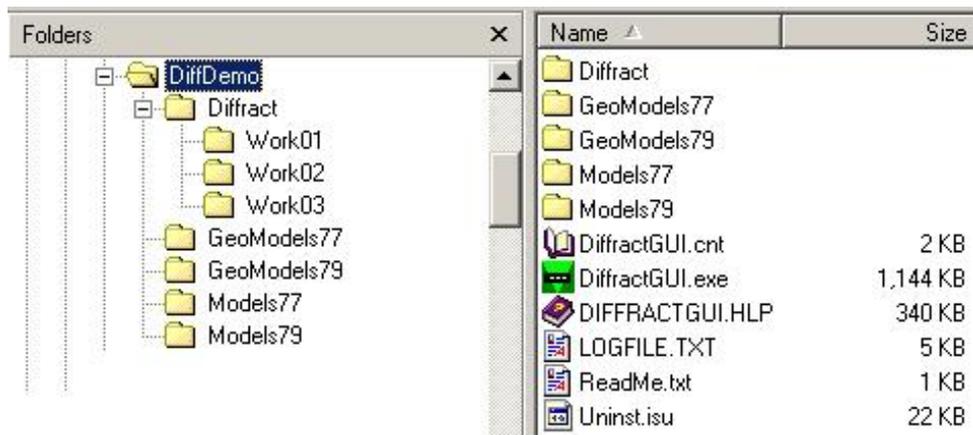


## Instructions to set up and run simple simulations within DIFFRACT's *Graphical User Interface* (GUI)

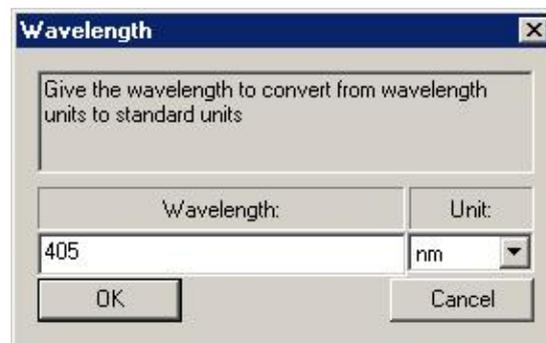
The following instructions will help you install the *Limited Edition* of DIFFRACT (Ver.7.9) on your computer, then experiment with several simple simulations. Immediately after installation, you should familiarize yourself with the buttons on the **menu bar**. Hold the cursor over each button and wait a second until the name of the button appears on the screen. If you need additional information about a specific button, click on the **Help** button first. A question mark (?) will appear next to the cursor. With the question mark still attached to the cursor, drag the cursor and click on the desired menu bar button. The corresponding help file will open, allowing you to read the relevant information.



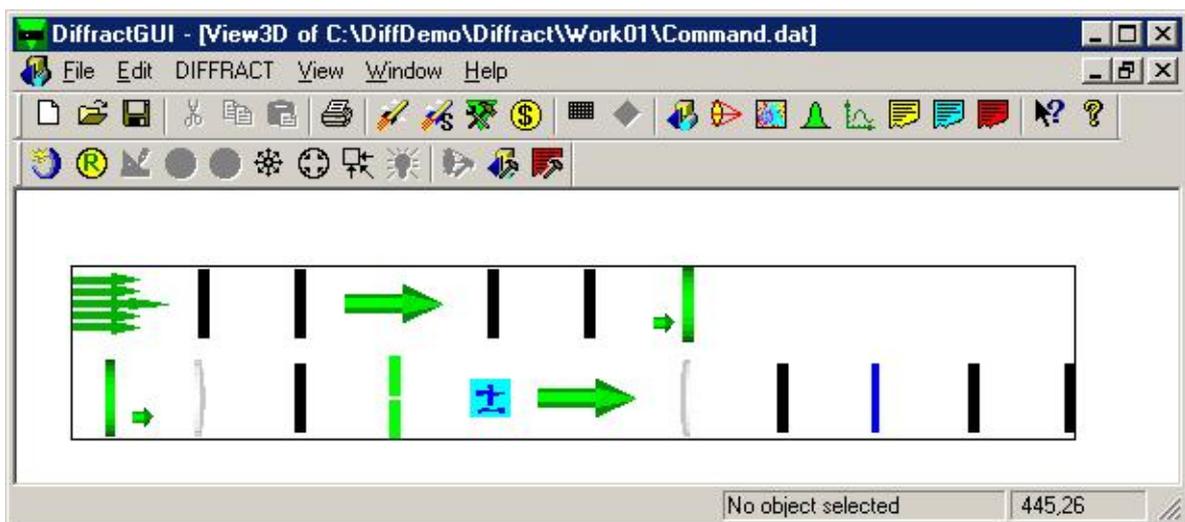
1. Copy the compressed file *LimitedDiffGUI.zip* to your hard disk and expand it by double-clicking on its icon. If the unzipper offers to install your package, accept this offer, otherwise double-click on the unzipped file **SETUP.EXE**, then specify a target directory on your hard disk, say **C:\DiffDemo**, to which the package should be installed. After installation your directory **C:\DiffDemo** will contain several files and subdirectories (folders). One file is **DiffractGUI.exe**, on which you must double-click in order to start the program. One of the folders within **C:\DiffDemo** is **<Diffract>**. Inside **C:\DiffDemo\Diffract** you should see **Limited\_Diff79.exe** and **Settings.log**, as well as three working subdirectories, **<Work01>**, **<Work02>**, and **<Work03>**. (Note: By double-clicking on **Limited\_Diff79.exe** you can launch the Limited Edition of DIFFRACT, Ver.7.9, without its *Graphical User Interface*. It is, therefore, recommended that you do NOT invoke this program, but instead run **DiffractGUI.exe** from its home directory **C:\DiffDemo**.) Within each working subdirectory, namely,

C:\DiffDemo\DiffRACT\Workxx, you will find a test run called **Command.dat**. The procedures described below will guide you in a step-by-step fashion to run DIFFRACT and its GUI from these Command.dat files. Once you are familiar with these test runs, you should be able to set up your own simulations and run them under DIFFRACT's *Graphical User Interface*.

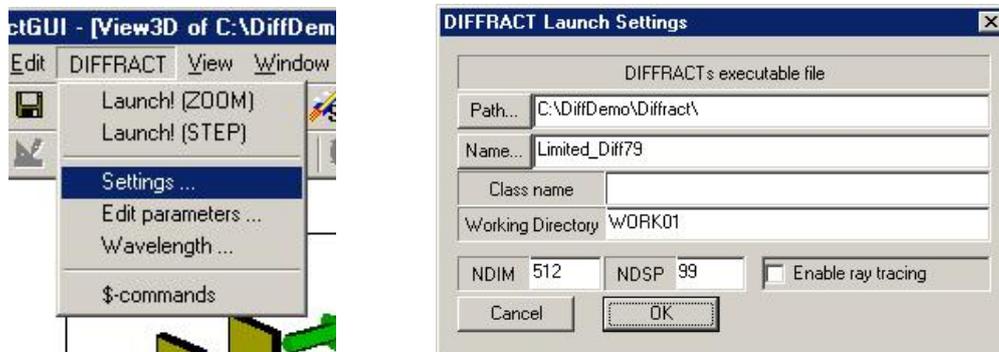
2. Return to the C:\DiffDemo directory and double-click on **DiffRACTGUI.exe**. After the title screen, you will see the main Window of DiffRACTGUI on your monitor. From the menu bar choose File\_Open, then select the file C:\DiffDemo\DiffRACT\Work01\Command.dat and double-click on the filename. A dialog box will open to inform you of the wavelength  $\lambda$  chosen for this particular simulation (in units of nm,  $\mu\text{m}$ , or mm).



Say OK to this dialog box. At this point another Window, **View3D**, opens up to show the diagram of the simulated system. (This diagram will be referred to as the **Workbench**).

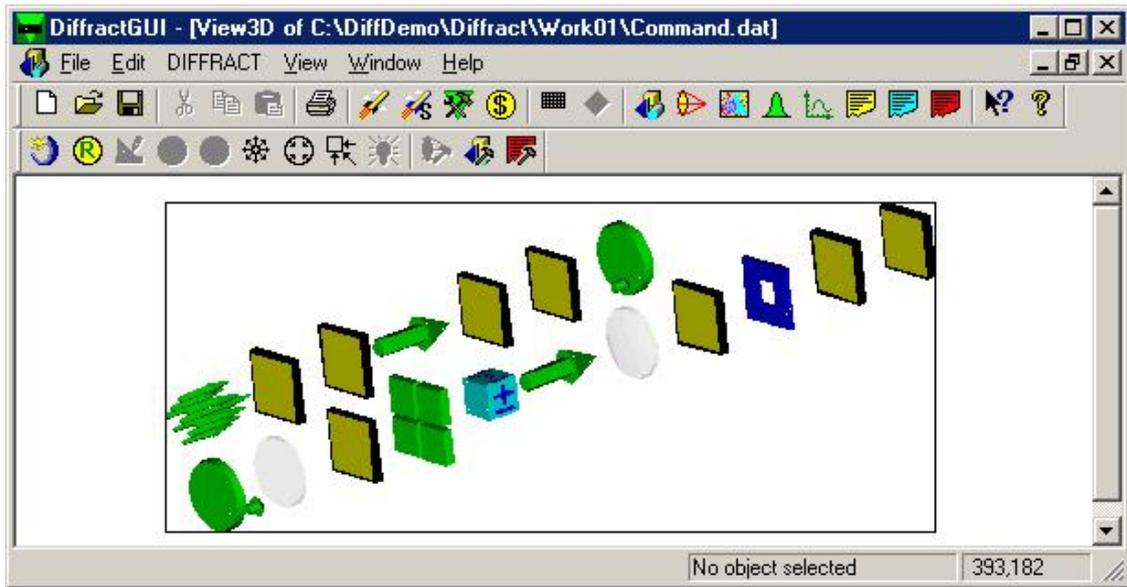


3. Once the **Command.dat** file of the optical system is opened and the View3D window is showing the corresponding **Workbench**, click on the menu bar item DIFFRACT and select Settings.

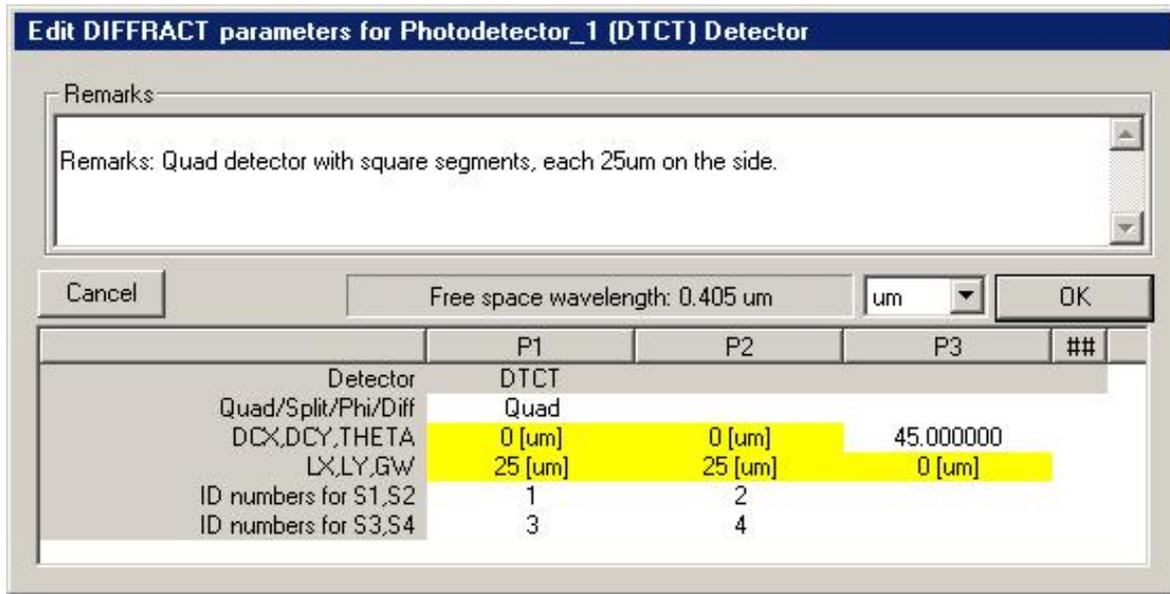


A dialog box will show the location and the name of DIFFRACT's executable, the working subdirectory, and some of the initial parameters that must be handed over to DIFFRACT upon launching. (The parameters NDIM and NDSP that appear in this dialog box specify, respectively, the mesh dimension used in the simulation and the dimension of the display mesh used for various plots within DIFFRACT.) Although these parameters are set automatically by DiffRACTGUI, the user can also modify them, if need be, within the *DIFFRACT\_Launch\_Settings* dialog box.

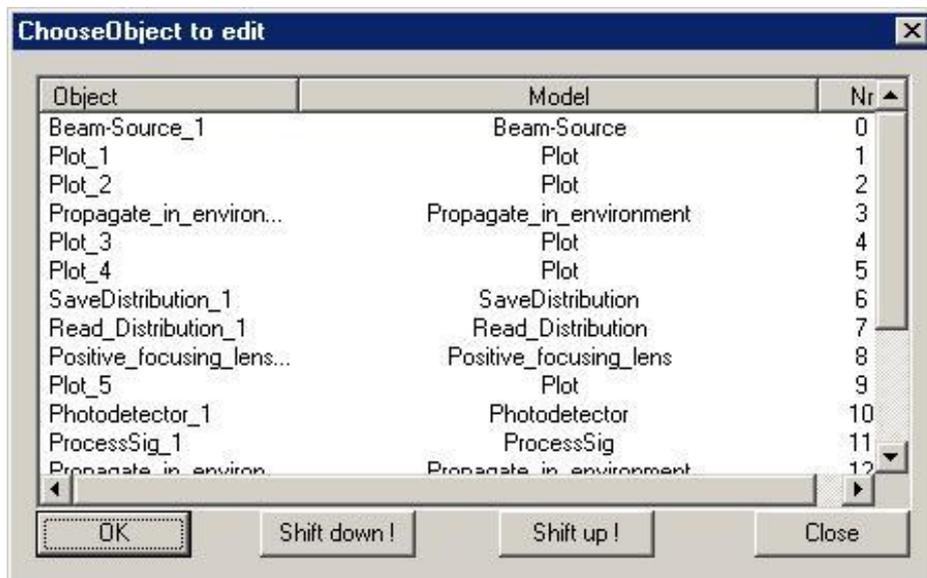
4. To get a better view of the system displayed in the **View3D** Window, click the mouse outside the box that confines the system diagram (i.e., outside the Workbench), then use the  $\leftarrow \uparrow \rightarrow \downarrow$  arrows from the keyboard to move the Workbench, or hold down the Ctrl key while pressing the  $\leftarrow \uparrow \rightarrow \downarrow$  keys to change the perspective. You may apply the same operations to the individual elements of the system by clicking the left mouse button on each object (i.e., selecting the object), then using the arrow keys (with or without holding down the Ctrl key) to move and/or rotate the selected object.



5. To observe the parameter values chosen for each object on the Workbench, double-click on the object. The *Edit\_DIFFRACT\_Parameters* dialog box will open, and you can see the various parameter values chosen for the object. You may edit these parameters simply by clicking the left mouse button on them and either selecting or entering the desired new values. In the language of DIFFRACT, the *Edit\_DIFFRACT\_Parameters* dialog box shows the corresponding command block for the selected object, be it BEAM, LENS, MASK, PLOT, or any other object available in DIFFRACT's menu. Notice that the free-space wavelength  $\lambda$  of the simulation is specified at the top of the command block within the *Edit\_DIFFRACT\_Parameters* dialog box. By changing the units of  $\lambda$  (say, from mm to  $\mu\text{m}$ ) you will notice that all length parameters within the dialog box will automatically change accordingly. This feature allows the user to set the units of length at the top of the command block, then enter all the length parameters in his desired units (e.g., mm,  $\mu\text{m}$ , nm, or even units of *lambda*, which means that all lengths are entered in normalized form, divided by the free-space wavelength  $\lambda$  of the light source.)



6. By double-clicking in the **View3D** window outside the Workbench (or inside the Workbench away from any object) you will open the *Choose\_Object\_to\_edit* dialog box. Here again you can select an object and edit its parameters, or *Shift Up* or *Shift Down* selected objects using the buttons at the bottom of the dialog box.

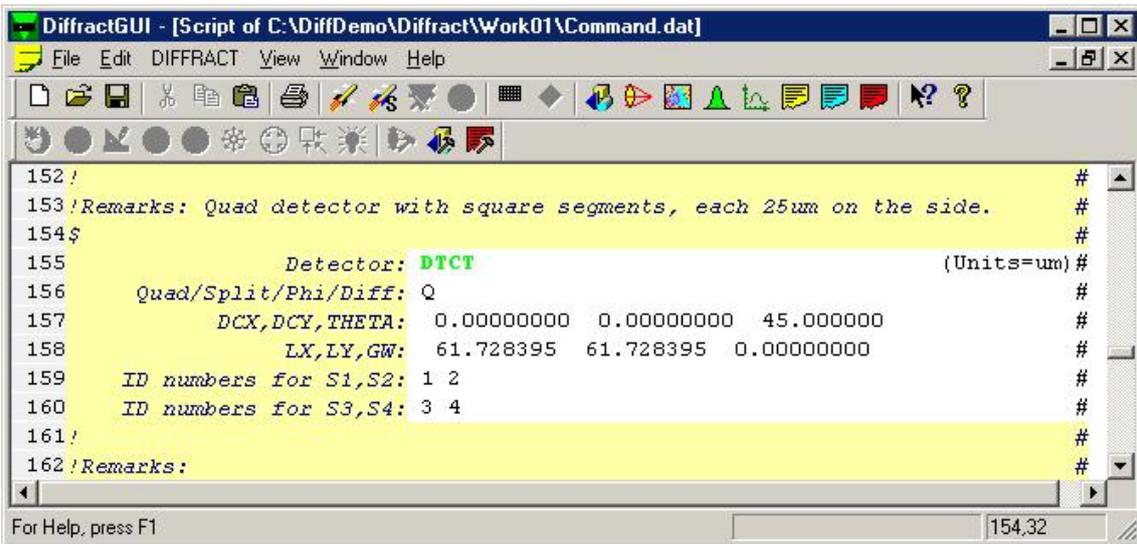


A new object may be added to the simulated system (i.e., the Workbench) by selecting any object on the Workbench, then selecting the *NewObject*  button

on the menu bar. A list of available objects appears and, when you select one by clicking on its icon, the selected object will be inserted after the object that you had initially selected on the Workbench.

7. Use the menu bar buttons *Inflate* , *Deflate*  and *Align\_to\_top*  to change the size of the **Workbench** and/or to move it to the upper left corner of the screen. You can also grab the box with the cursor and drag it through the **View3D** Window. Move or rotate any of the objects, then use the *Reposition* button on the menu bar to observe the modified object reverting to its initial position/orientation.

8. If you make a change to the system on the Workbench, you should use the *Save*  button of the menu bar to save the corresponding **Command.dat** file. Observe the entire Command.dat file by clicking on the *View\_Command.dat* button  of the menu bar. When the Command.dat opens, you will see all the length parameters in normalized units (i.e., divided by  $\lambda$ ). This is how DIFFRACT wants to see the length parameters. In the Command.dat file, you will also notice the expression (units = *xx*) written in the upper right corner of each command block. This *does not* mean that the length units for that block (as written in the Command.dat file) are *xx*. It simply means that if you go back to the Workbench and open the *Edit\_DIFFRACT\_Parameters* dialog box for that item, the preferred units will be *xx*. (Of course you can change your preferred units within the *Edit\_DIFFRACT\_Parameters* dialog box. Then, the next time that you click on *View\_Command.dat*, you will see the new units written at the top of the corresponding command block.)



```

152 ! #
153 !Remarks: Quad detector with square segments, each 25um on the side. #
154 $ #
155         Detector: DTCT (Units=um) #
156     Quad/Split/Phi/Diff: Q #
157     DCX,DCY,THETA: 0.00000000 0.00000000 45.000000 #
158     LX,LY,GW: 61.728395 61.728395 0.00000000 #
159     ID numbers for S1,S2: 1 2 #
160     ID numbers for S3,S4: 3 4 #
161 ! #
162 !Remarks: #

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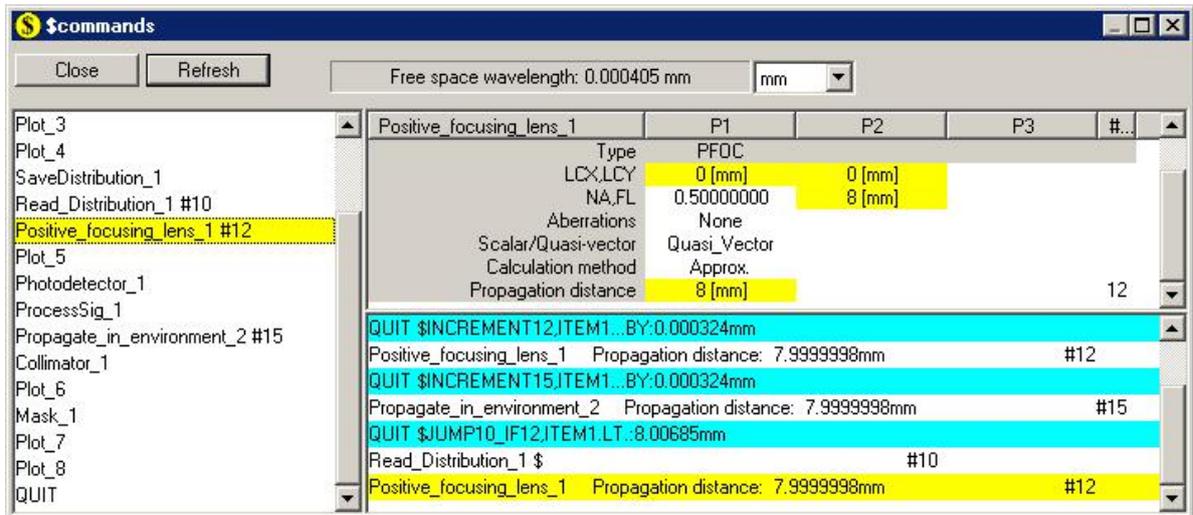
For Help, press F1 154,32

9. You may insert new objects into the **Workbench** by first selecting an object from the Workbench, then clicking on the *Command\_Panel*  button of the menu bar. A Table of all available objects will appear, and you can pick any object from the *Command\_Panel* for insertion into the Workbench immediately after the selected object on the Workbench.



This is the easiest method of inserting new objects into the simulated system. In fact, you can build a brand new system simply by opening a new file (by clicking on *File\_New* from the menu bar), then clicking the desired objects one by one from the *Command\_Panel* into the new file. You can then proceed to double-click on each new object on the **Workbench**, and enter the relevant set of parameters into the corresponding command block as it appears in the *Edit-Diffract\_Parameters* dialog box.

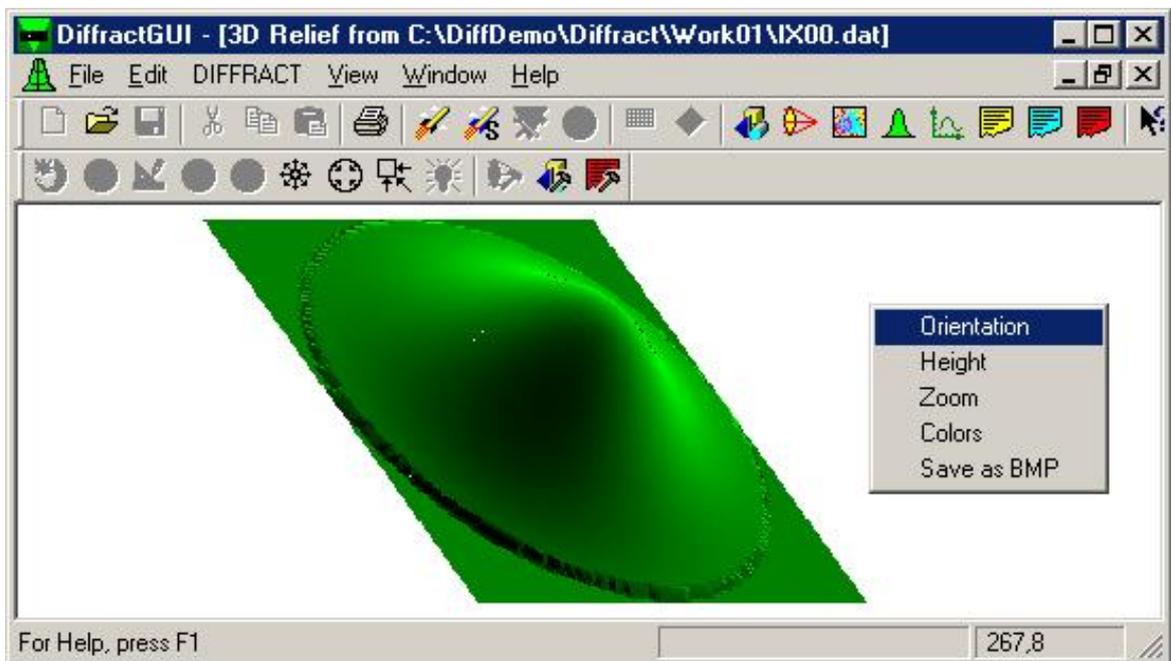
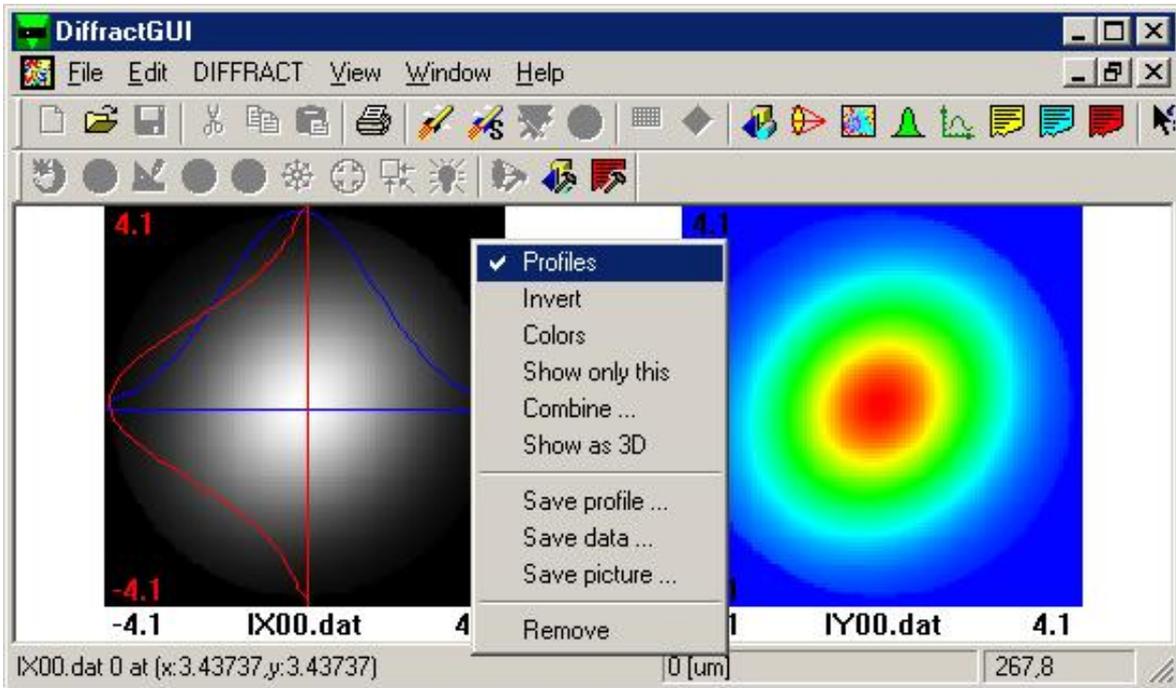
10. While in the *View\_Command.dat* environment, you may also look for the **\$commands** inserted here and there within the **Command.dat** file. These \$commands allow for looping operations within the Command.dat; they refer to certain line numbers within various command blocks. The line numbers are **assigned by the user** to each line and are placed at the end of the line immediately after the # sign. Look for some of these line numbers on the right margin of the Command.dat file following the # signs. Whether **Tagging** a particular item on a given line, or asking the program to **Increment** the value of a particular item on a given line, or asking the program to **Jump** to a new line within the Command.dat file, the \$commands provide a powerful tool-set for creating loops inside the **Command.dat** file. The *\$commands\_editor*  of the menu bar allows the user to insert these \$commands at various locations within the Command.dat file. All the user has to do is select the object before which the \$command(s) are to be inserted, then type the first few letters of the \$command at the desired location and press the Enter key. The *\$commands\_editor* of DiffractGUI automatically inserts the correct **\$command** at the specified location, then allows the user to replace the unknown parameters of this \$command (identified by ?) with specific values.



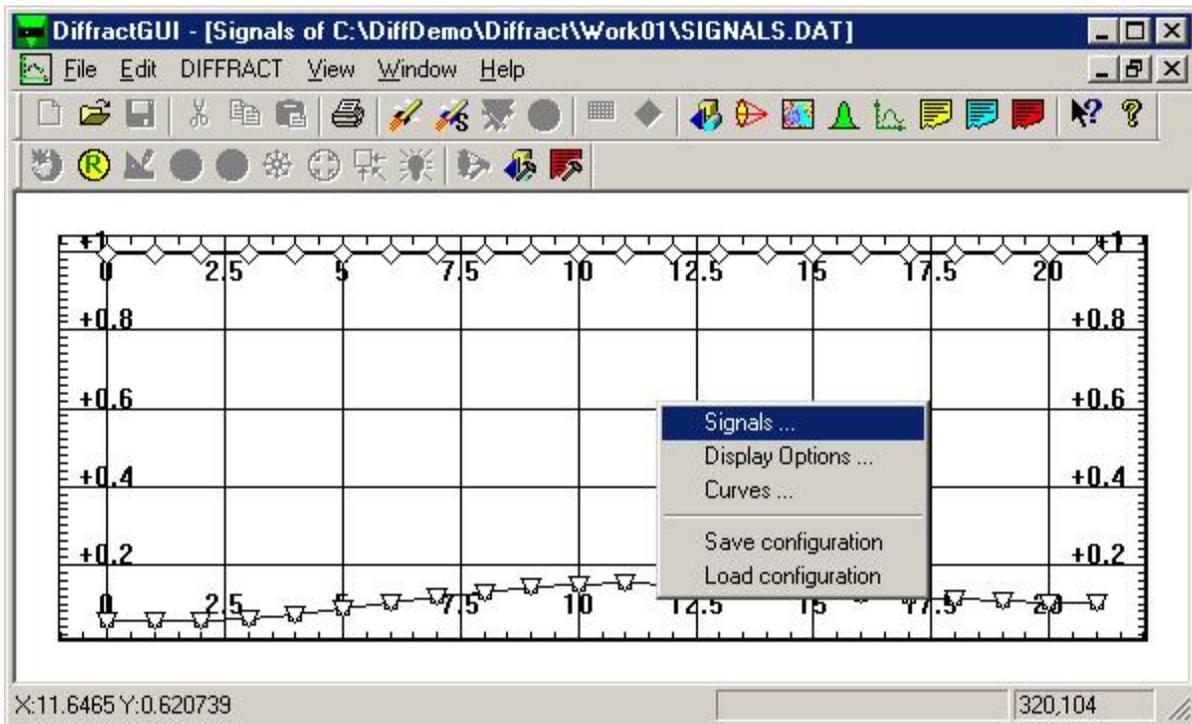
11. Once the system is constructed on the **Workbench** and its parameters are specified, the user must save the Command.dat file (using the *Save*  button of the menu bar), then proceed to launch DIFFRACT using either the *Launch\_Diffract(Zoom)*  or the *Launch\_Diffract(Step)*  buttons from the menu bar. In the **ZOOM** mode DIFFRACT goes through the entire Command.dat file and stops only after the simulation is completed. In the **STEP** mode, DIFFRACT goes through the Command.dat file in step-by-step fashion, displaying the program's input and output parameters one page at a time, then waiting for the user to press the Enter key to continue its operation. Launching in the STEP mode allows the user to check the simulation and verify that the various steps have been correctly implemented. Launching in the ZOOM mode is for simulations that have been checked thoroughly, and should now be executed without any interaction with the user. In particular, when looping commands are inserted into the Command.dat file, the user may submit the job to the *Launch\_Diffract(Zoom)* and walk away for the duration of the simulation.

12. At the end of the simulation all the graphic files, the Session.dat file, and (if applicable) the Signals.dat file will be stored within the working subdirectory. At this point the user can select any of the **PLOT** objects from the **Workbench** and click on the *View\_Bitmap*  button to see the desired plots in bitmap. (**PLOT** objects are used to display Intensity, Log\_Intensity, Phase, Polarization, or Geometric-optical Ray distributions at various cross-sections of the system.) Clicking on these bitmap images with the **right mouse button** causes a list of available options to appear. Using this list, the user can choose to display the

bitmap image in color or in gray-scale, can ask for a 3D plot, or inverted colors, etc. Similarly, the user can select a **PLOT** object on the Workbench, then click on the *View\_Relief*  button to see a 3D plot of the corresponding distribution.



If the **Signals.dat** file happens to have been created during a simulation – this is generally the case when the **Process\_Signals** object is used to compute a combination of **Detector** signals and print the output to the Signals.dat file – then clicking on the *View\_Signals*  button of the menu bar will display plot(s) of the computed signal(s). A right mouse click on the Signals Window shows the available options for this plotting routine.

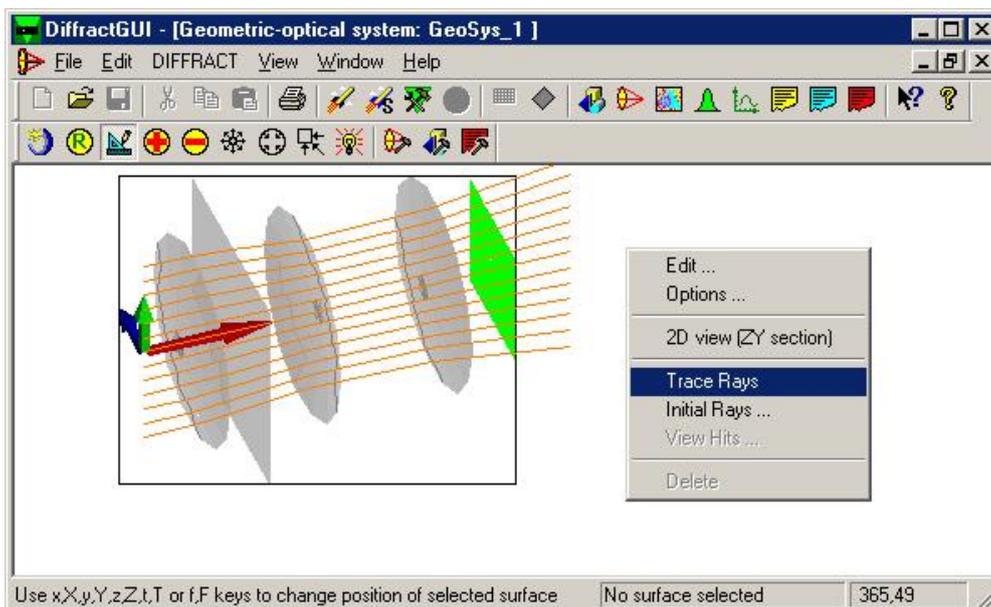


Every simulation produces a text file called **Session.dat** within the working subdirectory. Clicking on the *View\_Session.dat*  button of the menu bar displays this file, allowing the user to look for the numerical values of all input parameters of the simulation as well as several key output parameters.

13. Using the remaining buttons on the menu bar (*View\_GEOP* , *Trace\_rays* , *Use\_DIFFRACT\_dimensions* , *Scale\_Up* , *Scale\_Down* ) , you can manipulate **Geometric-optical Systems** (GEOP), display them either in 3D or in 2D cross-section, specify a number of rays that would go through the system, then trace these rays and observe the landing sites of the rays on various surfaces, etc. An example of a simple Geometric-optical\_System is given in Test\_run3 (located in the working directory C:\DiffDemo\Diffract\Work03).

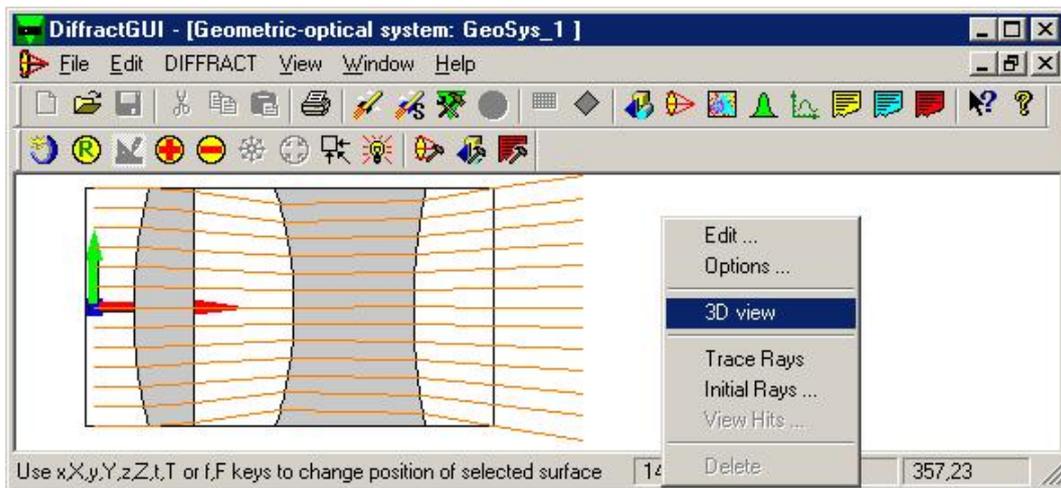
Open the COMMAND.DAT file in folder <Work03> and observe a Geometric-optical\_System (GEOP object) on the **Workbench**. Click the left-mouse-button on the GEOP object, then click on **View GEOP** button  to open **GeoSysView**. Inside this view, drag the Geometric-optical\_System to the center of the window, then click on **Use DIFFRACT dimensions** button  on the EditBar to display the four glass surfaces of this GEOP system in their proper (relative) positions and dimensions (as specified in the GEOP object's command block).

The **ScaleUp**  and **ScaleDown**  buttons may be used to inflate/deflate the system in this GeoSysView. You may also use the ← ↑ → ↓ arrow keys (with or without holding down the Ctrl key) to reposition/reorient the system. Click on individual surfaces within the **GeoSysView**, then use the same buttons/keys as above to modify the scale, position, or orientation of each surface independently of all the others. You may do the same with the GEOP's coordinate system (by clicking the left-mouse-button on any of the large red, blue, or green axes), or with GEOP's Destination plane (the green plane seen in **GeoSysView** on the right-hand side). When necessary, use the **Reposition** button  of the EditBar to realign the system.



Double-click on any GEOP surface, and the **Edit DIFFRACT Parameters** dialog box corresponding to that surface will open, where the parameter values may be changed, if necessary. Double-clicking on the box itself (or outside the box) will open the **ChooseObject to Edit** dialog box for the entire GEOP. Again you may

choose any surface from the menu, and proceed to modify its parameter values as desired. While in **GeoSysView**, click the right-mouse-button anywhere in the window for the **pop-up menu** to appear, then choose **2D View** to observe a cross-sectional diagram of the GEOP system in the YZ-plane. Use the pop-up menu again, but this time click on **3D View** to revert to a 3D view of the system.



The pop-up menu (opened with a right-mouse click) offers several options, among them **Initial Rays**. Click on this option, and a dialog box will appear. Choose some arbitrary values for  $dx$ ,  $dy$ ,  $dz$ ,  $d\theta$ ,  $d\phi$  (say, 0.2, 0.2, 0, 0, 0), then click the **Add** button a few times to generate several initial rays for tracing through the system. Click the right-mouse button again, and this time choose the **Trace Rays** option. The traced rays will be displayed. (The same task may be accomplished with the **Trace Rays** button  of the EditBar.) You may now select any of the GEOP surfaces, bring up the pop-up menu (with a right-mouse click), and **View Hits** on that surface.

Note that the *Limited Edition of DIFFRACT* does not allow the **RAYS** option that normally produces a set of rays from an incident beam on a **Geometric-optical System**. As such, the *Limited Edition* does not allow tracing of wavefronts through a GEOP. The user may thus create an *isolated GEOP* within DiffRACTGUI, observe it in full 3D view or in cross-section (2D view), and analyze a few selected rays traced through it. Such a GEOP, however, cannot become an object in a complete simulation that requires wavefront-tracing through the GEOP, a feature reserved for DIFFRACT's *General and Student Editions*.