BLViewer

User's Guide

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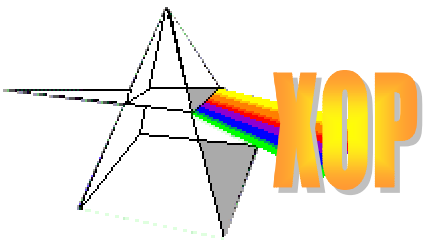


Preface

BLViewer is a software tool to create interactive 3D representations of optical systems. An optical system is composed by a source and one or several optical elements arranged sequentially. BlViewer has been design for displaying optical systems ray-traced by SHADOW (www.nanotech.wisc.edu/shadow/shadow.html) It is distributed as an application of the ShadowVui interface to SHADOW, available in the XOP package (www.esrf.fr/computing/scientific/xop)

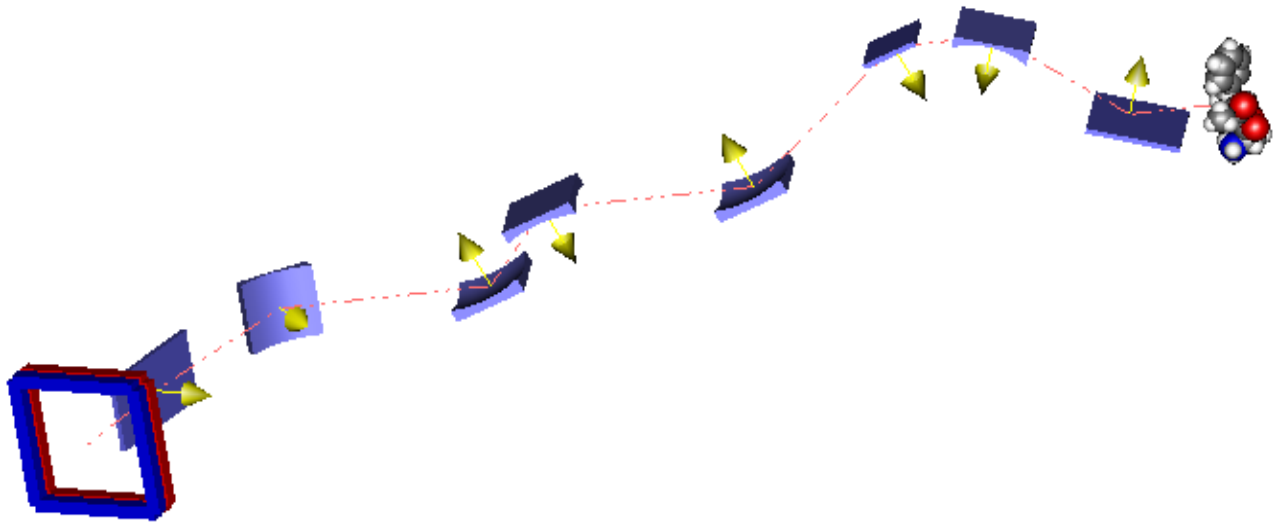


Fig 1- Example of an an optical system as represented by BLViewer. The rings represent the source, several optical elements (mirrors and crystals) are displayed with their respective surface normal. A molecule symbolized the sample.

Glossary

- **Optical system:** A set of elements and planes. It contains a *source* (mandatory) and a number of *optical modules* (optional) concatenated one after the other.
- **Source:** The space region from where light is emitted. By default, the source is placed on the left of the view. BLViewer shows a coordinate reference frame in the place of the source, from where photons (i.e., rays) are emitted.
- **Optical module (o.m.):** A region of space containing one *optical element* and a minimum of two *optical planes*, one before the optical element. (source plane) and another after the after the optical element (image plane). It can optionally contain more planes.
- **Optical element (o.e.):** an element that reflects, refracts or diffracts the beam. Usually mirrors, lenses, multilayers, crystals, etc. The nature of the optical element is not important for BLViewer, as it will be represented like a kind of box. The optical surface is flat, even in the case where it has been defined curved in SHADOW. Usually the curvature radii are be so large that they would appear as plane. A customized 3D object can be optionally loaded (in this case, the optical surface can be anything)
- **Optical Axis:** The straight line joining the center of optical planes and o.e's in the order that they are intersected by the beam.
- **Optical plane (o.p.)**: a plane positioned perpendicular to the optical axis. Optical planes are used to define the boundaries of the o.m. and to see beam cross sections.
- **Normal:** the normal to the o.e. surface at its center

Functional description of BLViewer controns

Starting BlViewer

BlViewer is started from the SHADOWVUI main window (see Fig. 2), using the "BLViewer" button or the "Results" item in the menu bar.

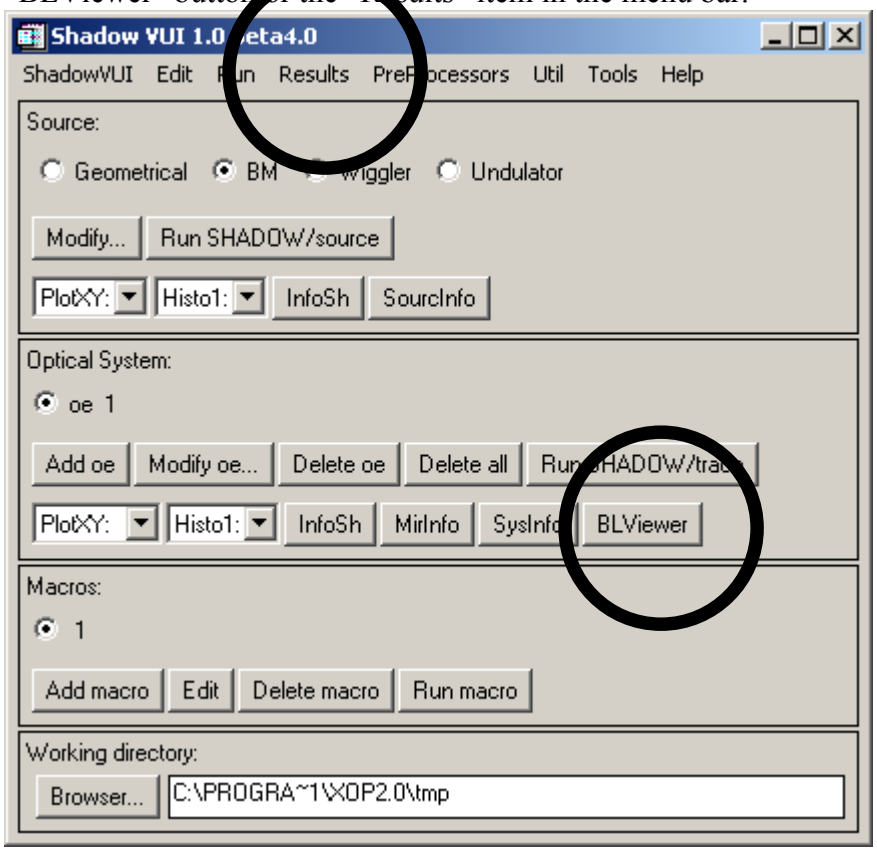


Fig 2 The SHADOWVUI main window. Circles are shown from the places where it is possible to launch BLViewer.

If BlViewer is started by clicking the button, the optical system in the working directory is loaded. In this case, the optical system parameters are read from the SHADOW files `systemfile.dat` and `end.xx`. If BLViewer is started from the menu bar, no system is loaded.

The main window

The BLViewer window (Fig 3) contains a menu bar, several buttons, a large graphical area where the 3D representation is displayed, and an information field.

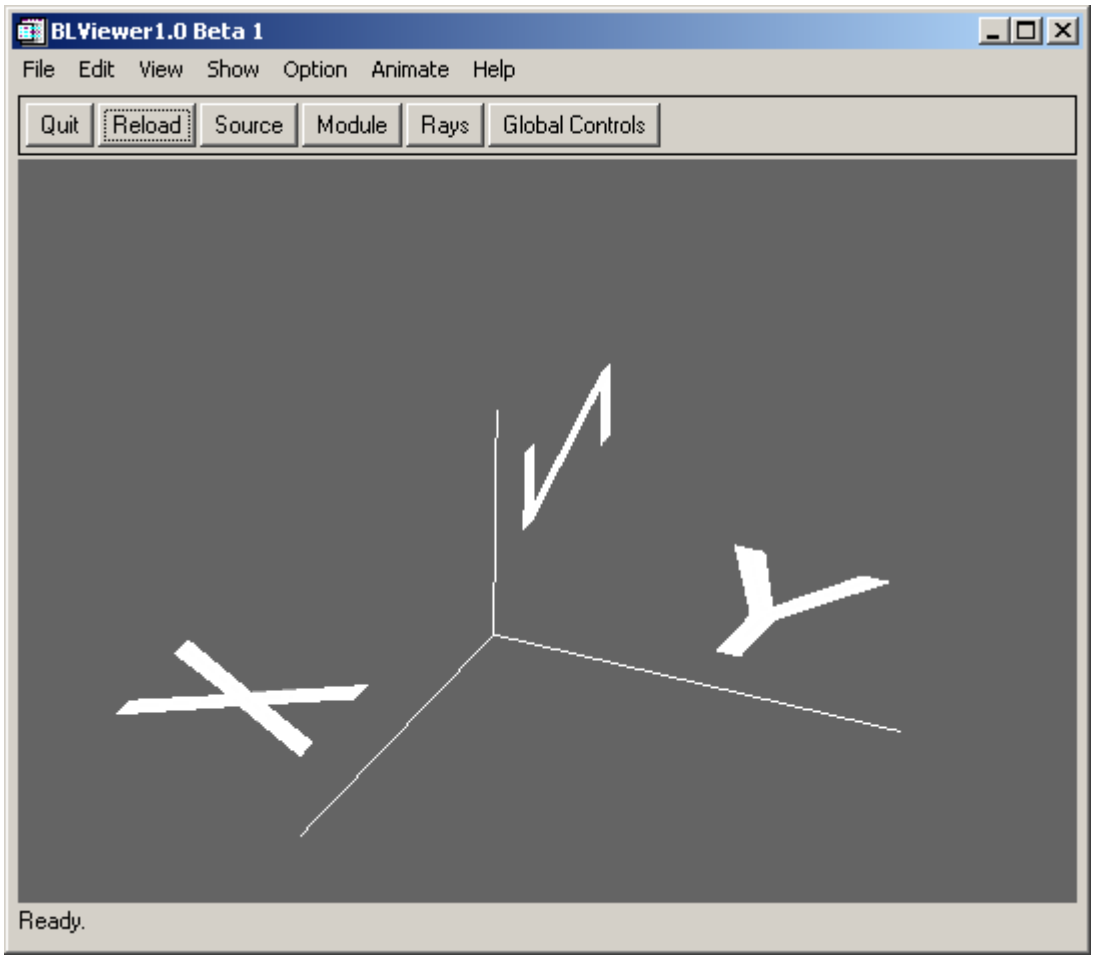


Fig 3 The main BLViewer window.

Menu bar

File >	**Open >**	**System File (*.dat) >**	**With End.xx**	Opens an Optical System using "end.xx" files.
			With Start.xx	Using "start.xx" files.
		BlViewer File (*.blv)	Opens an Optical System saving in BlViewer format.	
	Save As…	Saves the current Optical System in BlViewer format.		
	Realod	Reloads the files with the definition of the representation and refreshes the display.		
	Print…	Creates a hardcopy of the representation.		
	Grab Picture…	Creates a new window with a bitmap of the representation, for being saved to a disk file.		
	Quit	Closes BlViewer.		
Edit >	**Delete optical module**	Deletes the currently selected optical module.		
Add >	**Optical Module…**	Adds an Optical Module and pops up the parameters window.		
View >	**Perspective**	Show 3D representation from a predefine view.		
	Top View (X/Y)	Shows 3D representation from top.		
	Side View (Y/Z)	Shows 3D representation from a side.		
	Front View (X/Z)	Shows 3D representation from the front.		
	Perspective…	Rotates the predefine view with users customized angles.		
	Linear	Inter-mirror distances in linear scale.		
	Logarithmic	Inter-mirror distances in are represented as the logarithmic of the real ones.		
	Frame	Optical elements and objects are transparent (only a frame is shown).		
	Opaque	Optical elements and objects are opaque.		
Show >	**Optical Elements**	Show/Hide optical all elements.		
	Optical Axis	Show/Hide all optical axes.		
	O.E. Normal	Show/Hide Normal on all o.e.		
	O.E Axes	Show/Hide axes on all modules.		
Animate >	**Rotation (start/stop)**	Rotate the 3D representation. Use the same option to stop animation.		
	Rays (start/stop)	Trace rays slowly. Rays must be loaded. Use the same option to stop animation.		
Option >	**Background Colors…**	Change background color.		
Help >	**Help…**	Display help on BLViewer		
	About…	Display information on BLViewer.		

Note that some options are accessible from several places in interface.

buttons

Quit	Close the application.
Reload	Reloads the files with the definition of the representation and refreshes the display.
Source	Open a dialogue box with source controls.
Module	Open a dialogue box with optical module controls.
Rays	Open a dialogue box to load and trace rays.
Global Controls	Open a dialogue box to control parameters that affect globally all modules

Graphical area

Interactive actions on the representation can be applied by using the mouse. Left-click and drag to rotate the representation. Right-click and drag it to translate the view.

Information's text

It gives some information about the status of BLViewer.

Dialog boxes to control the 3D representation

Source control

The source is the first piece of the representation. It always exists. It is composed by the three axes of the reference frame and its labels. A user customized object can be optionally loaded from a mesh in a `*.wrl` file (VRML format version 2.0). It can be resized and replicated in three directions. The control's description is in Fig. 4.

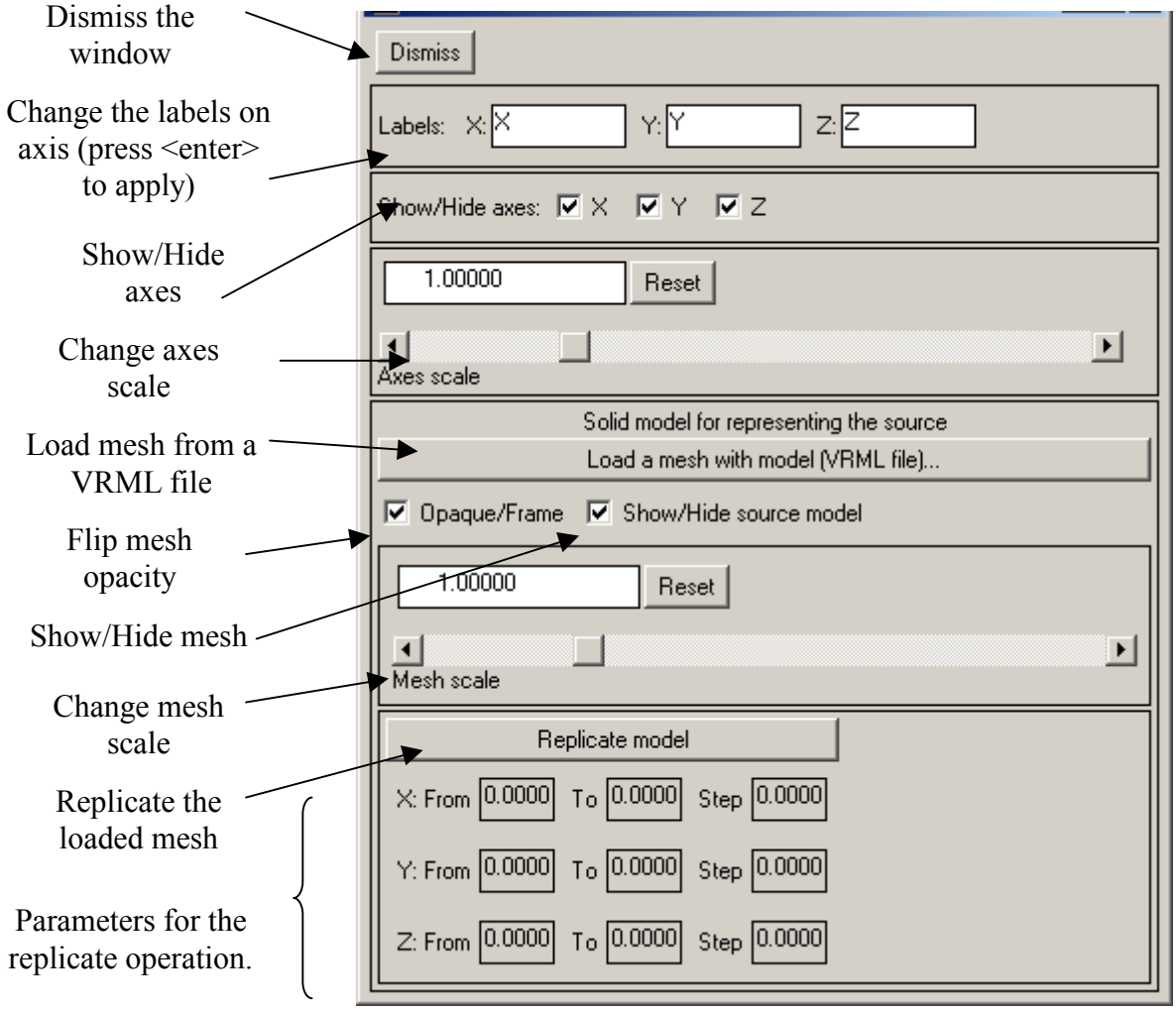


Fig 4 The *Source* control window.

Warning: it can be very long to load and display a complex mesh. Thus, use repeat operation with moderation.

Module control

This window present controls to modify the optical module attributes. The components of a module are represented in Fig. 5

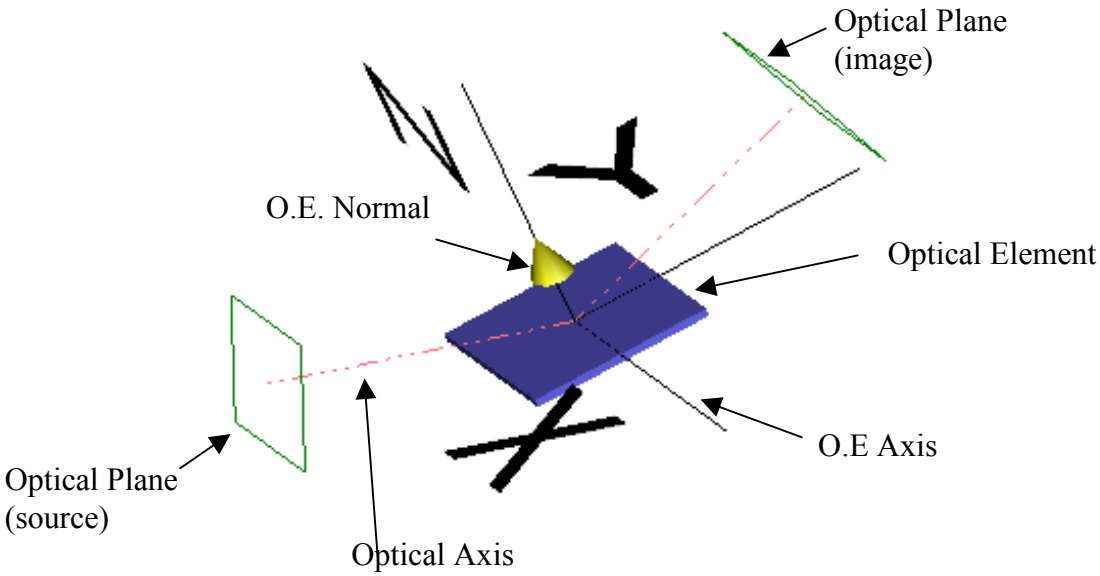


Fig. 5: Graphical representation of the components of the optical module.

The position and orientation of a module (Fig. 6) is defined with two distances and two angles. The source plane of a generic module *n* is placed at the same position than the image plane of the module *n-1*. For the first module, the source plane is coincident with the plane *XZ* of the source. BLViewer displays all planes of the modules, in spite of this redundancy. It is then possible to switch on and off any module independently of the others.

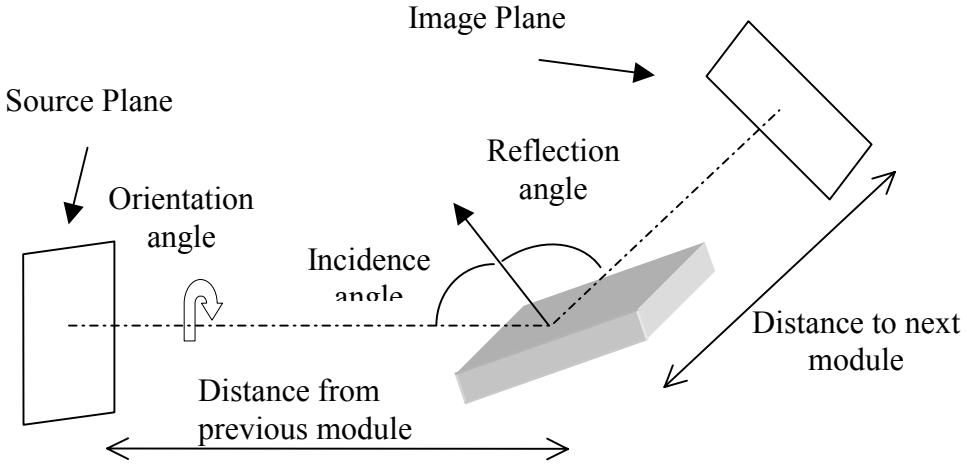


Fig. 6: Schematic description of the position and orientation parameters of the optical module.

The description of the module control window is in Fig. 7

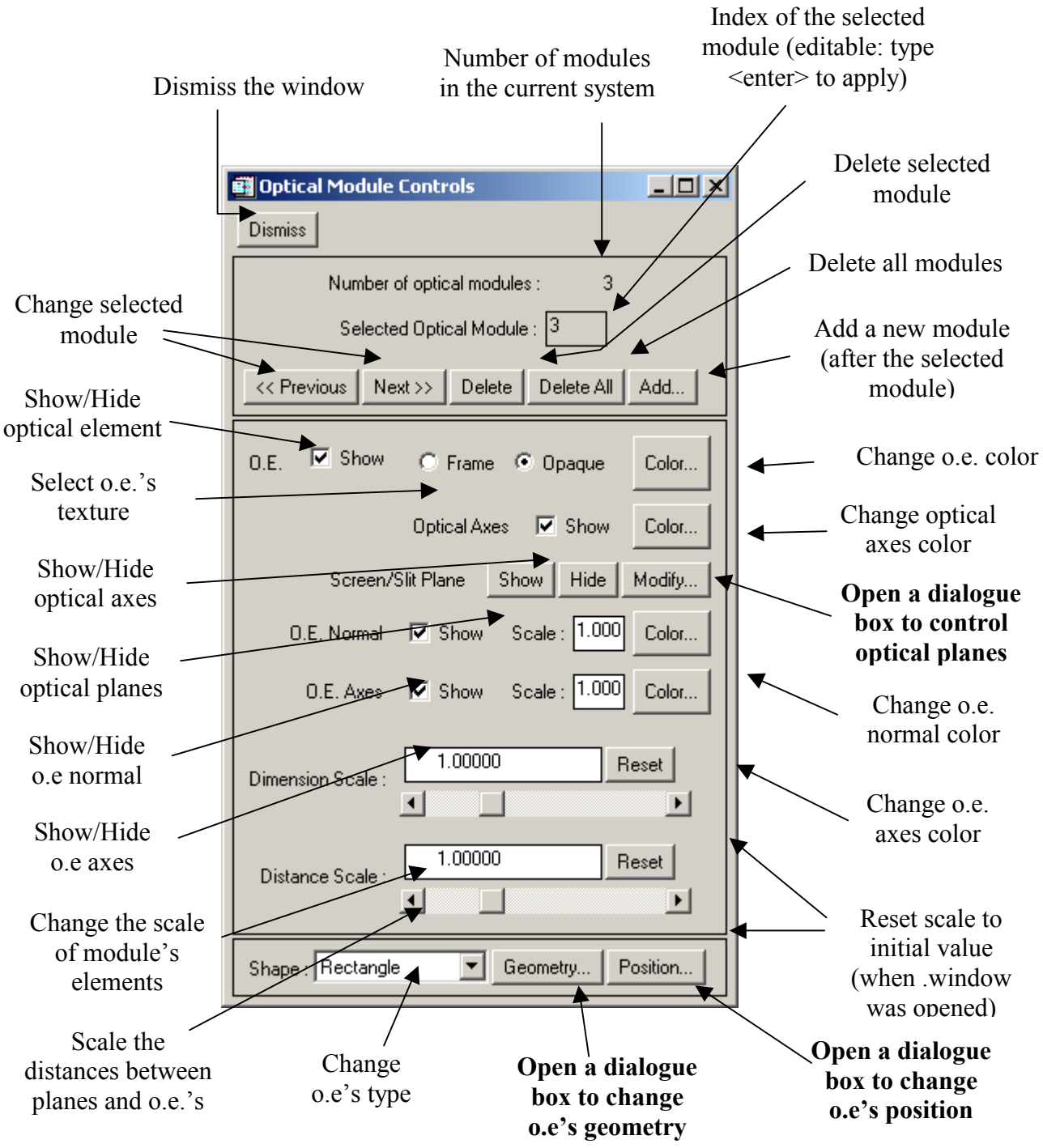
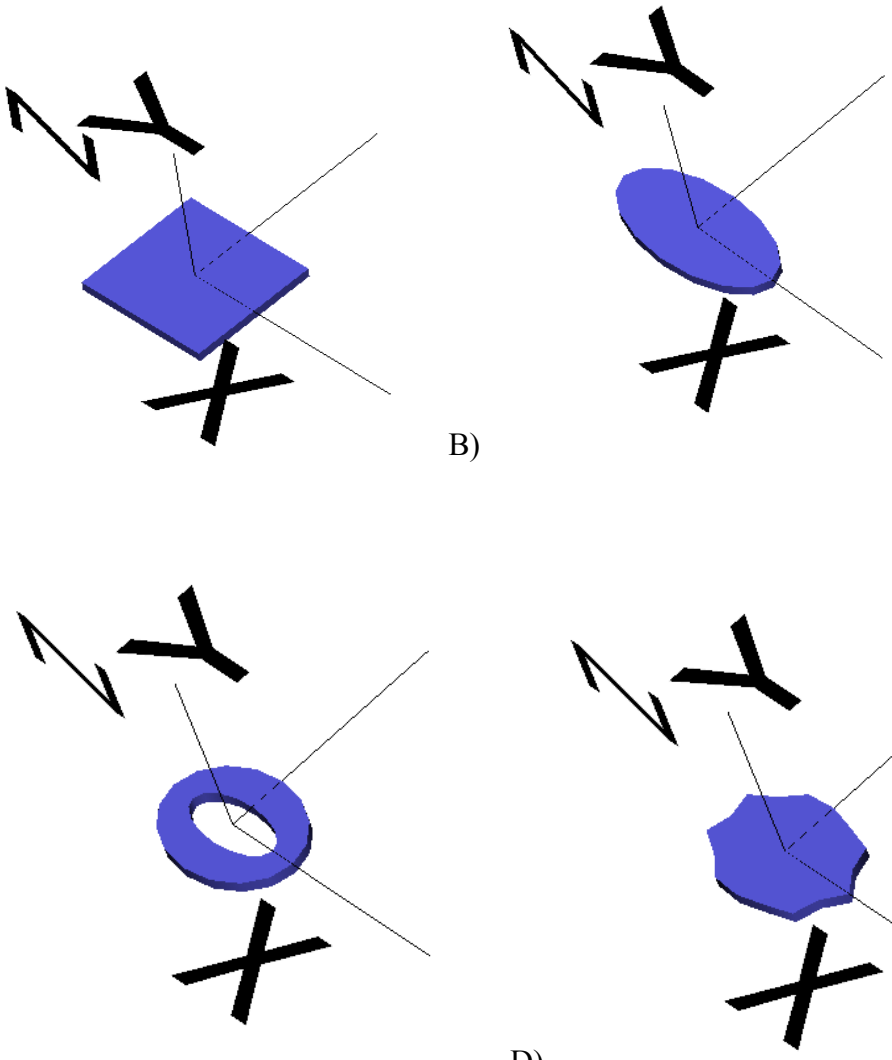


Fig. 7. Description of the controls for the optical module.

BLViewer has four types (see Fig. 8) of built-in o.e's: Rectangular, Ellipse, Ellipse with a hole, and Infinite surface (displayed using an irregular shape). In addition, it is possible to importe an external mesh file in the VRML (version 2.0) format using the option "External (VRML)". An example is shown in Fig. 9.



A) B)

C) D)

Fig 8. BLViewer pre-built o.e.'s: A) Rectangle, B) Ellipse, C) Ellipse with a hole, and D) Infinite surface.

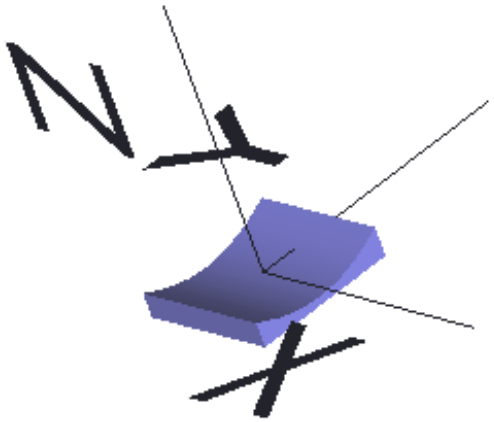


Fig 9: Example of a customized concave mirror from a VRML file (`concaveY.wrl`), Two other files, `concaveX.wrl` and `concave.XY.wrl` contain other curved o.e's, bent in the sagittal direction and in both directions, respectively.

By clicking the 'Geometry…' button of the module control window one obtains the dialog box to modify the dimensions of the o.e's. The "Position…" button opens a dialog box to change the positioning of the o.e. and image plane. If you are using a customized VRML object, you can also also use these parameters.

Global control window

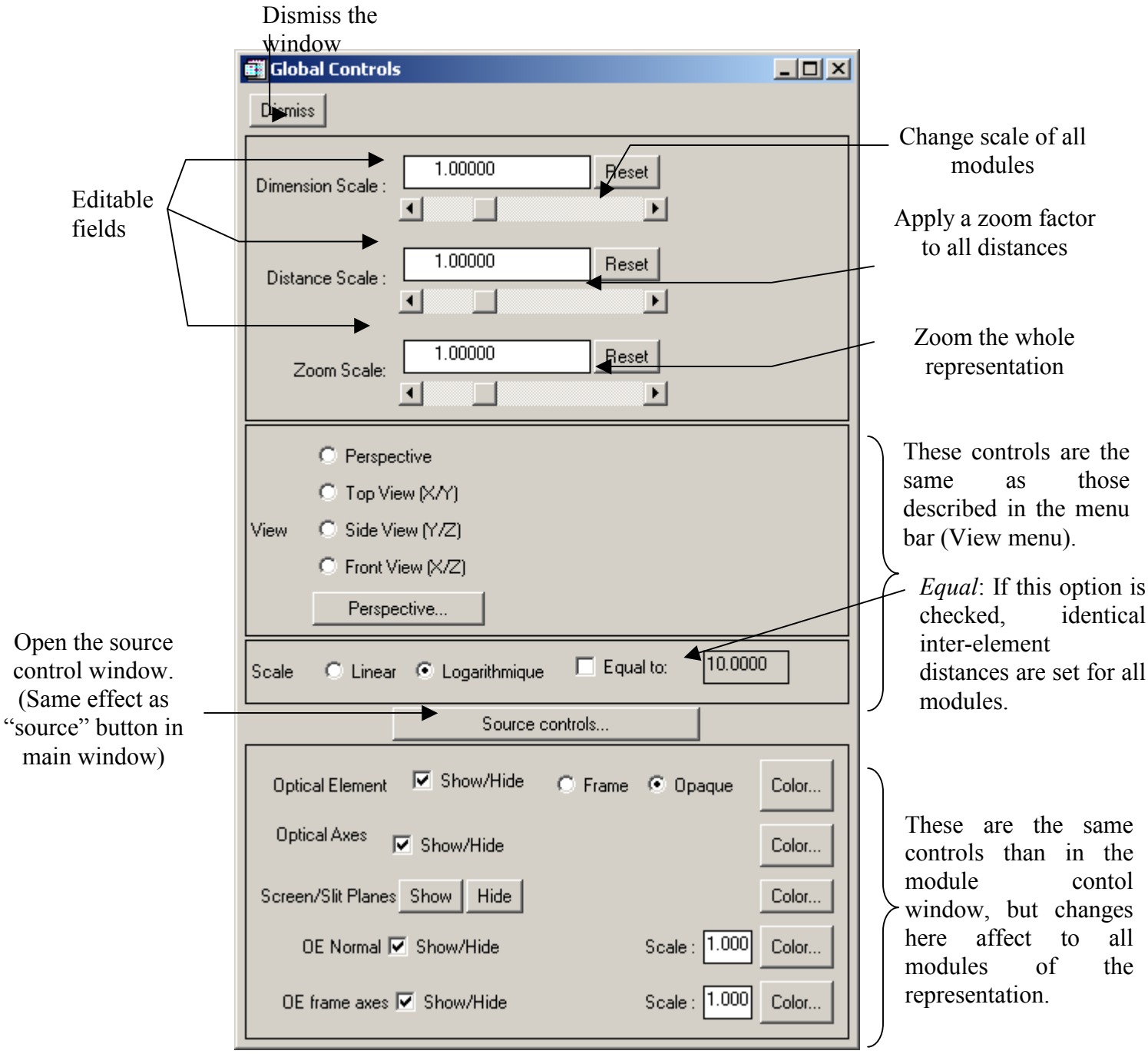


Fig 10. Global control window.

Planes control window

An optical plane is a flat surface placed perpendicular to the optical axis. It intersects the beam and allows to visualize the beam cross sections.
A typical shadow run uses few thousand rays. It is difficult to get visual information from all of them in a 3D representation. To make the visualization clearer it has been implemented the possibility to paste a bitmap image on an optical plane (see Fig. 11). In addition to the two planes that always exist in a module (source and image) it is possible to add any number of additional planes. In the case that planes are defined in SHADOW (called *screens*) they are loaded in BLViewer. In the optical module, it exists an invisible flat surface in the plane *XY* where it is also possible to paste a bitmap image.

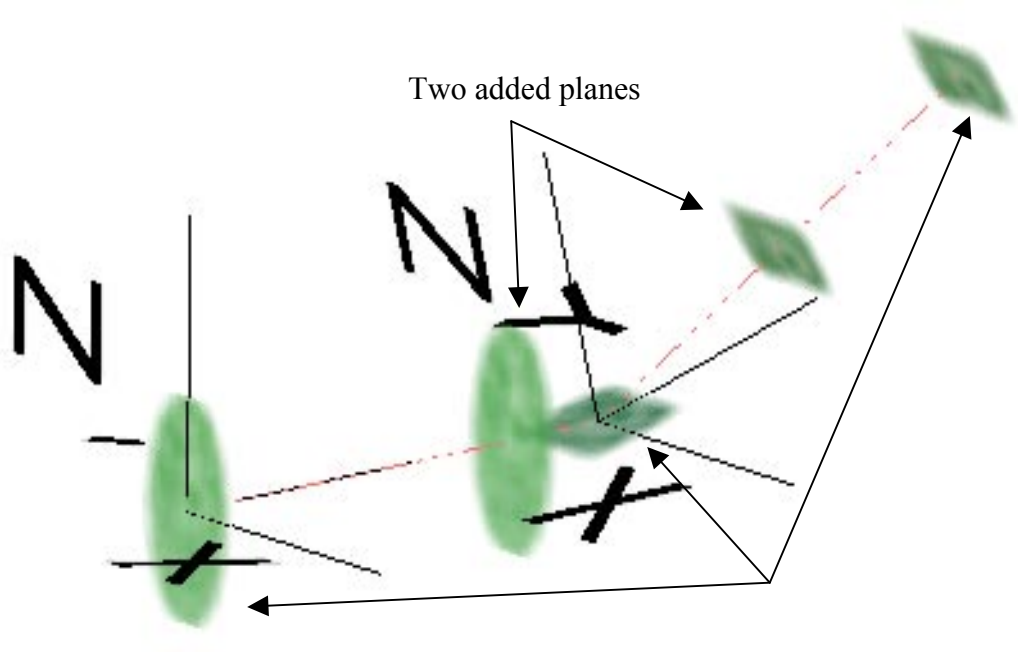


Fig 11: An example of an optical system where the beam cross sections are represented with bitmap images created by BLViewer from SHADOW's files. One can see how a large beam intercepts partially a mirror, and how is reflected. The optical element is not visible. Instead, a bitmap image is pasted on its surface plane.

To define the optical plane parameters, click on the "modify…" button of the module window. A new window appears, as shown in Fig. 12.

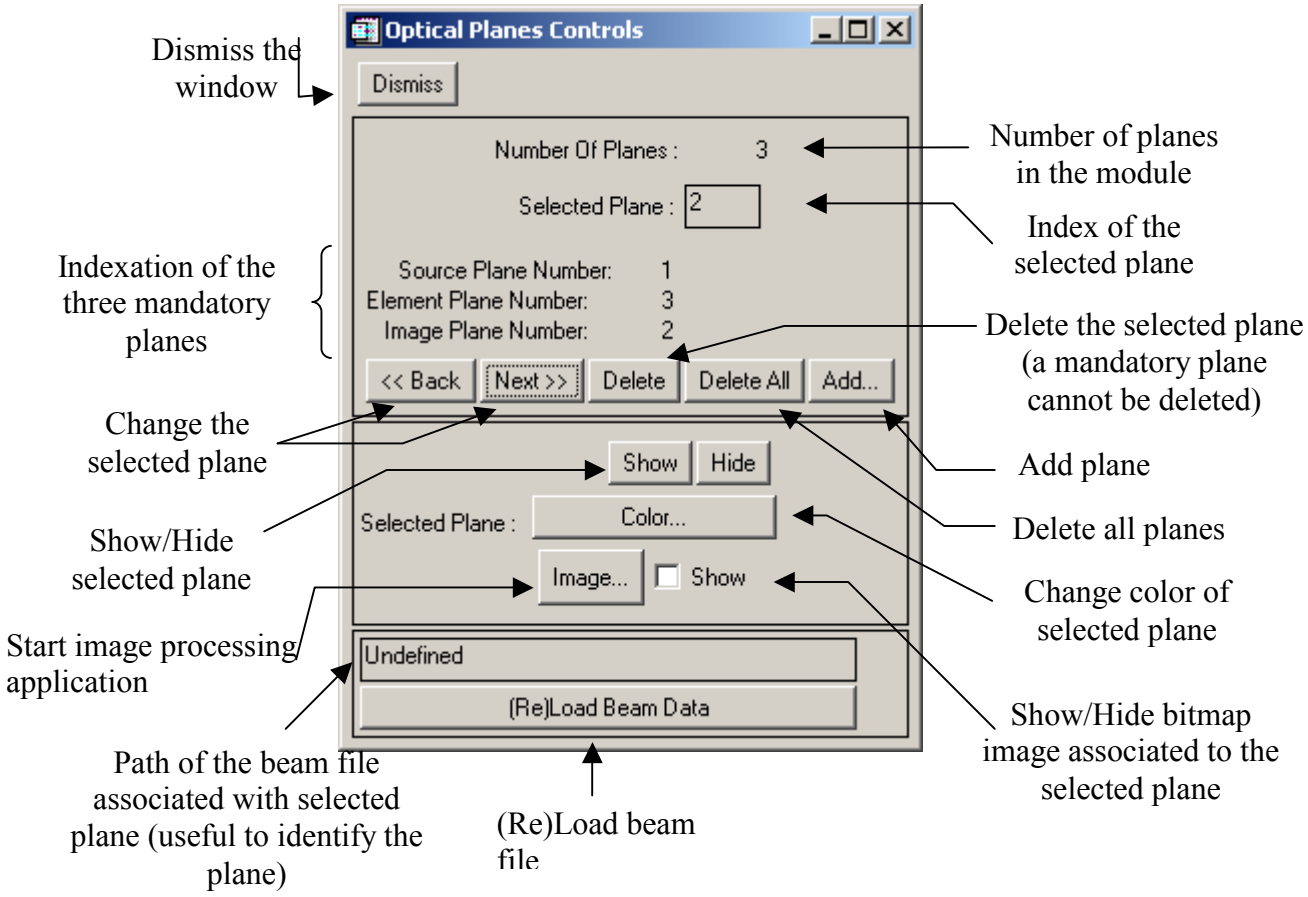
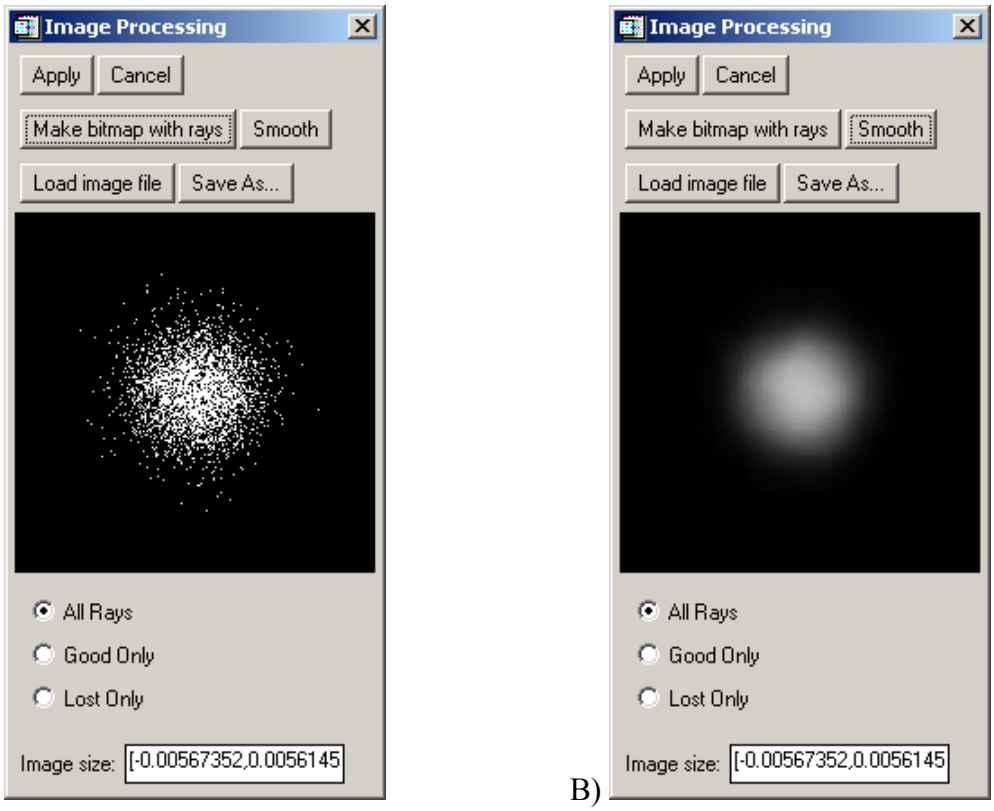


Fig 12: Control window for optical planes.



A) B)

Fig 13. The bLViewer image processing tool with a bitmap crated using SHADOW's rays (A) and the same informations after smoothing (B).

Click on “Image…” button to start an image processing (Fig. 13) application that allows to load and create a bitmap image.

There are two ways to get a picture:

1. Load it from a disk file using the load button.
2. Create it using the information of the rays calculated by SHADOW on top of the selected plane. By using the button “Make bitmap with rays” a bitmap with the image of the rays is produced. For that, as in SHADOW, all rays, good rays, or only lost rays can be used. Of course, rays have to be loaded previously (see Rays controls) in order to create such image. The dimension of the image is found at the bottom of the window. It is possible to edit it (and type <enter>) to recreate the image with customized size.

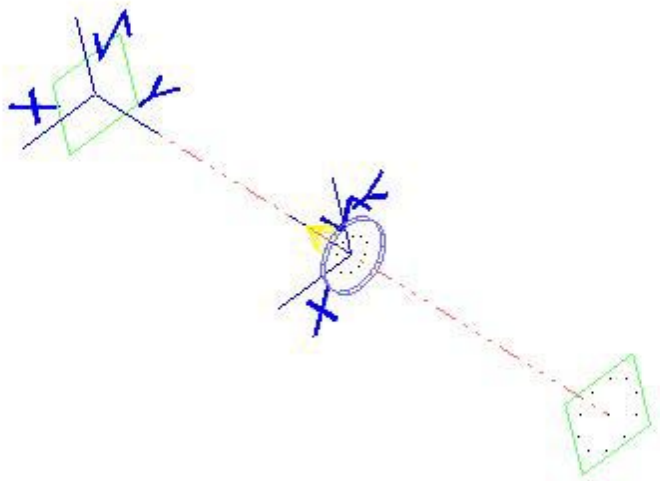
Once a bitmap image is loaded or created, it is possible to smooth it (using the “Smooth” button) to make a better representation of the beam density.
The result can always be saved to a disk file. However, it is not necessary to create the file in order to use the image. Just click on “Apply” button and the image will be exported to the optical system representation.

Rays Control window

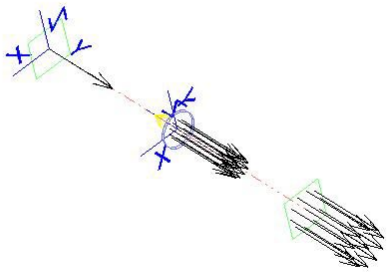
BLViewer does not calculate the ray trajectories of your optical system. It gets them from SHADOW’s files.
SHADOW calculates the intercepts of the rays with the optical planes and puts these coordinates in different files. BLViewer reads these files and displays this information using three kind of graphical items (see Fig 14):

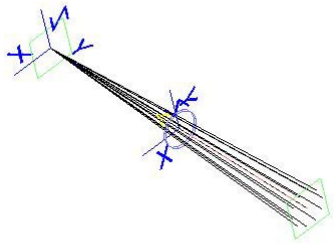
- Points: the interception points between the beam and optical planes and o.e’s surfaces are displayed.
- Vectors. There is a vector starting at the position of each ray. The direction of the vector coincides with the direction of the ray.
- Lines: Straight lines are used to join intercept points between planes and o.e’s.

There are two types of rays in SHADOW: good rays and lost rays. Rays are lost when they intercept the o.e. surface outside its physical dimensions. Lost rays hurt the o.e’s plane without hurt the o.e’s surface. The rays control window is popped-up when the “Rays” button in the main plane is pressed. This panel is described in Fig. 15



A)





B) C)

Fig 14. The three types of ray representations: points (A), vectors (B) and lines (C).

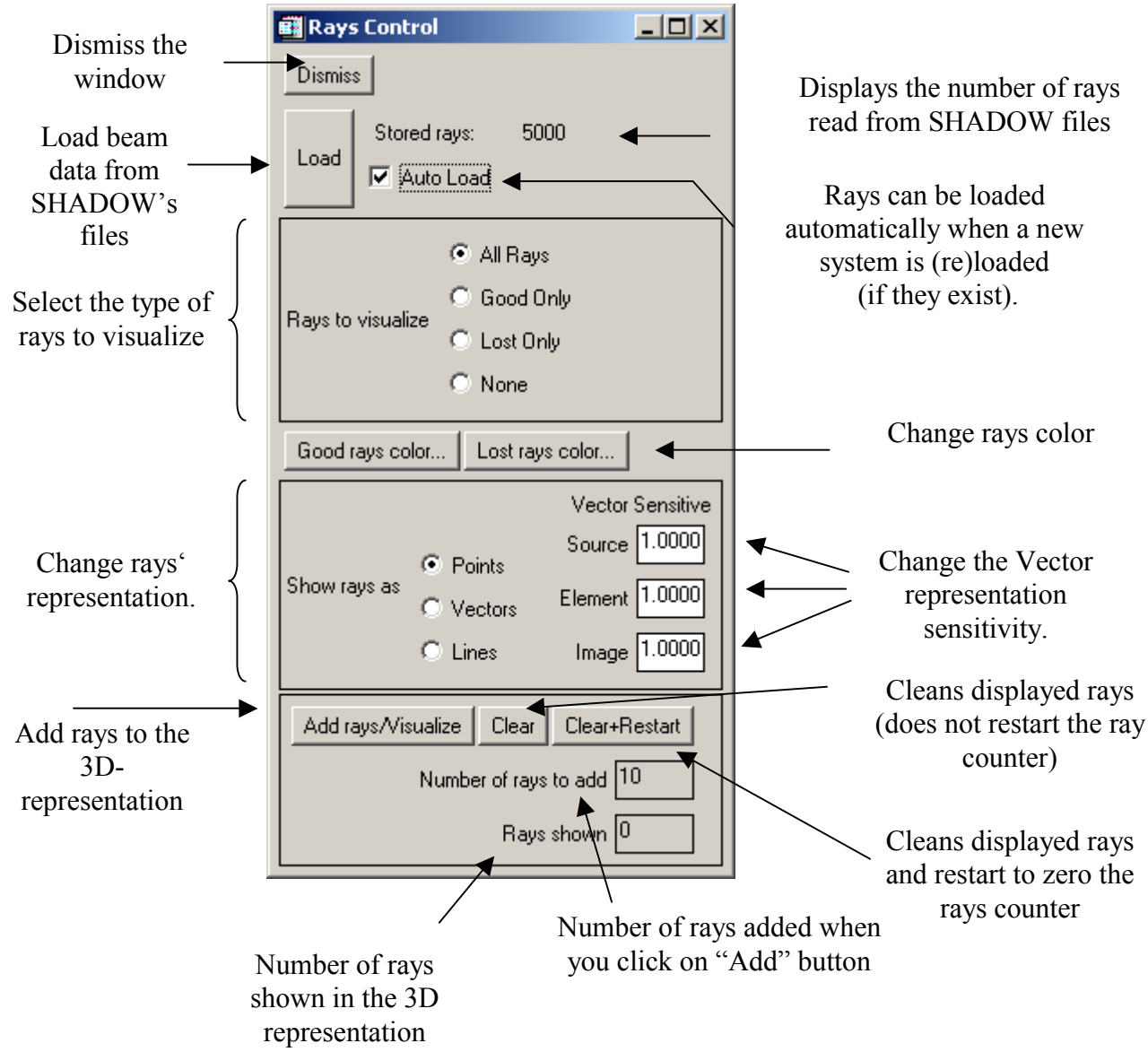


Fig 15. The rays control panel

Warnings:

- Ray trajectories may be discontinuous if you apply different zoom or scaling to different modules
- Ray trajectories may look wrong if logaritmic transformation is applied to distances
- In the case of very grazing incidence mirror, the rays may look to travel back and forth. Improve the display by retracing the system with a less grazing angle.
- When you click on Add, a fixed number of rays from the loaded SHADOW files are added, independently if they are good or lost. It may happens that not all "added" rays are displayed in the case that "Good only" or "Lost only" is selected. Click on "All Rays" to view all of them.

Examples

Example 1

Open the SHADOW workspace `ex11a.ws`. Answer "No" to the asked questions. Then

- run the source by pressing "Run SHADOW/source' in the main SHADOWVUI window
- run the pre-coded macro by pressing the "Run macro button" in the main SHADOWVUI window. (This macro redefines the flag for some rays in the source).
- Press "Run SHADOW/Trace"
- Click on the 'BLViewer' button. You get the window in Fig 16. Experience rotations and translation by left and right-clicking (respectively) and dragging.
- Click on "Rays" button in th BLViewer window. A new window pops-up
- Click on "Load" button to read SHADOW's result files. Then click on "Add" button several times to display rays as points. You get the the representation in Fig. 17, where the good rays are displayed in red and the lost rays in yellow. You can switch now to "line" representation.
- Press the "Quit" button to close the BLViewer window.

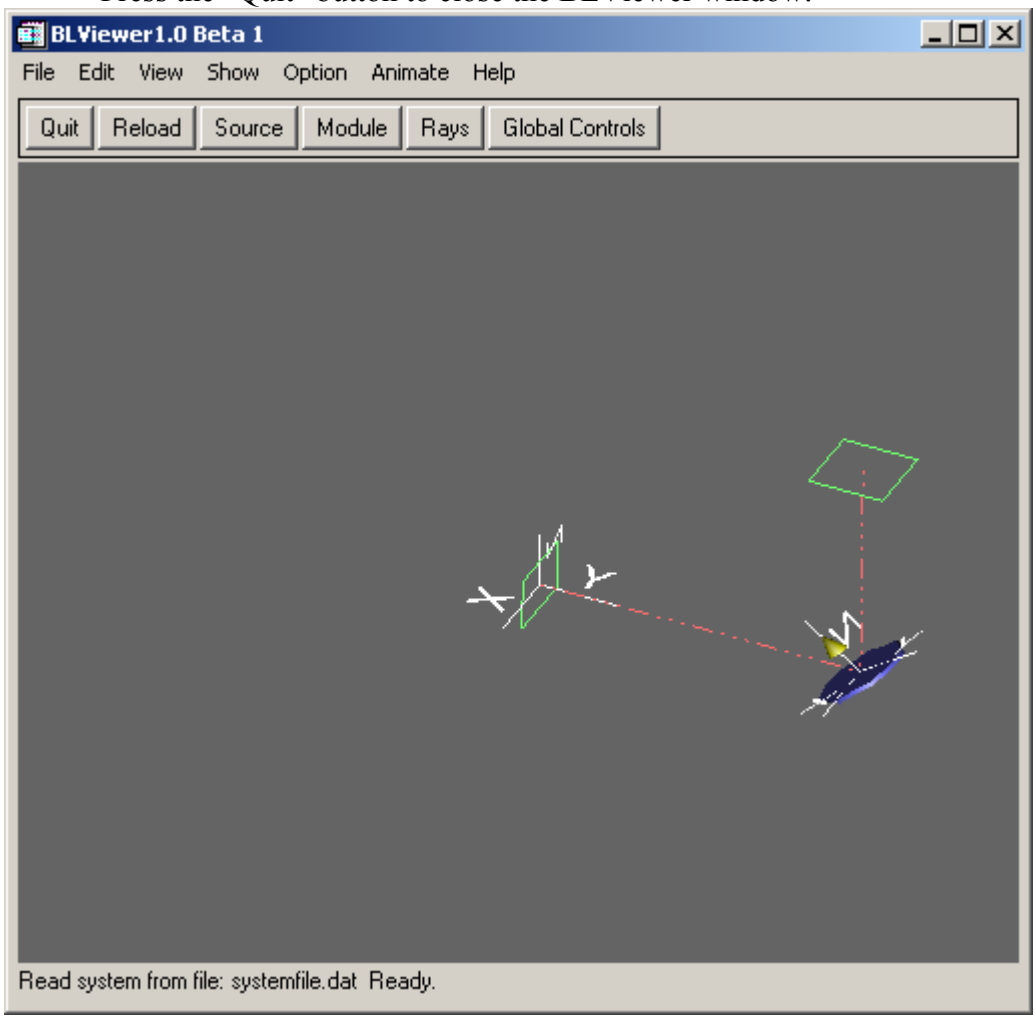


Fig 16: Default representation for the SHADOW's system from workspace ex11a.ws

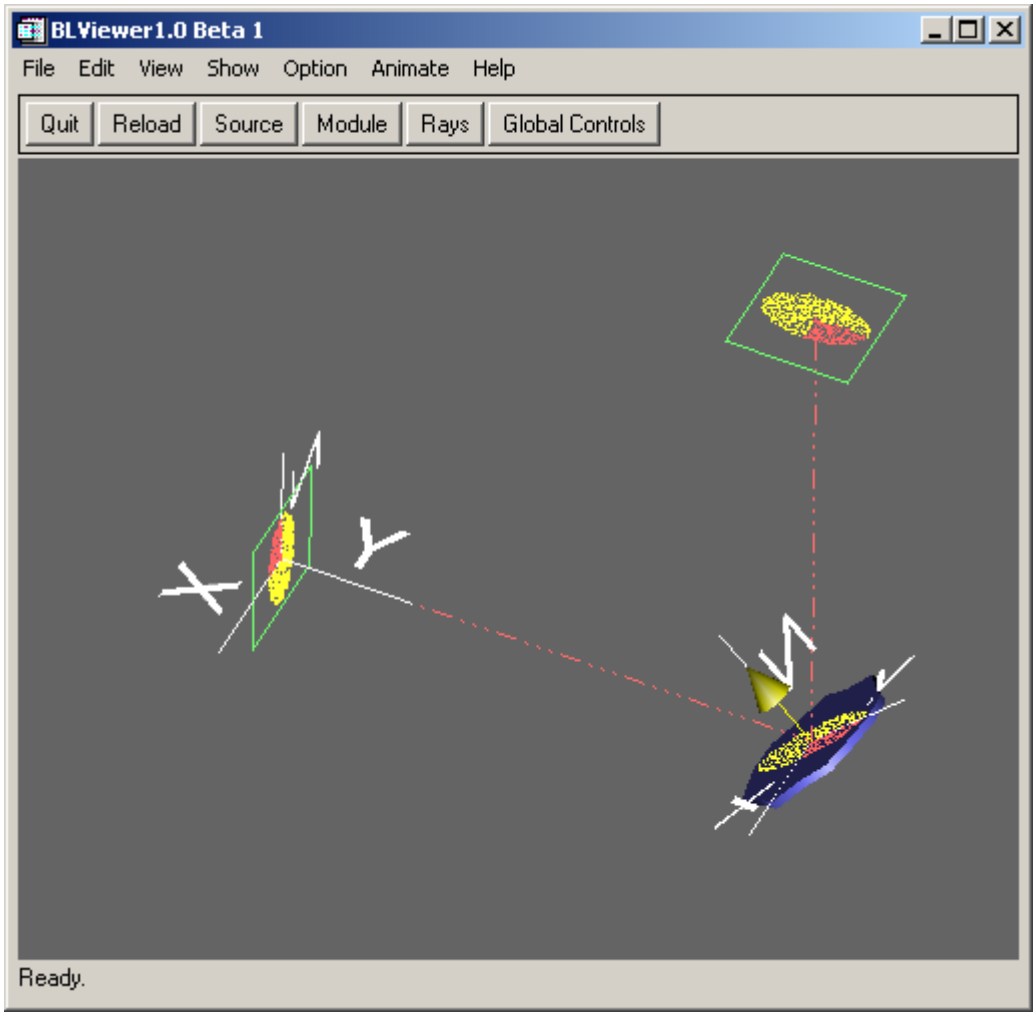


Fig 17. Optical system with rays represented as points. Red points represent good rays and yellow points are for bad rays.

Example 2

This example shows how it is possible to create customized views of optical instruments without using SHADOW. Of course, no rays can be represented.

- Start BLViewer from the "Results' item in the menu bar of ShadowVUI
- From the menu bar use "Edit" and "Add optical module" three times, to create three optical elements.
- Click on the 'source" button, hide all axes and labels, and load the VRML file `ring.wrl`. Replicate it in *Y* direction from 0 to 1 with step 0.1. Play with the zoom. The result wants to symbolize an undulator.
- Select "modules" panels, and for the o.m. 1 and 2 load the VRML files `concaveXY.wrl` and `concaveX.wrl`, to represent curved mirrors. Hide labels, axes and planes.
- Let is define a sample symbol (a molecule). As it is not possible to load an external VRML file associated to an optical plane, we have defined a third module, with the intension of placing our sample in the o.e. position. Select the third module, set under the "Position…" window the distance equal to zero. In

the shape corresponding to this module, load the VRML file `molecule.wrl`. Play with the zoom.

- Set the background color to white (i.e., [255,255,255]) using Options->Backgroud colors…
- Using the "File->Grab picture" option, create a jpeg file with the view. The result is shown in Fig. 18

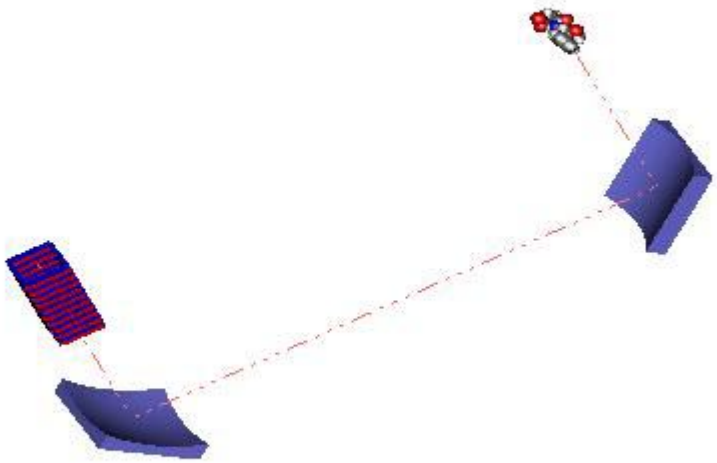
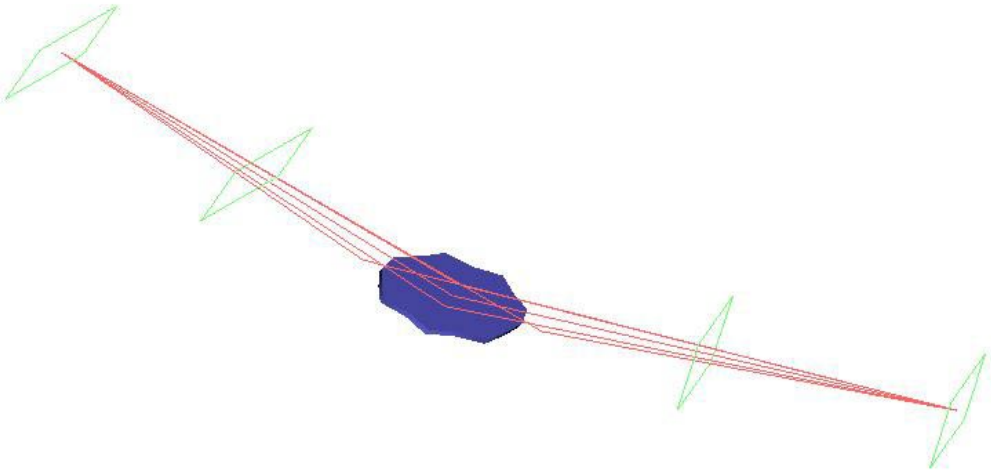


Fig 18. Result from example 2

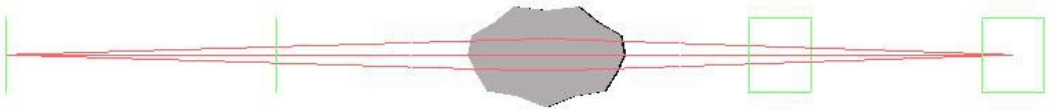
Example 3

Let us create some views of a focusing mirror using some rays. Load the SHADOWVUI workspace file `example3.ws` that contains a conic grid source with only few rays and a toroidal mirror. Run it. Open BLViewer using the "BLViewer" button in the SHADOWVUI window. Using the "Ray" window, load the only 8 existing rays and visualize them as lines. Remove labels and normals of the optical module and source. Play with the zoom, rotations, etc. Some views are in Fig. 19.

A)



B)



C)

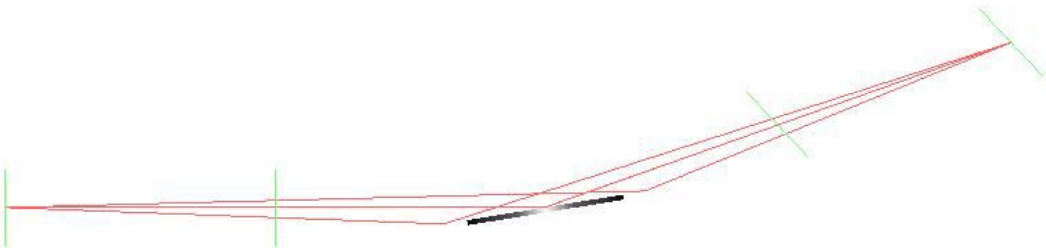


Fig 19: Focusing mirror: A) Perspective view, B) Top view , and C) Side view.

Example 4

Run the SHADOWVUI workspace `example4.ws` containing a system composed by a first collimating mirror and a second refocusing mirror. The beam cross sections are converted to bitmaps and then smoothed using the BLViewer image-processing tool under the optical plane controls. In order to compare the cross sections at different plane, the image dimensions are set to `[0.05,0.05]` in all planes. After removing labels, normals, etc. and playing with zoom and distances one can get a figure like in Fig. 20

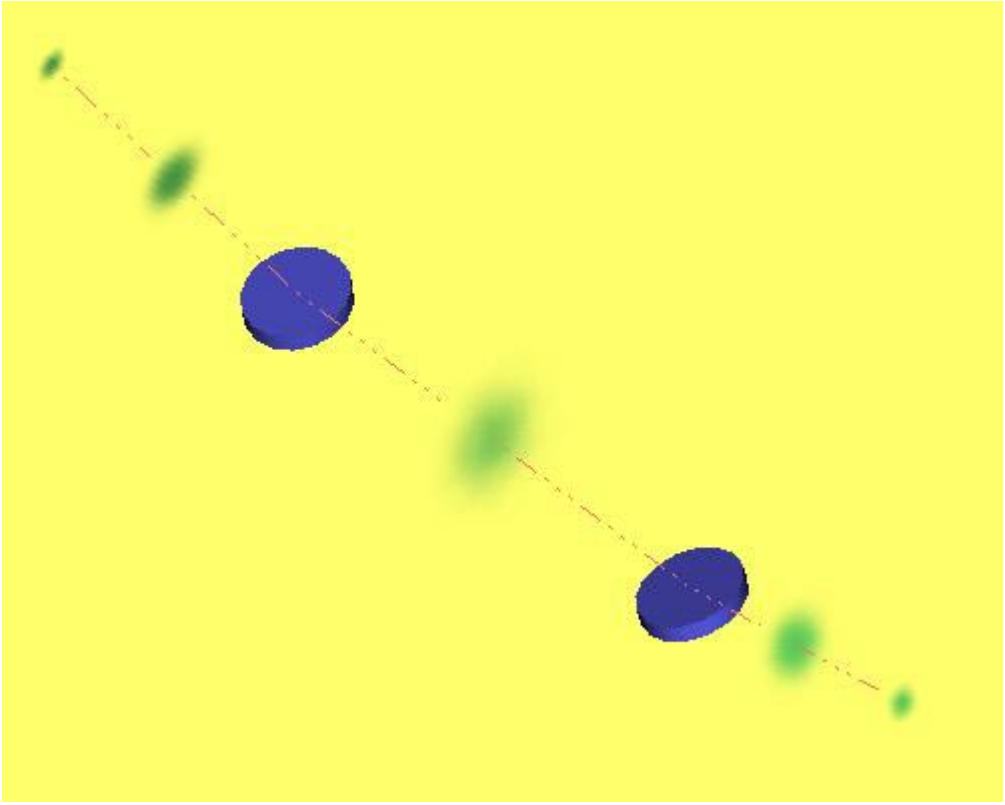


Fig 4. View of example 4, showing a first collimating mirror (on the left) and a second refocusing mirror. The beam cross sections are smoothed bitmaps calculated using data from SHADOW's files.

Suggestions and bug reports

Please send them to Manuel Sanchez del Rio <srio@esrf.fr>