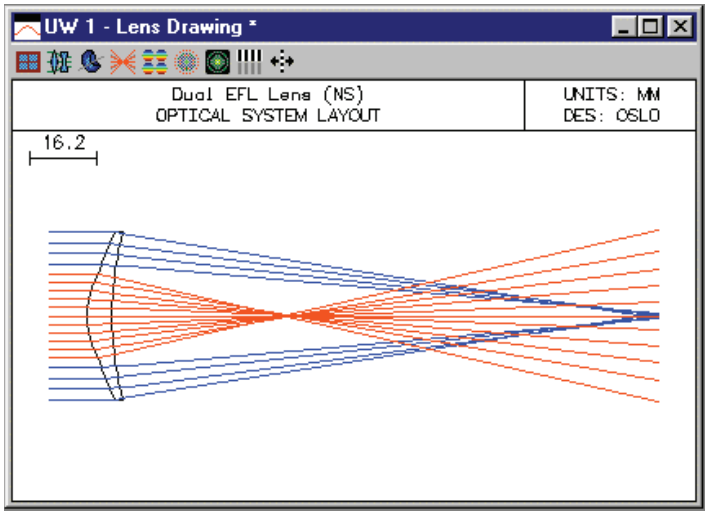
Dual focal length lens

The following is intended as a simple example of non-sequential ray tracing. The system to be studied is a simple meniscus lens whose front surface has two regions having different curvature. Rays through the center of the lens encounter one curvature, rays through the edge another. The lens data are as follows.

```
*LENS DATA
Dual EFL lens (NS)
 SRF      RADIUS      THICKNESS   APERTURE RADIUS       GLASS  SPE   NOTE
  0         --        1.0000e+20    1.0000e+14            AIR

  1         --             --         18.000000 AS         AIR   *
  2     20.000000          --         10.000000            BK7 C *
  3     40.000000          --         20.000000 X          BK7 C *
  4     80.000000          --         20.000000            AIR   *
  5         --        127.000000      20.000000            AIR   *

  6         --             --         20.000000

*TILT/DECENTER DATA
  2     DT    1          DCX       --       DCY       --       DCZ       --
                         TLA       --       TLB       --       TLC       --
  3     DT    1          DCX       --       DCY       --       DCZ     1.409325
                         TLA       --       TLB       --       TLC       --
  4     DT    1          DCX       --       DCY       --       DCZ     6.000000
                         TLA       --       TLB       --       TLC       --
  5     DT    1          DCX       --       DCY       --       DCZ    10.000000
                         TLA       --       TLB       --       TLC       --

*SURFACE TAG DATA
  1     LMO NSS  (5 surfaces)
  3     ELI   1
  4     ELI   1
  5     DRW OFF

*APERTURES
 SRF   TYPE APERTURE RADIUS
  0     SPC   1.0000e+14
  1     CMP    18.000000
  2     SPC    10.000000
  3     SPC    20.000000

     Special Aperture Group 0:
     A  ATP      Ellipse  AAC    Pass Thru  AAN       --
        AX1   -10.000000  AX2    10.000000  AY1   -10.000000  AY2    10.000000
```



The following comments may help you to understand the data:

Surface 2 is the central portion of the front surface. Surface 3 is the outer portion of the front surface, and surface 4 is the back surface.

The central zone of the first surface has a 10 mm aperture radius and a radius of curvature of 20 mm. The outer zone of the first surface has a 20 mm aperture radius and a 40 mm radius of curvature.

Surface 3 has a special aperture to create a hole in its center for surface 2. The “Pass Thru” designation makes the central portion of the surface equivalent to a hole.

The glass BK7 is put on surfaces 2 and 3, because the normal action is for rays to refract into these surfaces in the *to positive* direction. In the present example, rays will not encounter either of these surfaces from the back side, so no special actions are needed.

It is very important to ensure that the entry port and the exit port completely surround the non-sequential surfaces. For this lens, the center portion of the lens is placed in contact with the entry port, which is OK, because the sag of the surface is always positive. The axial thickness of the lens is 6mm, which determines the DCZ of surface 4. The exit port (surface 5) is placed at a distance of 10 mm from the entry port, to ensure that no portion of surface 4 falls outside the non-sequential region. The remaining DCZ (of surface 3) is determined by the requirement that the sags of surface 2 and 3 are identical at the edge of the central zone (10 mm height). The value can be found using the edge thickness (**eth 2 3 10 10**) command in OSLO, which produces the required value 1.409325.

To force the program to draw an aperture connecting surfaces 3 and 4, the element ID (ELI) is set to 1.

The DRW OFF designation on surface 5 keeps the program from drawing the exit port.

The data for this lens is entered as follows:

Select File >> New, enter the file name “bifocal.len”, then enter 5 for the number of surfaces. Click OK to dismiss the dialog box. The surface data spreadsheet will appear.

In the surface data spreadsheet, click the row button for surface 1, then the row button for surface 5 to select the surface range (entry and exit ports, plus 3 lens surfaces).

Set up a non-sequential group using Edit >> Non-sequential Group. Click the View Srf radio button at the top of the spreadsheet, so you can see the surface data. Click the Draw On radio button so you can see the effects of your data entries. Enter the value 18 for the Entrance Beam Radius.

Enter the data for the RADIUS of surfaces 2-4 as given in the listing above. Surface 2 is the central portion of the front surface. Surface 3 is the outer portion of the front surface, and surface 4 is the back surface.

Enter the data shown above for the apertures. The central zone is to have an aperture of 10 mm radius, and the overall lens is to have an aperture of 20 mm.

Surface 3 has a special aperture to create a hole in its center for surface 2. Click the button next to the aperture of surface 3, and select Special aperture data from the pop-up list. Enter “1” for the number of special apertures, then enter the data from the above listing in the special aperture spreadsheet that pops up. The “Pass thru” designation makes the central portion of the surface equivalent to a hole.

The glass BK7 is put on surfaces 2 and 3, because the normal action is for rays to refract into these surfaces in the *to positive* direction. In the present example, rays will not encounter either of these surfaces from the back side, so no special actions are needed.

Next you need to enter the data for the surface locations, relative to the Entry port (surface 1). It is very important to ensure that the entry port and the exit port completely surround the non-sequential surfaces. For this lens, the center portion of the lens is placed in contact with the entry port, which is OK, because the sag of the surface is always positive. The axial thickness of the lens is 6 mm, which determines the DCZ of surface 4. The exit port (surface 5) is placed at a distance of 10 mm from the entry port, to ensure that no portion of surface 4 falls outside the non-sequential region. The remaining DCZ (of surface 3) is determined by the requirement that the sags of surface 2 and 3 are identical at the edge of the central zone (10 mm height). The value can

be found using the edge thickness (**eth 2 3 10 10**) command in OSLO, which produces the required value 1.409325.

For each of the surfaces 3-5, click Special >> Local/Global Coordinates, and enter the appropriate DCZ data as discussed above.

To force the program to draw an aperture connecting surfaces 3 and 4, for both surfaces click on Special >> Non-sequential Data, then set the element ID to 1.

To keep the program from drawing the exit port, on surface 5, click Special >> Surface Control >> General, and set the Surface appearance to Not drawn.

To show the ray trajectories, set the thickness of surface 5 to 127, as shown above, then click Update >> Operating Conditions >> Lens Drawings. In the spreadsheet, set the Image space rays button to Image Srf, set the number of field points to 1, set the number of rays to 15, and then click OK to dismiss the spreadsheet.

At this point, if all has gone well, your Autodraw window should have a picture similar to the one shown above. You should now experiment by changing all the data a little to see what happens.