

## CODE V: ASSIGNMENT #4

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In this assignment you will be creating a microwave telescope. As the name implies, this is simply a telescope that magnifies microwave radiation. One use for a telescope of this nature is measuring cosmic microwave background radiation. Measuring irregularities in microwave background radiation is strong evidence of the Big Bang theory, and dedicated groups of astronomers are currently working world wide to measure such irregularities. The microwave telescope being studied in this assignment consists of a primary mirror, a secondary elliptical mirror, a conical corrugated feed horn, and a microwave receiver. This lens system will be entered one surface at a time so it is easier to visualize exactly what is happening when you enter data into Code V.

### STEP 1:

Enter the first 2 surfaces (surface 1 is a dummy surface) of the telescope in a new Code V file titled Microwave Telescope. Go to File->New Lens. The new lens wizard will open. Click next, and choose blank lens. Use an EPD, (entrance pupil diameter), of 608 millimeters, and use a value of 0.1e8nm for the wavelength. Be sure the system units are set to inches. Use the lens data manager to edit the surface, type->sphere, input data as in fig 1 and make a printout resembling Figure 1. Label this Printout #1, (to be turned in).

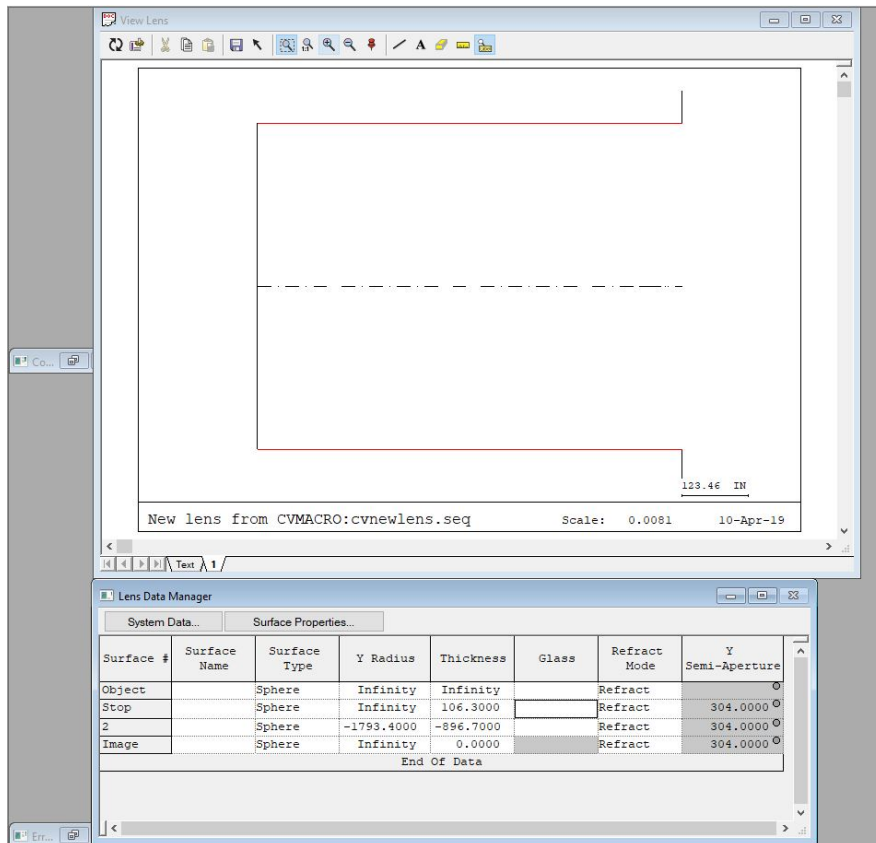


Figure 1

## STEP 2:

1. Now we wish to eliminate aberrations which we can do partially by having a conic surface, so change surface 2 into a conic surface. Do this by right-clicking on Surface 2 in the lens data manager->surface properties. Change Type to Conic. Set the conic constant=-1. Under materials, set the Refract Mode -> Reflect.
2. Now we wish to decenter the lens. Within Surface Properties for surface 2, select Advanced, then Decenters. Under Decenter Type -> Basic. Enter -617.5 for Y-Decenter value.
3. Sometimes it is necessary to have a user-defined aperture rather than allowing Code V to assign a value, and this happens to be the case for surface 2. Within Surface Properties for surface 2, select a clear, circular aperture with the Y Semi Aperture equal to 472.8. Enter 617.8 for the Y Decenter value. Note that we do not enter -617.5 due to the way the coordinate system operates in Code V. Print a picture similar to Figure 2. Turn this in.

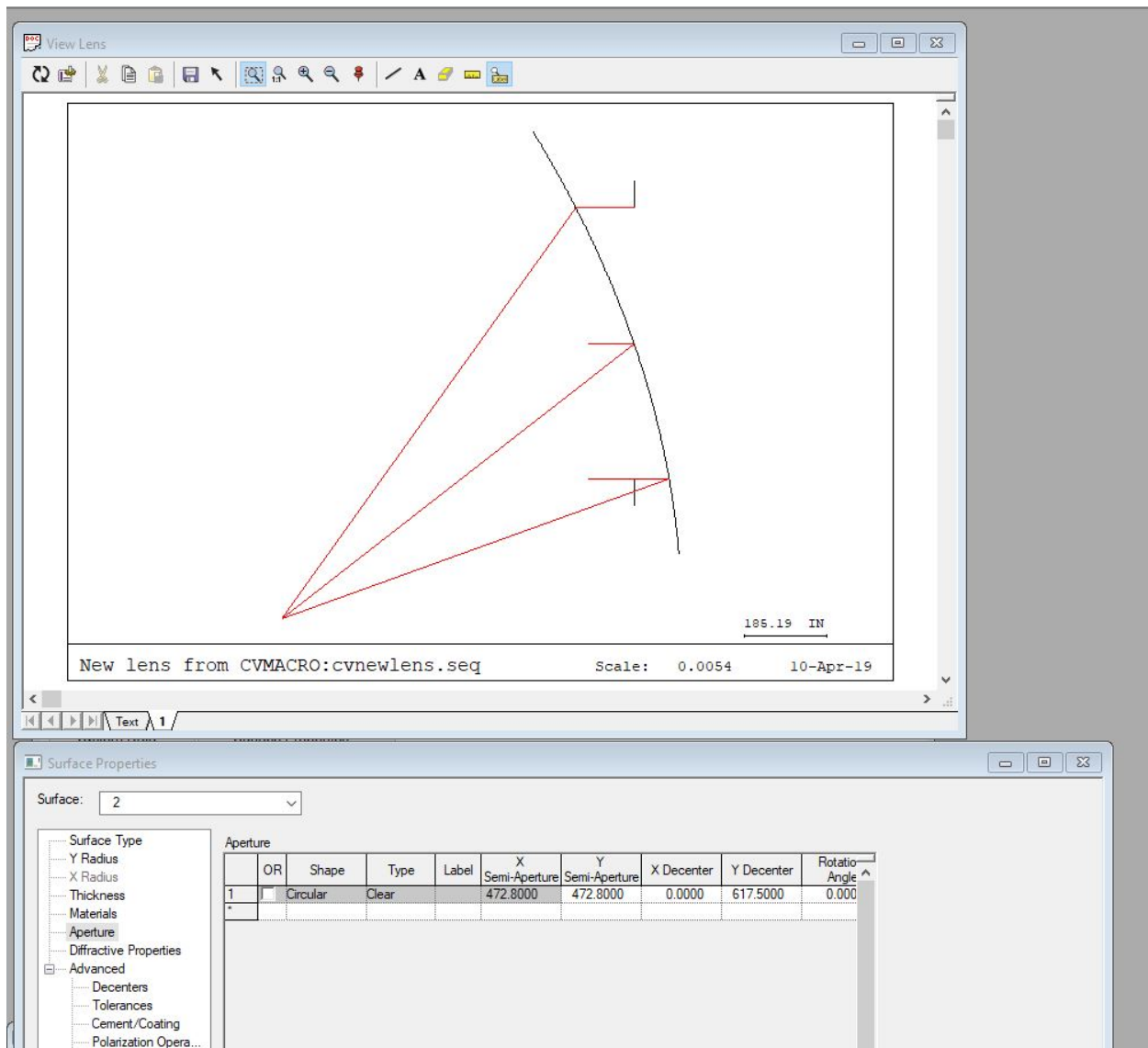


Figure 2

### STEP 3:

Insert a new surface (surface 3) using the lens data manager. Enter -85.24 for surface thickness. Go to Decenters, select Basic Decenter type, enter -64.482 for Alpha. Print a picture similar to Figure 3. Turn this in.

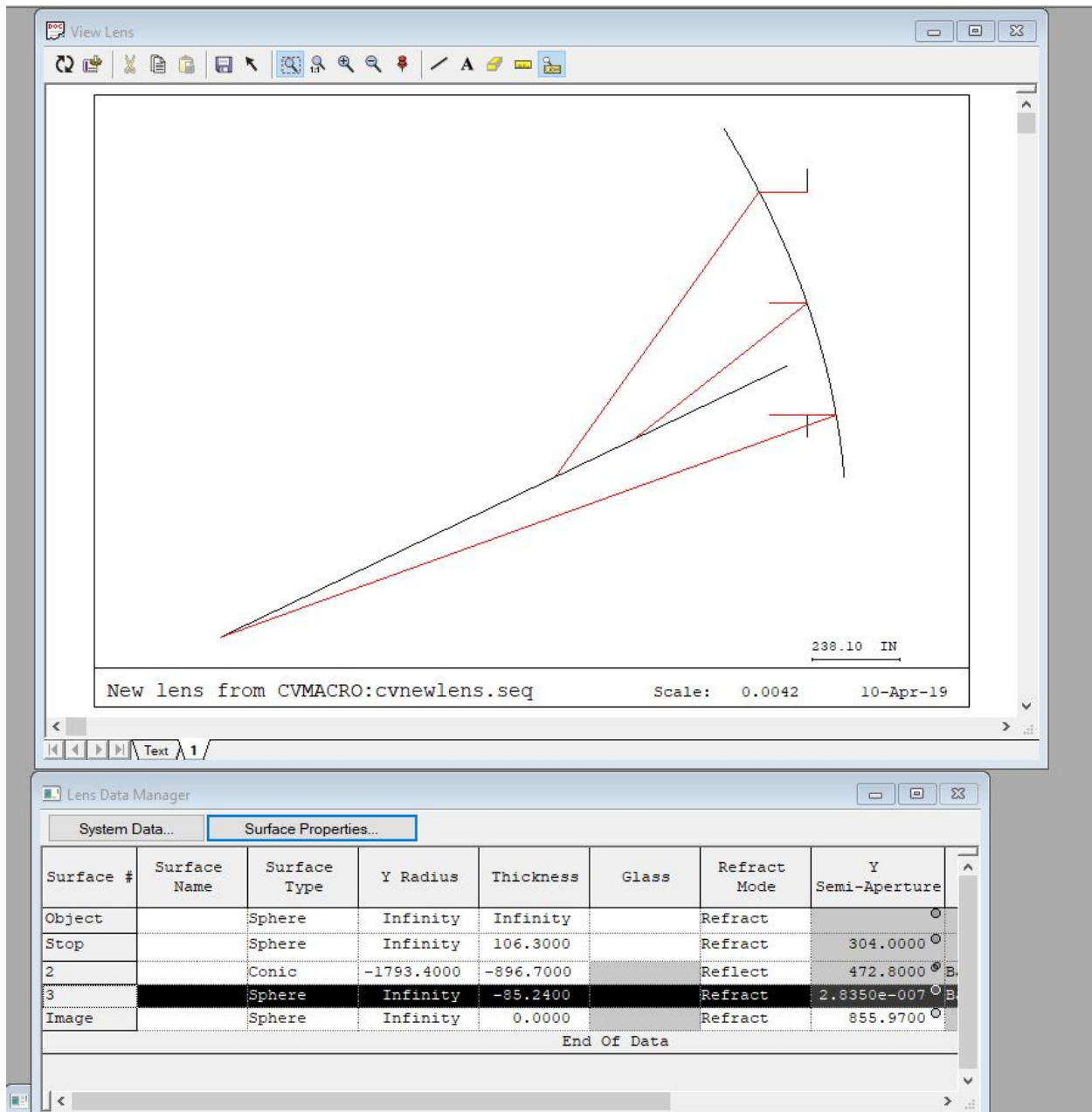


Figure 3

#### STEP 4:

Enter the secondary elliptical mirror. Insert a fourth surface (surface 4). Make it conic and choose a conic constant of -0.38591. Make the surface reflecting. Enter 138.19 for Y-Radius. Enter 364.84 for thickness. Give surface 4 an elliptical aperture, Semi-Aperture: X=90.7, Y=82.95, Decenter: X=0.0, Y= -127.35. Print a picture similar to Figure 4. Turn this in.

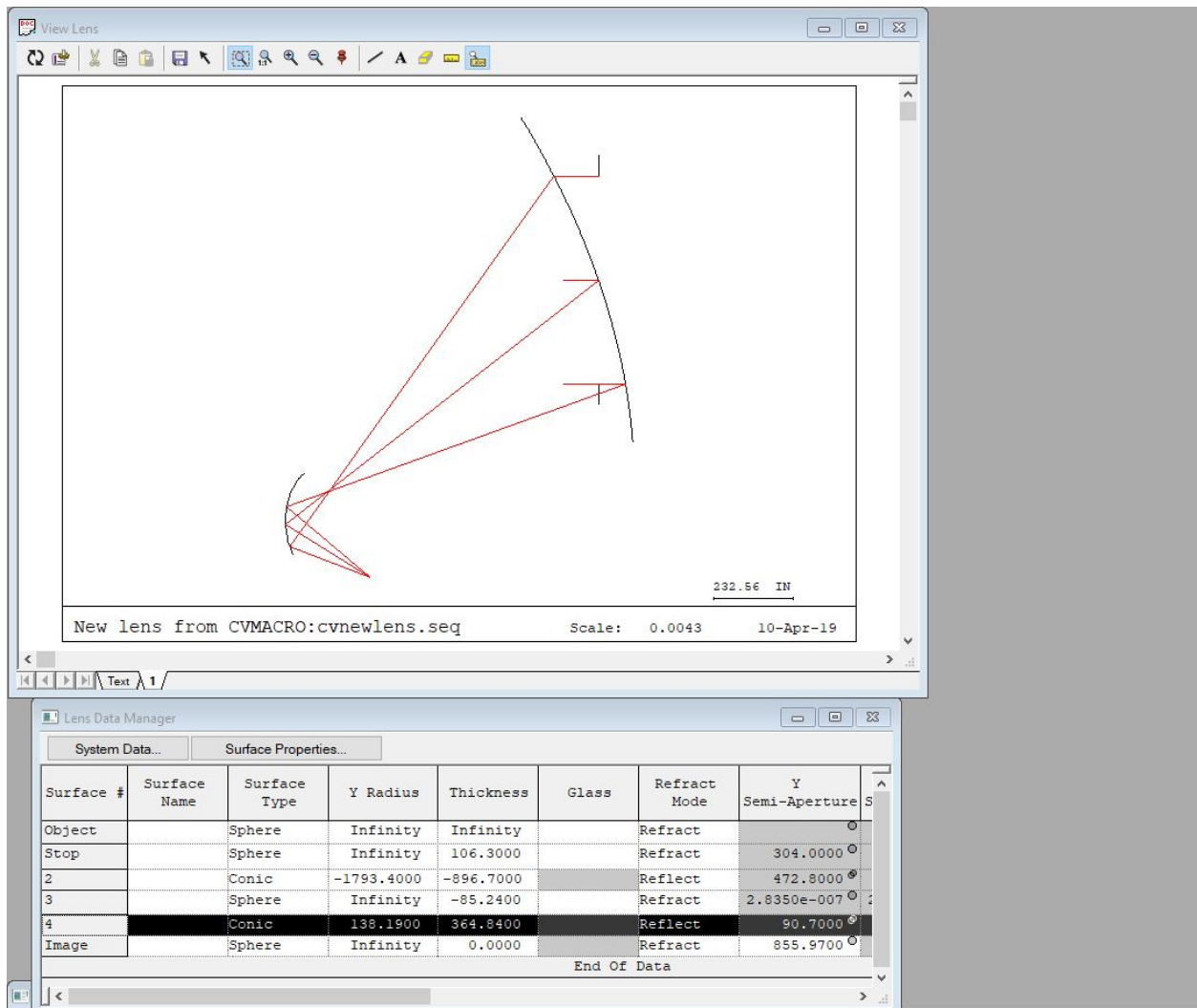


Figure 4

## STEP 5:

Make a point spread function. Go to Analysis->Diffraction->Point Spread Function. Choose Point Spread Function Intensity Normalization -> Decibels, and choose a threshold of 3 decibels. In output controls tab, uncheck the generate output listing box. Print picture similar to Figure 5. Turn this in.

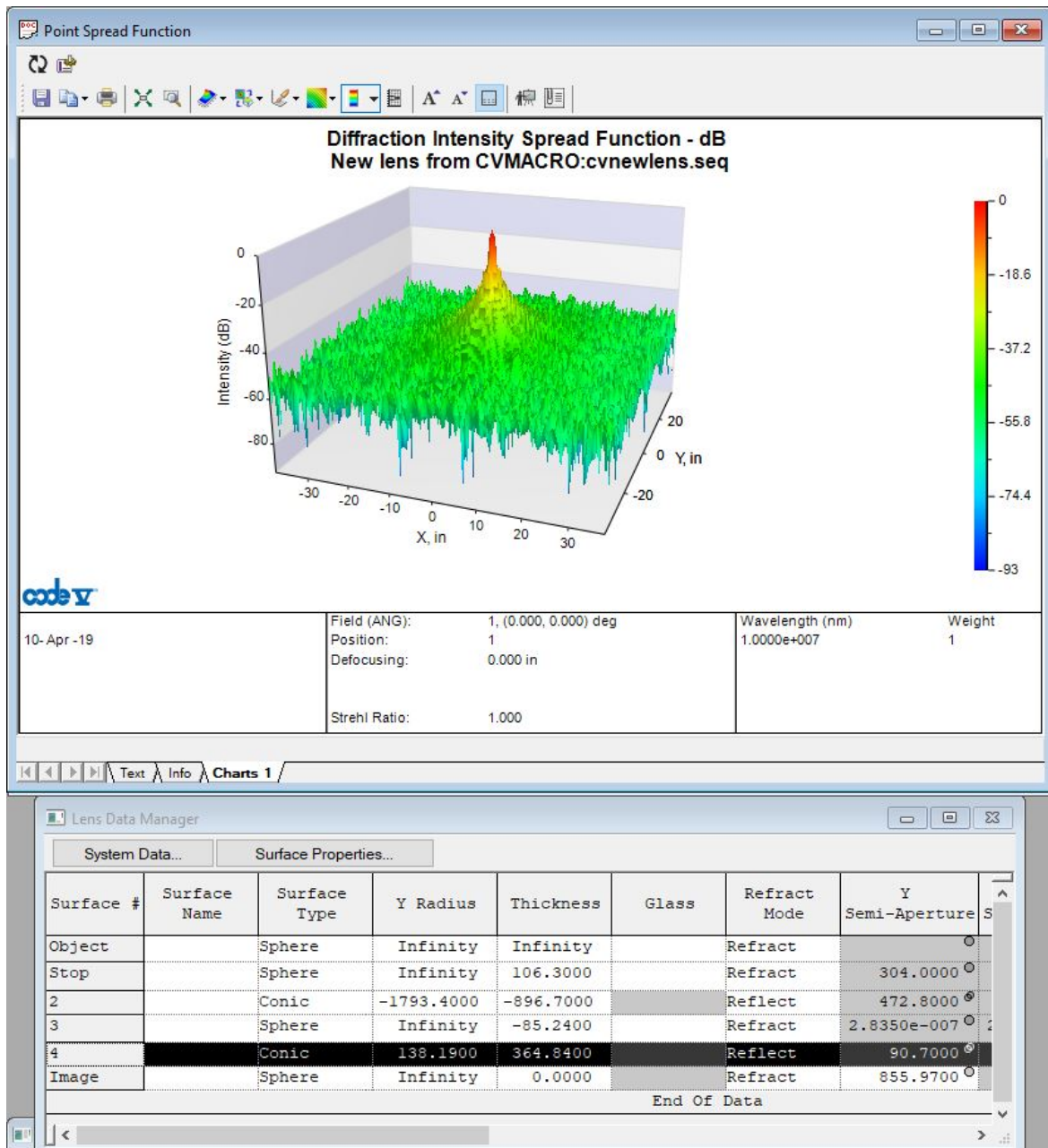


Figure 5

### STEP 5:

Make a point spread function, this time choose the “Strehl” output mode. Print a picture similar to Figure 6. Turn this in.

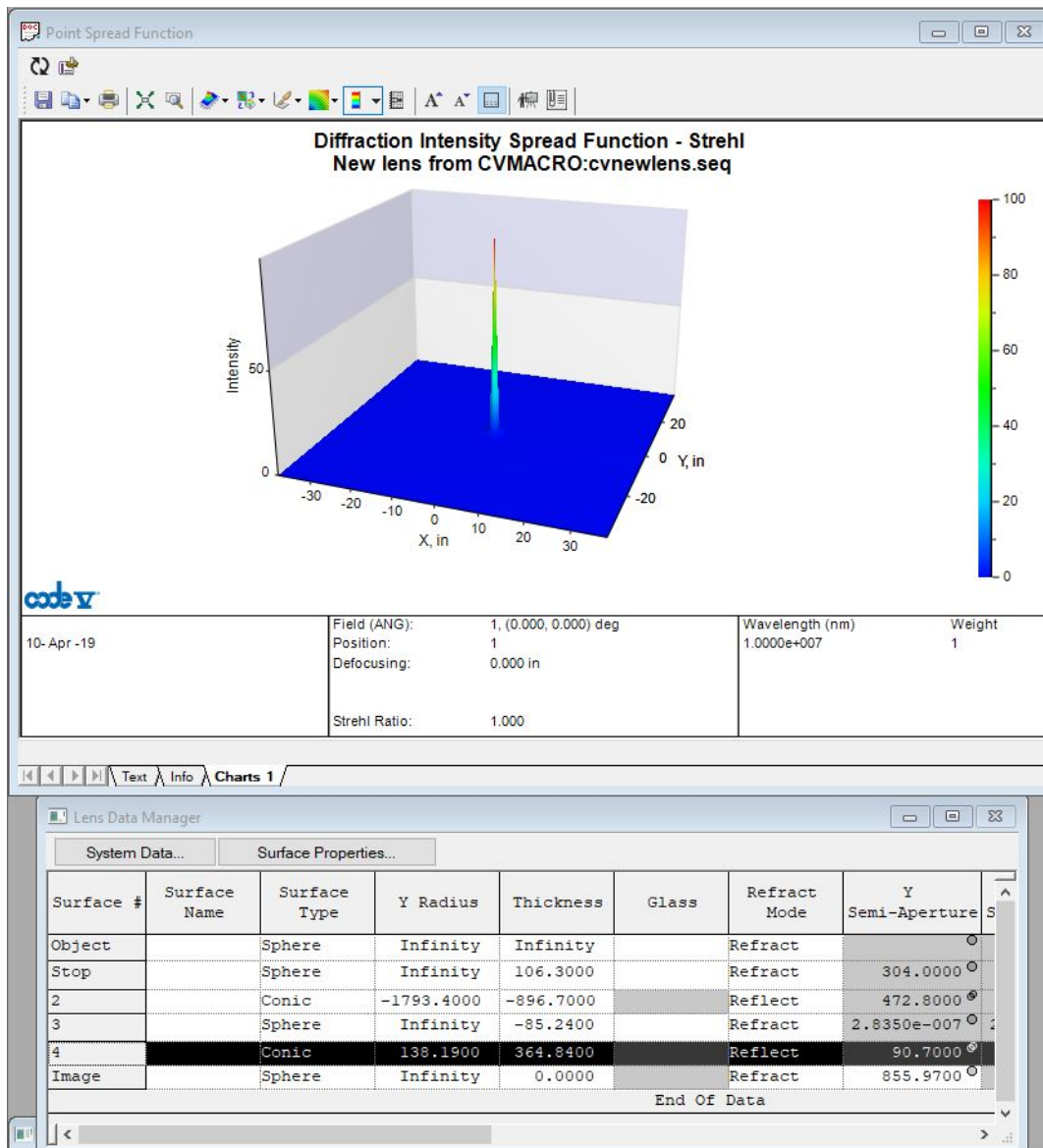


Figure 6

## STEP 6:

Make a third and final PSF. Choose Output type: decibel, threshold: 3db. This will generate figure 5 again. In the toolbar of the plot window, select chart type -> Contour. Print a picture similar to Figure 7. Turn this in.

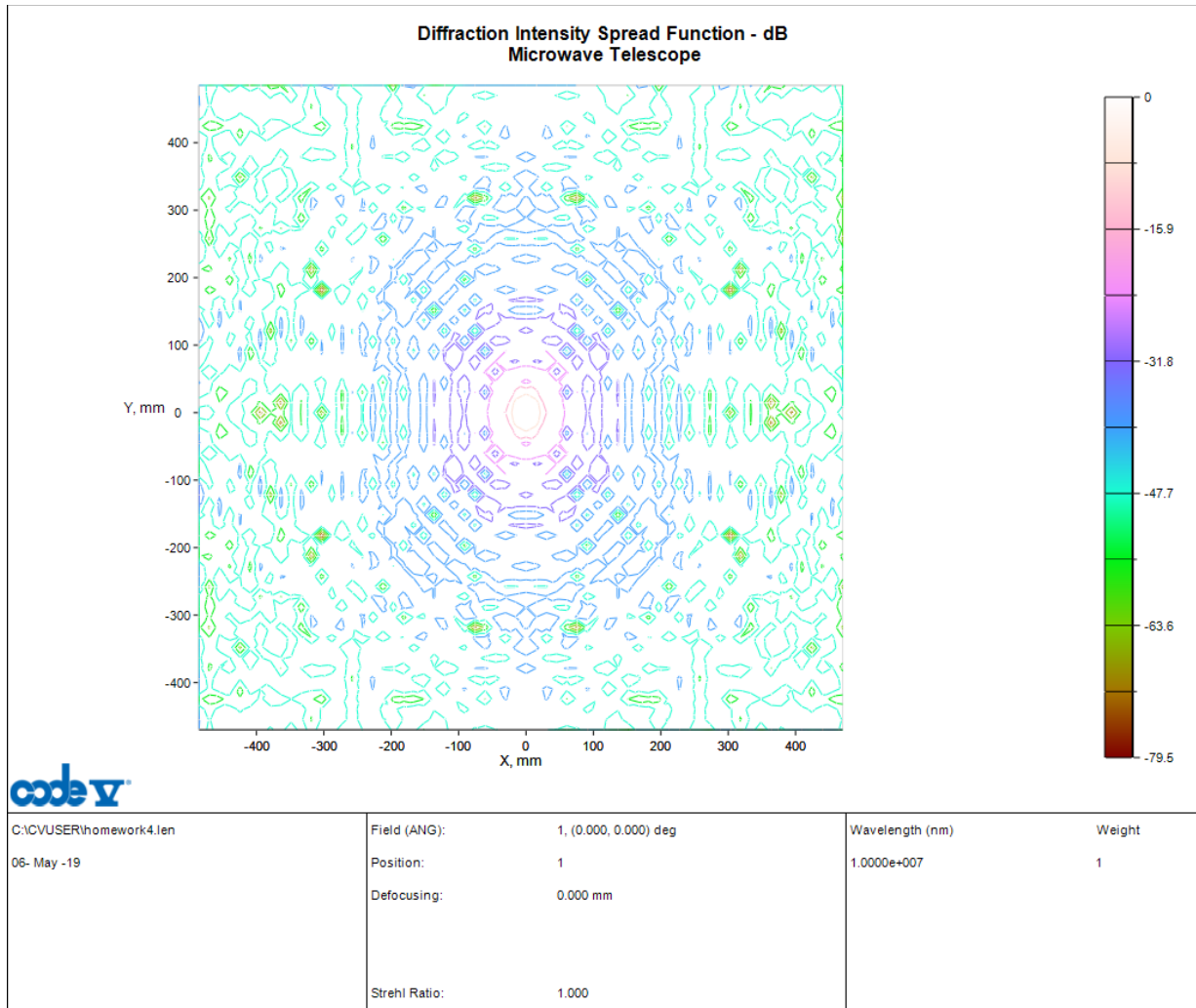


Figure 7

### Questions:

1. Explain why Figs 5 & 6 have different appearances even though they represent the same PSF (In one paragraph).
2. Explain the way in which the coordinate system is set up in step 2 (One paragraph). See the Code V Reference manual for detailed explanation.