toolbar].



A typical example is shown left. In this graph, the transmission for the un-coated system is shown in black, while for the transmission for the system coated with ARB2 is shown in red.

You may choose

- the waveband for analysis
- separate S & P plots
- include bulk absorption effects

by using the various text boxes and check boxes on ths form.

7.4 LINOS lens library

The component database only contains the prescriptions of single LINOS components. LINOS also provides prescriptions for a number of complete systems. These are held in the LINOS lens library. The library contains:

- systems composed entirely of LINOS components[14]
- systems taken from the patent literature[15]

All systems in the library are held as SPD files [SPD is the file format for WinLens designs]. Any system in the library can be loaded into WinLens using the standard 'File' menu options.

The lens library can be freely downloaded from the LINOS website [www.winlens.de]. It is provided in the form of a self extracting zip file [WinLensLibrary.EXE].

When you have downloaded the library file, run it [either use the 'Run' option from the start menu, or double click on WinLensLibrary.EXE in the windows explorer. It will then start to extract all the files from the library.

As part of this process, you can then select the folder for the library. Usually you would expect to put the library in a sub folder from the WinLens folder, however this is entirely up to you!

The library consists of a number of nested folders. Please feel free to explore the contents.

[14] These may be freely used and modified.

[15] Notes on systems from patent files: LINOS Photonics makes no guarantees of any kind regarding the performance of the lens files. It is the user's responsibility to ensure that he is not in violation of the authors patents rights. LINOS Photonics cannot be held responsible for any violation of patent rights by the user.

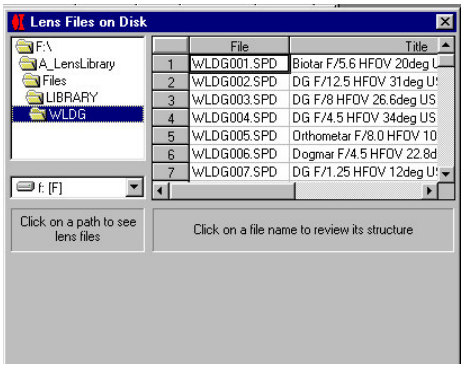
7.5 Disk file viewer

WinLens has standard 'File' menu options for loading systems from disk. These can be files from the LINOS lens library or files that you have saved yourself.

These options are fine in themselves, but there are some circumstances in which they are rather limited:

- Reviewing many files to find the correct system.
- Inserting all of an existing system on disk into the current system
- Inserting part of an existing system on disk into the current system

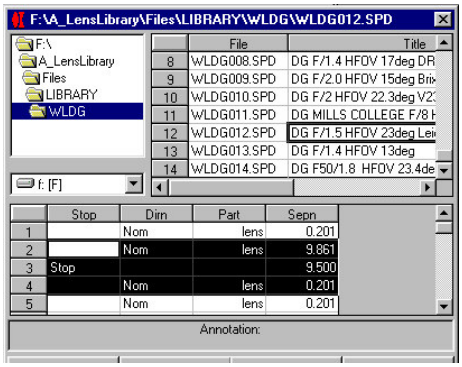
To help in this case there is the 'disk file viewer' dialog. From the 'File' menu, select the 'Disk file viewer' option. WinLens will load the form. This has a folder selector [top left]



Select the folder containing the file[s] of interest. The spreadsheet to the right, will then show all WinLens files in that folder [listed by name and internal title]

In the example shown here, we are looking at some of the double gauss systems in the lens library.

If you now select a file [by simply clicking on a row in the spreadsheet], you will then see the details of the system, laid out in a similar fashion the system data editor.



When you have selected the correct file, you can:

- Load the entire system into WinLens [replacing existing system]
- Copy the entire system into the 'clipboard', ready for pasting
- Copy part of this system into the 'clipboard', ready for pasting.

In this example, we see three rows of the system selected. If you click the 'Copy selection' button then these lines will be copied to the 'clipboard'

It is very simple to paste elements within WinLens. Go to the System data editor. Place the cursor in the row at which you want the paste to start from. Either:

- pull down the 'Edit' menu and select the 'Paste' option
- click the 'Edit' tab in the main toolbar, and click the 'Paste' icon.

The data on the 'clipboard' will then be inserted, moving down any components after that point, to make space for the new components.

A final note: if you have selected several rows in the System data editor, then the selected rows will be overwritten by the 'clipboard' contents.

8 Final Notes

A few concluding thoughts and information on

- *Pre-Designer*
- *LINOS capabilities*
- *On-line resources*
- *Book recommendations*
- *Journals*
- *LINOS offices*

"In all science, error precedes the truth, and it is better it should go first than last."

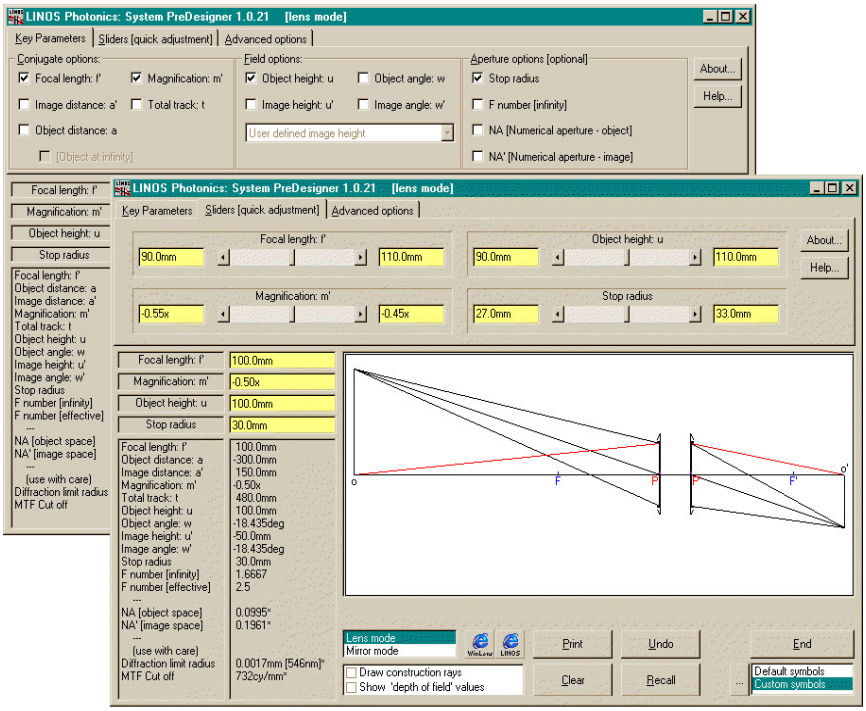
- Hugh Walpole

This manual provides a brief introduction to WinLens. For more information on WinLens in particular and optical design in general, we suggest that you look at the WinLens help file. There is also a separate manual available which deals with optimisation in WinLens.

In the following sections, we will discuss other tools and resources.

8.1 Pre-Designer

This is a simple free utility from LINOS which is designed to help with the stage before lens design. It will enable you to investigate the overall system parameters, before you actually commit any effort to the design phase.



Given any three conjugate and field requirements, this program can calculate the other dependant parameters. For example, if you know that your optical system must have, a focal length of f, a magnification of m' and an object height of h, Pre-Designer will draw the system paraxial layout and calculate the related object/image distances, magnification throw, image height and angles.

However you are not limited to that particular combination of parameters. You may select the key parameters from a comprehensive list. Pre-Designer will work through the appropriate sums for you, and display the results.

You may also select an aperture parameter, such as stop radius, or f-number. If you do then the drawing will also show aperture rays, and other aperture related parameters will be calculated and displayed.

Once parameters are chosen, sliders are available for real time changes to any of the values of the parameters.

Finally, some special features are available for handling some particular situations or requirements. These include:

- object at infinity
- standard image formats [film & CCD]
- principal plane separation
- non unity index object or image media
- custom symbols [useful for teaching purposes]
- option to draw cardinal points [focal, principal and nodal points]

It is suitable for lens designers, optical engineers and teachers & students of optics. It can be freely downloaded from http://www.winlens.de.

8.2 LINOS capabilities

LINOS is a world leading manufacturer of opto-mechanical components and systems. We offer both off-the-shelf components and complete OEM systems designed from scratch by our widely experienced R&D department.

LINOS Photonics: component catalogue
We have an extensive catalogue of optical and opto-mechanical components. Contact us for a copy or look on our website. In addition, WinLens contains the data for most of our catalogue lenses, achromats etc. Just type in the part number[s], build up an optical system and see the performance. Whichever method you use, you will find excellent components to suit your requirements

LINOS Photonics: OEM
LINOS is not just a supplier of off-the-shelf components. We have a long history of working with customers to implement existing designs. Alternatively, we are happy to take your basic requirements and transform these into suitable designs & equipment. As a system partner and OEM supplier in the area of precision optics, mechanics and laser technology, LINOS is a one stop shop, from consulting stage to complete production of your product. Right from the start we make available to our OEM partners, the complete know-how of our company. Qualified engineers and experienced practical designers follow the product from planning through development to the finished product. We use modern CNC techniques which can handle quantities from single items to mass production. We guarantee a high quality standard. Many OEM customers, in such demanding industries as photolithography and telecoms, no longer require an incoming inspection of LINOS parts because of our proven quality track record. Finally, timely deliveries are assured because of our up to date production methods and flexibility.

LINOS Photonics: PROMPT
Progressive Methods of Production Technology, established by LINOS. For very rapid turn round of optical systems using the in house optical & mechanical design and manufacture. Complete systems can be produced within days.

8.3 On-line resources

The LINOS home page can be found at http://www.linos.de/ .More information about optics [useful equations, drawings etc] may be found within the LINOS web-site at http://www.linos-photonics.de/en/homefr8.html

WinLens 4.3 can be downloaded free of charge from http://www.winlens.de.

The WinLens suite can also be downloaded from the same site. This is an inexpensive set of programs composed of:

- WinLens Plus: for optical design
- WinLens Tolerancer: for tolerancing
- Glass Manager: a powerful glass database
- Material Editor: utility for managing optical materials for the suite

Program updates, the glass and component databases and a library of designs in WinLens format are here and can be downloaded free of charge.

8.4 Book and paper recommendations

Papers:

- R. Schuhmann, G. Adams, 'Low-cost analysis software for optical design', Proc. SPIE, 3780 (1999)
- R. Schuhmann, G. Adams, 'Software for tolerance analysis of optical systems', Proc. SPIE, 4093 (2000)
- R. Schuhmann, G. Adams, 'Enhancements to the optimisation process in lens design (I)', Proc. SPIE, 4441 (2001)
- G. Adams, R. Schuhmann, 'Enhancements to the optimisation process in lens design (II)', Proc. SPIE, 4441 (2001)

Encyclopedia:

- K. Mütze (Editor), 'ABC der Optik', Verlag Werner Dausien
- H. Paul (Editor), 'Lexikon der Optik', Spektrum Akademischer Verlag Heidelberg
- G. Litfin, R. Schuhmann, 'Optical components and systems', Encyclopedia of Applied Physics, Vol. 12 (1995), VCH Publishers

Introduction to *Physical Optics*:
- F. L. Pedrotti, L. S. Pedrotti, 'Introduction to Optics', Prentice-Hall International
- H. Niedrig (Editor), 'Bergmann, Schaefer, Lehrbuch der Experimentalphysik' Vol. III, 'Optik', Verlag Walter De Gruyter
- M. Born, E. Wolf, 'Principles of Optics', Pergamon Press

Introduction to *Optical Imaging/ Technical Optics*:
- W.T. Welford, 'Aberrations of optical systems', Adam Hilgar
- A. E. Conrady, 'Applied Optics & Optical Design', Dover Publications
- Chr. Hofmann, 'Die optische Abbildung', Akademische Verlagsgesellschaft Geest & Portig, Leipzig
- H. Haferkorn, 'Optik', Verlag Harry Deutsch
- G. Schröder, 'Technische Optik', Vogel-Buchverlag Würzburg
- H. Naumann, G. Schröder, 'Baulemente der Optik', Carl Hanser Verlag München Wien
- G. Litfin (Editor), 'Technische Optik in der Praxis', Springer Verlag

Introduction to *Optical Design*:
- D. C. O'Shea, 'Elements of Modern Optical Design', John Wiley & Sons
- M. Berek, 'Grundlagen der praktischen Optik', Verlag Walter de Gruyter
- D. Malacara, Z. Malacara, 'Handbook of Lens Design', Marcel Dekker
- M. Laikin, 'Lens Design', Marcel Dekker
- H. Haferkorn, W. Richter, 'Synthese optischer Systeme' VEB Deutscher Verlag der Wissenschaften
- R. R. Shannon, 'The Art and Science of Optical Design', Cambridge University Press

8.5 Journals and Periodicals:

- 'Applied Optics', Optical Society of America - OSA *(Applied Optics)*
- 'EuroPhotonics', Laurin Publishing *(Europien Optics Scene, , Laser, Fibers, Imaging Optics, Electrooptics-Photonics)*
- 'F&M', Carl Hanser Verlag *(Optical Devices)*
- 'LASER', b-Quadrat Verlags GmbH *(Industrial Laser Technology)*
- 'Laser Focus World', PennWell, *(Photonics)*
- 'LaserOpto', AT-Fachverlag GmbH *(Industrial Laser Technology)*
- 'OPN – Optics & Photonics News', Optical Society of America – OSA *(Photonics)*
- 'Optical Engineering', International Society for Optical Engineering – SPIE *(Applied Optics)*
- 'Optik', Urban & Fischer Verlag *(Physical Optics)*
- 'Photonics', Laurin Publishing *(International Optics Scene, Laser, Fibers, Imaging Optics, Electrooptics-Photonics)*

8.6 LINOS Photonics offices

If you want to speak to someone then please feel free to contact the main offices, whose addresses, phone numbers and other details are given below.

	Germany	**United Kingdom**	**United States**	**France**
Company name:	**LINOS Photonics GmbH & Co. KG** (Corporate Headquarters)	**LINOS Photonics UK Ltd**	**LINOS Photonics INC**	**LINOS Photonics SARL**
Address:	Koenigsallee 23 D-37081 Goettingen	2 Drakes Mews, Crownhill Milton Keynes Buckinghamshire MK8 OER	459 Fortune Boulevard Milford MA 01757-1723	90, avenue de Lanessan 69410 Champagne au Mont d'Or
Phone:	+49 (0) 5 51/69 35-0	+44 1908 26 25 25	+1 508-478-6200	+33 (0)4 37 49 13 53
Fax:	+49 (0) 5 51/69 35-1 66	+44 1908 26 25 26	+1 508-478-5980	+33 (0)4 37 49 13 36
e-mail:	sales@linos.de	sales@linos.co.uk	info@linos.com	info-fr@linos.com
Net:	www.linos.de/ www.linos-katalog.de/	www.linos.co.uk/ www.linos-catalog.com	www.linos.com/ www.linos-catalog.com	

LINOS Photonics also has representatives in many countries.