

# OSLO

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Optics Software for Layout and Optimization

## *Optics Reference*

Version 6.1

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Lenses like the above Cooke triplet are typically designed for film cameras. The above lens has a 50mm focal length, which suits the 24x36mm format used for 35mm cameras. The lens is not optimum for a typical digital camera, which has a smaller image size, because the focal length is too long. In this example we consider the use of the GENII error function to redesign the lens to have a focal length of 10mm, more suited to contemporary digital cameras. In addition, we will make the lens faster by 3dB, so that the paraxial specifications become 50mm efl,  $f/2.8$ , 20 degrees field angle.

The steps are the following:

- Open the demotrip lens, open the surface data spreadsheet, and right-click in the spreadsheet to pop-up the edit menu. Scale the lens to a focal length of 10mm. Then, set the entrance beam radius to 1.78571mm. Note that this makes the speed  $f/2.8$  (use Pxc in the text window).
- Change the apertures of all the surfaces to 1.8 mm so the larger beam can get through. With the scaled lens, the elements are too thin to support an aperture of 1.8. Increase the thickness of the front and back elements to 0.7mm, and the thickness of the center element to 0.3mm. Now the on-axis beam can get through, but the focal length is no longer 10mm because the thicknesses have been changed.
- To fix the focal length, put an axial ray angle solve on the last refracting surface (6), setting the angle to -0.178571. This will adjust the curvature so the focal length is exactly 10mm again. As soon as you have adjusted the curvature, remove the solve by clicking the button in the radius cell and selecting *Direct Specification*. The curvature will not be changed, but the constraint will be removed, and the curvature can then be used as a variable in optimization.

*The GENII error function is designed to hold the paraxial properties of the system at the values that exist at the start of optimization. It is essential that you have the right paraxial properties (focal length, aperture, and field) prior to beginning to optimize. Fortunately, you have just set up the system so that it has the correct properties - efl = 10, fnb = 2.8, ang = 20.*

- Click on the Variables button in the surface data spreadsheet and make all the curvatures variable. Also make the air spaces variable. Close the variables spreadsheet but not the surface data spreadsheet. You will see "V's" on the appropriate buttons.
- Use Optimize>>Generate Error Function>>GENII Ray Aberration to enter the error function. Accept all the defaults in the dialog box without change.
- Change the Lens ID to something more descriptive of the current system, and save the lens in your private directory under a new name. The final solution in the public demo library is called digitrip.len, so pick a related but different name. Then close the Surface data spreadsheet using the Green check and immediately re-open it. This allows you to cancel unfortunate changes that might be made during optimization by canceling using the Red X button. After you have re-opened the spreadsheet (turn on Autodraw so you can see what is happening to your lens), you are ready to optimize it.
- Use the Ite button in the Text window to iterate the design until it doesn't improve anymore. This should produce an error function of about 0.64.
- Change the center element from F4 to a model glass, leaving the index and v-number unchanged, by clicking the button in the Glass column and selecting Model. Then click the button again and make it a special variable (RN only). In the variable spreadsheet, set boundaries of 1.5 to 1.8 for the RN variable. Close the variables spreadsheet.
- Change the glass in the front and back elements to LAK33.