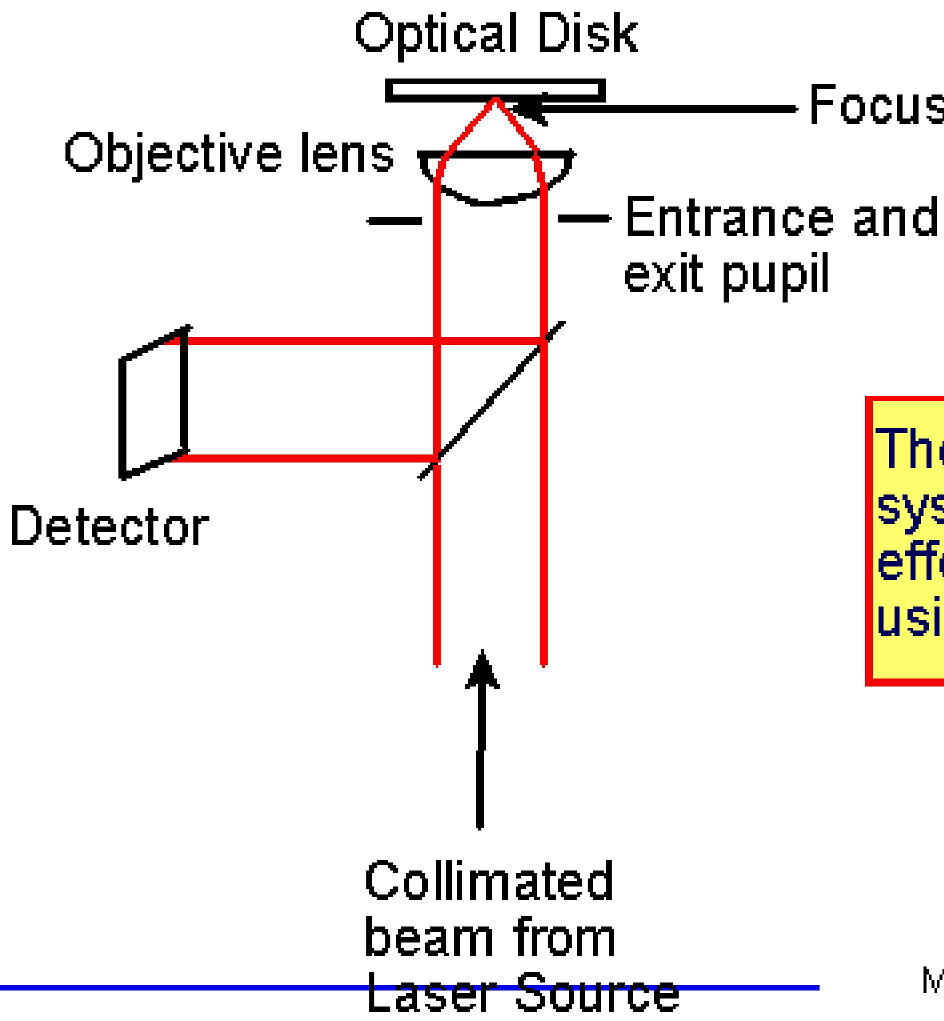
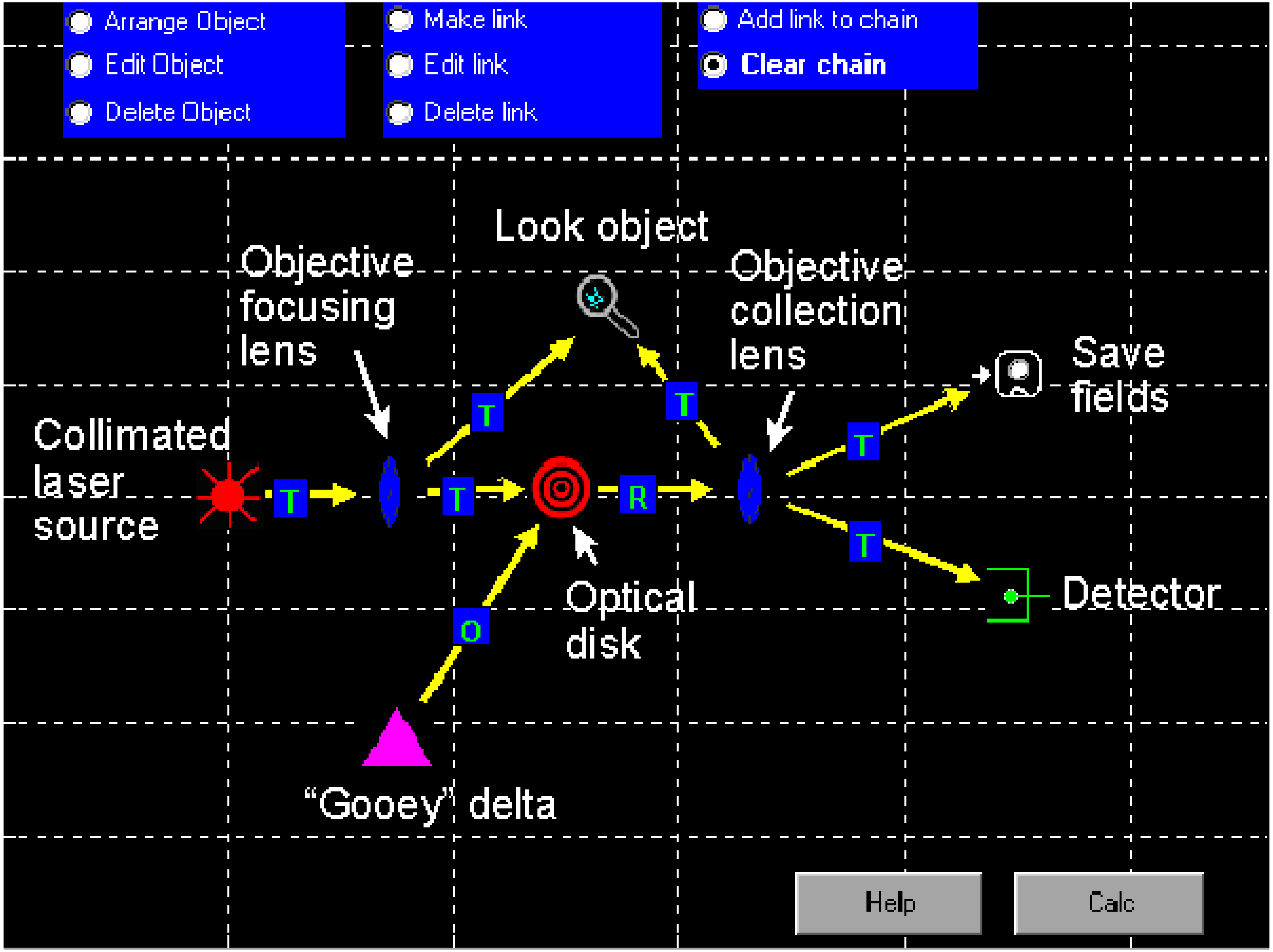
Modelling a scanning spot system for optical data storage using Optiscan



The scanning spot system shown can be effectively modelled using OPTISCAN

Optiscan project

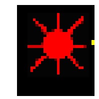


Modelling a Scanning spot system for Optical Data Storage using Optiscan

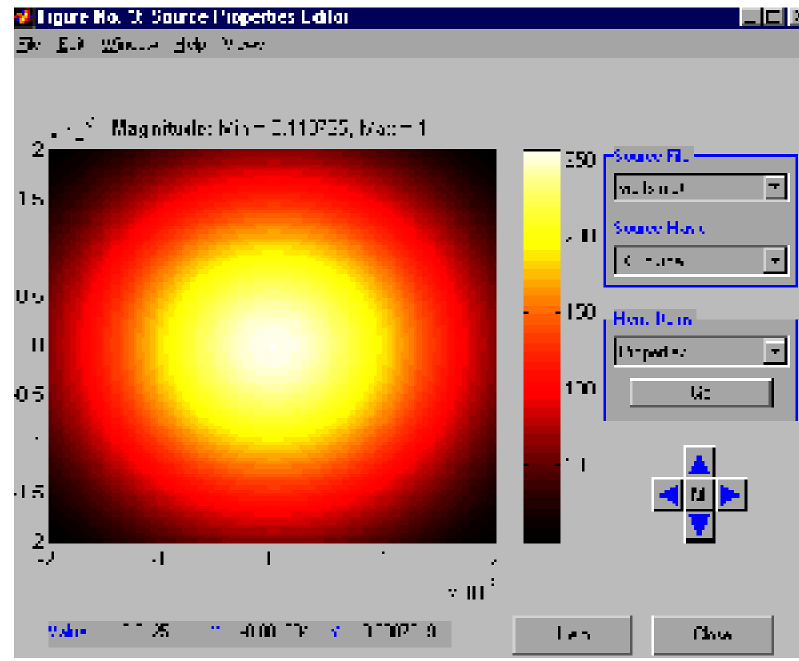
This is a tutorial outlining the steps to modelling a laser scanning system used for scanning optical disks. The topics covered will be as follows:

- Ideal laser source
- Ideal focusing and collection optics
- Grating-like object to scan
- "Gooey" delta object
- Detector to measure the current output from the scanning system
- Saving the scalar optical output fields of the system
- Appendix on propagation and sampling
- Appendix on building up a scan object

Ideal laser source



1.) Edit the source by right mouse click on the source.
2.) Click source properties.



The user will notice:
1.) The source is a gaussian TEM 00 source.
2.) The source has a diameter of 4mm.
3.) The source is off-set by -2mm in the x-direction to center the source in the sagittal plane.

Edit the source type:
1.) The source has a wavelength of 0.5µm.
2.) The source is temporally and spatially coherent.

Ideal focusing Optics

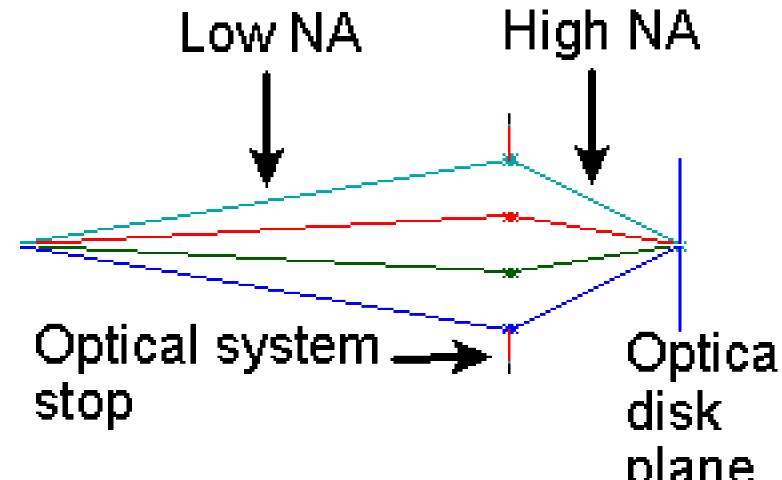
Focusing

1.) Edit the focusing optics by right mouse click on the first optics object from the left side of the GUI.

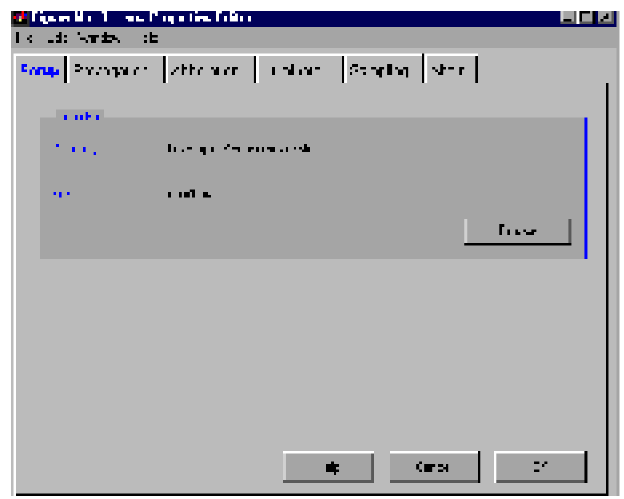
The user will notice:
1.) Low NA to high NA focusing optics.

2.) Click "properties Go" to look at the lens properties of the focusing optics.

The user will notice:
2.) The propagation window has "direct curved" for the source located at the entrance pupil of the optical system, "ABCD:direct" for propagation of light from the entrance pupil to the exit pupil and "High NA (dir cos)" for propagation from the exit pupil down to the disk.
3.) The sampling window has 35 sampled points across the pupil*.
4.) The numerical aperture of the High NA conjugate of the focusing optics is 0.5.



Optics properties window



* For more discussion on sampling in OPTISCAN refer to the appendix

Ideal Collection Optics

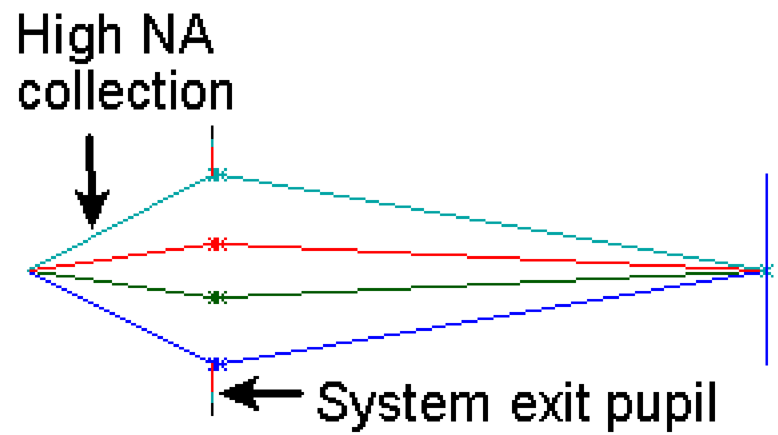
Collection

1.) Edit the collection optics by right mouse click on the first optics object from the left side of the GUI.

The user will notice:
1.) High NA to low NA collection optics.

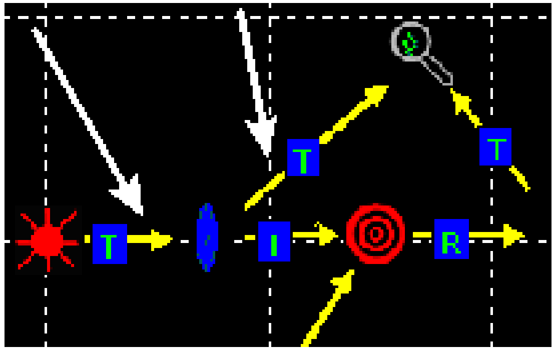
2.) Click "properties Go" to look at the lens properties of the collection optics.

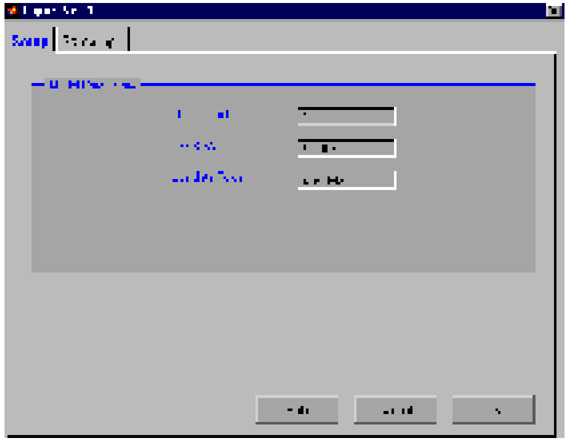
The user will notice:
2.) The propagation window has "High NA (dir cos)" for the propagation of light from the disk to the entrance pupil, "ABCD:direct" for propagation of light from the entrance pupil to the exit pupil and "None:Curved Exp" for propagation to the exit pupil down.
3.) The sampling window has 35 sampled points across the pupil*.



Focused Spot

To see the form of the focused spot on the disk:
1.) Click on the "add link to chain" button on the OPTISCAN GUI and then click on the yellow links, link1 and link 2, between the source, focusing optics and the "look" object.
2.) Click on the "Calc" button on the bottom right hand side of the GUI.
3.) The "setup" screen will appear. Proceed by clicking "OK"

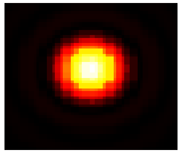


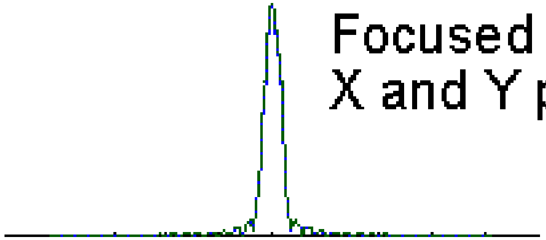


The user will notice:
1.) The "look" object output will be a focused gaussian spot.

Right mouse click on the focused spot:
1.) The out-put will be an X and Y profile of the focused spot.

Focused spot

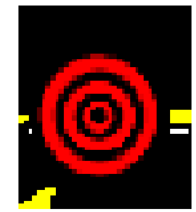




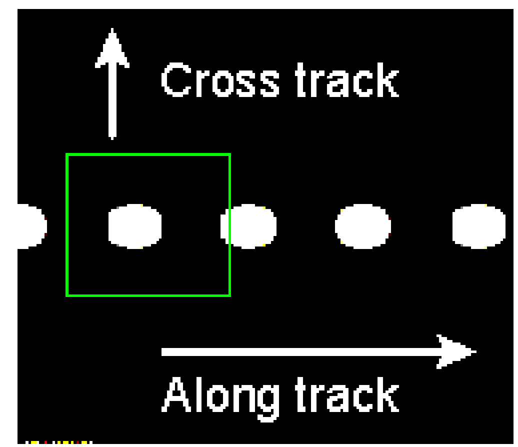
Focused spot X and Y profile

Grating-like object to scan

1.) The scan object is a reflective target that can be used for scalar optics calculations. In this particular model the marks, representing data bits, have a reflectivity of unity on a background with reflectivity of 0.
2.) Right mouse click on the scan object to look at it.



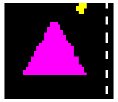
The user will notice:
1.) The object area is 6x6μm^2 with the object centered on 0 in both the along track and cross track directions.
2.) The individual bit sizes are 0.9μmx0.7μm in the along track and cross track directions, respectively.
3.) There is a green window in the target space. This window defines the spot/target interaction area, and it should typically be twice the diameter of λ/NA. Where λ is the light wavelength and NA is the numerical aperture of the high NA focusing optics.



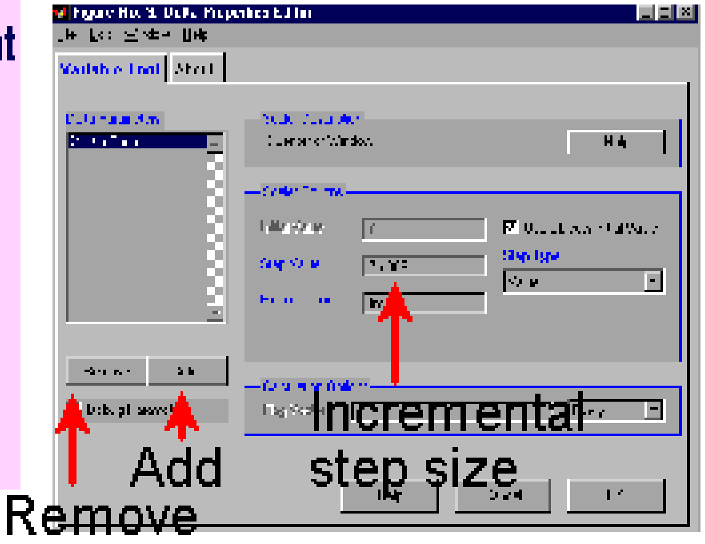
Refer to the appendix for discussion on building a target

"Gooey" delta object

1.) The "gooey" delta is essential in optical scanning applications as it allows the position of the focused spot on the optical disk to be changed. The incremental step size is user defined.
2.) Right mouse click on the object.



The user will see:
1.) The properties window with the X-window center that is to be incremented.
2.) The incremental amount.
3.) "Remove" and "Add" buttons to add or remove system parameters to be incremented. In this application only the X window center and the Y window center can be incremented by the "gooey" delta.
4.) The incremental step size is set to be 1/20 of the target bit period. Numerically this is 0.07µm.



In scanning applications the number of steps, also the number of scan locations, is set in the "calc" wizard as the number in the "chain count".

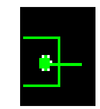
Detector to measure the current output from the system

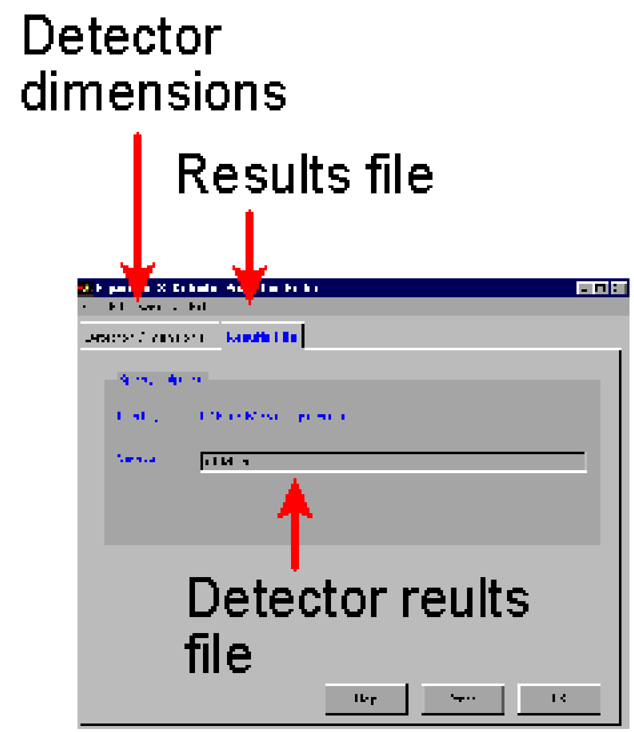
1.) The detector measures the integrated irradiance of the light fields in cident upon it in the system exit pupil.
2.) Right mouse click on the detector to look at it.

The user will notice:
1.) The detector has an area of 4x4 mm^2, which is the same as the exit pupil and the $1/e^2$ point of the TEM 00 gaussian source.
2.) The magnitude scale of the detector is unity even though the detector window appears dark.

3.) Click the "properties" go button.

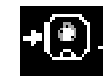
The user will notice:
3.) The detector is off-set by -2mm in the X (along track) direction.
4.) The detector is sampled by 100 points over the diameter.
5.) The results file screen gives the name of the file where the current values are saved.

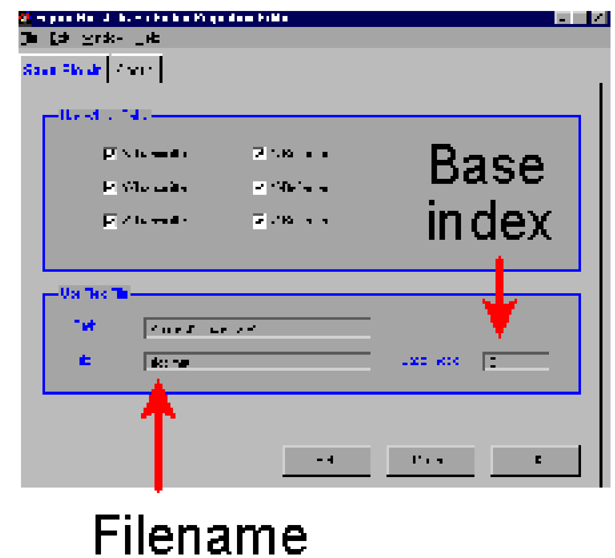




Saving the scalar optical output fields of the system

1.) The save fields object is used to save the scalar fields incident upon the exit pupil.
2.) Right mouse click on the object.



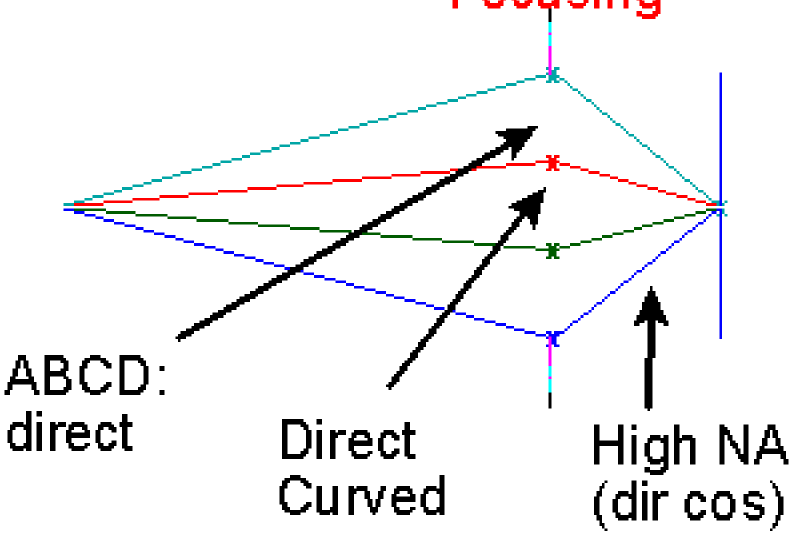


The user will see:
1.) The space to set the user defined filenames.
2.) The “%v” notation after the filename.
3.) The base index set to 100.

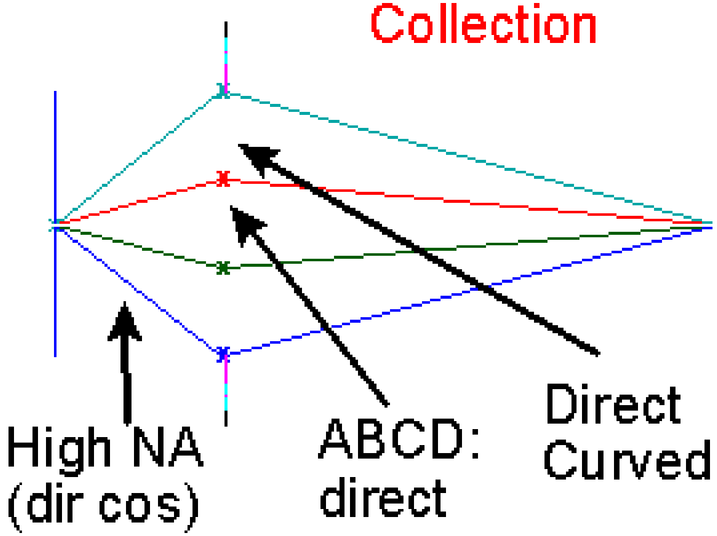
The filename combined with the base index and “%v” enables the filename to be changed from “scan101.mat” to “scan102.mat” for one complete OPTISCAN calculation loop. The “%v” increments the filename numerically by 1.

Appendix on propagation and sampling

Focusing



Collection



The number of points set in the system pupil is with respect to the High NA propagation for the focusing and collection optics and is set by the desired sampling on the disk. For example, if the smallest feature size is 0.1µm the sampling required would be $\Delta x = 0.1\mu m/5 = 0.02\mu m$. Then considering the theory of discrete fourier transforms the pupil sampling is calculated using, $\Delta\alpha = \lambda/(N\Delta x)$, $N_{PUPIL} = 2N.A./\Delta\alpha$.

In the case of this demo the value of $N_{PUPIL} = 35$ and $\Delta x = 0.067\mu m$

The number of sampling points for the High NA propagation in the collection optics must be the same as that set for the number of points for the High NA focusing optics

Appendix on building up a scan object

1.) Build your own reflective target using the "build" menu. Once the size and the offset of the target has been set the sampling and hence the size of the MATLAB™ target matrix has to be set. The size of the matrix will determine how well the target matrix represents the target the user wishes to simulate. A note of caution, if the MATLAB™ matrix is too large the calculation may require too much computer RAM. Typically the maximum size of the target matrix should be 500x500 points for a PENTIUM™ II 300MHz personal computer.

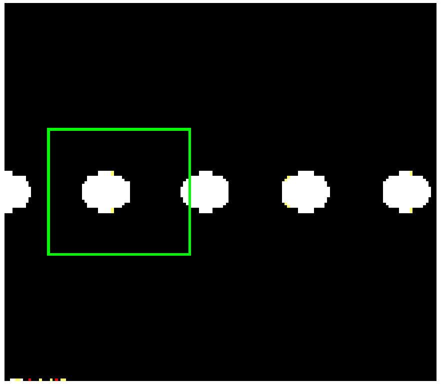
2.) In this application the matrix size is 200x200 points.

3.) To make a user defined target click on the "menu items" window in the target properties window and select "Multiply piece" then "go".

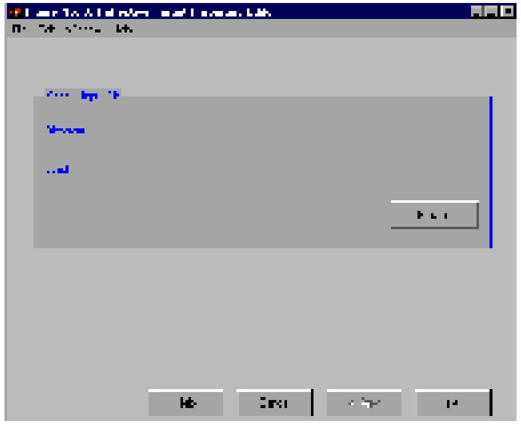
4.) A browser window will appear. Click "browse" and select the target directory of the the project "scanning".

5.) Select "zilch.mat " (zilch is slang for nothing or zero)

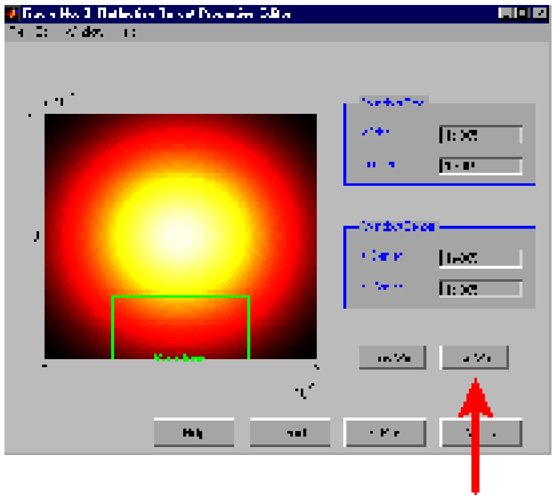
Scan object



Browser window



6.) Click “next” until you come to the screen similar to the one shown on the right.
7.) Click the “Full Win” button. This will allow the entire screen to be replaced by the matrix “zilch.mat”.
8.) **Note the size of “zilch.mat” and the number of sampled points set by the user must be the same.**
9.) Click “next”.
10.) The user will have to define a new name for the target matrix that they are building.
11.) Once the user name is specified the user will have a target matrix full of zeros. The matrix is ready to have bitmap pieces added to it. The bitmap pieces are made by the user in COREL™ PRESENTATIONS™ or POWERPOINT™ and saved in a conveniently accessible directory.
12.) Click the “**replace a piece**” button in the “menu items” window and choose “**add a piece**”.
13.) Import the user defined bitmap object.
14.) Specify the length (X) and width (Y) and co-ordinates of the object.
15.) Start again for adding the next object!



Full-Win