

# YOUR FIRST OSLO SESSION

## 1. Introduction

This document gives a click-by-click description of how OSLO can be used to carry out a very simple task involving synthesis, analysis, and optimization of a spherical concave mirror. It is in general applicable to all editions of OSLO, including OSLO EDU. This means that more advanced facilities, which may only be available in OSLO Standard and Premium editions, are not included.

The exercise will demonstrate the two main modes of calculation, the geometrical approximation, in which light is treated as a ray, and physical, in which the light is treated as propagating as a wave front, and the results take account of diffraction.

### Symbols used in this chapter

A left-click on the mouse is indicated by a white arrow, and a right-click by the box with the word “Right”. If a drop-down menu is selected by a left-click, then it is represented by a black circle and arrow.

Step by step instructions are marked with bullet points. Instructions about what to do if things go badly wrong are in *italics* and labeled **HELP!**.

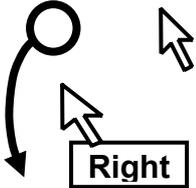
Anything typed from the keyboard (whether as a command or as an entry in a dialog box) is shown in **this typeface**.

Labels and headers in spreadsheets and dialog boxes are given in **bold**.

Buttons to be clicked are shown in **grey**.

Check-boxes (called “radio buttons” in the documentation) are shown like this:

Messages which appear whenever the cursor hovers above an icon are shown in a shaded box. These are known as tool-tips.



Questions and answers, representing a typical dialog between a lens designer and the customer, are given in **bold type**.

## 2. The user interface

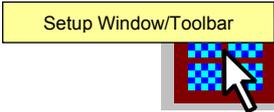
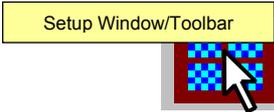
A number of terms are defined here, and given in **bold** print.

At the top of the main window in the blue border is the **title bar**, which gives the lens identifier, the file name under which the current lens was last saved, and the edition of OSLO which is running.

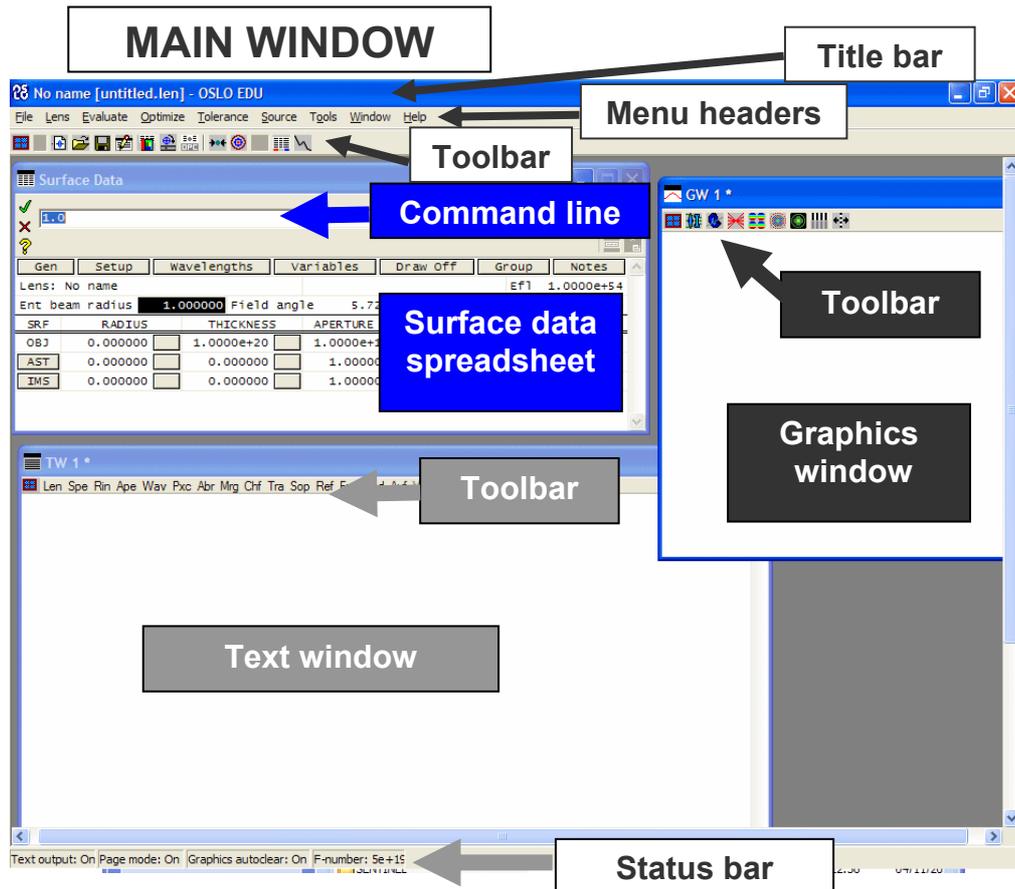
Beneath this lies a row of **menu headers**, **File**, **Lens**, **Evaluate**, etc, each of which has its own **drop-down menu**. Many of the program commands can be accessed through these menus. The last of the menu headers is **Help** which gives access to the on-line documentation. In Windows, this can also be accessed via the F1 key on the keyboard.

Below that is a row of icons forming the main window toolbar, which give one-click access to the most frequently used control functions. The first of these is the **Setup**

**Window/Toolbar** icon which gives access to a list of further groups of icons which can be added to the toolbar. Other icons are to **Open surface data spreadsheet**, **Open a new lens**, **Open an existing lens**, **Save the current lens**, **Open the standard text editor**, etc. Each icon has a description of its function which pops up as a tooltip.

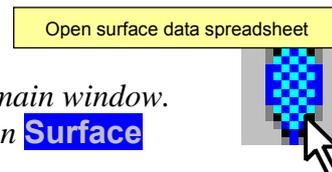


At the bottom of the main window, there is a **status bar** which can be expanded and customized by the user.

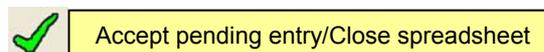


The window which opens in the top left hand corner is called the **surface data spreadsheet**. This is the area where all the properties of the lens and its working conditions are defined. Other spreadsheets are available, but only one spreadsheet can be open at a time.

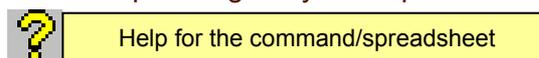
**HELP!** If the surface data spreadsheet does not open, click on the blue lens icon on the left of the toolbar in the main window. Alternatively, select from the **Lens** menu header the option **Surface Data Spreadsheet...**



Immediately above the surface data spreadsheet is the **command line** where **OSLO commands** are typed. They are executed either by pressing **Enter** or by clicking on the green tick:



Online documentation for any command may be accessed by typing the command in the command line, and then pressing the yellow question mark beside it.



If no command is entered the documentation for any currently open spreadsheet is given.

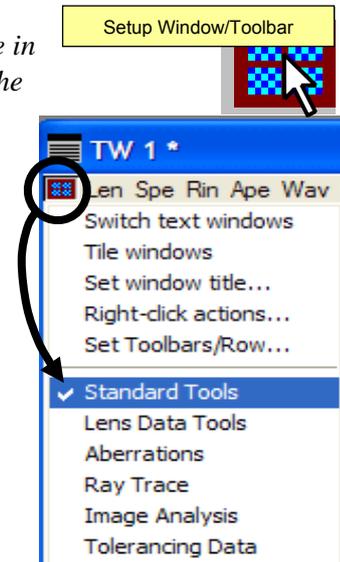
Below the command line there is a **message area**, and on the right hand end there is the **history button**.



There should also be a **text window** visible. This is where printed output is directed. Along the top of this there lies a **toolbar** consisting of a row of text labels, which are OSLO commands, executed by clicking.

**HELP!** If the text window toolbar does not look like the one in the diagram, click on the **Setup Window/Toolbar** icon in the top left-hand corner of the text window, and select **Standard Tools** from the menu. Any or all of the toolbar groups may be selected for a text window. Either one or two, but not more, text windows can be shown at a time.

The user may create additional toolbar entries using the CCL programming language.



Also on the main screen there is at least one **graphics window**. This has a **toolbar** consisting of a row of **icons**. All graphical output is displayed in one of the graphics windows.

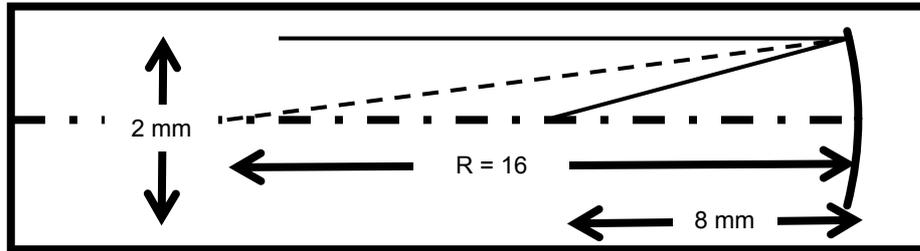
**HELP!** If the graphics window toolbar does not look like the one in the diagram, click on the **Setup Window/Toolbar** icon on the left-hand side of the graphics window toolbar, and select **Standard Tools** from the menu. Only one of the graphics window icon groups may be displayed at a time, but different graphics windows may have different groups. Up to 30 graphics windows may be created and displayed by the user at any one time. Two more may be generated automatically.

**HELP!** If you have trouble finding the text window or the graphics window, then from the **Window** menu header select **Tile Windows**. Alternatively type the command **tile** into the command line and then either click on the green tick ✓ or press **↵ (Enter)** on the keyboard.

### 3. Spherical mirror example

The remainder of this section will consist of instructions on how to specify a concave spherical mirror of radius 16 mm, and then to assess its on-axis performance at apertures of  $f/4$  and  $f/2.3$ . Finally its performance at  $18^\circ$  off axis will be assessed, and the stop position and image radius of curvature optimized to give the best performance over the field of view.

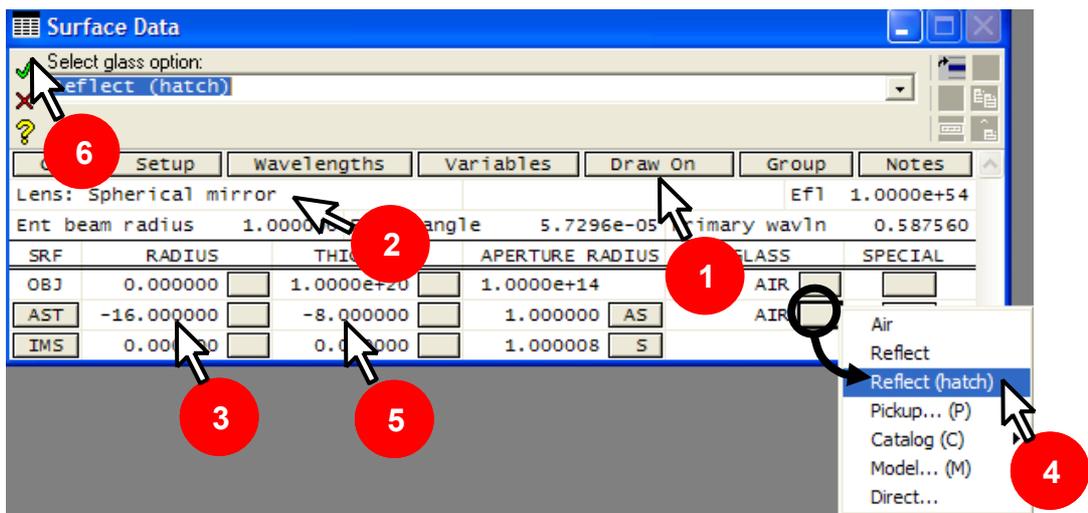
For clarity, each section will be prefaced by a question from a “customer,” given in bold type.



**Question:** Does a spherical mirror working at  $f/4$  give a “diffraction limited” image at its focus when used with a 2 mm diameter parallel axial beam of green light?

#### 3.1 Defining the lens system data

The working conditions of the lens (such as units, paraxial setup data, wavelengths and field points) are defined by entries in the surface data spreadsheet above the double line.



On the surface data spreadsheet:

1. Left-click with the mouse on **Draw Off** to open the **Autodraw** window. The label on the button changes to **Draw On** while the **Autodraw** window is active.
2. Add the lens identifier (up to 32 characters): **Lens: Spherical mirror**  
Click once on the green tick.

**HELP!** If you were to choose a different name for the lens identifier, and the name happened to be a valid OSLO command words (such as **spe**), the name would be rejected

and the relevant command executed instead. To avoid this, the title might be enclosed in quotation marks: e.g. "spe".

The default value of **Ent beam radius** is 1.0 mm, the default primary wavelength is 0.58756  $\mu\text{m}$  (the green helium d-line), and the default units are mm, so for this exercise these do not need to be changed. Also at this stage it is only necessary to assess the mirror on axis, so the field angle does not need to be changed from the default value of 1 milliradian.

### Defining the lens surface data

Turning now to the data below the double line, the first line (labeled OBJ) refers to the object space, numbered 0. A parallel beam is the default condition for a new lens. So the **THICKNESS** - that is the object distance - is infinity (in OSLO, that means  $10^{20}$ , written **1.0000e+20** lens units). Nothing has to be changed on this line since in the object space a medium (**GLASS**) of **AIR** is also the default. The object radius (1.0000e+14) is calculated from the field angle by the program, and is not specified by the user.

On the second line for surface 1 (**AST**):

3. Because the aperture is "f/4" the focal length must be 4 times the beam diameter of 2 mm, and the focal length is half the radius of curvature. Change the **RADIUS** to: **-16** (mm). Since this is measured from the surface to its center, a negative radius implies a surface concave to the incoming beam.
4. Click on the grey button next to **AIR** under **GLASS** and select **Reflect (hatch)** (or **Reflect** - the only difference being the appearance of the drawing).
5. Change the **THICKNESS** from 0.000000 to: **-8** (mm). This is the separation from surface 1 to surface 2. It is negative because after reflection the light travels in the opposite direction to the local z-axis.
6. Once again, click on the green tick (✓) to confirm the changes.

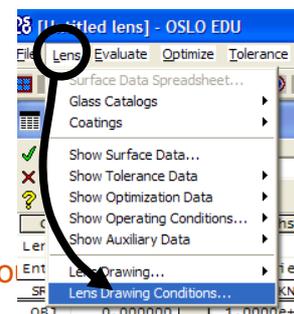
Note that for surface 1, the **APERTURE RADIUS** (1.000000) has **AS** in the grey box next to it. **A** means that this surface is the aperture stop. **S** means that the size of the surface is governed by a "paraxial solve," which means that it will be adjusted to accommodate (approximately) both axial and off-axis beams without truncation.

On the third line, which corresponds to the image (**IMS**) a **RADIUS** of 0.0 means that the image is plane. Once again its size is the default - it is adjusted using a "paraxial solve." The box for the next space (**THICKNESS**) will be used for a defocus value, but is zero at present. The box showing the medium after the image (**GLASS**) is of course blank.

There is no need to close the surface data spreadsheet before starting the next section.

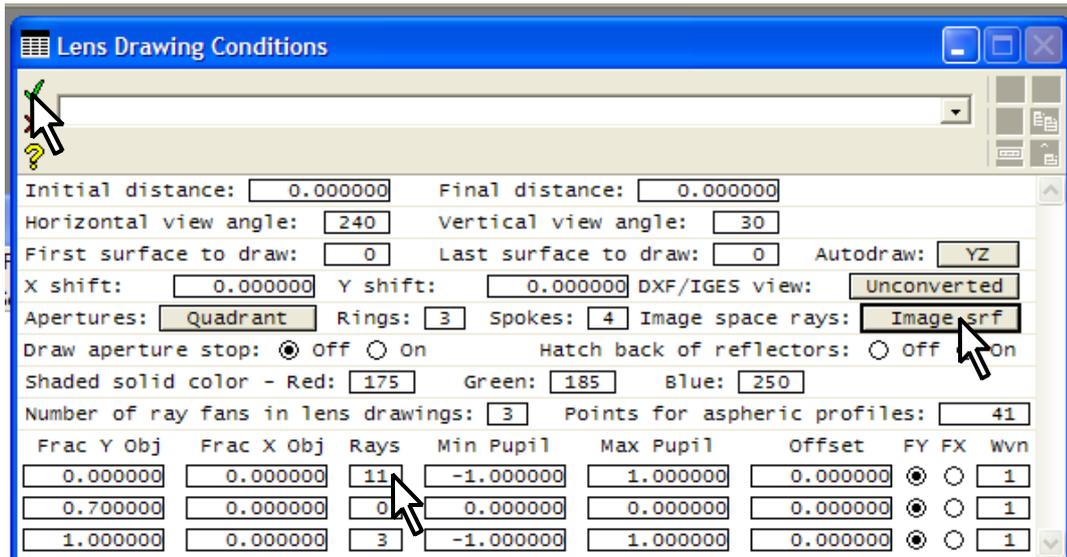
### Drawing the lens in the Autodraw window

In the main window:



- Click on the **Lens** menu header to open the menu list shown.
- Select the last item, **Lens Drawing Conditions ...**

The **Lens Drawing Conditions** spreadsheet will appear. This is the spreadsheet where the overall appearance of lens system drawings is determined.

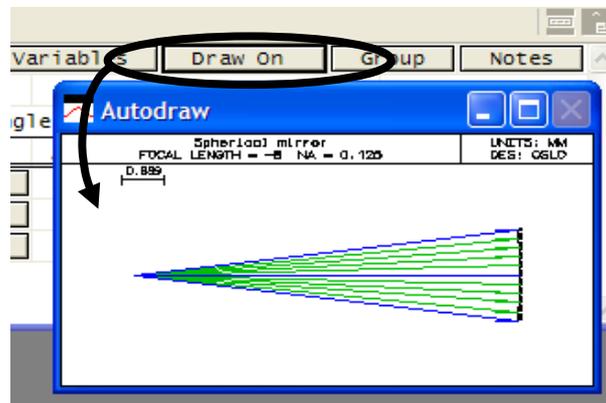


In the **Lens Drawing Conditions** spreadsheet:

- After **Image space rays**: select **Draw rays to image surface**.
- The table at the bottom determines what rays will be displayed. In the column headed **Rays** type on the first line **11** for the number of rays to be drawn for the first (on axis) field point - for which **Frac Y Obj = 0.00000**. These rays will be drawn with a green pen.
- Leave everything else unchanged, and close with the green tick ✓.

The **Autodraw** window should now have the appearance shown in the diagram, provided the surface data spreadsheet is open.

**HELP!** The **Autodraw** window may be hidden behind one of the others. If this happens to be the case, from the **Window** menu header select **Tile Windows**



## Plotting the on axis spot diagram

A spot diagram is a map of the pattern of rays incident on the image from a single object point, using the “geometrical approximation” which ignores the wave nature of light.

- From the **Evaluate** menu header select:

### Spot Diagram

#### ► Single spot diagram...

- In the **Print or plot spot diagram** spreadsheet, click on three radio buttons as shown:
  - Plot spot diagram.**

Plot ray intersection points as:

- Symbols**

Show Airy disc in plot:

- Yes**

- Leave the other entries as defaults; the axial (**FBY = 0, FBX = 0**) is the default so there is no need to use the **Set Object Point** button.
- Click on **OK**

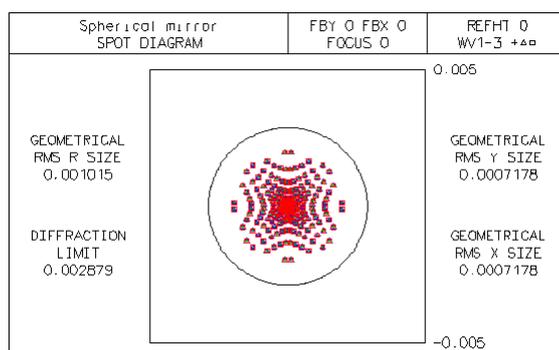
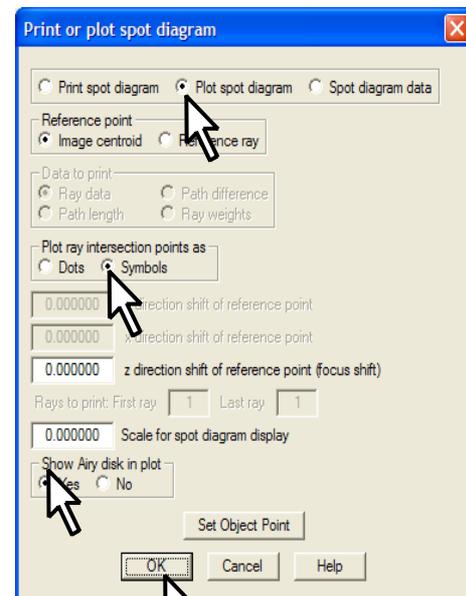
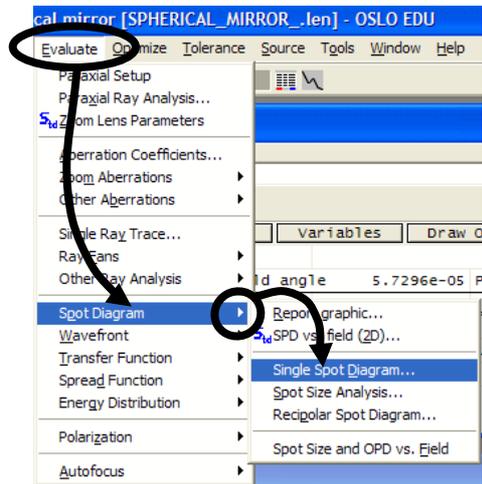
The colored symbols in this diagram represent the distribution in the image plane of rays which evenly fill the pupil from a single point on axis. The three colors representing the three default wavelengths. The black circle represents the first minimum of the Airy disc, which is the intensity in the image of a perfect lens of the same aperture, in monochromatic light of the default central wavelength of 0.58756  $\mu\text{m}$ .

The most important aspect of the diagram is that all the rays fall within this circle. This is one of the criteria by which the assertion can be made:

**Answer: Yes, the image quality at the focal point is “diffraction limited” - i.e. limited by the wave nature of light and not by aberrations.**

**HELP!** Once again, if you have trouble finding the graphics window, from the **Window** menu header select **Tile Windows** or type the command **tile** into the command line.

- Close the surface data spreadsheet by clicking on the green tick ✓.



## Listing the lens surface data

- Click on the **Len** header in the text window to list radii, thicknesses, apertures, glass types and surface notes.

```
*LENS DATA
Spherical mirror
SRF      RADIUS      THICKNESS  APERTURE RADIUS      GLASS  SPE  NOTE
OBJ      --          1.0000e+20  1.0000e+14           AIR
AST      -16.000000    -8.000000   1.000000 AS    REFL_HATCH
IMS      --          --          8.0000e-06 S
```

- Click on **Rin** to list the indices and thermal expansion coefficients.

```
*REFRACTIVE INDICES
SRF  GLASS/CATALOG      RN1      RN2      RN3      VNBR      TCE
0    AIR                1.000000  1.000000  1.000000  --        --
1    REFL_HATCH         1.000000  1.000000  1.000000  --        --
2    IMAGE SURFACE
```

- Click on **Ape** to list apertures and any special apertures.

```
*APERTURES
SRF  TYPE  APERTURE RADIUS
0    SPC  1.0000e+14
1    CMP  1.000000
2    CMP  8.0000e-06
```

- Click on **Wav** to give the wavelengths and the spectral weighting factors on each.

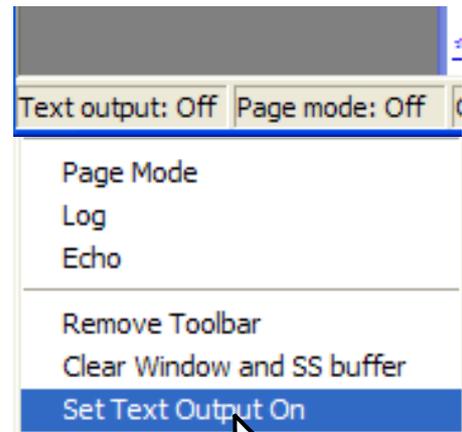
```
*WAVELENGTHS
CURRENT  WV1/WW1      WV2/WW2      WV3/WW3
1        0.587560  0.486130    0.656270
         1.000000  1.000000    1.000000
```

- Click on **Pxc** to list the focal length and some of the operating conditions.

```
*PARAXIAL CONSTANTS
Effective focal length:  -8.000000   Lateral magnification:  -8.0000e-20
Numerical aperture:    0.125000   Gaussian image height:  8.0000e-06
Working F-number:      4.000000   Petzval radius:         -8.000000

Lagrange invariant:    -1.0000e-06
```

**HELP!** There are occasions when the text output gets turned off inadvertently. This is most likely to occur if a CCL command is interrupted before it has had time to complete its task. If nothing appears in the text window when text output is expected, look at the first panel on the status bar at the bottom of the main window. If it reads **Text output: Off**, right click within the text window, and select the last menu entry: **Set Text Output On**.

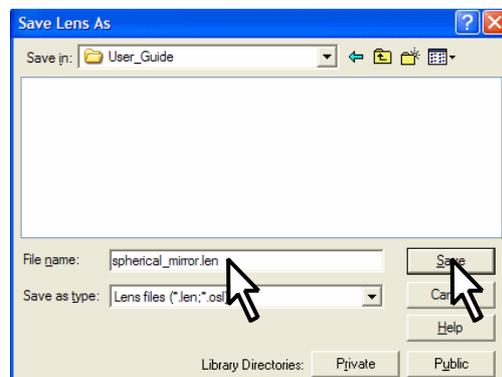


Right

## Saving the lens

To create a new folder and save the lens in it:

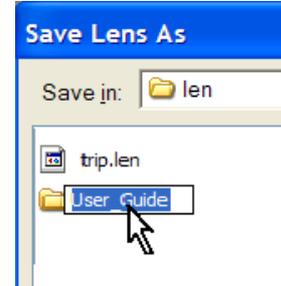
- From the **File** menu header select **Save Lens as ...**
- Of the two buttons labeled **Library Directories** at the bottom of the **Save Lens As** window, click on **Private**



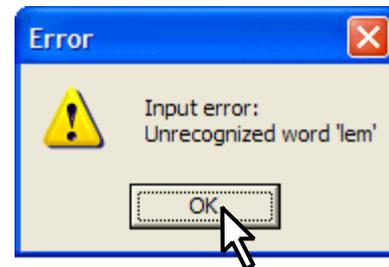
- At the top of the window, click on the icon:



- Type the name for the new folder: **User\_Guide** and click on **Open**
- Under **File name** type: **spherical\_mirror**
- Click on **Save** to save the lens with the file name **spherical\_mirror.len**  
Note that OSLO is case insensitive, so this file cannot coexist with another file called, for example, **SPHERICAL\_MIRROR.len**
- Close the surface data spreadsheet with the green tick ✓
- The lens will be stored in the private lens directory **C:\Program Files\OSLO\EDU64\private\len** (or similar), in the newly created **\User\_Guide** subdirectory.



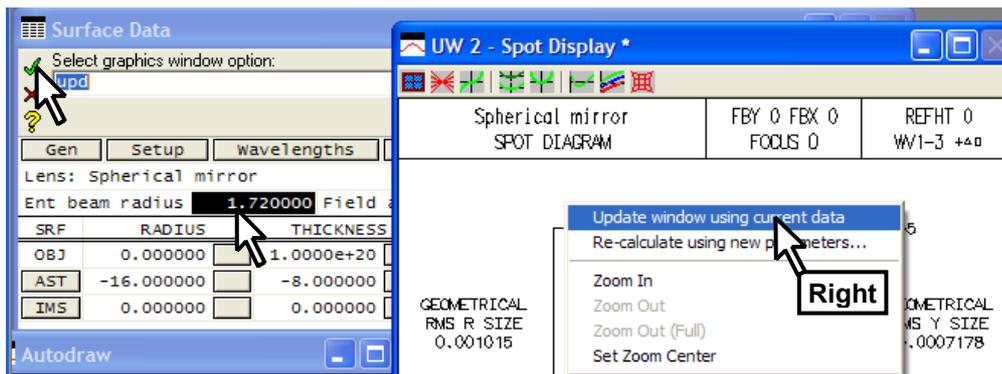
**HELP!** It sometimes happens that the program apparently freezes, and any clicks only result in a gong-like sound. When an error message appears, this needs to be cleared by clicking on OK. If, however, through an activity of the Windows operating system, the error window has been hidden behind another open window, it needs to be located and closed before OSLO will work again.



### Changing the aperture

**Question:** If the aperture of the spherical mirror is increased to 3.44 mm is it still “diffraction limited” at the new aperture?

- In the **Surface Data** spreadsheet increase the entrance beam radius from 1 mm to **1.72** mm.
- Confirm with the green tick ✓.



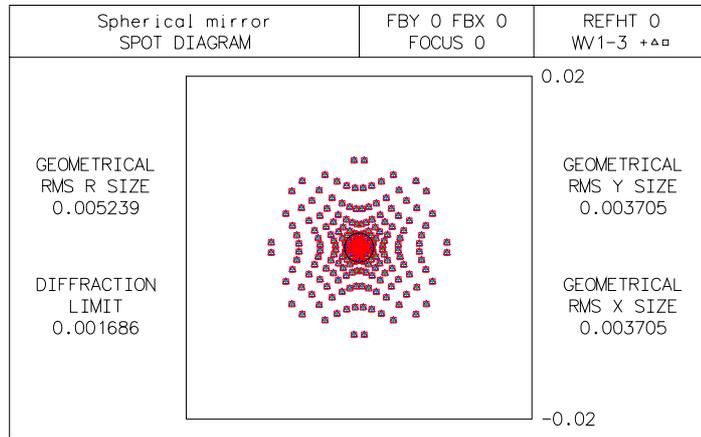
Now recalculate the spot diagram:

- Right-click anywhere inside the graphics window containing the spot diagram plotted previously.
- Select **Update window using current data:**

to give the diagram shown.

Because the aperture has increased, the spot diagram is bigger (because of greater aberrations) and the Airy disc is smaller (it is inversely proportional to the aperture). Most of the rays therefore now lie outside the Airy disc circle.

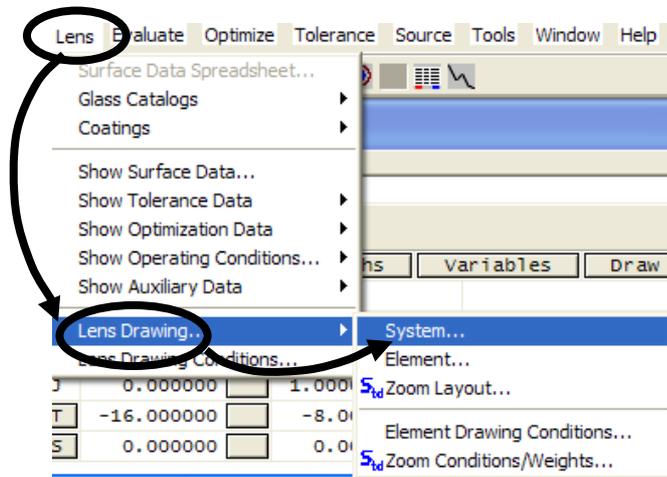
**Answer: No, it is far from diffraction limited.**



Drawing the lens in the graphics window, with “zooming”

To draw the lens system in a graphics window:

- From the **Lens** menu header select **Lens Drawing ...**
- **System**
- Accepting all the defaults click on **OK**

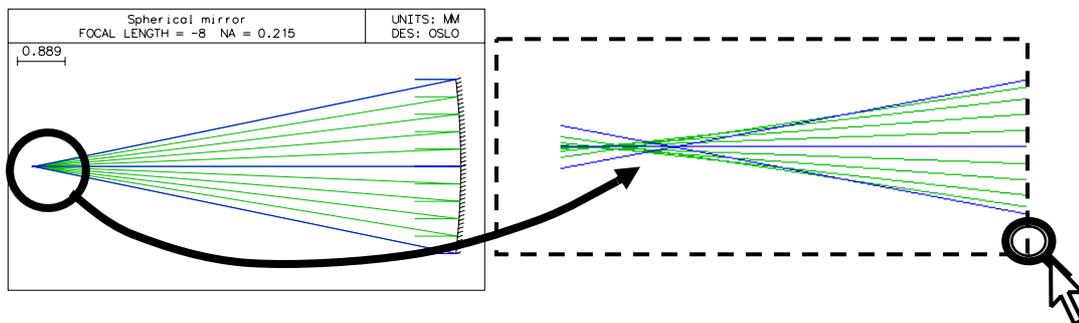
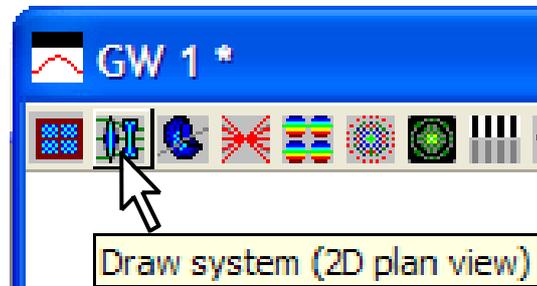


Alternatively,

- Click on the first icon in the graphics window standard toolbar for **Draw system (2D plan view)**.
- Select **Plan View ...**

To view the paths of rays near the focus at a higher magnification:

- On the graphics window, left-click-and-drag around the focus as shown below.
- Left click twice within the graphics window to return to the full frame image.



Note that the zooming action will work on all graphics windows *except* the **Autodraw** window.

Clearly a better focal plane can be chosen, a short distance to the right of the current one.

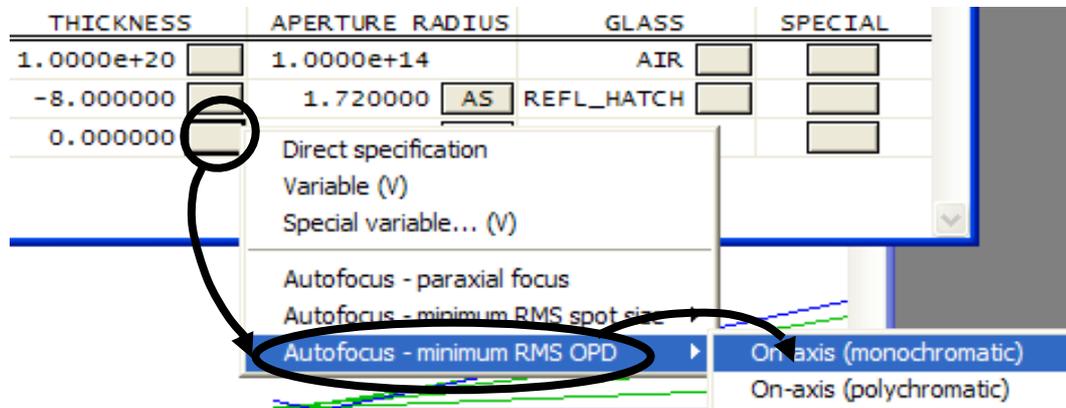
### Finding the best focal plane

**Question:** At this new aperture, where should the focal plane be chosen to give the best image quality for green light on axis?

This can be found most quickly using the “autofocus” facility in the surface data spreadsheet, one of a number of built-in optimization functions.

- Open the **Surface Data** spreadsheet.
- Click on the grey button next to the thickness for the image surface (surface **IMS**).
- Select **Autofocus - minimize RMS OPD ...**  
 ▶ **On-axis (monochromatic)**

In this context, RMS OPD refers to the root mean square optical path difference (or wave aberration). This autofocus action has the effect of finding the focal plane which minimizes the RMS OPD and entering the necessary displacement as the thickness for the image space. The thickness for the space preceding the image



space is left unchanged.

Listing the lens data:

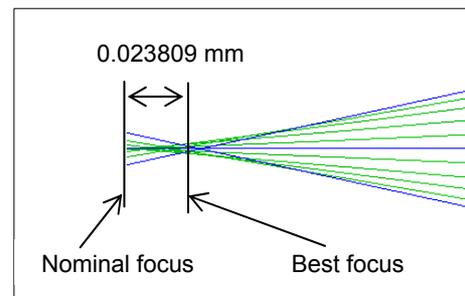
- Click on the **Len** header in the text window - this gives the extent of defocus needed:

```
*LENS DATA
Spherical mirror f/2.33
SRF      RADIUS      THICKNESS  APERTURE RADIUS  GLASS  SPE  NOTE
OBJ      --          1.0000e+20  1.0000e+14      AIR
AST      -16.000000    -8.000000  1.720000 AS    REFL_HATCH

IMS      --          0.023809
0.005127 s
```

The value listed for the defocus, shown as the thickness at the image plane, is 0.023809 mm. To get the actual distance from the mirror to the image it is necessary to add this the defocus value to the nominal distance of -8 mm.

This is the only case in OSLO where an entry



in the thickness column of the surface data spreadsheet for a surface affects the axial position of that surface rather than the surface which follows.

**Answer:** The best focus at an aperture of f/2.33 is at 7.976 mm from the mirror.

Plotting the on axis point spread function (PSF)

**Question:** Is the image “diffraction limited” at the new focal plane?

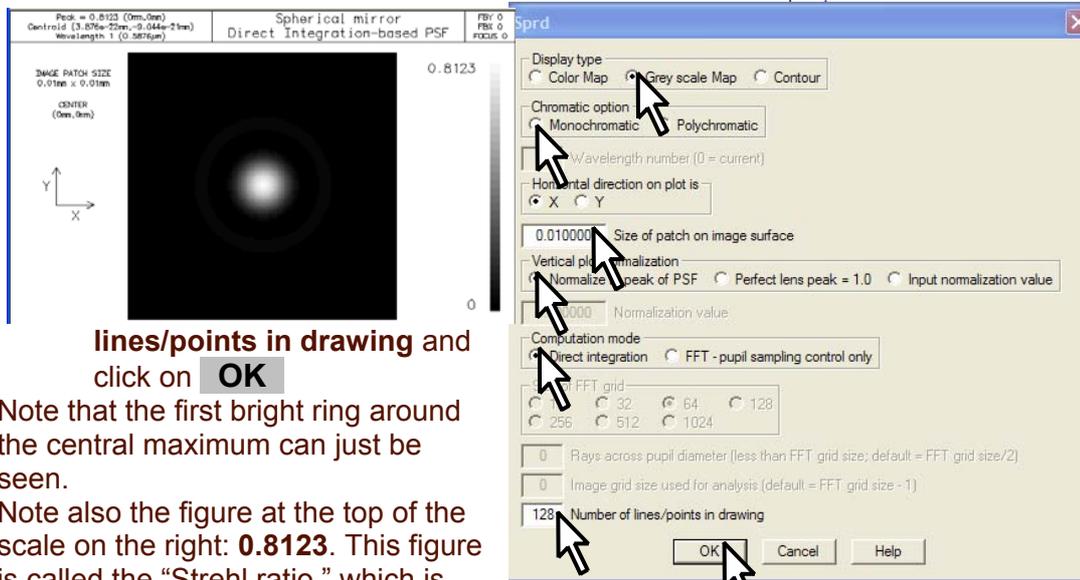
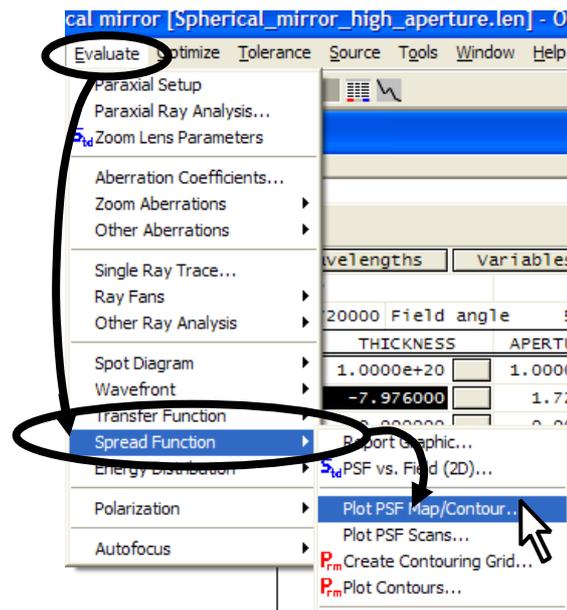
The evaluations carried out hitherto only show approximations to the actual distribution of light in the image of a point source, since a spot diagram takes no account of diffraction.

To plot the true distribution of light in the image of a monochromatic point source, that is to say, the point spread function:

- From the **Evaluate** menu header select:  
**Spread Function**  
**► Plot PSF Map/Contour...**

In the **Sprd** window which opens:

- Click on the radio button  **Grey scale map**
- Click on the radio button  **Monochromatic**
- Type in **0.01** for the **Size of patch on image surface.**
- Click on the radio button:  **Normalize to peak of PSF**
- Click on the radio button:  **Direct integration**
- Type in **128** for **Number of**



lines/points in drawing and click on **OK**

Note that the first bright ring around the central maximum can just be seen.

Note also the figure at the top of the scale on the right: **0.8123**. This figure is called the “Strehl ratio,” which is the intensity at the central peak of

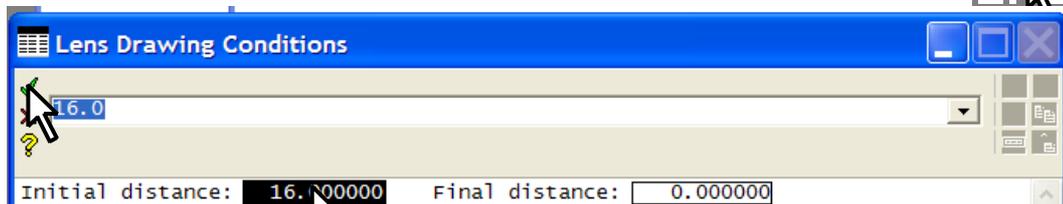
the image of a point source measured as a fraction of the Airy diffraction pattern of an ideal lens. If the Strehl ratio exceeds 0.8, a lens system is described as “diffraction limited”.

**Answer: Yes, the image is diffraction limited on axis at the new focal plane.**

### Extending the rays in the lens drawing

Edit Lens Drawing Conditions

- Open the **Lens Drawing Conditions** spreadsheet by clicking on the icon in the main window toolbar.

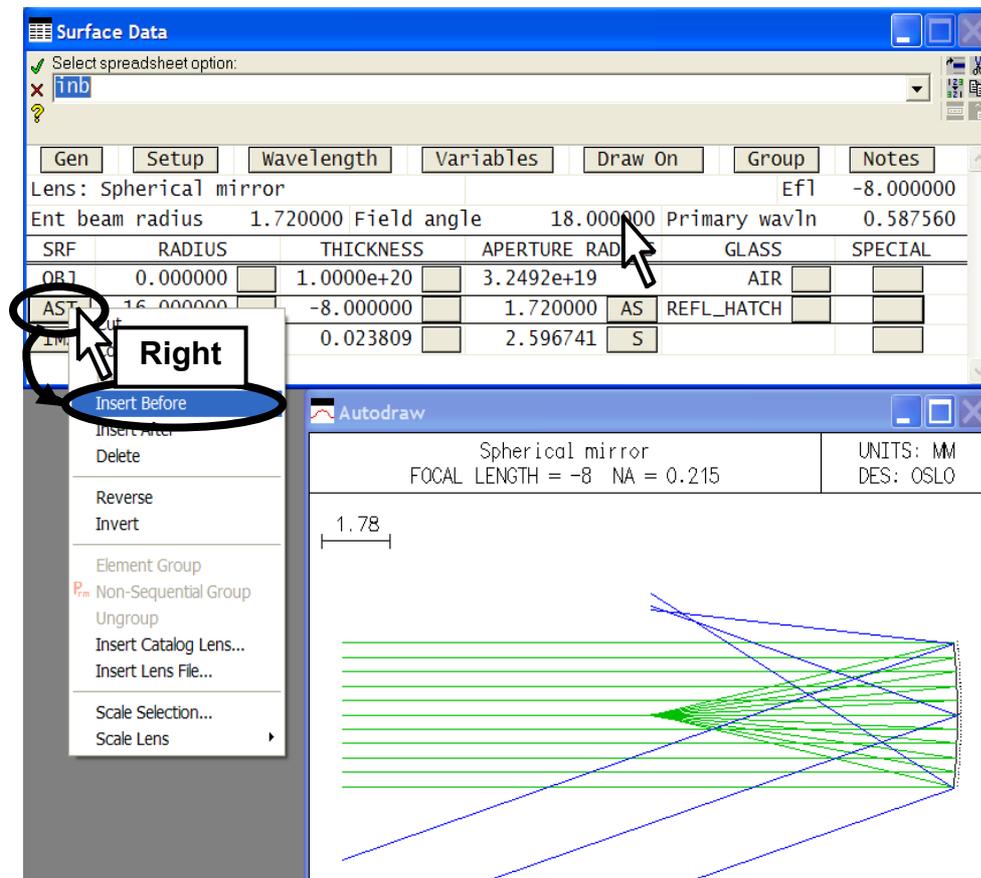


- After **Initial distance** enter **16.0**.
- Close the spreadsheet with the green tick ✓.

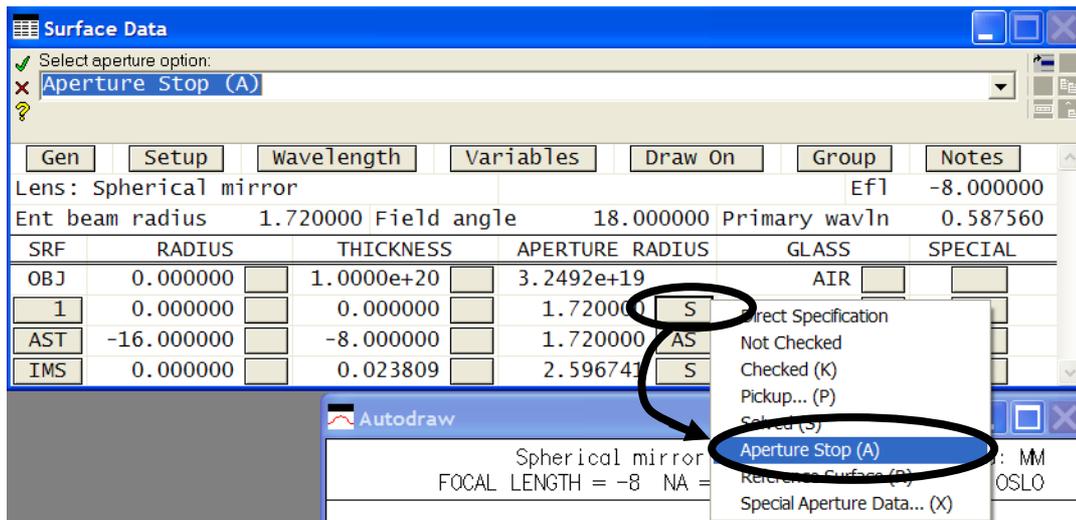
### Calculating the off axis optical path difference (OPD)

**Question: What is the maximum OPD at full field for a semi-field angle of 18° (total field angle 36°)?**

- Open the **Surface Data** spreadsheet.
- Enter **18.0** degrees as the (semi-field) **Field angle**
- Left click on the grey **SRF** button for surface **1 (AST)** to highlight the whole row.
- Right click to bring up the menu of options.
- Select **Insert before** to insert a new surface as surface 1.



- Under **APERTURE RADIUS** for the new surface **1**, click on the grey button.
- Select **Aperture stop (A)**

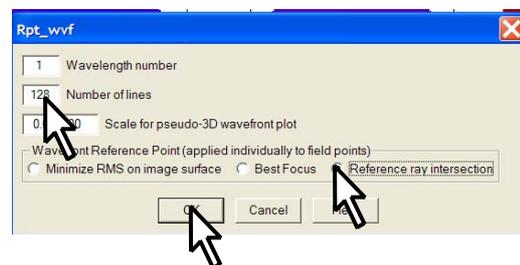


The aperture stop indication (**AST**) on the grey button under **SRF** will now move to surface 1, which at the moment is in contact with surface 2.

Note that the aberrations of the rays in the off-axis beam (drawn in blue) are so large that they can easily be seen in the lens drawing.

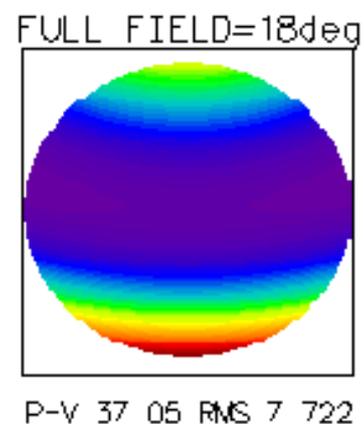
To calculate the optical path difference, or wave aberration, over the whole pupil for three field points (on axis, 0.7 field and full field):

- From the **Evaluate** menu header select:  
**Wavefront** ► **Report graphic...**
- and in the dialog box which opens:
- Enter **128** as the **Number of lines**
  - Select  **Reference ray intersection**
  - Click on **OK**



Note the peak-to-valley figure of 37.05 wavelengths under the map for the full field wave aberration.

**Answer:** The axial performance is better than the standard criterion of a quarter of a wavelength for the diffraction limit, but at full field off axis the maximum OPD is 37 wavelengths.



## Optimizing

The aperture stop is the limiting aperture of the axial beam. Its longitudinal position determines the beam which is selected to form the off-axis image, and if the field is large, this can have a significant effect on image quality.

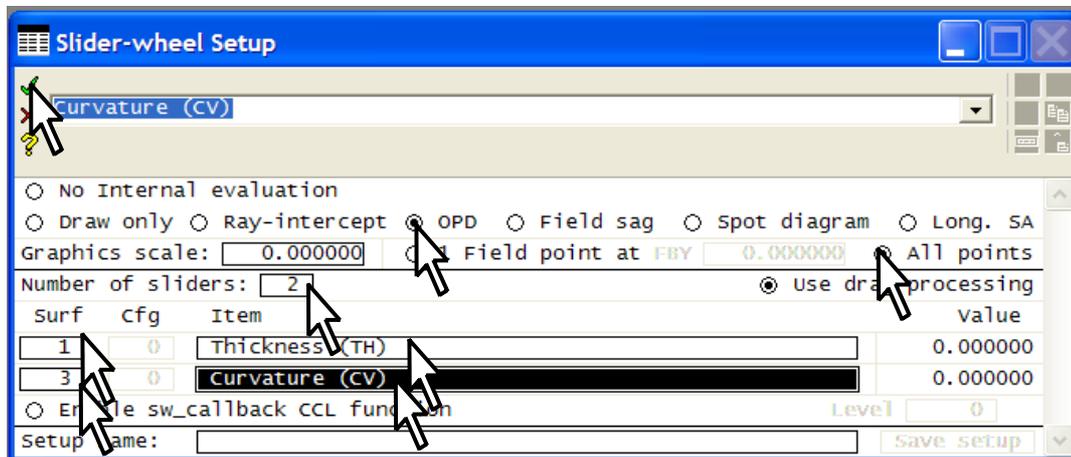
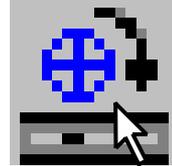
Also the image has been assessed only over a plane surface - this is of course the usual convention. For this exercise, however, we will investigate the benefits of allowing the image to become curved.

**Question: Where should the stop be placed, and what curvature of the image is needed, to obtain the best performance over the whole field?**

Open the slider wheel spreadsheet

The answer to this question will demonstrate slider wheel optimization, one of the most useful features of OSLO.

- Close the surface data spreadsheet.
- Open the **Slider-wheel Setup** spreadsheet, by clicking on the icon on the main window header.



The entries above the line define the contents of the window(s) which will be displayed during slider-wheel optimization.

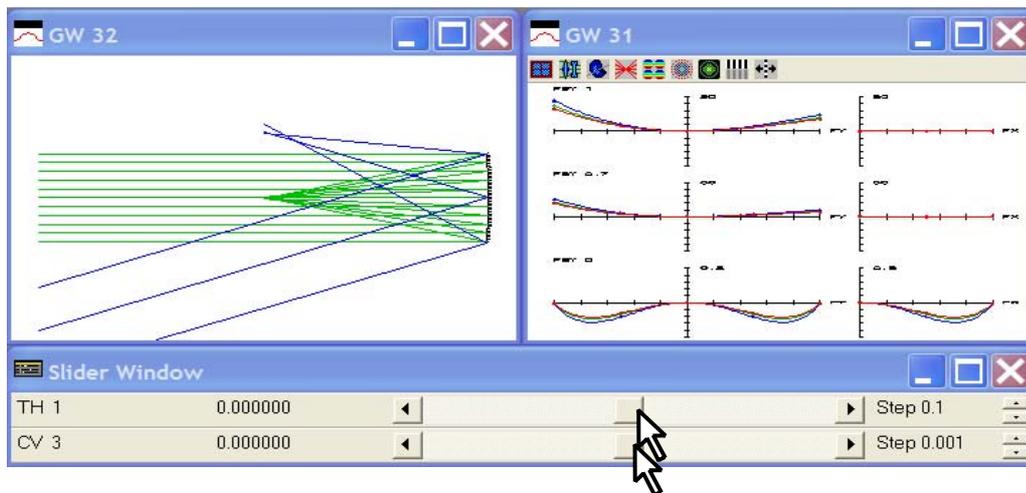
- Select  **OPD** (optical path difference, another name for wavefront aberration)
- Select  **All points**

Entries below the line determine which parameters will be adjusted with slider-wheels:

- Leave the default of **2** for the **Number of sliders** (up to 32 can be defined at any one time).
- On the first line, enter **1** under **Surf** and type **th** in the box under **Item**. Alternatively click on the box and select **Thickness (TH)** from the menu of options.
- On the second line, enter **3** under **Surf** and type **cv** under **Item**.
- Click on the green tick ✓ to close the **Slider-wheel Setup** spreadsheet.

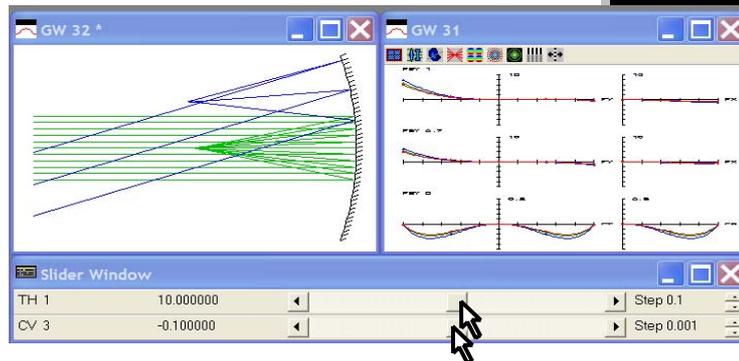
- Curvature (CV)
- Curvature pickup multiplier (CVM)
- Conic constant (CC)
- Thickness (TH)**
- X decentration (DCX)
- Y decentration (DCY)
- Z decentration (DCZ)
- Alpha tilt angle (TLA)
- Beta tilt angle (TLB)
- Gamma tilt angle (TLC)
- Tilt vertex offset in x (TOX)
- Tilt vertex offset in y (TOY)
- Tilt vertex offset in z (TOZ)

The two graphics window which open, **GW31** and **GW32**, are specific to slider-wheel optimization. The scrollbar at the right of each slider wheel track can be used to adjust the step increment of the slider-wheel motion. Changing the step size also has the effect of centralizing the slider-wheel in the track.

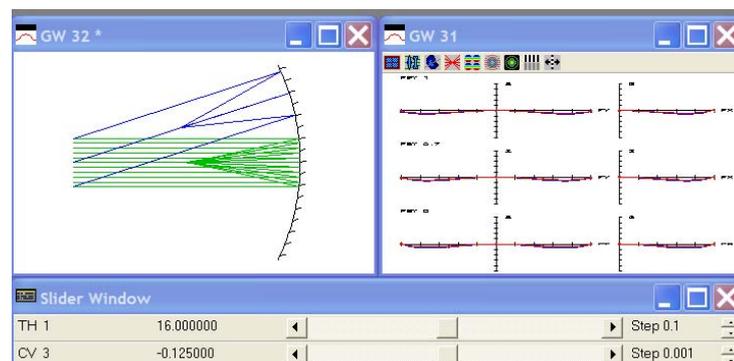


- Watching the lens drawing in **GW 32**, and the plots of the optical path difference in **GW 31**, move the upper slider to the extreme right (**TH 1 = 10**) and the lower slider to the extreme left (**CV 3 = -0.1**).
- Once again, open the **Slider-wheel Setup** spreadsheet, by clicking on the icon. However this time just close it again immediately. This has the effect of centralizing the two slider-wheels and re-drawing both windows with different scales.

Although the OPD graphs give no indication of scale, it can be seen that the performance is much improved.



- Repeat the sequence once more until the best result is given. This should be when **TH 1 = 16.0 mm** and **CV 3 = -0.125 mm<sup>-1</sup>**



**Answer:** The aperture stop must be at the centre of curvature of the mirror, and the image surface must be a sphere with its centre at the aperture stop.

## Assessing the final design

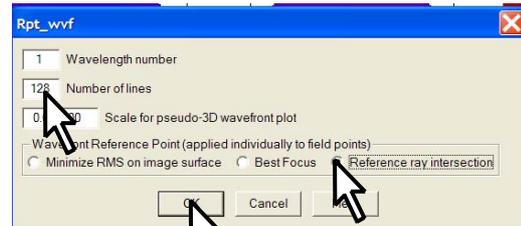
To evaluate the optical path difference of the new system, once again:

- From the **Evaluate** menu header select:

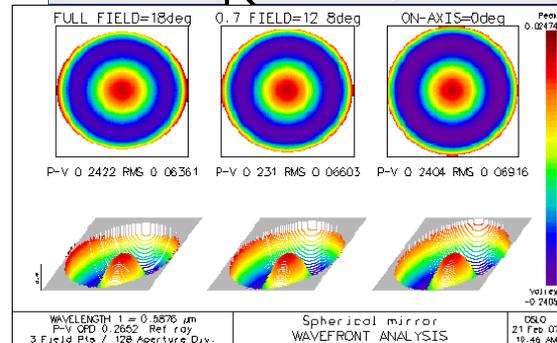
**Wavefront ► Report graphic...**

and in the dialog box which opens:

- Enter **128** as the **Number of lines**
- Select  **Reference ray intersection**
- Click on **OK**



The peak-to-valley wave aberration at the edge of the field is less than a quarter wavelength, so the lens is diffraction limited over the whole (curved) field.



## Listing the data

To list the correct prescription of the final design, the image separation needs to be adjusted. In the command line:

- Enter the command: **th 2 -7.976** (note the spaces after **th** and after **2**)

```
SRF 2:
TH -7.976000
```

- Enter the command: **th 3 0;rtg** to give the final listing (again note the spaces):

```
SRF 3:
TH --
```

### \*LENS DATA

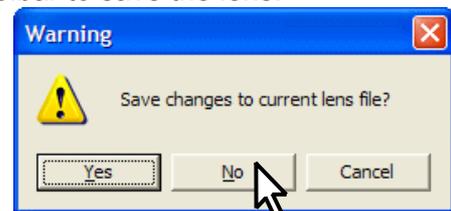
Spherical mirror

SRF	RADIUS	THICKNESS	APERTURE RADIUS	GLASS	SPE	NOTE
OBJ	--	1.0000e+20	3.2492e+19	AIR		
AST	--	16.000000	1.720000 AS	AIR		
2	-16.000000	-7.976000	6.918715 S	REFL_HATCH		
IMS	-8.000000	--	2.612316 S			

- Click on the save lens icon in the main toolbar to save the lens.

## Exiting the program

- From the **File** menu header select **Exit**. If any more changes have been made a message label will give a warning to save the lens, otherwise those changes will be lost.
- Click on **No** and the program terminates.



## 4. Conclusion

This tutorial shows how OSLO commands can be accessed either from the menu headers, from the text window headers, from icons or entered directly into the command line.

Command names are important for accessing the documentation in the on-line help. Here are some of the commands that have been used (either explicitly or via the menus and icons) in this chapter:

<code>file_new</code>	Opens a new lens file
<code>uoc drl</code>	Updates lens drawing conditions
<code>pls</code>	Plots spot diagram
<code>len</code>	Lists lens data
<code>save</code>	Saves lens
<code>drl</code>	Draws lens
<code>auf</code>	Autofocus
<code>sprd</code>	Plots the point spread function
<code>lse</code>	Opens the surface data spreadsheet
<code>rpt_wvf</code>	Plots wavefront map at 3 field points
<code>swe</code>	Opens the slider-wheel spreadsheet
<code>th</code>	Changes a thickness
<code>rtg</code>	Lists radii/thicknesses/glass types
<code>exit</code>	Terminates OSLO.

To obtain a full list of commands:

- From the **Help** menu header select **OSLO Help F1**
- Select the **Contents** tab and click on **Command Reference**. The commands are listed in the alphabetic sub-directories shown here.

