## *TIR prism/mirror system*

Many optical systems contain reflecting prisms and mirrors for redirecting beams or changing the orientation of images. Plane mirrors generally have no effect on image quality, and reflecting prisms are usually equivalent to blocks of glass. Nevertheless, for mechanical and tolerancing reasons it is often necessary to include the effects of tilted and decentered surfaces in the design data. This section gives an example of how to add a right-angle prism and turning mirror behind the lasrdblt.len lens. The example is primarily tutorial, not optical.
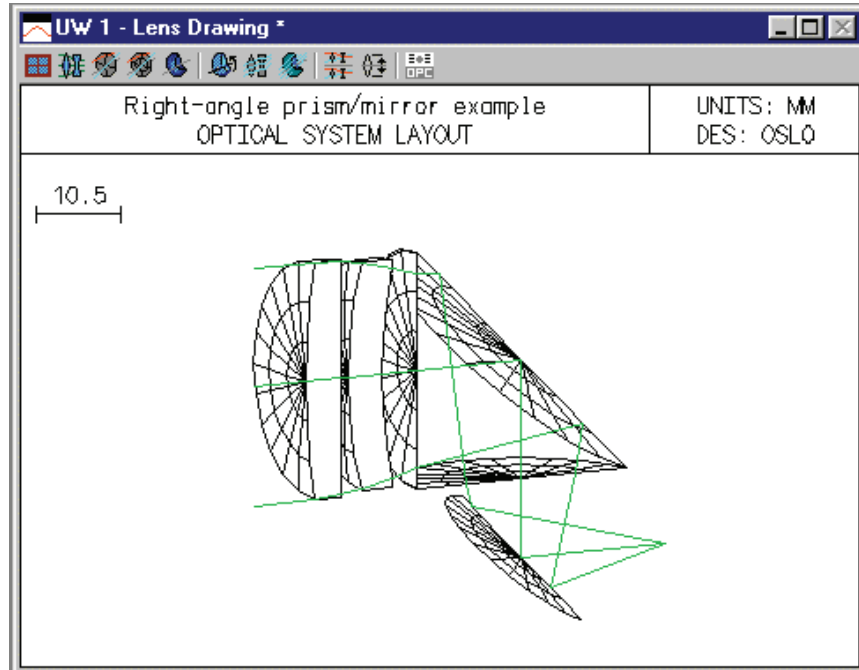

The prism will have an aperture of 10 (note that apertures in OSLO are specified by their radii, not diameters), and will be located 1 mm to the right of the last lens surface.

1) Open the lasrdblt.len file, change the lens identifier to "Right-angle prism/mirror example" and save it in your private directory under a new name.

2) Before entering any surface data, click Lens >> Lens drawing conditions, and modify the spreadsheet so that it looks like the following. The items to be changed are Apertures, Image space rays and Number of field points for ray fans. These changes will make the Autodraw window more useful.
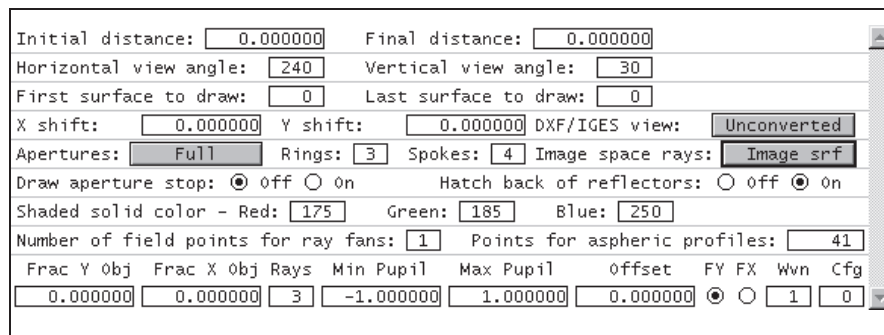
3. Close the Lens drawing operating conditions spreadsheet and return to the surface data spreadsheet. Drag the bottom of the window frame down until there is room for four more rows, then move the cursor to the row button for surface 5. Now press SHIFT+SPACE four times to insert the additional rows (this is a shortcut to using the mouse), or click row button 5 and click the Insert Before toolbar icon 4 times. Drag the bottom of the spreadsheet window down to see all the rows. Enter 1 for the thickness of surface 4.

4. Next you will insert the prism. Enter SF15 for the glass on surface 5. Click on the Special button for surface 6, select Surface Control >> General, and turn on TIR only. This means that rays will be reflected if they undergo total internal reflection and will fail otherwise. Note that for a TIR surface, the refractive index of the surface is the one for the medium into which the ray goes if it *fails* the TIR condition. The program knows that if the ray is totally internally reflected, the refractive index is the same as that in the incident medium.

5. Set the apertures of surfaces 5 - 7 to 10. Set the thickness of surface 5 to 10. The Autodraw window should now look as follows:
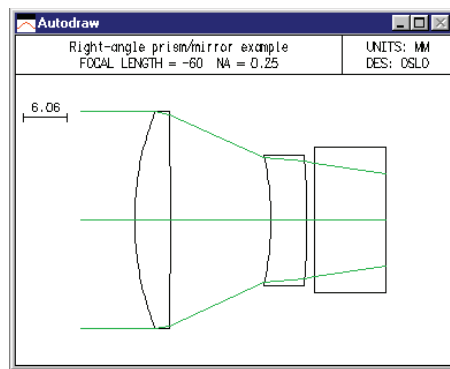
5. Surface 6 will be the reflecting face of the prism, tilted at 45 degrees. Click the Special button and select the Coordinates item on the pop-up list. In the spreadsheet, enter 45 for TLA, and change the Tilt and bend button to Yes.

6. Enter -10 for the thickness of surface 6. Thicknesses are negative after an odd number of reflections, as discussed previously. Enter 10*sqrt(2) for the aperture.

7. The center of the turning mirror is to be 8mm below the prism. Set th 7 to -8.
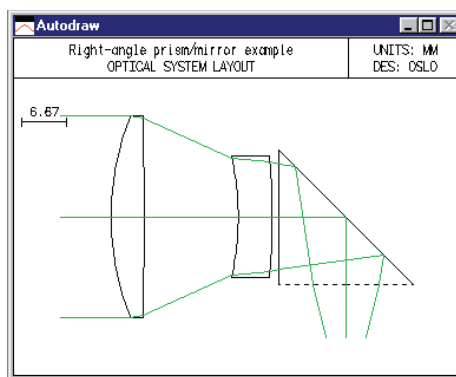
8. Click the Spe button in the text window. The following should appear in the Text window.
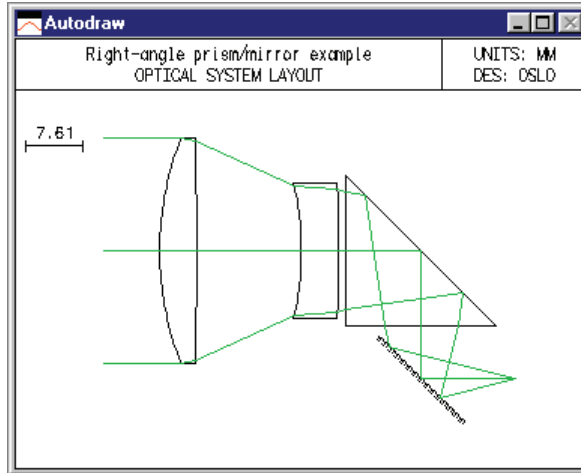
```
*TILT/DECENTER DATA
  6     DT    1        DCX       --       DCY       --       DCZ       --
        BEN             TLA   45.000000   TLB       --       TLC       --

*SURFACE TAG DATA
  6     TIR    1
```

The next step will be to add a turning mirror that reflects the beam so that it continues from left to right.

9. Enter data for the turning mirror as shown below. Use an axial ray height solve to locate the final image surface, in the same manner as the laser doublet example. The mirror is entered using the Reflect (Hatch) item on the Glass Options list. This has no optical significance, but causes the back side of the mirror to be hatched on the drawing, as shown. Set the aperture to 8mm. Select Special, Coordinates to set the tilt to -45 degrees, and set the bend flag.

SRF	RADIUS	THICKNESS	APERTURE RADIUS	GLASS	SPECIAL
OBJ	0.000000	1.0000e+20	1.0000e+14	AIR	
AST	41.040000	5.000000	15.000000 A	LASF35 C	
2	-542.675000	13.900000	15.000000	AIR	
3	-40.695000	5.000000	9.000000	LASF35 P	
4	-124.330000	1.000000	9.000000	AIR	
5	0.000000	10.000000	10.000000	SF15 C	
6	0.000000	-10.000000	14.142136	AIR	FC
7	0.000000	-7.000000	10.000000	AIR	
8	0.000000	12.599165 S	8.000000	REFL_HATCH	C
IMS	0.000000	0.000000	0.002000		

Lens:Right-angle prism/mirror example Zoom 1 of 1 Efl 60.000049
Ent beam radius 15.000000 Field angle 5.7296e-05 Primary wavln 0.632800

```
*TILT/DECENTER DATA
   6    DT    1         DCX      --      DCY      --      DCZ      --
        BEN            TLA   45.000000   TLB      --      TLC      --
   8    DT    1         DCX      --      DCY      --      DCZ      --
        BEN            TLA  -45.000000   TLB      --      TLC      --

*SURFACE TAG DATA
   6    TIR    1
```

Note that an axial ray height solve is used on surface 8, even though the system has tilted elements. In the case where only tilts of plane surfaces are used, and the bend flag is used to propagate the optical axis, paraxial optics remain valid.