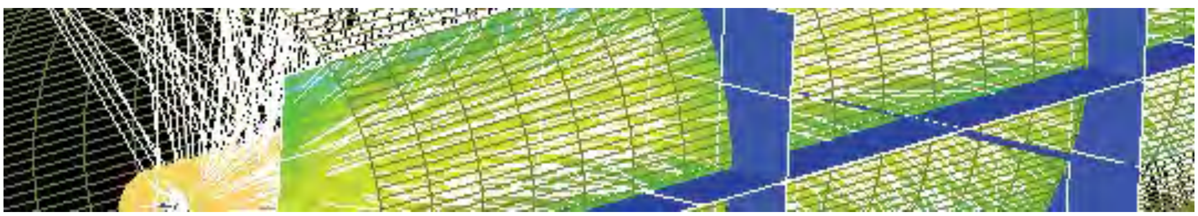
ASAP

Optical design and analysis software

GETTING STARTED GUIDE



LANIKA SOLUTIONS PRIVATE LIMITED

TF-04, Gold Signature, No. 95, Mosque Road, Frazer Town, Bangalore - 560 005, INDIA

Phone: +91 – 96866 80190 Email: info@lanikasolutions.com www.lanikasolutions.com

BRO acknowledges and recognizes the registered trademarks of product names in this manual:

Acrobat is a registered trademark of Adobe Systems, Inc.

AutoCAD is a registered trademark of Autodesk Corporation.

ASAP is a registered trademark of Breault Research Organization, Inc.

ReflectorCAD and REMOTE are trademarks of Breault Research Organization, Inc.

CATIA is a product of Dassault Systemes

ZEMAX is a registered trademark of Focus Software, Inc.

Windows 7 and Vista are registered trademarks of Microsoft Corporation.

CODE V is a registered trademark of Optical Research Associates.

Sentinel is a registered trademark of SafeNet, Inc.

OpenGL is a registered trademark of Silicon Graphics.

SolidWorks is a registered trademark of SolidWorks Corporation

broman0108_getstart ()

1 GETTING STARTED

The ASAP Getting Started Guide is intended to help you install ASAP® 2015 from Breault Research Organization, Inc, give you a brief introduction to its features, and do a brief exercise.

This chapter describes the contents of your ASAP package: the BRO installation media, and, for new users, the hardware key. It also includes information about technical support and how to contact BRO if you need assistance.

ASAP INSTALLATION MEDIA

The ASAP installer installs ASAP as well as release notes and user documentation. The file, Release_Notes.txt, is copied to the installation area on your computer in: C:\Program Files\Breault Research Organization\ASAPyyyyVv, where yyyy is the major year version of ASAP, and Vv the current version level. User documentation is automatically copied to the installation folder named User Documentation. The types of documentation are listed below.

1. *ASAP Reference Guide* includes all the ASAP command topics from ASAP Help.
2. Over 50 technical publications discuss how to use new and existing features.
3. The *ASAP Primer* introduces ASAP concepts and use. Each of the more than 20 chapters are building blocks of knowledge to facilitate new users in understanding ASAP.

You may also search, download or print ASAP documentation in Adobe® Acrobat® PDF directly from the BRO Knowledge Base, which includes the most current versions:

http://www.breault.com/knowledge-base

NEW ASAP USERS

If you are a new ASAP user, the following items should be in your ASAP package or sent to you by email.

Software authorization keys

Your unique set of alpha-numeric software authorization keys is sent to you via email, if you are the end user. After installing ASAP, install the ASAP license keys. See the topic, “Using the ASAP License Manager” in ASAP Help.

SUPPORT

Maintenance Plan

Maintenance Plan members are entitled to major upgrade releases as well as all minor ASAP releases. Major and minor releases are available via Web download. Stay current on software, access all BRO Light Source Library models, and work with experts in Technical Customer Service.

Technical Customer Service

If you are a Maintenance Plan member and you have questions about ASAP that are not answered in this manual, in ASAP Help, or the Knowledge Base, please contact BRO Technical Customer Service: support@breault.com. You can expect to receive a response within 24 hours of first contact.

TROUBLESHOOTING STEPS

Please perform the following troubleshooting steps before contacting BRO for technical service:

1. Determine which release of ASAP you are running.
2. Note any error messages that occurred while you were working in ASAP, and what occurred leading up to the error.
3. Check ASAP Help or the Knowledge Base for information concerning the problem or question. The Knowledge Base includes Application Tips for many common issues.

Sending your input files

1. If necessary, send us your ASAP input files (such as *.inr, *.inx, *.enx, *.enz).
2. To speed up the troubleshooting process, please send a stand-alone file with a few lines of sample code to indicate the problem, and explain what you saw and what you expected.
3. Include your customer ID and the ASAP version number in your message (available on Help, Registration in ASAP).

BRO WEB SITE

BRO recommends that you periodically visit its Web site: software.breault.com, to find out what is new. Learn about software features and optics training classes, view feature or application-specific videos, and more.

2

INSTALLING ASAP

This chapter describes how to install, start, and uninstall ASAP, and briefly discusses computer recommendations, support, and user documentation. If you have questions or issues during the installation procedure, please contact BRO Technical Customer Service. See “Contacting BRO” on page 3 for information.

BRO’s computer recommendations for running ASAP are listed in the table below. When determining your computer requirements, BRO encourages you to select a system that supports optimum performance for ASAP, and uses memory and processor resources intensively for its computation, analysis, and graphical output. If you are running ASAP on a Windows 7 operating system with a 64-bit version, add as much memory as your budget allows for optimal performance.

TABLE 1. **ASAP Computer Recommendations**

Computer Processor	For the latest information, please contact BRO Customer Service.
Operating System	ASAP is supported on the following operating systems and versions: - Windows 10 Professional and Ultimate, 64-bit - Windows 7 Professional and Ultimate, 64-bit - Windows Vista Business and Ultimate, 64-bit

See the Help topic, “Achieving Optimal Performance in ASAP” for an explanation of system memory and ASAP speed.

NEW ASAP INSTALLATION

A typical new ASAP installation scenario involves the following sequential steps. See “Installing ASAP software” for complete instructions.

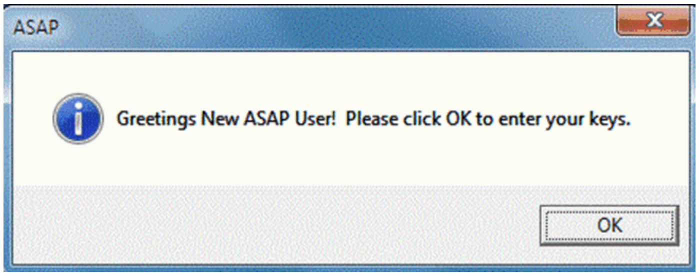
1. Install the ASAP program on your hard drive from the installation media that matches your operating system. You must “Run as administrator”.
2. Install the hardware key on your computer.
3. Start ASAP.

Installing ASAP software

***NOTES** Prior to installing ASAP, verify that the installation media matches your operating system. Also, verify that your hardware key is NOT attached to your computer.*

To install ASAP, you must first log in as Administrator or log into an account with equivalent privileges. BRO recommends that you download the file and run it locally, if you are using the Software download page on the BRO web site. For Windows 7 or Vista, use the “Run as administrator” option.

1. If you are installing from installation media, insert it into the DVD drive.
2. Click **Install ASAP** and follow the prompts. By default, ASAP is installed in a new folder, C:\Program Files\Breault Research Organization\ASAPyyyyVv where yyyy is the major year version of ASAP, and Vv is the current **v**ersion level. Previous ASAP version folders are not overwritten. To use the same folder as the previous version, uninstall the previous version first.
3. Restart the computer after completing the installation.
4. Launch ASAP. When prompted, enter your software authorization keys, which were sent to you via email, if you are the end user. Note: After installing ASAP, you can view registration information from the Help menu in the ASAP Registration dialog box.
5. If you are installing ASAP on a computer on which no other version of ASAP was ever installed, you may encounter the following message. Copy the keys in the email and paste them from the Clipboard into the ASAP Registration dialog box.



Installation message for new users

***NOTE** You may install ASAP on multiple machines. For ASAP to launch successfully on any machine on which it is installed, you must register your software keys on the local client machine. See the topic, “Using the ASAP License Manager” in ASAP Help.*

STARTING ASAP

You can start ASAP from your desktop by clicking the ASAP icon, on your desktop, or from the Start menu under Programs.

UNINSTALLING ASAP

In accordance with Microsoft guidelines for Windows program installations, BRO provides a simple uninstall capability for removing an existing version of ASAP from your computer. The uninstaller removes executable, Help, and related program files.

CAUTION ***To preserve the uninstall capability, do NOT alter, rename, or delete the uninstall executable and uninstall log files. These files reside in the folder in which ASAP was installed. Typical names for these files are unins000.exe and unins000.dat, respectively.***

Uninstalling ASAP in Windows

1 Log in to the Administrator account, or as local administrator.

2 *Windows 7*: Click **Start, Control Panel**; under Programs click **Uninstall a program**. The window, Uninstall or change a program is displayed.

3 *Windows Vista*: Click Start, Control Panel, Programs, Uninstall or change a program.

4 Right-click C:\Program Files\Breault Research Organization\ASAPyyyyVv and click **Uninstall**. If asked, click **Yes** to confirm the uninstall. The Windows Installer dialog box indicates the status of the uninstall. When it finishes, close the Control Panel.

NOTE ***The ASAP Uninstaller does not remove files that were added after the initial ASAP installation. The Uninstaller might not delete the folder in which ASAP was installed.***

THE ASAP USER LANDSCAPE

3

This chapter introduces you to the layout of the ASAP user landscape, commonly called the user interface (UI). It is the visible part of the program that communicates with the hidden ASAP kernel, taking your input from the various windows and dialog boxes to create and analyze your optical systems. When you use the UI, ASAP reformats your input into ASAP command syntax. Whether or not you know the exact syntax of commands, you are free to focus on the optical engineering task at hand.

ASAP uses a four-step workflow that is reflected in the user interface, particularly the menus:

1. Build the optical system, including geometry and optical materials.
2. Add sources of light to the system.
3. Trace rays to simulate system behavior
4. Analyze the ray trace to draw conclusions about performance.

BUILDER, SCRIPTING, OR BOTH?

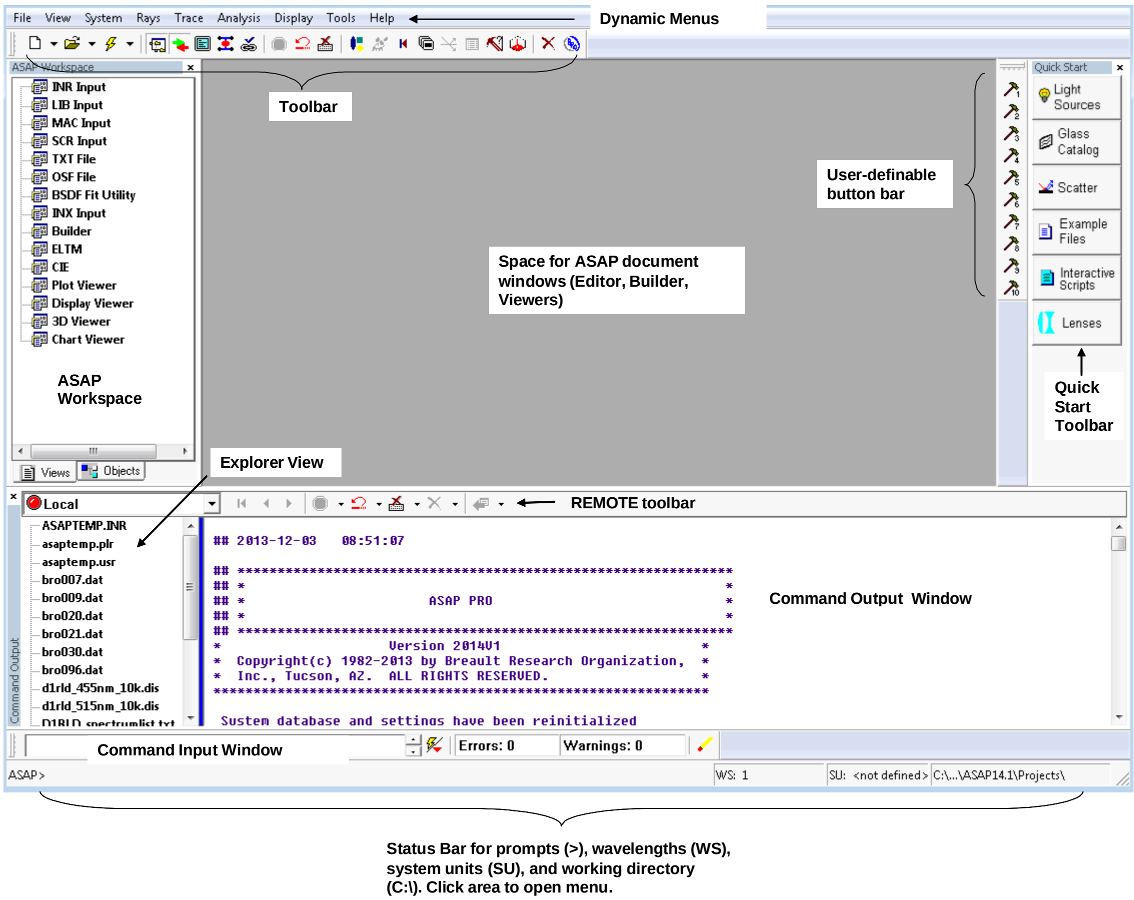
When you are a new user, you might start working primarily with the ASAP Builder, in combination with menus and dialog boxes, to build your optical systems. You can also work with the ASAP scripting language. As you personalize the UI to suit your needs, you will find ASAP offers a smooth, nearly seamless cross-over from the UI to command scripting.

Once you are familiar with the way ASAP works with both the ASAP Builder and the ASAP scripting language, you will know which interface is more compatible with your preferences. In either case, both methods follow the four-step workflow.

ASAP will soon become—if it has not already—an indispensable tool for designing, analyzing, and prototyping your optical systems.

***TIP** When you open ASAP for the first time, the main ASAP window looks like the illustration in "Example of the ASAP window (default mode)".*

***TIP** BRO recommends that you set your display monitor to at least 800 x 600 resolution with 64K colors.*



Example of the ASAP window (default mode)

See “ASAP Interface” on the Contents tab of ASAP Help. This book, or section, includes topics about windows, menus, and toolbars to familiarize with ASAP.

IN AND OUT OF THE WINDOWS

While working in ASAP, several document windows are available for user tasks. You can easily move in and out of a window. ASAP Workspace reflects whichever window you have in focus:

- ASAP Workspace for viewing lists of open document windows, files, and objects.

- Command Input for entering scripting language and viewing the active local (or remote) machine, and Command Output for displaying the results.
- Builder and Editor windows for creating and refining your script files, using embedded assistants, for digitizing images, optimizing files, or performing tolerance analysis.
- Plot Viewer, Chart Viewer, 3D Viewer, and Display Viewer for displaying your work in progress, including CIE color analysis, Conformal Radiometry, and Polarization (Poincare Sphere).
- Quick Start toolbar for easily accessing light sources, glasses, scatter and random models, example scripts, interactive scripts, and lenses.
- BSDF Fit Utility for fitting Harvey and polynomial models.
- Editor window for designing custom dialog boxes.
- User Interface Preferences dialog box (File, Preferences) for user settings.

***NOTE* Each window or toolbar that is listed above is described in ASAP Help.**

IMPORTING AND EXPORTING

4

You can import or export several types of files, either those generated by ASAP or those used as inputs to ASAP. These file types are outlined below. For more detailed information, see *Importing/Exporting* in ASAP Help on the Content tab.

BRO LIGHT SOURCE LIBRARY AND WIZARD

The BRO Light Source Library, available to ASAP customers with current software maintenance agreements, is a collection of U.S. and European source models that can be imported directly into ASAP projects. Current sources include filament, light-emitting diode (LED), arc, and cold cathode fluorescent (CCF). The Light Source Library reduces planning and prototyping costs by eliminating the need to scan, measure, and model industry sources.

Once ASAP is installed, you can insert a library source file from the Library via the Light Sources Manager, which is accessed via Rays, Use Light Source Library Wizard; on the Quick Start toolbar, Light Sources tab, or in the ELTM Module.

The Light Source Wizard is activated when you select a source in the Light Sources Manager. Two main steps are required when using the BRO Light Source Library wizard: Create and save ray set(s), and Writing ASAP script commands to a template. Each of these steps is described in ASAP Help, and in the technical publication, *Source Wizard for BRO Light Source Library*.

EXTERIOR LIGHTING TEST MODULE (ELTM)

The Exterior Lighting Test Module (ELTM) imports your geometry files to determine whether it is in compliance with standard government lighting tests. For more information, see “ELTM - Exterior Lighting Test Module Overview” in ASAP Help. ELTM is an optional add-on for ASAP. BRO light sources can be accessed in ELTM on the Geometry tab.

CAD SUPPORT

CAD, IGES, and STEP files

ASAP supports translation of imported CAD (*.gtx, *.catpart, *.catproduct), IGES (*.igs), or STEP Part 42 (*.stp, *step) files for analysis. See “Importing CAD, IGES, or STEP Files” in ASAP Help.

ASAP includes a integrated file translators. You can translate GTX, IGES (Initial Graphics Exchange Specification) and STEP Part 42 files to ASAP format for performing optical analyses on geometries initially created in a CAD program. Using the file import feature in ASAP, models from a wide variety of CAD software can be included in optical analysis.

ASAP also supports exporting IGES (*.igs) files. See “Export to CAD dialog” in ASAP Help.

CATIA files

Import CATIA V5 files via the optional add-on CATIA Module for ASAP. The module does not require installation of the CATIA product. See “Importing CATIA Files via the CATIA Module” in ASAP Help.

SolidWorks geometry

Use the SolidWorks Parts Only 3D modeling engine with ASAP to assign object and layer names. Import SolidWorks® geometry files from SolidWorks, with ASAP. These files are saved in the GTX file format via the dialog box, Save As. See “Importing SolidWorks Files” in ASAP Help.

ZEMAX, CODE V, AND SYNOPSYS FILES

ASAP PRO includes the fully integrated capability of importing ZEMAX®, CODE V®, and SYNOPSYS™ files. You can open these file types (*.zmx, *.seq, or *.len) in ASAP from the Open dialog box on the File menu.

The ZEMAX translator works directly on the ZEMAX (ZMX) ANSI or Unicode file formats. See “Importing ZEMAX Files” ASAP Help.

REFLECTORCAD FILES

Use ASAP to check the output of a reflector you created in ReflectorCAD™. Follow instructions in ReflectorCAD Help for changing appearance-related settings in ReflectorCAD for output appearance and contouring. Before exporting the ReflectorCAD file to ASAP, you must convert the ReflectorCAD file to an ASAP *.inr input file. Use the Export, To ASAP command in ReflectorCAD on the File menu to do this step. (You may also import an ASAP source distribution file into ReflectorCAD with the Dis2Sdf.exe utility. See the ReflectorCAD User's Guide.

ASAP EDITIONS AND ADD-ONS

5

BRO offers two editions and several add-ons of ASAP optical software solutions to match your optical design requirements. For more information, please visit our Web site, www.breault.com.

Edition	Solution
ASAP	Includes everything necessary to design and analyze your imaging and illumination system with the fusion of mechanical and optical engineering in mind. Includes ASAP REMOTE for distributed processing in ASAP.
ASAP PRO	Enhanced ASAP edition for complex analyses where coherent light propagation and polarization come into play.

ASAP Optional Add-ons:

(http://www.breault.com/software/asap-optional-add-ons)

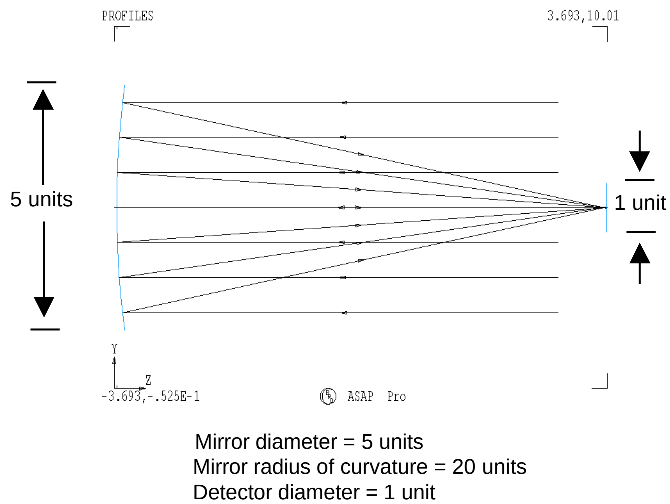
BIO Toolkit (for ASAP)	Enhanced version of ASAP includes proprietary BRO plug-ins for modeling light propagation in biological tissue.
CATIA Module (for ASAP)	This module allows ASAP users to open native CATIA V5 files from within ASAP. CATIA users can count on accurate, seamless geometry transitions into ASAP. See “Importing CATIA Files via the CATIA Module” in ASAP Help for supported CATIA release versions.
ELTM Module (for ASAP)	The Exterior Lighting Test Module (ELTM) automates the task of SAE, FMVSS, and ECE test compliance for automotive industry. The ELTM Module also supports and stores user-defined tests, walks users through the setup process and presents a pass/fail indicator for each test point.

See the chapter, “Installing ASAP” for a list of supported operating systems in the table, “ASAP Computer Recommendations” on page 11.

6

A QUICK TOUR OF ASAP

Perhaps the best way to get an overview of ASAP is from a simple example. In this chapter you will create a small concave mirror with a spherical surface, and trace rays to see the type of image it produces. The geometry consists only of the mirror, and a detector to collect the rays.



Ray trace of concave mirror

Although the problem is simple, we will use the four steps that are fundamental to all ASAP simulations:

1 Building the system
2 Creating the source
3 Tracing the rays
4 Performing the analysis

We will step through this procedure to give you a feel for the process, and then look at each of the steps in detail in the next few sections.

Before beginning the work of building a system, there are a few tasks to take care of.

Preliminary tasks

1 Use the Windows Explorer or My Computer to create a new folder for this project.

For example, use a folder at the location, c:\ASAP Work and name it Spherical Mirror Project. You may select any path that is convenient for you. This is where ASAP will store all the working files associated with this project.

2 Start ASAP by double-clicking the ASAP icon on the desktop.

3 From the File menu (on the main toolbar), select Set Working directory and select the new folder.

4 From the main toolbar, select the triangular arrow next to  (New). From the drop-down list, select Builder.

5 From the File menu, select **Save As**, and give the file a name (for example, Spherical Mirror).

BUILDING THE SYSTEM

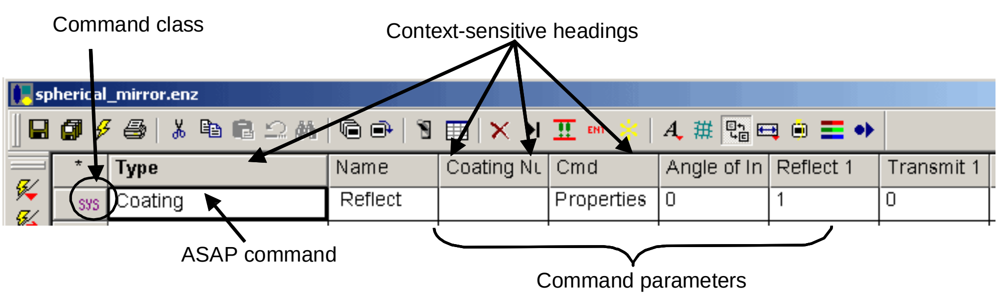
Now for the preliminary steps in the Builder. You can start by defining the properties, which tell ASAP about the transmission and reflection characteristics of the various surfaces in your system. See the sidebar below, “Defining the System in the Builder”.

ASAP is able to calculate Fresnel coefficients with real or complex indices of refraction, multi-layer thin-film coatings, or custom coatings specified by your own model. But for this problem, we will define some simple ideal coatings for the mirror and detector. This first coating is for the mirror.

DEFINING THE SYSTEM IN THE BUILDER

The ASAP Builder is a spreadsheet-style window for defining geometry, properties, and sources, as well as for tracing rays and performing analysis. When the Builder window is the main focus, the ASAP toolbar changes to include the Edit, Preview, and Builder menus.

Each row is used to enter a single ASAP command. You begin entering a command by double-clicking in the left-most cell of a new row to open a context menu. The menu lists all the available Builder commands. Once you have entered a command, ASAP generates context-sensitive headings at the top of each column applicable to that row. The headings prompt you to enter appropriate command parameters for the highlighted cell.



Spreadsheet-style rows and columns

Making a new entry in the Builder

1 Double-click in the left-most cell under the Type column in the first line of the spreadsheet.

A context menu of commands opens.

2 From the context menu, select System, Materials, Coatings.

Column headings describe the various parameters in the cells below. The Type column displays Coatings and the Cmd column displays Properties.

3 Double-click the cell in the Name column, and assign a name to the coating.

In our example, we have assigned Reflect. We will refer to this type of coating later, using this name.

4 Press the Tab key, or click another cell to complete the entry.

5 In the same way, set Reflect 1 to 1 and Transmit 1 to 0.

The coating lets you define an ideal mirror coating that reflects 100% of the incident flux and transmits none.

You have finished the first entry. The remaining columns can remain blank. (They could be used to define additional reflection and transmission coefficients when more than one wavelength is used.)

***TIP** New entries can go in the next available blank row of the Builder spreadsheet, or you can skip lines for ease of reading. ASAP ignores blank rows when it runs a file. To insert a new blank line, right-click in the Type column and select Insert.*

The only other coating you need is an absorbing coating, for placing on the detector to stop the rays.

6 Create the coating as in the previous steps, but this time name it Absorb, and set the Reflect 1 and Transmit 1 columns to 0.

INCLUDING OTHER PARAMETERS

In many cases, the preliminary setup of our system will also include other parameters, like the definition of a set of system units, one or more wavelengths, and perhaps the properties of some refractive media. You can skip those parameters in this simple example, since you will not be doing anything for now that depends on wavelength or the absolute dimensions of the objects.

DEFINING THE MIRROR

Once the coatings are defined, you can proceed to build the system geometry. Only two geometric elements exist in this model: the spherical mirror and the detector.

***NOTE** Because ASAP is a non-sequential ray-trace program, the geometric elements do not need to be defined in any particular order. You may start with the mirror.*

1. Double-click the left-most cell of a new row, below the coating properties. This time, select System, Geometry, Surfaces, Spherical on the shortcut menu.

Notice how the column headings have changed to correspond to this new command.

2. Name this element Mirror.
3. We want to define a mirror *perpendicular* to the Z axis, which is the default.

The Z axis is the traditional optical axis for simple systems.

4. Leave the location of the mirror at the origin (Z=0), which is also the default.
5. Give the mirror a radius of curvature of 20 units.
6. Select Ellipse as the aperture shape.

The Aperture column describes the shape of the mirror. By double-clicking this cell, you will see the choices in the drop-down box. You want a circular mirror, so select Ellipse on the Aperture option.

7. Set both Semiwidth X and Semiwidth Y to 2.5 units, making a circular mirror with a diameter of five units.

The remaining columns could be used to place a hole in the aperture. You could use this, for example, if you want to make a Cassegrain telescope system. In this example, you can leave those cells blank.

Defining optical properties

Next, we need to define some optical properties for this mirror. You can give it the characteristics of the coating that you named “Reflect” earlier.

1 Start a new entry by double-clicking the Type column cell, below the mirror definition. Select System, Object Control, Object Modifiers, Interface from the context menu. Change the coating from Bare to Reflect.

This gives the mirror the 100% reflectivity you defined earlier. The media on both sides of the mirror surface can remain set to the default value: Air. (You would change one or both of these in the case of a refractive interface.) You can preview the mirror with the BRO 3D Viewer. For information on the 3D Viewer, please see ASAP Help

2 From the toolbar, select Preview, All.

The menu command, All, shows you a 3D view of the current system.

***NOTE** While ASAP is preparing data for the preview, you will see activity in the Command Output window. As you will see later, this window reveals the communication between the ASAP user interface and the kernel. You could have achieved the same result by sequentially typing the commands into the Command Input window yourself.*

3 Try to manipulate the system, using the button toolbar above the 3D Viewer window. (Each button reveals a ToolTip as the pointer goes over it. The status bar includes a more detailed description.)

Defining the detector

The final geometric element in this model is the detector. Start this new entry as before by double-clicking the left cell of a new row. As always, you can leave blank rows, if you like. Select System, Geometry, Surfaces, Plane. Define the detector as follows:

Name	• Detector
Axis	• Z
Location	• 10
Aperture	• Ellipse
Semiwidth X	• 0.5
Semiwidth Y	• 0.5

1 View the results with Preview, All to see both the mirror and the detector. Close the 3D Viewer.

2 Add the optical properties as before, from the context menu (System, Object Control, Object Modifiers, Interface, Coating). This time, replace Bare with Absorb to use the coating we defined that neither reflects nor transmits. When we trace rays later, this will cause the rays to stop on this surface.

3 Save your Builder file (File, Save).

NOTE ***Builder files can be saved in two formats: *.enx, an XML format and *.enz, a compressed XML format.***

The system is now complete. Your Builder window should appear as shown below.

TIP ***Remember that when you look at the* Builder*, the column headings correspond only to the row or cell that is currently selected. In this example, the Detector* row was *selected.***

*	Type	Name	Option	Axis	Location	Aperture	Semiwidth X	Semiwidth Y
SYS	Coating	Reflect		Properties	0	1	0	
SYS	Coating	Absorb		Properties	0	0	0	
OBJ	Spherical	Mirror	Z	0	20	0	Ellipse	2.5
MOD	Interface	Coating	COATING	Reflect	Air	Air		
OBJ	Plane	Detector	Axis	Z	10	Ellipse	0.5	0.5

Viewing Builder entries, with the Detector row selected

CREATING A SOURCE

For this example, you will define a grid of parallel rays. This is a two-step process in ASAP.

Defining a grid of parallel rays in ASAP

- Define where the rays start.
- Define the direction at which they point.

1 Double-click the first cell of a new row in the Builder, somewhere below the geometry definitions. From the context menus, select Rays, Grids, Grid. Set the parameters in each Builder column as follows:

Option	• Ellipse
Axis	• Z
Position	• 9
X Axis Min	• -2.5
X Axis Max	• 2.5
Y Axis Min	• -2.5
Y Axis Max	• 2.5
X Axis Rays	• 100
Y Axis Rays	• 100
Aperture	• (leave blank)
Random	• (leave blank)

Illustrated parameters for Grid Elliptic *source*

These parameters set the location of the starting point of a grid of rays. They are all located on a plane perpendicular to the Z axis, 9 units from the origin (the vertex of the mirror). They fill a circle of radius 2.5 units. If the array were rectangular, there would be 10,000 rays total (100 on a side). Since you asked for an elliptical distribution to match the shape of the mirror, the 100x100 rectangular grid is trimmed with an ellipse, and the corners will be missing.

***NOTE** You have placed the rays between the mirror and the detector so that no rays can strike the detector before interacting with the mirror. In a more realistic model, the detector could be made from two surfaces, a front and a back.*

2 Double-click the left cell of the next row and select Rays, Grids, Source.

The `DIRECTION` command sets the directions of the rays. There are three fields to set: Vector A, Vector B, and Vector C. These three values are components of a direction vector along the X, Y and Z axes, respectively.

3 Set Vector A and Vector B to zero, and Vector C to -1.

This directs the rays from their starting points near the detector, along the -Z direction toward the mirror. The two source-definition lines in the last completed row of the Builder window should look like the following figure when you are finished:

*	Type	Cmd	Option	Vector A	Vector B	Vector C	Vector A'	Vector B'	Vector C'	Vector A''
ENT	Grid	Elliptic	Z	9	-2.5	2.5	-2.5	2.5	100	100
CMD	Source	Direction		0	0	1				

Viewing Builder entries for ray direction

This is a good time to save your Builder file again.

4 On the File menu, select Save.

TRACING THE RAYS

Having defined the system and a ray source, the most difficult tasks are done. The job of tracing the rays falls entirely to ASAP. ASAP traces each ray from its initial position along its prescribed direction, interacting with any objects it finds in its path. ASAP makes no assumptions about the order in which the rays strike the geometrical elements. (This is the essence of non-sequential ray tracing.) How the rays interact with each object depends on the properties of that object. This process continues until all rays can be processed.

If you have entered everything correctly into the Builder window, you can expect every ray to intersect with the mirror, reflect, and proceed to the detector. Later, you will view a profile of the system, and plot some of the rays as they are traced to make sure that everything is going as planned.

RUNNING THE BUILDER

Although you have previewed your system several times, you have never actually instructed ASAP to build the system. This is accomplished by "running" the Builder to place both the system definitions and the rays into their respective databases in memory.

Running a Builder file

1 Start by clicking (End) on the ASAP toolbar. This initializes ASAP and prevents you from running the same system more than once.

2 From the Builder toolbar, click (Run).

Watch the ASAP Command Output window while ASAP is running. The commands sent to the ASAP kernel are echoed in this window. If any errors occur, ASAP reports them here. Scroll up the window to check for errors.

See the sidebar, "Errors Found While Running the Builder" on page 37, which illustrates what happens when you omit one of the essential parameters in a Builder entry. In this example, the number of rays to place along one of the the `GRID` dimensions was omitted.

ERRORS FOUND WHILE RUNNING THE BUILDER

ENT	Grid	Elliptic	Z	9	-2.5	2.5	-2.5	2.5	100	
CMD	Source	Direction		0	0	-1				

If you make an error in the Builder, such as leaving out a critical parameter (see above illustration), ASAP writes an error message to the Command Output Window as soon as you run the Builder (see illustration on right).

```
--- INTERFACE COATING REFLECT AIR AIR
--- ENT OBJECT;PLANE Z 0 ELLIPSE 0.5 0.5 'DETECTOR'
--- LOCAL -1.0 1.0 -2.0 1.0 -1.0 1.0
--- GRID ELLIPTIC Z 9 -2.5 2.5 -2.5 2.5 100
***                                        ^ERROR
   GRID ELLIP requires at least a total of 10 entries

--- GRID ELLIPTIC X x y y' z z' n n' [ c ] [ RANDOM f ]
                  Y y z z' x x'
                  Z z x x' y y'
--- $IO INPUT CLOSE
```

Some parameters in the Builder are optional, and some are not. Generally, the Builder offers a default value for the parameters that are required. In this example, the default value for the number of rays in the minor axis direction was removed, and replacement value was not entered. As a result, ASAP has issued an error message.

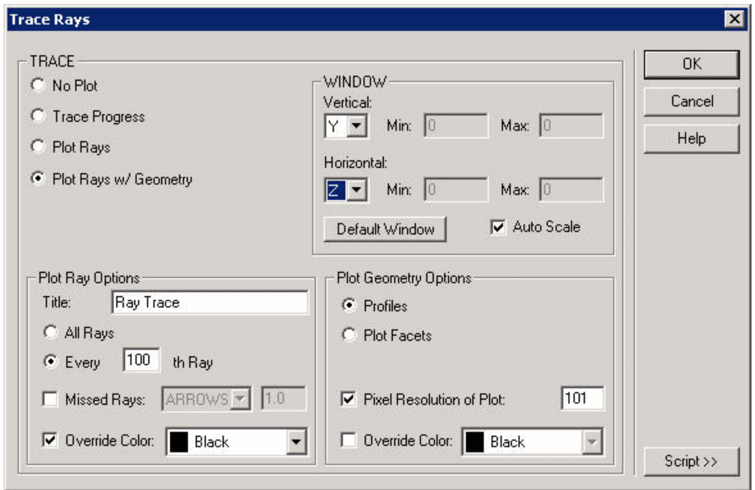
If you make an error, correct it in the Builder, click to reinitialize ASAP, and rerun the Builder.

GRAPHICS FOR THE RAY TRACE

You do not have to graphically plot the ray paths while they are traced, but it is useful for verification purposes to plot the ray paths with the geometry. In ASAP, ray tracing is an entirely mathematical process, during which ray intersections and new ray trajectories are calculated as the rays interact with the various interfaces. It generally takes far longer to draw the ray graphics than it does to do the calculations involved in tracing rays.

***TIP** Display at least a few rays as you trace them to verify that the rays were created in the right place, and that you pointed them in the correct direction.*

1 From the toolbar, select Trace, Trace Rays. The Trace Rays dialog box controls the parameters and geometry of the ray trace.



Parameters for plot window and ray trace plot

2 From the TRACE area of the dialog box, select **Plot Rays w/ Geometry**.

3 In the Plot Ray Options area, enter Ray Trace in the Title textbox. Specify **Every 100th Ray**.

4 Select **Override Color**, and choose the color in which you would like the rays to appear.

5 In the WINDOW area, make sure that **Vertical** is set to Y and **Horizontal** is set to Z. Check **Auto Scale** to ensure that the **Min** and **Max** values associated with each axis are set at 0 (the Min/Max values are grayed out). This instructs ASAP to scale the plot automatically.

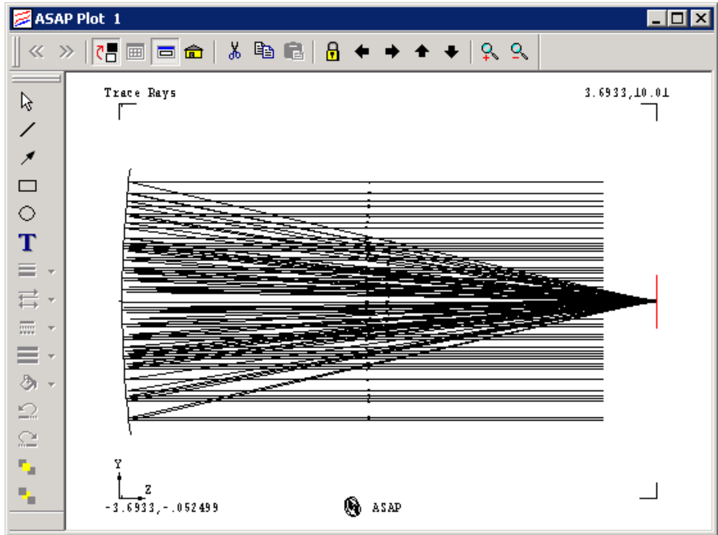
6 In the Plot Geometry Options area, select **Profiles**.

7 Click **Pixel Resolution of Plot**, and enter a resolution value of 101.

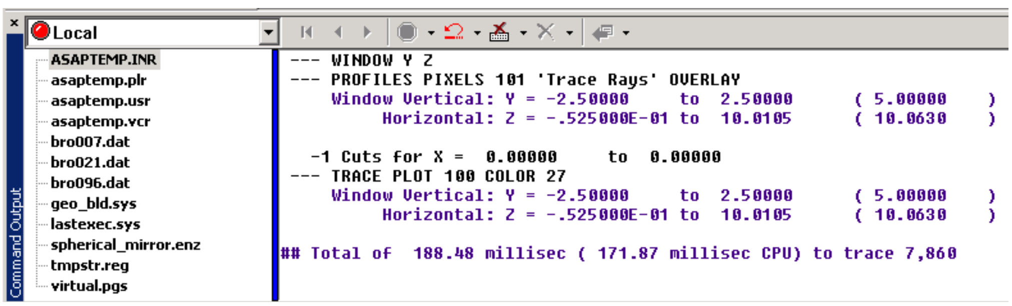
The Pixel Resolution setting controls the resolution of the graphic, dividing the vertical direction into 101 elements.

8 Click **OK**.

The Command Output and ASAP Plot windows should appear more or less as shown below. Some of the values may differ, depending on the speed of your computer. However, the Command Output window must be free of errors and warnings, and the rays must converge on the detector as expected.



First ray trace plot



Information about the plot, displayed in the Command Output window

9 Keep the Plot Viewer open. You may close the Builder window.

Performing tracing and analysis in the Builder

So far, we have used the menu items and dialog boxes to demonstrate the tracing and analysis parts of an ASAP simulation. All these actions can be done with commands in the Builder file. First, we set the window with the Window command from System, Geometry, Verify Geometry, Graphics, Window, and change the axis to Z. Next, we set the Pixels command from System, Geometry, Verify Geometry, Graphics, Pixels.

Now, we can choose to look at a faceted plot or a profile of the system geometry, or both. If all the plots are to be viewed in the same window, use the Overlay option to keep open the plot window for the next plot. In our case, use the Overlay option for the Profiles and Plot Facets choices. However, do not use the option on the Trace Plot command, since this would leave the plot window open for the analysis plots. The ray trace and plot commands are found on Trace, Trace. Select the Plot option on the Trace command. The Builder file should now look like the following figure.

*	Type	Start Object	End Object	Step		List	List Rays	Plot	Plot Rays
CMD	Window	Axis	Y			Z			
CMD	Pixels	39	1	Off					
CMD	Plot	facets	5	5	0			Overlay	
CMD	Profiles	0	0	-1			OVERLAY		
CMD	Trace							Plot	100

Trace Plot command added

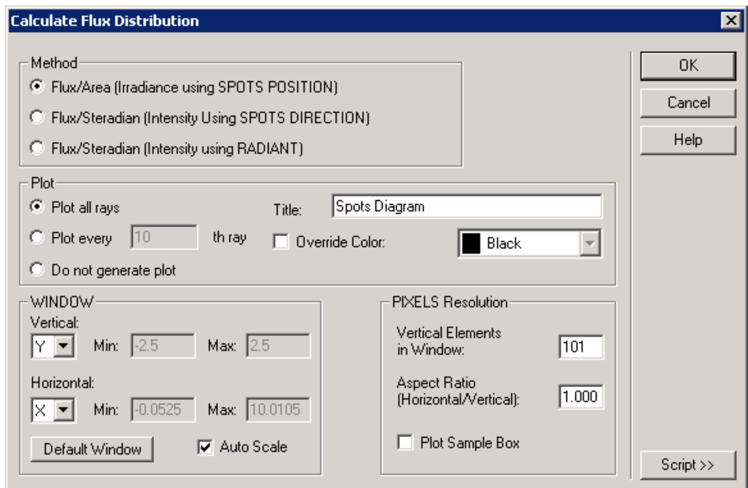
The same graphics resulting from the dialog boxes are produced again. Verify the results by running the Builder file.

PERFORMING THE ANALYSIS

The last step in the process is analyzing the results. In this case, you will see the type of image you have produced on the detector. Begin by making a spots diagram that shows where each ray landed.

Making the spots diagram

1 From the Analysis menu, select **Calculate Flux Distribution** to open the dialog box, Calculate Flux Distribution.



Settings for the spots diagram

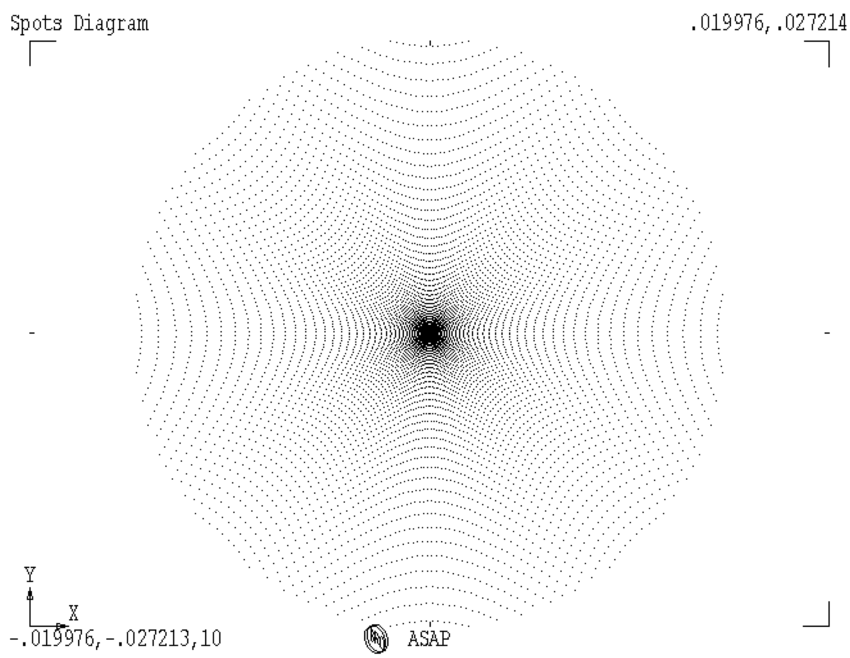
2 In the **Method** section, select **Flux/Area (Irradiance using SPOTS POSITION)**.

3 Select **Plot all rays** from the Plot section, and type Spots Diagram in the **Title** textbox.

4 In the **WINDOW** section, select Y for **Vertical** and X for **Horizontal**. Select **Auto Scale**.

5 In the **PIXELS Resolution** section, type 101 in the **Vertical Elements in Window** textbox, and 1.000 in the Aspect Ratio textbox.

6 Click **OK** to produce the diagram.



Spots diagram

***NOTE** The spots diagram shows some plotting artifacts resulting from the regular nature of the grid source you used, rather than from the optical properties of the objects.*

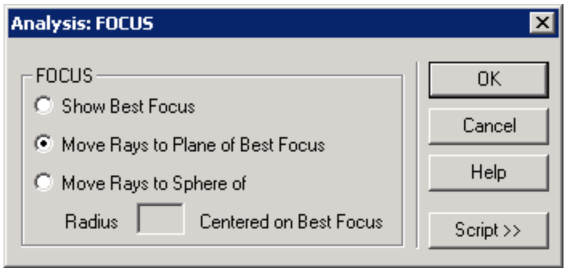
BEST FOCUS

You placed the detector at a position equal to half the radius of curvature of the spherical mirror. But is this the best focus? ASAP has, among its many analytical tools, a utility that shifts the rays along their trajectories to find the best root mean square (RMS) focus.

Determining best focus

1 From the toolbar, select Analysis, Focus Rays.

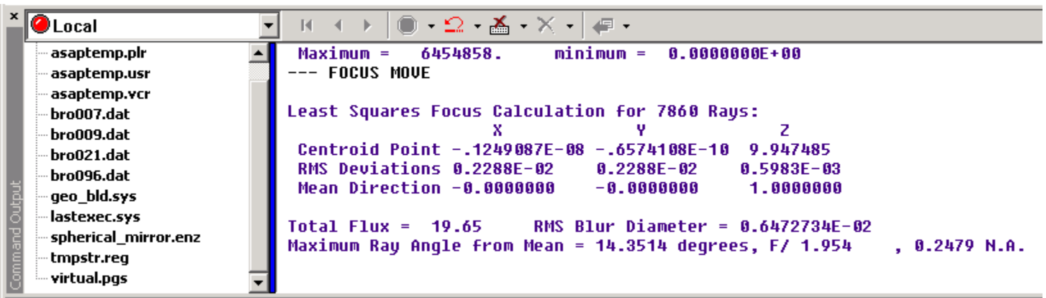
You will see the dialog box shown below.



Move rays to plane of best focus

Ask ASAP to move the rays to the plane of best focus. Click OK.

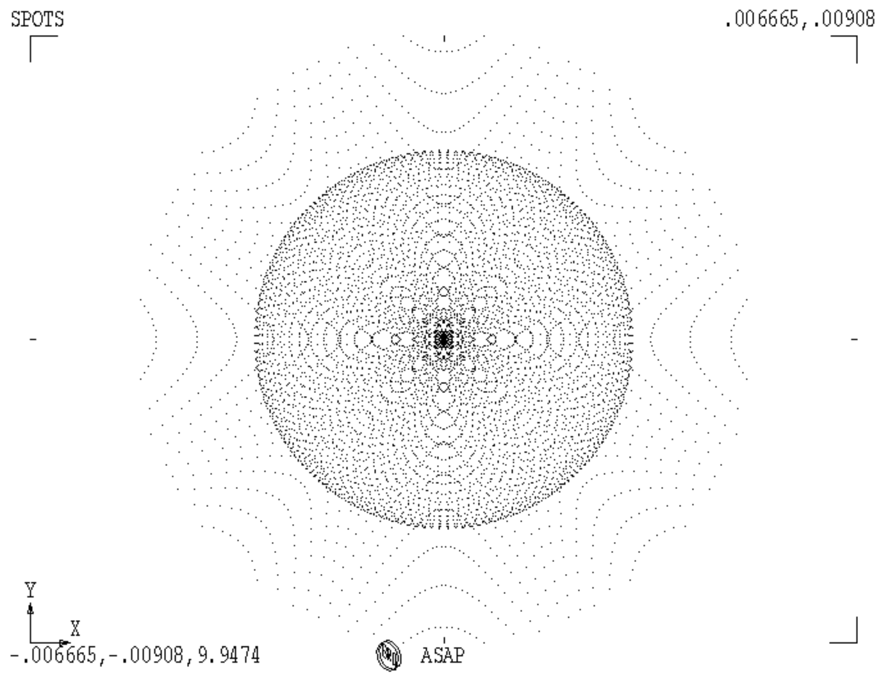
When you click OK, you will see, by looking in the Command Output window, that the best RMS focus is actually at Z=9.947485, rather than 10 units where you placed the detector.



Best focus output

2 Next, make another spots diagram to see the effect of the small shift in focus.

This change is quite noticeable, both in the appearance and size of the resulting spot. From the scale of the two diagrams, notice that the overall size of the spot was reduced by a factor of three, as theory predicts.



Spots at best RMS focus

The values displayed are the X and Y coordinates of our autoscaled window at the Z-position of 9.947.

***NOTE* Compare the change in scale between the X (vertical) extent of this spots diagram with the previous diagram performed, with the rays located at half the radius of curvature.**

Before proceeding to visual analysis results, we will create the Builder commands to produce the same results as shown above for the Spots diagram, before and after determining best focus.

The window needs to be reset so that we can view the results perpendicular to the propagation axis of the rays; that is, the plot window should be in the X-Y plane. If the pixel value needs to be changed for the analysis, this is the time to make the change. These commands are found on the Builder menu: System, Geometry, Verify Geometry, Graphics, Window, and on System, Geometry, Verify Geometry, Graphics, Pixels. Let ASAP autoscale the window size. Select 101 (or some other value) for the pixel resolution, as was done above in the dialog boxes for these two settings.

Finally, the Spots diagram is on the Builder menu: Analysis, Calculate Flux Distribution, Spots. Since the detector is not placed at the best focus position (we do not know the best position yet), we need to find the best focus position on Analysis, Focus, Spots. Repeat the commands for the plot window and the spots diagram after the Focus Move column. The Builder file should now have the following appearance for the recently added commands.

*	Type	Option	Cmd	Unit Option		Attribute		Object	Number O
CMD	Window	Axis	Y			Z			
CMD	Pixels	39	1	Off					
CMD	Plot	facets	5	5	0			Overlay	
CMD	Profiles	0	0	-1			OVERLAY		
CMD	Trace							Plot	100
CMD	Window	Axis	Y			X			
CMD	Pixels	101	1	Off					
CMD	Spots	Direction	DIRECTION						
CMD	Focus			Move					
CMD	Window	Axis	Y			X			
CMD	Spots	Position	POSITION						

Spots position

The graphics results are the same as those produced with the dialog boxes. Verify these results by running the Builder file.

VISUALIZING THE RESULTS

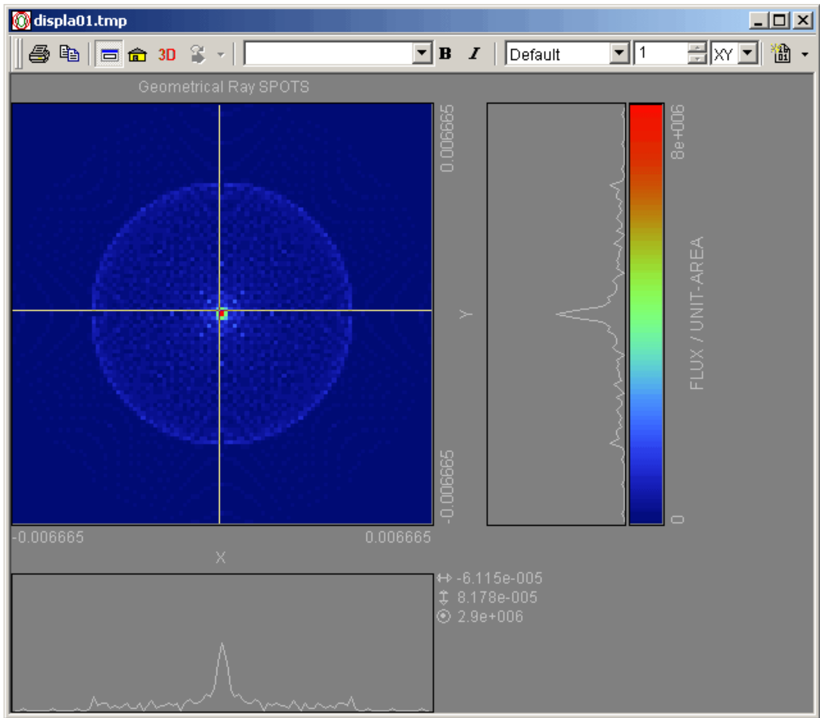
Once the spot diagram has been made, these results can be further analyzed with a variety of analysis and visualization tools on the Display menus. We will highlight just a few of them.

NOTE ***If the ASAP toolbar does not show the Display menu, the window that is in focus needs to be changed. Click the ASAP Workspace window to return to the main ASAP toolbar.***

Using the visualization tools

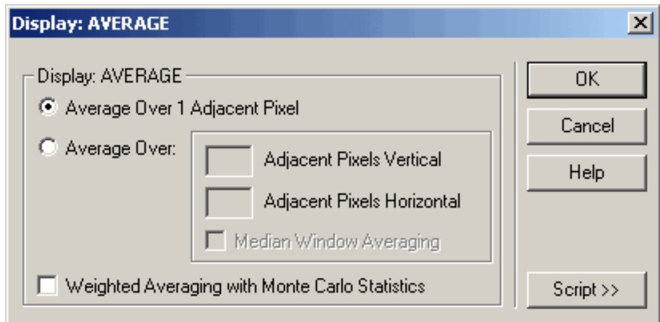
1 From the toolbar, select Display, Graphics, Picture.

You will see the regular patterns again, which result from our use of a rectangular grid of rays with fixed spacing.



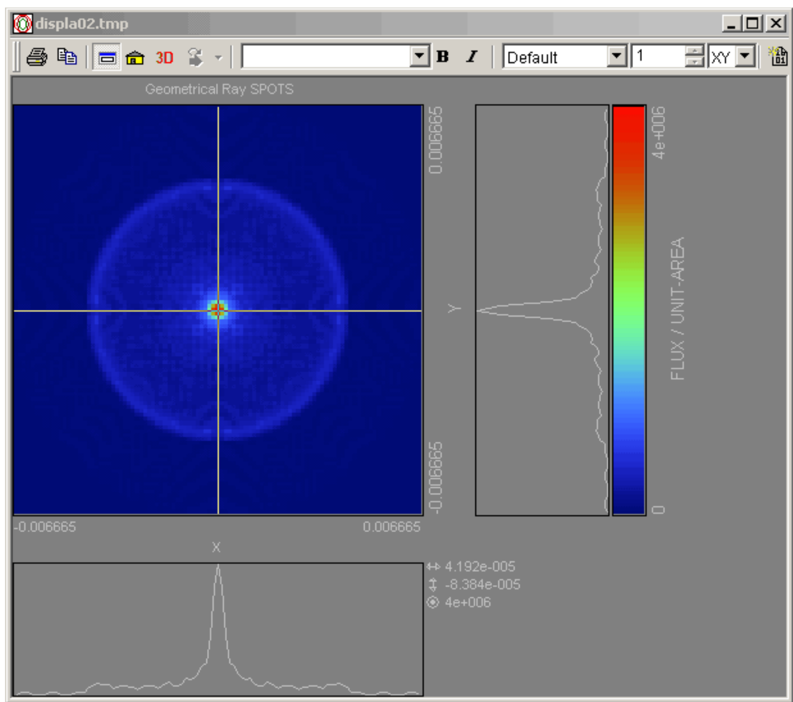
Spots diagram in Display Viewer window

2 Next, apply some averaging. From the Display menu select Processing, Average. In the dialog box, Display: AVERAGE, click **Average Over 1 Adjacent Pixel**. Click **OK**.



Apply averaging

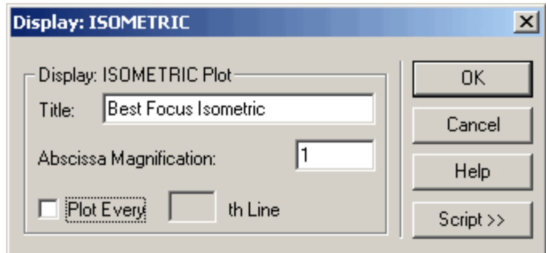
3 Make another picture with Display, Graphics, Picture to see the effect.



Effect of averaging over one adjacent pixel

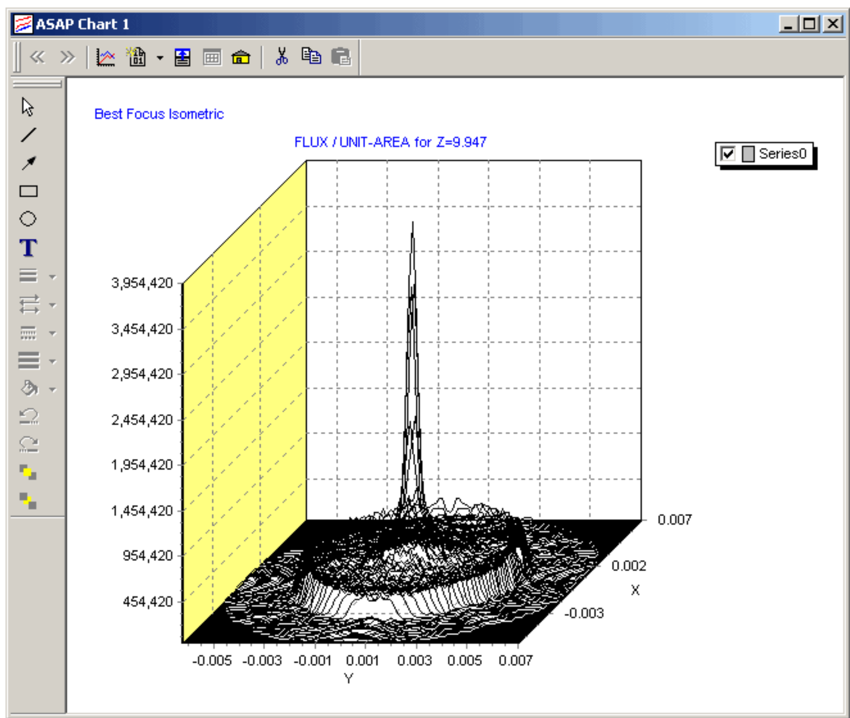
You can change the display settings by right-clicking in the area of the Display Viewer that you want to change.

4 Next, from the Display menu, select Graphics, Isometric.



Display isometric plot

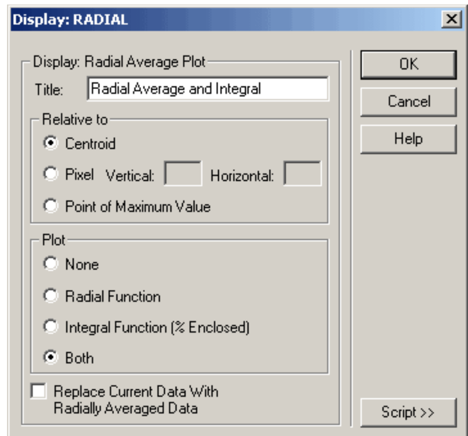
5 Type Best Focus Isometric in the **Title** textbox, and **1** in the **Abscissa Magnification** textbox. Click **OK** to view the plot in the ASAP Chart window.



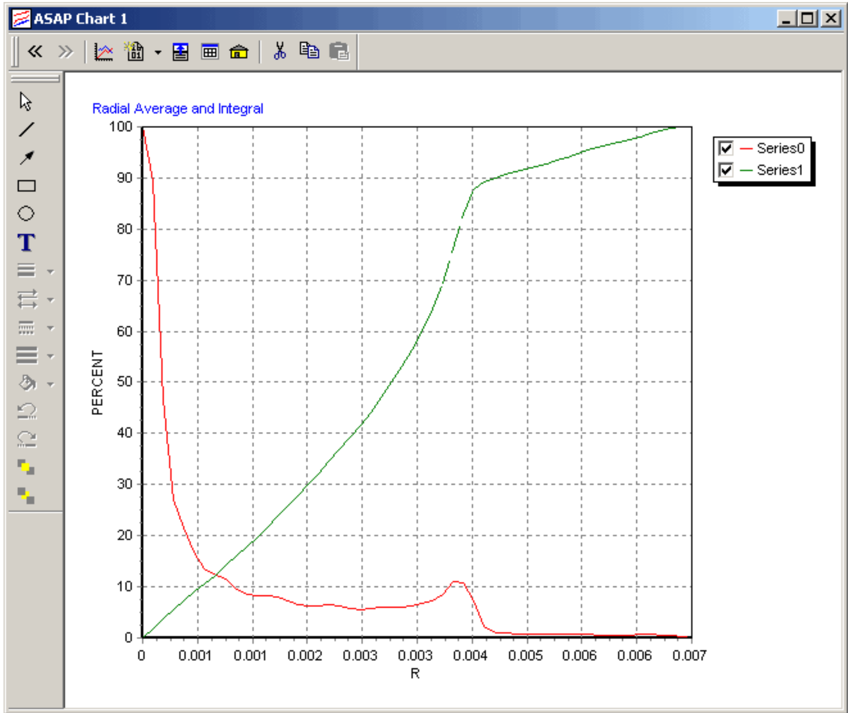
Best focus isometric plot

Finally, do a radial average of the image and plot with a cross-section of the averaged image, and the enclosed energy as a function of radius.

6 Select from the Display menu, Graphics, Radial. Use the options shown in the dialog box, Display: RADIAL, to explore where the flux is concentrated at the image.



Radial averaging of plot



Plot of radial average and integral

Performing visualization in the Builder

Now, Builder commands for the visualization tools will be used. The Display command uses a file created with the Spots Distribution command. The Picture command is a good way to visualize the flux distribution command.

1. Display and Picture are found on Analysis, Display, Display and Analysis, Display, Graphics, Picture.
2. Find the picture results with and without averaging.
3. Perform the Display command again, before averaging the numbers in the distribution file.

Finally, we want to look at other views of the distribution file. An isometric view and a radially averaged view are both useful for seeing some summary characteristics of the distribution.

4. Find the viewing commands on Analysis, Display, Graphics, Isotropic and on Analysis, Display, Graphics, Radial.

The Builder file now ends with the last commands we just used.

*	Type	Pixel i	Pixel j	Weight Op	
CMD	Display				
CMD	Picture				
CMD	Display				
CMD	Average	1	1		
CMD	Average	1	1		
CMD	Picture				
CMD	Isometric				
CMD	Radial	Pixel			Both

Radial command added

The graphic results are, once again, the same as those produced with dialog boxes. Verify this by running the Builder file.

SUMMARY

While completing this quick tour of the basic ASAP analysis process, you worked through the four basic steps required for all ASAP work:

- Creating a system, including geometrical entities, and assigning optical properties to these entities.
- Creating a source.

In this case the source was a grid of parallel rays. This may represent an extended source at infinity or a collimated source.

- Tracing the rays through the system and onto a detector.
- Performing some basic analysis.

You looked at a spots diagram before and after finding the best focus. After making a spots diagram, you created a distribution file, sorting the rays according to their location on the detector. This tour was a starting point to other forms of analysis and visualization, such as averaging.

LANIKA SOLUTIONS PRIVATE LIMITED
TF-04, Gold Signature, No. 95, Mosque Road, Frazer Town, Bangalore - 560 005, INDIA
Phone: +91 – 96866 80190 Email: info@lanikasolutions.com www.lanikasolutions.com