

Start Code V by double-clicking the Code V icon on the PC adjacent to the storage cabinet.

Title the lens using the "Lens -> Title" menu item. Something like "Ay 105 achromatic doublet" would be a good choice.

Go to "Lens -> Wavelengths" and indicate that you want to enter three wavelengths. Specify a red, green, and blue wavelength in nanometers (e.g. 750, 550, 400). Other fields in this dialog box can stay at their default values.

Click on "IMG" in the input window. Go to the "Surf -> Insert -> Surface" menu item and insert 3 surfaces. The input window will then include lines for STO and 2-3. STO represents the aperture stop. For our lens, the stop is surface 1, so this is OK. You will enter the surface properties for the lens surfaces on these lines.

Go to "Display -> Draw Lens -> Auto Draw On" to turn on automatic drawing of the lens.

Specify the lens as follows. Make sure everyone in your group gets to specify part of the lens:

Surface	Radius	Thickness	Glass	RMD	Aperture
STO	203.94	11.94	BK7_SCHOTT	REFR	31.75
2	-156.41	8.86	SF2_SCHOTT	REFR	31.75
3	-569.57	343.67		REFR	31.75

The "RMD" column specifies whether the surface is reflective or refractive. BK7 and SF2 are types of glass, and Schott is the manufacturer.

Specify that we want to trace  $f/5.6$  rays through the system by going to the "Lens -> Pupil Specification -> f/number" menu item and specifying a F/N value of 5.6.

Save your lens definition by clicking the "Save / Restore" button in the blue input window. Hit "3" for "Save" and specify a filename. The software will add ".len" to the end of the filename you specify and save the lens definition in C:\CVUSER.

You can see a lot of data about the lens you have entered by going to "Display -> List all lens data" and reading the command window (go to the "Window" menu to bring it up, if necessary.)

We would like to evaluate chromatic aberration of this doublet. We'll do that by producing a spot diagram in front of, at, and behind the nominal focus. Go to "Lens -> Other specification -> Through focus definition" to define the focus positions we want to look at. We'll look at three positions, starting position -1.5, increment 1.5 (so we the nominal focus, plus 1.5 mm in front and behind).

Having done that, go to "Image -> Quick spot diagram". The three spot diagrams will appear in the "P1" plot window. (Use the "Window" menu to bring it forward if it doesn't pop up.)

Print the spot diagram using "File -> Print." You can print from the PC on the left. If you need to print from the one on the right you will have to copy files to disk or FTP them over. As a last resort you can use the printer in 03 Robinson (Milan and Melissa's office) -- it's called hp03. The lab printer is color, but the 03 Rob one is black-and-white -- it will use different symbols for the three wavelengths rather than pretty colors.

Which focus setting is best for red? Green? Blue? What does this tell you about the achromatic doublet?

Now, let's make a field map showing the rms spot size as a function of x and y field angle. That is, we'll see how the image of a point grows as we move off-axis. Go to "Analysis -> Field Map" and go to the blue input window. Hit "Enter" on the first and second pages to accept the defaults. Under "FFD" on the third page, hit "6" to specify RMS Spot Diameter, then hit enter to accept the rest of the settings on page 3. Hit enter again on page 4. On page 5, hit "4" under FCO to specify that we want a range of field angles, and specify the X and Y field angles as having a minimum of -10 degrees and a maximum of 10 degrees. Then, hit the "green light" on the toolbar to tell it to "go" and produce the plot. Print it, if you like, and note your observations.

You can perform other analyses by exploring menus. Remember to hit the "green light" after setting the parameters, and look for plots in the plot window and textual results in the command window.

If you want to add off-axis rays to spot diagrams and raytraces, you can add them from the "Lens -> Wavelengths" menu by specifying more fields. Is the focal surface of the achromat a plane?

When you're ready to enter the singlet lens, reset Code V with "File -> Clear Lens" and specify wavelengths, the entrance pupil, and surfaces as you did before. Conduct the analysis requested in the lab handout, and any others that you want to do. The "Image -> Quick Best Focus" menu may help you evaluate focus. Note that it finds the best focus for each wavelength being studied, and weights them according to the weights in the "Lens -> Wavelengths" menu. It expresses them relative to the "reference wavelength" specified there. To get the focus shift from the reference for a single wavelength, set the weights for the other wavelengths to zero.

To set up the spherical mirror, reset Code V with "File -> Clear Lens." Set a single wavelength of 550 nm and an entrance pupil diameter of 50 mm, using the "Lens -> Wavelengths" and "Lens -> Pupil Spec -> Entrance Pupil Diameter" menus. Insert 3 surfaces:

Surface	Radius	Thickness	Glass	RMD	Aperture
STO		600			25
2	-1000	0		REFL	25
3		-500			25

Now, specify the tilt of the mirror by clicking on its line in the input window and then clicking "Surf. Data." Hit "4" for decenter, Make sure "Surface number" is "2" for the mirror and "type" is "1" for decenter and tilt. Specify an A-tilt of however many degrees you measured the mirror tilt to be.

Repeat this for surface 3.

You can now draw the lens and perform other analyses as you did before.