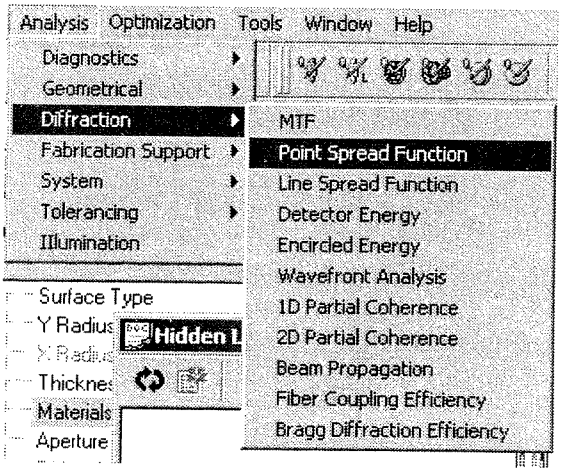
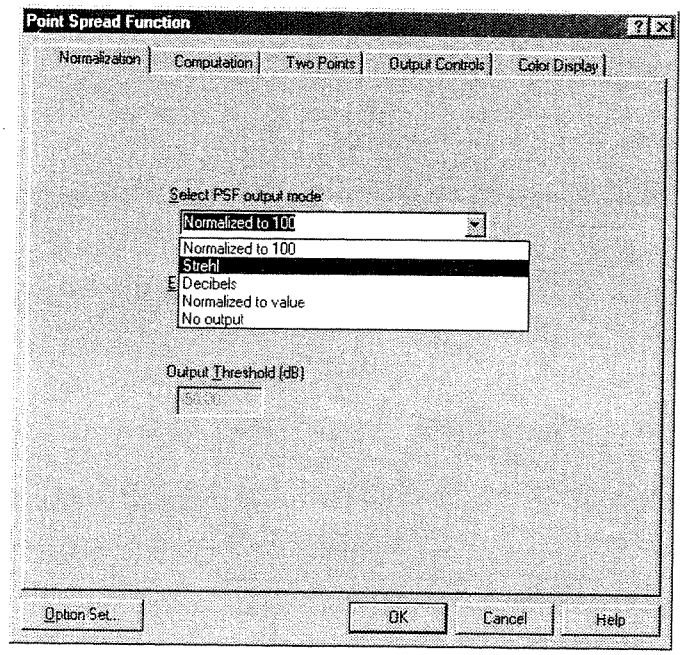
Diffraction Analysis (PSF)

What is the image quality? You can quickly take a look at the diffraction intensity profiles or PSF (point spread function). This is another option of CODE V, like the AUTO, SPOT, and WAVE options you used earlier. The dialog box for PSF offers quite a lot of settings or commands for the PSF calculations.

1. Choose the **Analysis > Diffraction > Point Spread Function** menu.



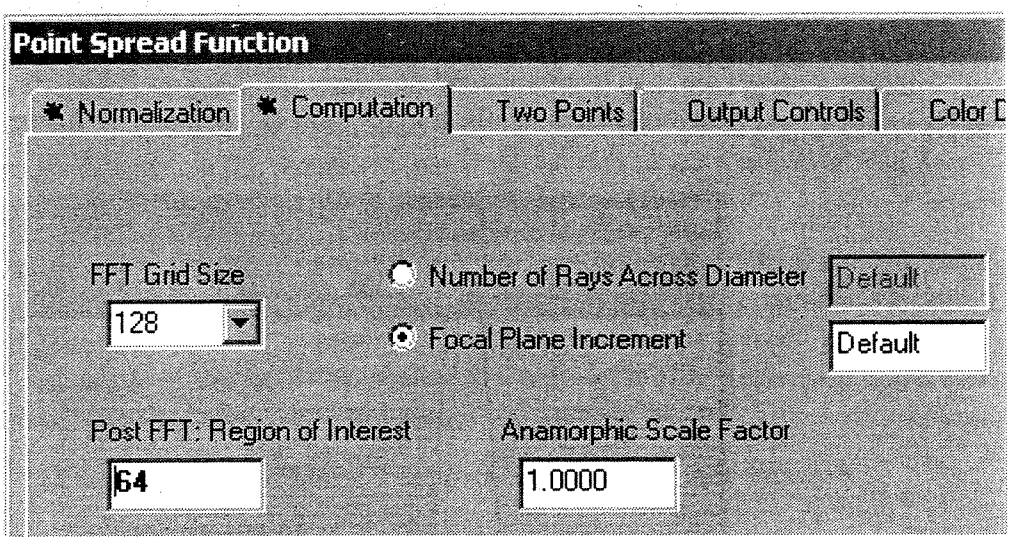
2. Click the **Normalization** tab and choose **Strehl** from the **Select PSF output mode** field.



Strehl ratio is a measure of image quality. By scaling the PSF to the Strehl ratio, the height of the PSF plot will indicate the energy contained in the PSF, which will be different for each field point.

3. Click the **Computation** tab.

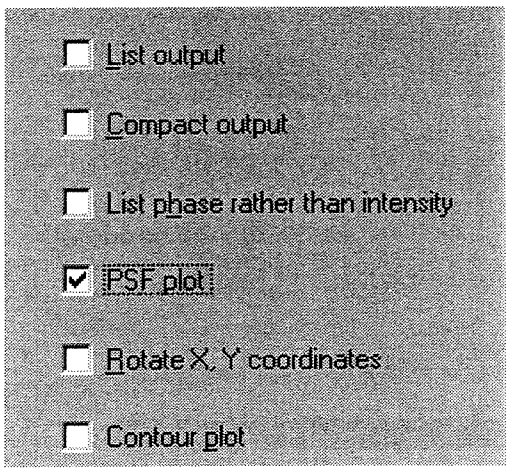
4. For the FFT integration grid size, enter **64** in the **Post FFT: Region of Interest** field.



PSF calculations use FFTs (Fast Fourier Transform) which require transform grid sizes that are powers of 2 (32, 64, 128, etc.). We will keep the default FFT grid of 128 but change the integration grid, which in this case will have the effect of "zooming" our plots by only showing the central 64 x 64 grid area of the 128 x 128 FFT grid.

5. Click the **Output Controls** tab.

6. Deselect the **List Output** checkbox, and select the **PSF plot** checkbox (if not already checked).



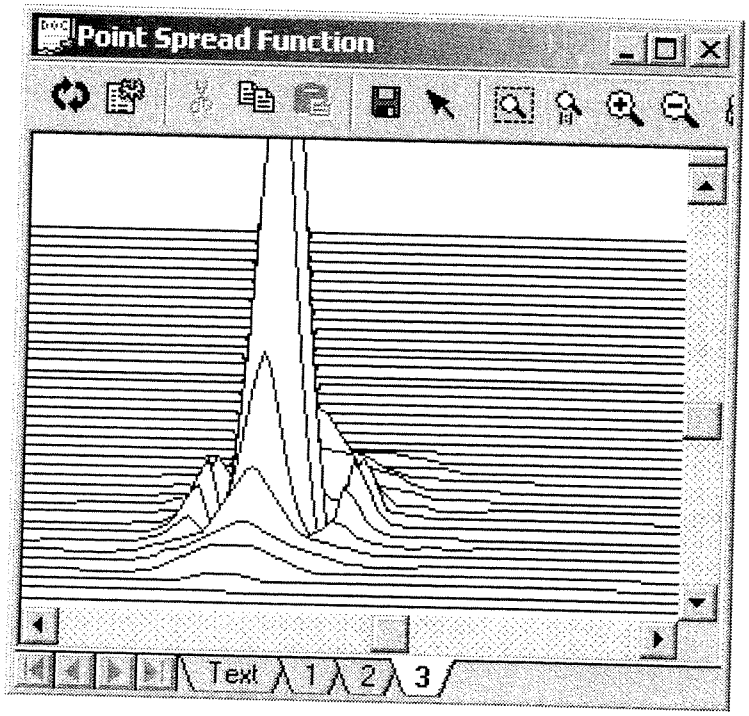
The listed output is a large matrix of numbers. The PSF plot is a 3D orthonormal view with height proportional to intensity. Pseudo-color displays are also available (Color Display tab).

7. Click the **Option Set** button, then click the **Save As** button, and save the settings you have just entered for possible later use.

   Note that you can preview the CODE V commands saved in the option set by clicking the **Preview** button in the **Option Sets** dialog box.

8. Click **OK** in the **Point Spread Function** dialog box to run the PSF.

   The output for the third field point (1° off-axis) is shown.



Commands and Macros

The Command Window

You may have noticed that whenever you made changes to the lens through the **Lens Data Manager**, **System Data**, or **Surface Properties** windows, that commands and text output appeared in the **Command Window**. CODE V has a complete and powerful command language in addition to the menus, dialogs, and toolbars you have used so far. You can do everything you need to do with the methods we have discussed so far. But you also have the option at any time to type commands directly on the command line at the bottom of the Command Window—just click in the Command Window and start typing.

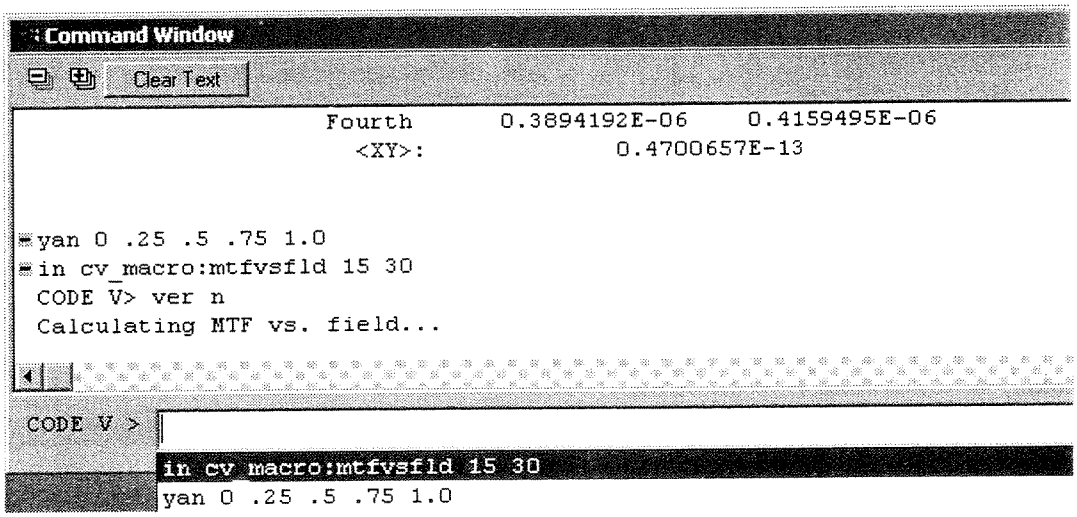
For example, you can add or remove field points in the System Data window, but if you wanted to use a command for this, you could use the YAN command (Y angle) in the Command Window. A command followed by a question mark is a query: what is the status of this item? To change to a new set of five fields, you could type the command YAN followed by the values. To do this:

1. Click in the command line at the bottom of the Command Window.
2. Type the following command:

   ```
   YAN 0 .25 .5 .75 1.0
   ```

3. Press the Enter key.

Any changes entered on the command line are immediately reflected in the corresponding dialog boxes or spreadsheets. You can also "recall" previously entered commands by pressing the up and down arrow keys (to scroll through the list), or by clicking the down arrow to the right of the command line field in the Command Window.



Commands can be typed one at a time in the Command Window, or multiple commands can be placed in a text file, saved, and run all at once with the IN command. Such collections of commands are called sequence files, macro files, or macros. ORA supplies many useful pre-written macros with CODE V, and if you learn the command language, you can write macros yourself. Macros can be simple lists of commands or complex programs; they offer a lot of flexibility. Many customers simply use pre-defined macros from ORA, while others write their own macros for special calculations.

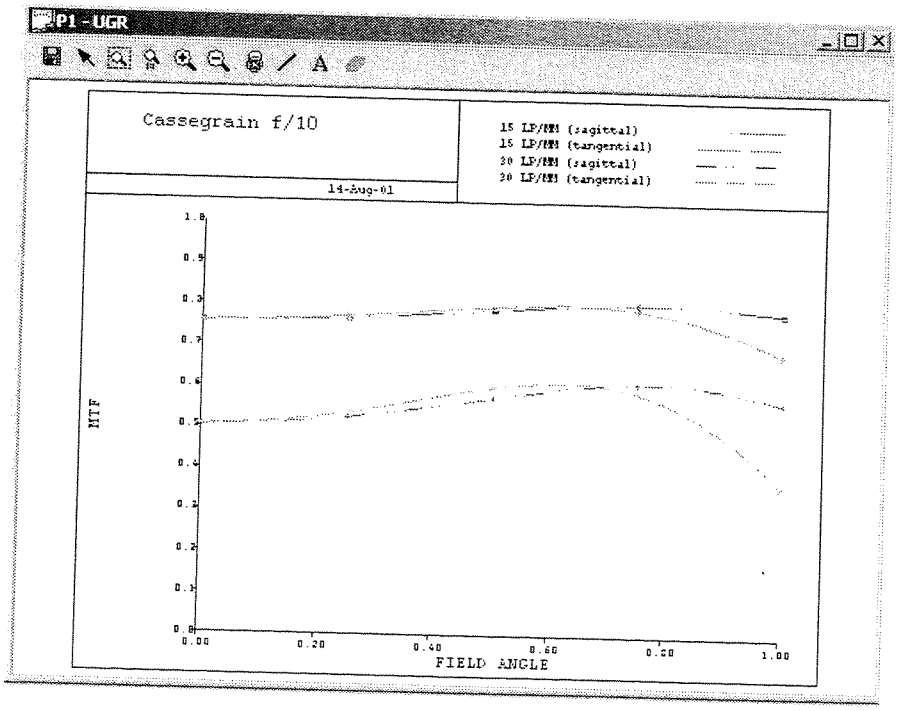
Tip: On the command line, you can enter multiple commands in a single line by separating each command with a semicolon (;).

Running a Macro

To follow up on the previous example, once you have increased the number of fields, you might be interested in how the MTF varies as a function of field for specified frequencies. This is not a built-in feature, but ORA supplies a macro that does just this! The macro is called MTFvsFLD.seq (macro files always end with a .seq extender). On the command line, enter:

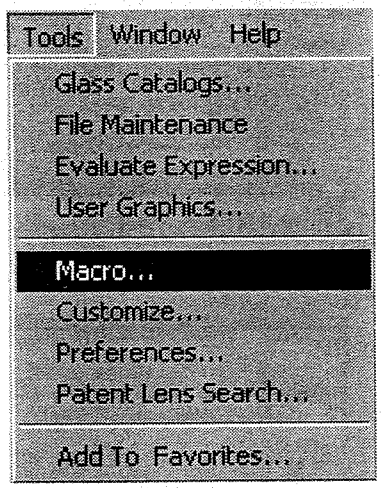
```
IN cv_macro:MTFvsFLD 15 30
```

You will get the following plot, showing radial and tangential MTF for 15 cycles/mm and 30 cycles/mm as a function of field position.

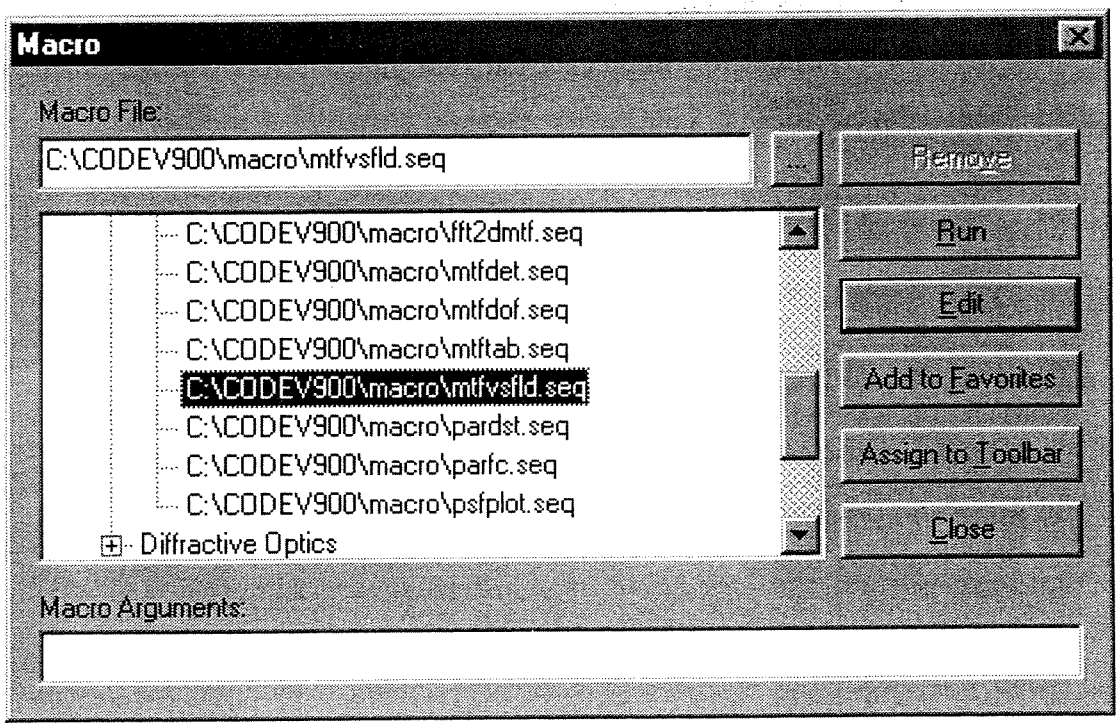


Macros can also be easily run using menus and the toolbar. To run MTFsvFLD.seq using the **Tools** menu:

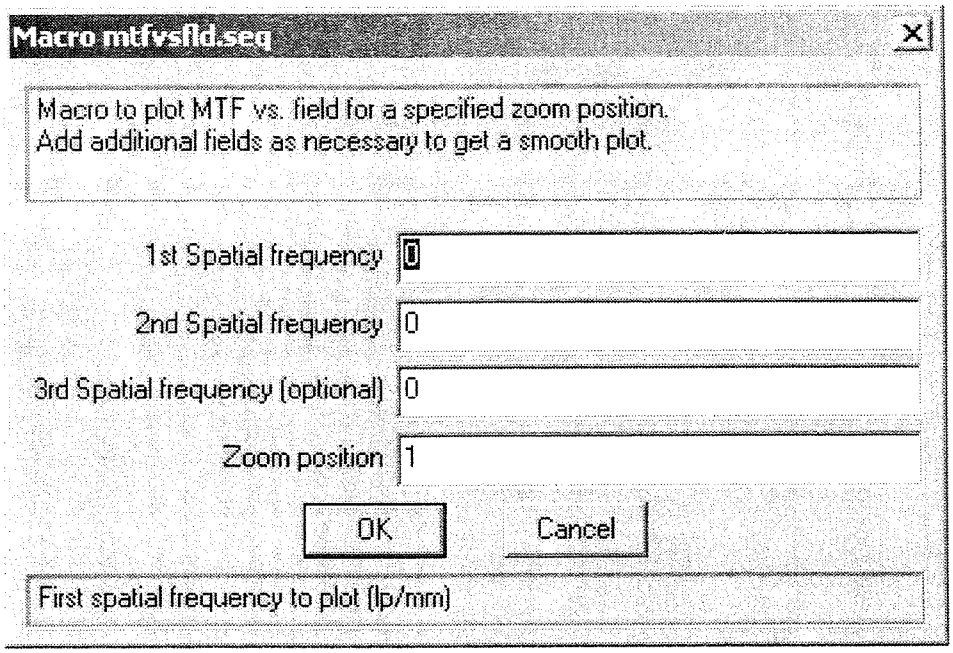
1. Choose the **Tools > Macro** menu.



2. In the **Macro** dialog box, click the + (plus sign) in front of **Sample Macros** to expand and display the list. Then, click the + in front of **Diffraction Analysis** to expand and display the macros in that category.
3. Scroll down to find **Mtfvsfld.seq** and click on it.
4. Click the **Run** button.



Most ORA-supplied macros include a dialog box interface as well as a command interface, so for Mtfvsfld.seq, you will see the following dialog box.



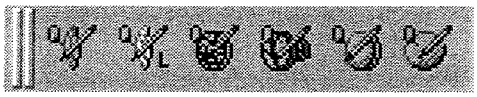
5. Enter the desired spatial frequencies for MTF, 15 and 30 cycles/mm.
6. Click the **OK** button.

   The macro will produce the same plot as before (see the command example above).

Summary for New Lenses

Here is a brief summary of the steps needed to set up a new lens.

1. Use the **New Lens Wizard** (**File > New** menu) to choose a starting point and define required system data.
2. If you start with a blank lens, right-click over the **Surface** column in the **Lens Data Manager** spreadsheet and choose **Insert** from the shortcut menu to create blank surfaces. Note that you do not need to start with a blank lens—the New Lens Wizard gives you options to start from and modify an existing lens file from ORA samples, from a large list of patents, or from your own previously saved "favorite" lenses. If you start from an existing lens, you may have to delete or insert surfaces and change surface property values to create your new lens model.
3. Use the **Lens Data Manager** spreadsheet to enter basic data values such as radius, thickness, and glass. Use surface labels to help remember the role of particular surfaces.
4. Use the **Surface Properties** window (right-click on any surface to access) to enter additional surface data such as special surface types, apertures, decenters, and surface solves.
5. Use the **System Data** window (**Lens > System Data** menu) to define additional system-wide data, including system solves, dimensions, and lens title.
6. Draw your lens to track progress, using Quick 2D Plot and other quick toolbar drawing icons:



7. Update lens drawings and other displayed data with the Execute button  found on many analysis and drawing windows (use the "tear off" feature to save non-updating copies of any graphics you wish to compare with later).
8. Save your work often, using the **File > Save Lens As** menu (for a new file name) or **Save Lens** (for a new version).

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