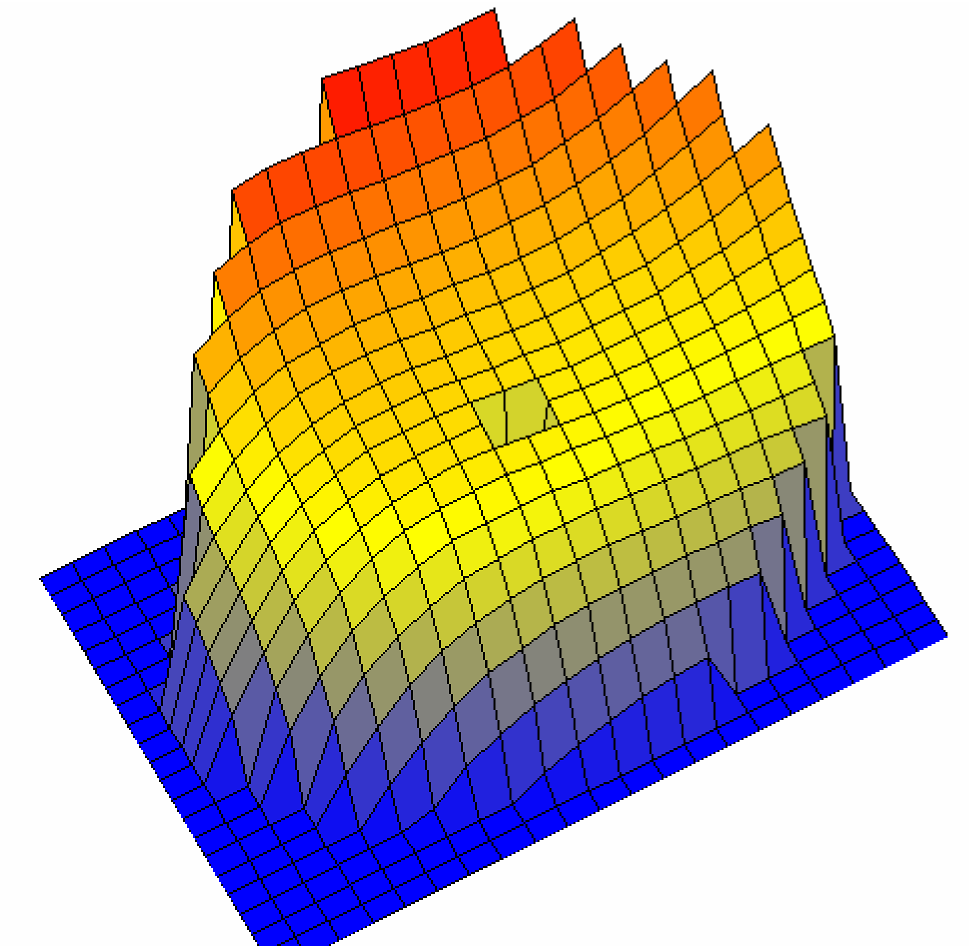
AgilEye™ Manual

Version 2.0

February 28, 2007



1717 Louisiana NE
Suite 202
Albuquerque, NM 87110
(505) 268-4742
support@agiloptics.com

Introduction

AgilEye Wavefront Analyzer is a wavefront analysis system that allows the user to view many different aspects of a beam and beam wavefront. Such aspects include the size of an incoming beam, the slopes of a wavefront, or the Zernike values of the beam. AgilEye allows manipulation of the camera data, including averaging of the images received and setting a lower intensity limit for data. AgilEye also allows customization of the AgilEye workspace, allowing up to 12 different windows to be opened at the same time, with up to three rows and four columns of windows. AgilEye analyzes the beam wavefront with a Hartmann Wavefront Sensor or a Shack-Hartmann Wavefront Sensor.

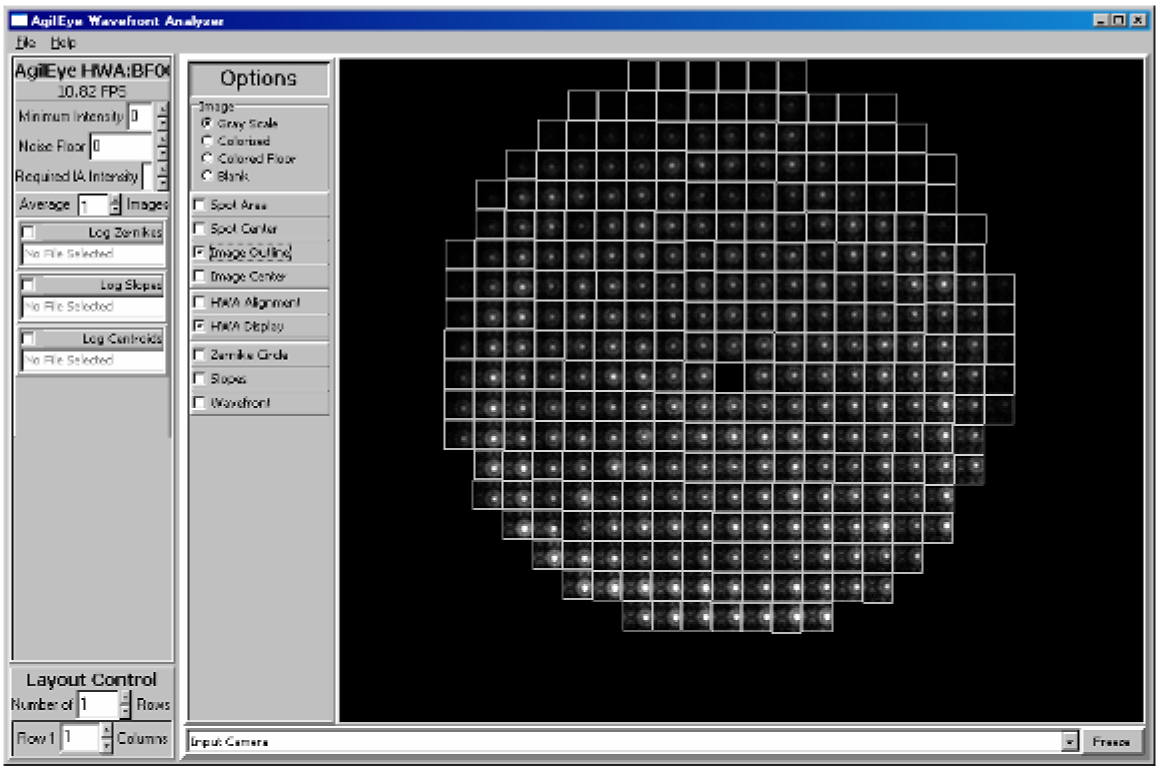


Figure 1. AgilEye

What AgilEye Does

AgilEye Wavefront Analyzer receives beam or wavefront data through a Hartmann Wavefront Sensor or a Shack-Hartmann Wavefront Sensor. When the beam passes through a wavefront sensor, the beam will be divided into many individual points of light. These points of light represent the wavefront of the beam. AgilEye will separate the wavefront into a series of boxes, with each box containing one point of light, or "beamlet". These boxes are integration areas. AgilEye calculates the centroid, first moment, and second moment of each integration area. The centroid is used to calculate the slope of the beam in each integration area. The slopes of all the beamlets is then used to calculate the Zernikes for the wavefront. The first and second moments are used to calculate the center and extents of each beamlet. AgilEye can display each integration area, their slopes, the center of each beamlet, and their extents as overlays on the raw image. AgilEye can also show a bar chart representation of the Zernike values of the wavefront. The beam wavefront can be displayed as a 3D surface that can be rotated by the user for viewing at different angles.

What AgilEye Includes

The AgilEye system consists of a computer and a Hartmann Wavefront Sensor or Shack-Hartmann Wavefront Sensor. The computer is a standard DELL computer with Windows XP installed. The computer supports USB 2.0 and has the AgilEye software pre-installed and tested on it.

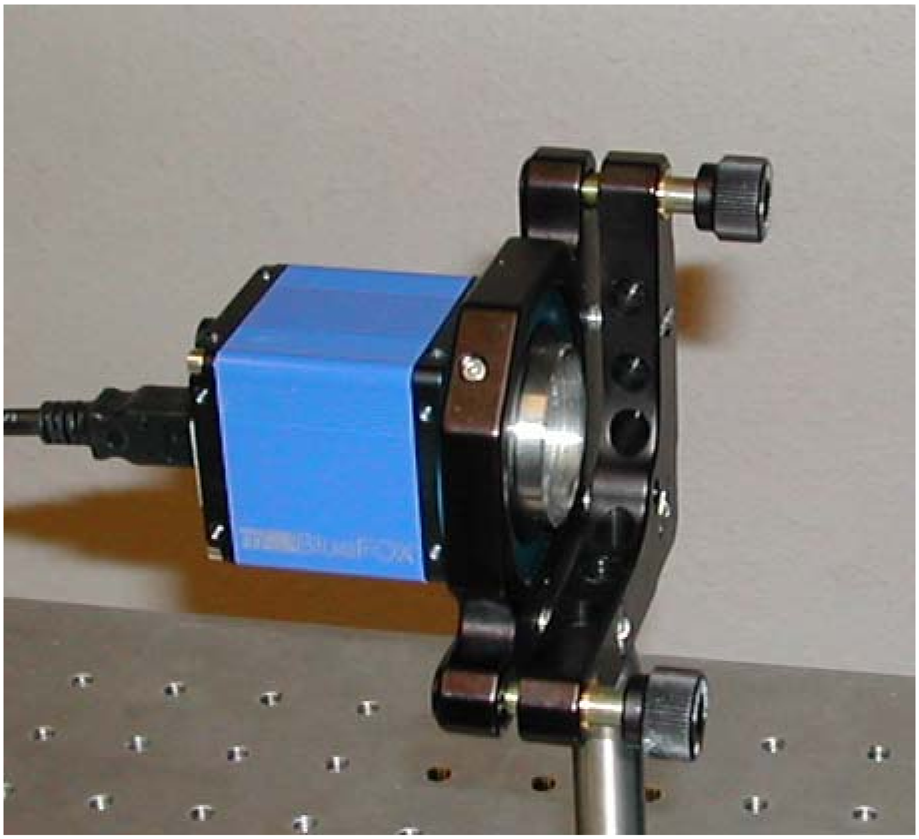


Figure 2. AgilEye Shack-Hartmann Wavefront Sensor

The Wavefront Sensor camera is a 640x480 gray-scale camera, able to, with AgilEye running, capture up to 20 frames per second of beam data. The camera communicates to the computer via a USB cable, using USB 2.0. The sensor's exposure range can be set to anywhere between 50μs to 10s. The camera sensor region is ~3.5mm across and 3.5mm high. The recommended beam size for any beam entering the camera is 3.3mm. The camera, a Hartmann Wavefront Array, will be either a Shack-Hartmann Wavefront Sensor or a Hartmann Wavefront Sensor.

The Shack-Hartmann Wavefront Sensor displays 1024 integration areas in a 32x32 integration area grid, using a lenslet array. The Hartmann Wavefront Sensor displays 676 integration areas in a 26x26 integration area grid, using a pinhole array. More information on the differences between a Hartmann Wavefront Sensor and a Shack-Hartmann Wavefront Sensor can be seen in the sections **How a Hartmann Wavefront Sensor Works** and **How a Shack-Hartmann Wavefront Sensor Works**, on pages 6 and 7 respectively.

How a Hartmann Wavefront Sensor Works

The Hartmann Wavefront Sensor (HWS) is designed to measure minute differences in a beam of light. The HWS consists of a plane of pinholes through which a beam shines onto a camera. Each pinhole represents an integration area. When the HWS is properly aligned, all the points of light will be centered in their integration areas.

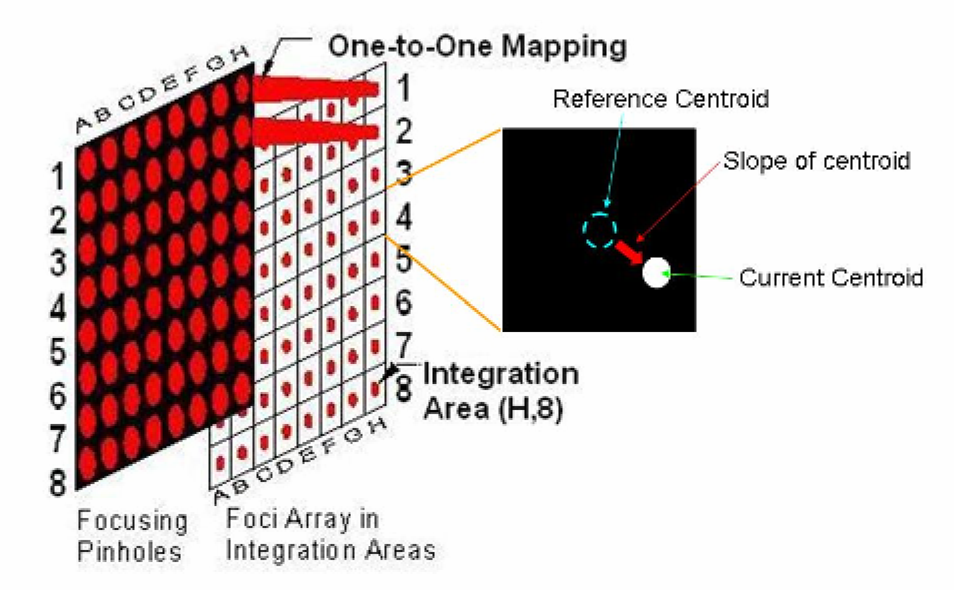


Figure 3. Pin hole integration areas of a Hartmann Wavefront Sensor

If the light shining through the pinholes is offset, and the Hartmann Wavefront Sensor is properly aligned, it means there are aberrations on the incoming beam. By measuring the slope of the integration areas, we can see how unaligned each point is. These slopes can be transformed into Zernike coefficients. Once we know what combination of Zernike coefficients make up a particular aberration, we can negate the same Zernike coefficients and place their matching voltage pattern on the mirror to correct the aberration.

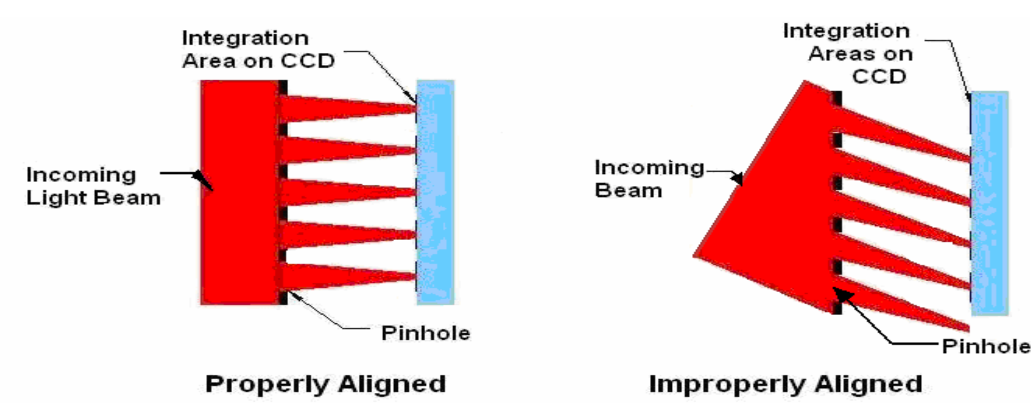


Figure 4. Proper alignment of a Hartmann WFS

How a Shack-Hartmann Wavefront Sensor Works

The Shack-Hartmann Wavefront Sensor (WFS) is similar to a Hartmann WFS. However, instead of using pinhole arrays to diffract the light onto the imaging plane, the Shack-Hartmann WFS uses lenslet arrays to focus the light onto the imaging plane. Using lenslets reduces the amount of light absorbed by the WFS, allowing the beam to retain its brightness. Alignment and aberration detection is the same for both the Shack-Hartmann WFS and the Hartmann WFS.

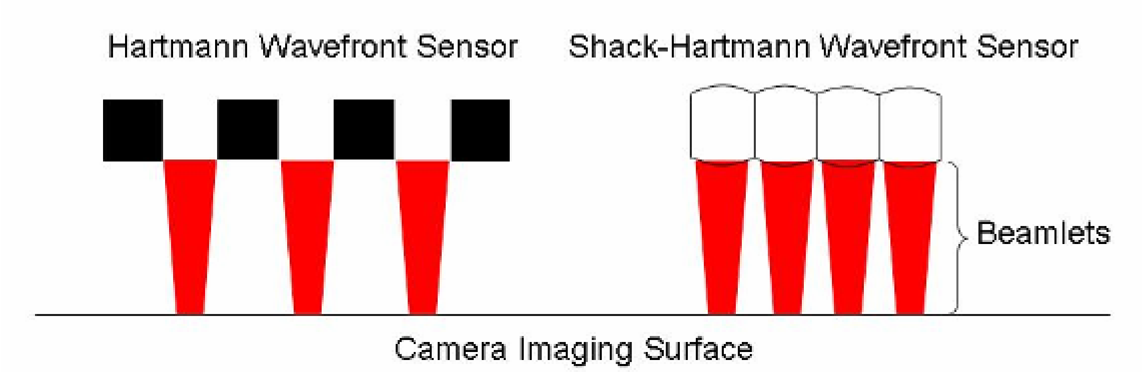


Figure 5. Hartmann and Shack-Hartmann imaging wavefronts

Proper Optical Setup

AgilEye requires a 3.3 mm diameter beam incoming to the camera. The beam must be collimated to ensure accurate readings by the wavefront sensor. This means the beam should retain its size no matter how far away the camera is placed. The camera can be added to an optical setup quickly by adding a beam splitter to give the camera it's beam and a telescope to both scale the beam to 3.3 mm and collimate it.

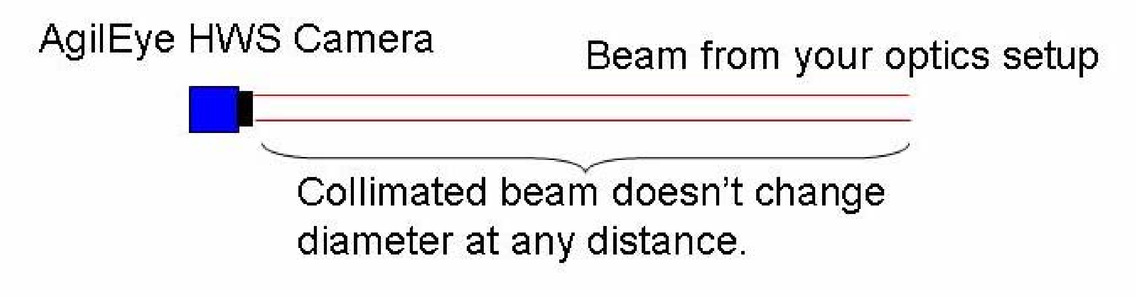


Figure 6. Collimated input beam for AgilEye

Step 1. Add a beam splitter to your optical setup that will direct the beam to where the AgilEye Hartmann Wavefront Array (HWA) will be.

Step 2. Place the HWA, in a tip-tilt mount, at the end of the optical path. Adjust the camera so that the center of the beam hits the camera at the center of the camera lens.

Step 3. Add a telescope in the beam path between the beam-splitter and the HWA. Adjust the beam until it is 3.3 mm in diameter and collimated.

Step 4. Plug in a USB cable into both your computer and the AgilEye HWA.

Figure 7. Connect the AgilEye HWS camera to your computer via a USB cable.

Step 5. Start AgilEye on the computer. You should be greeted with a display similar to the one below.

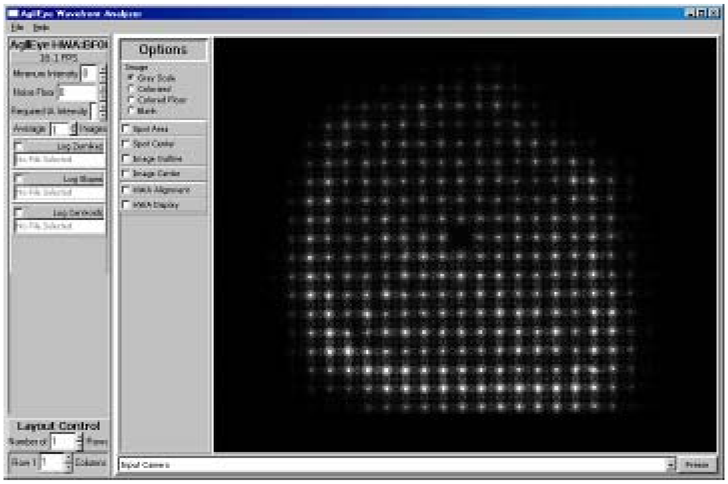


Figure 8. AgilEye Startup screen.

Step 6. In the main window, select **HWA Alignment**. A red crosshair will appear in the main display.

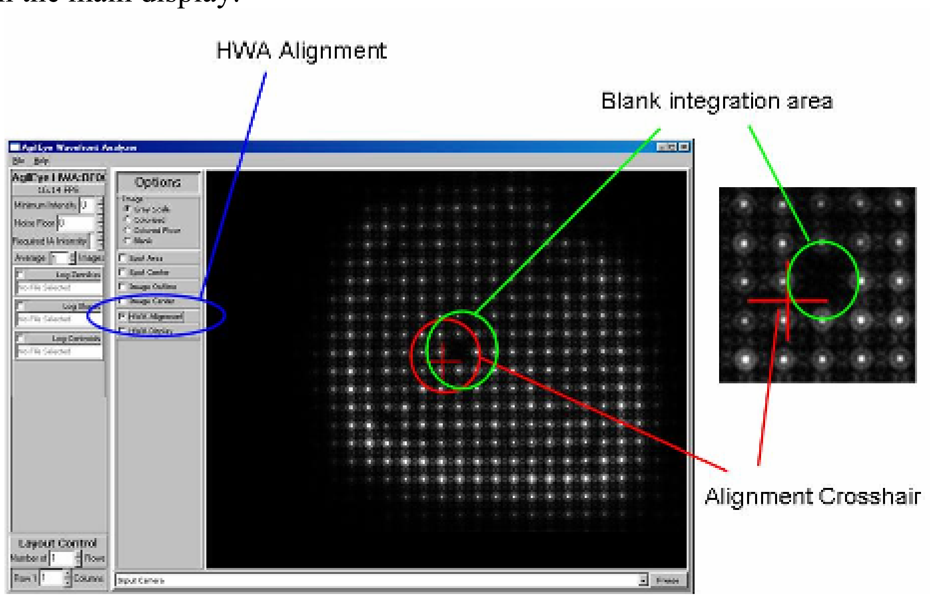


Figure 9. Unaligned Alignment Crosshair

Step 7. Near the center of the image there will be one integration area with a blank spot. Adjust that blank spot until the red crosshair is centered on it. The end-points of the alignment crosshair should be centered on the integration areas adjacent to the blank spot.

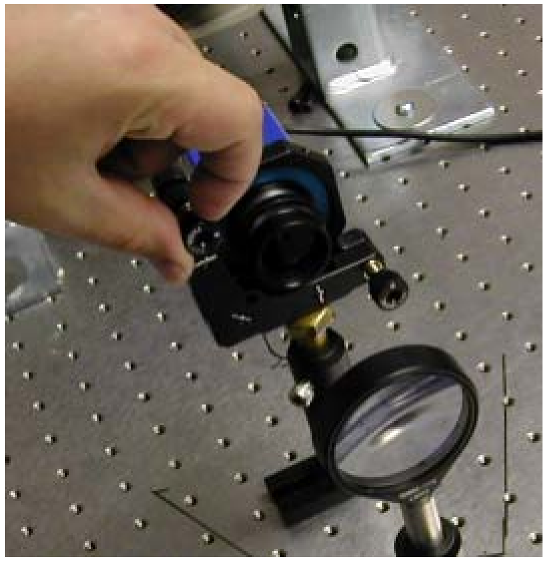


Figure 10. Adjust the tip-tilt mount on the AgilEye HWA…

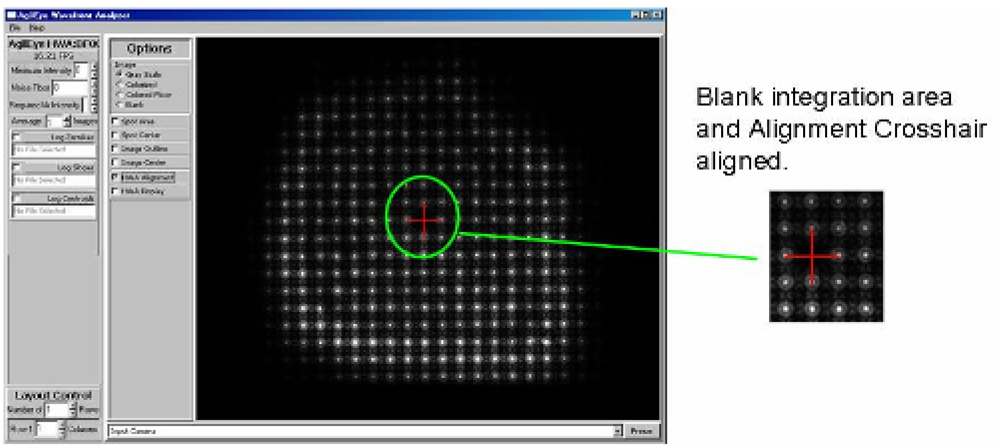


Figure 11. . . .until the Alignment Crosshair is centered on the blank integration area.

A Step 7 Note: **<u>Agilign™ Makes Alignment Easy!</u>**

When the Hartmann Array is properly aligned, all the points of light will be centered in their integration areas. AgilOptics has a proprietary system, called Agilign™ that allows the Hartmann Array to be almost perfectly aligned within seconds after setup. Agilign works by darkening (sacrificing during fabrication) the very central-most pinhole and using the black dot thereby produced to visibly identify to the user the center-most pinhole of the array as they observe the camera display. A corresponding cross has been stored in the software files during calibration at the factory and is displayed on the raw data screen. This cross designates the center of the central-most integration area, and represents a cross virtually written on the focal plane center. In the real world system setup, the dark (missing) spot on the screen and the cross (which is electronically superimposed on the camera's focal plane) are displaced in the z-axis by the focal length of the pinhole lens. This displacement allows the user to adjust the angle of the camera and the incoming beam to replicate the angles used in the factory calibration. When the missing central spot and the electronic cross are aligned, the system replicates the factory angles precisely and the WFS is aligned! The curvature plot later in Figure 20 shows the missing central integration area very clearly.

The real issue here is to be sure that the factory calibration is duplicated exactly since it is very possible to get the central-most beamlet to shine into one or more integration areas adjacent to the correct, original integration area. Many times in the past, the customer has had to rely on the back-reflection from the glass cover on the camera focal plane, with inconsistent alignment as a result. The Agilign™ system is truly a time saver and a very useful improvement, easing greatly the alignment of Hartmann sensors.

Step 8. Select **Input Camera Zernike Bars** from the drop-down menu below the main screen. A bar graph should appear in the main window.

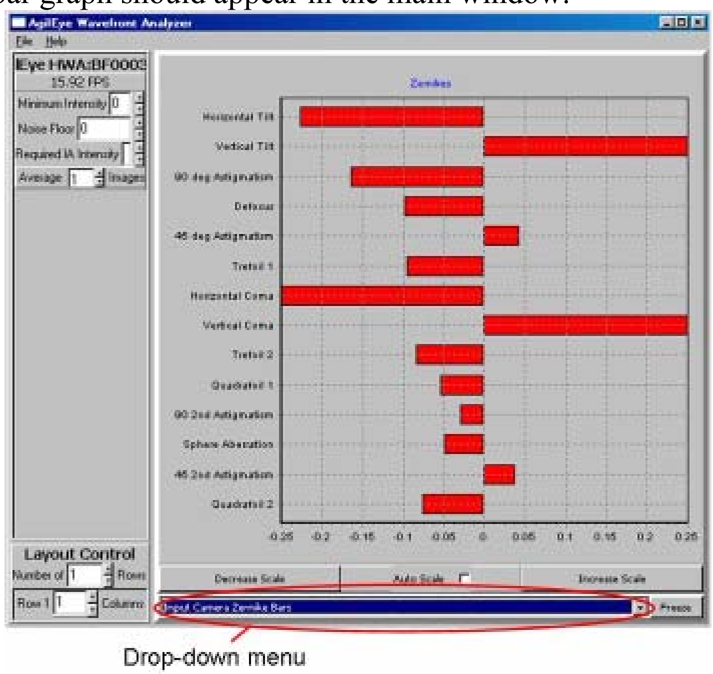


Figure 12. Input Camera Zernike Bars

Step 9. Adjust the tip-tilt mount and telescope until **X-Tilt**, **Y-Tilt**, and **Defocus** are minimized on the bar chart. When they are minimized, their bars will be very short in the center of the graph. If the optical setup is noisy, the Zernike bars may jump around. If so, try to center their range of motion on the middle of the graph, so that they jump as far to the left of center as they do to the right.

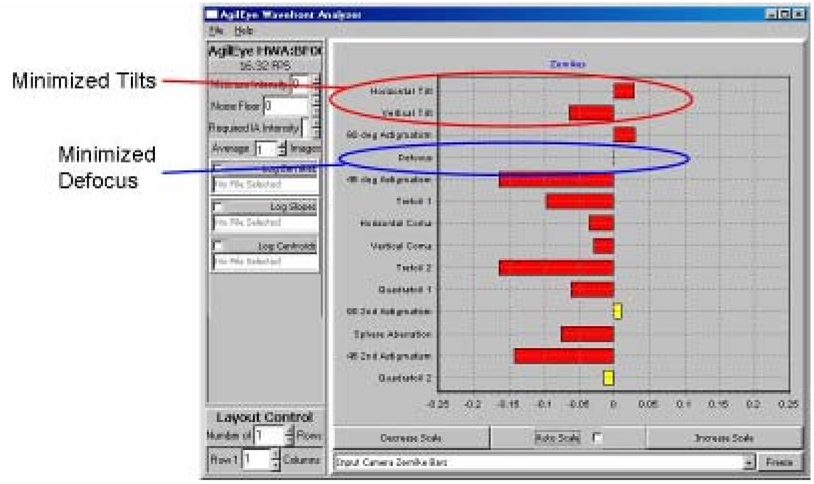


Figure 13. Minimized X-Tilt, Y-Tilt, and Defocus

Your camera is now aligned, and AgilEye is ready for you to use.

AgilEye Layout

Figure 14. AgilEye Layout

The AgilEye GUI is divided into two main sections. The left side of AgilEye is the user control side. Here the user can find camera controls, screen layout controls, and menu options. The right side of AgilEye contains the main GUI display. The main GUI display is where AgilEye displays each camera image or graph.

Main Menu

The main menu has two options. They are **File** and **Help**. **Fil**e contains the **Setup** and **Exit** options. **Setup** allows the user to select a camera for AgilEye's input images, and **Exit** closes AgilEye and saves the current settings. **Help** contains the option **About**, which contains version information for AgilEye and AgilOptics contact information.

Camera Settings

Camera Settings controls the input image from the camera. The first panel shows the currently-loaded camera. The second panel shows how quickly AgilEye is running in frames-per-second. The other panels work as follows:

Minimum Intensity	**– If the beam doesn't contain an intensity value of Minimum Intensity value or higher, no data is processed by AgilEye.**
Noise Floor	**- Any intensity values at or below Noise Floor value are set to zero.**

Required IA Intensity – **Required Integration Area Intensity. Any integration areas who's intensity is lower than the required integration area intensity are not used to calculate slopes and Zernike values.**

Average N Images - **Averages N images before making any calculations. All calculations are made on the combined average image.**

Logging Controls

The logging controls record data from AgilEye and save it to files for later use. When any of the logging controls are selected, a window pops up asking which file into which to save the data. Once chosen, AgilEye will constantly send all measured data concerning the logging topic to that file. The logging topics are:

Log Zernikes – **Logs the first 15 Zernikes for each frame of the wavefront.**

Log Slopes - **Logs the position and measured slopes of each Integration area in the wavefront.**

Log Centroids - **Logs the position of each integration area, and the position of the centroid of each integration area.**

Layout Controls

The layout controls determine how many display windows appear on the main GUI side of AgilEye, and their relative positions. AgilEye supports up to three rows of display windows, with four columns of display windows per row for a total of twelve display windows.

Main GUI Display

The Main GUI Display is actually just a display window. Up to twelve display windows can be viewed at a time, each with their own data. The image in a particular display can be "frozen" with the **Freeze** button. To return the display window to updating regularly, select **Release**, a button that appears when the display is frozen. To switch what sort of image a display has, select the image type you wish from the GUI Window Display Selector. The GUI choices are:

Input Camera - **Displays what the camera sees. When this mode is selected, a list of options appears to the left of the image. These options alter what the display shows. More detail on these options can be found on page 18.**

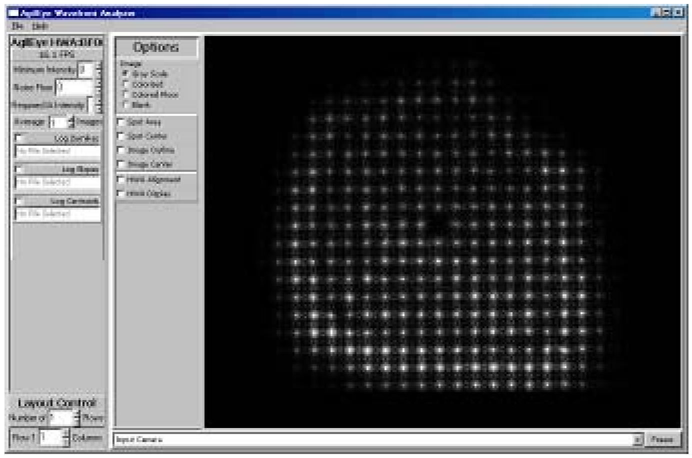


Figure 15. Input Camera view

Input Camera Three Dimensional - Displays a three-dimensional plot of what the camera currently sees. The height component is the intensity of the image that that point.

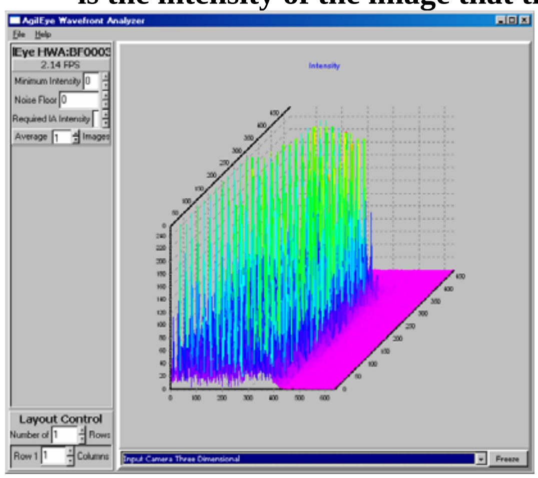


Figure 16. Input Camera Three Dimensional

Input Camera Zernike Bars - Displays the Zernike values for a wavefront from a Hartmann Wavefront Sensor or Shack-Hartmann Wavefront Sensor. Bars going left from the center represent negative Zernikes, while bars going right represent positive Zernikes. The Zernike Bar graph can be scaled to fit the user's needs.

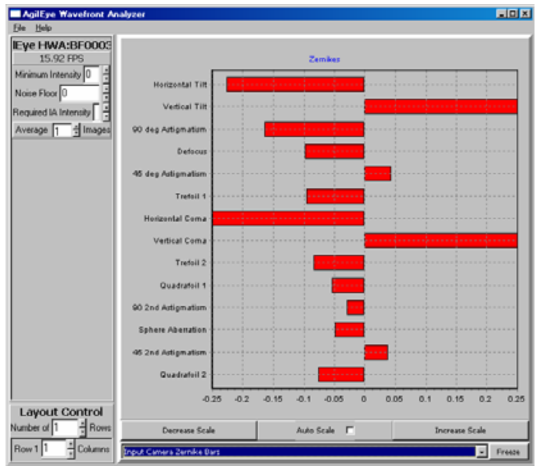


Figure 17. Input Camera Zernike Bars

Input Camera Three Dimensional Wavefront - Displays the wavefront from a Hartmann Wavefront Sensor or a Shack-Hartmann Wavefront Sensor as a three-dimensional model. The user may use left-click and drag to rotate the three-dimensional image to an angle of their liking.

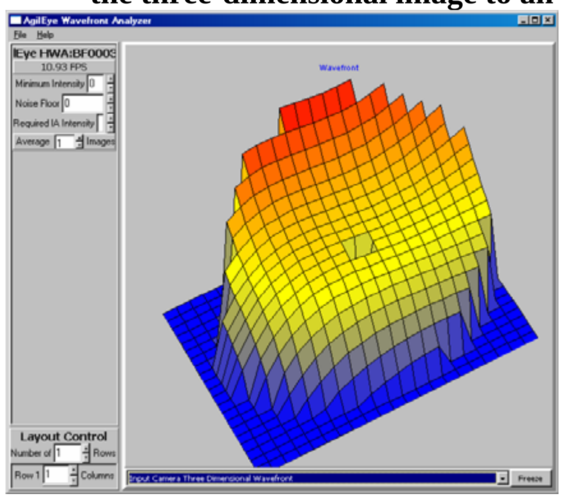


Figure 18. Input Camera Three Dimensional Wavefront

Camera Setup

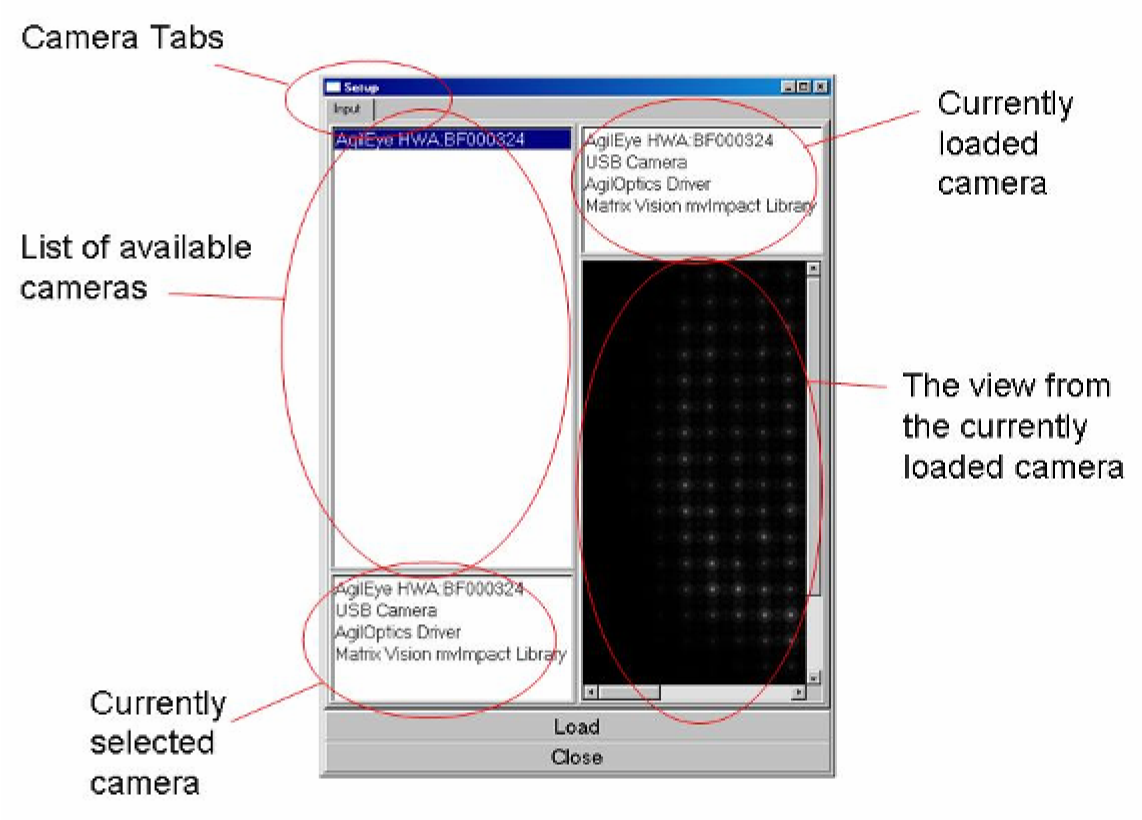


Figure 19. Camera Setup Window

The Camera Setup window can be found by selecting *File->Setup* in the main window. The Camera Setup window allows the user to select which camera is currently being used by AgilEye. The Camera Setup window comes with the following sub-windows and buttons:

Camera Tabs - **The Camera Tabs display each camera AgilEye has loaded.**

Camera List - **The Camera List shows all cameras that AgilEye detected on the USB. Single-clicking one of the camera names listed here will cause that camera's information to appear in the currently-selected-camera display box. Double-clicking one of the camera names will load that camera.**

Currently Selected Camera - This box displays the currently-selected camera. The currently-selected camera is the camera who's name is highlighted in the camera list.

Currently Loaded Camera – This box displays the currently-loaded camera. The currently-loaded camera is the last camera that was loaded by AgilEye. A loaded camera displays its view in a window below the Currently Loaded Camera box.

Load - This button loads the currently-selected camera. If the currently-selected camera is already loaded, nothing happens.

Close - This button closes the Camera Setup window.

Main GUI Display

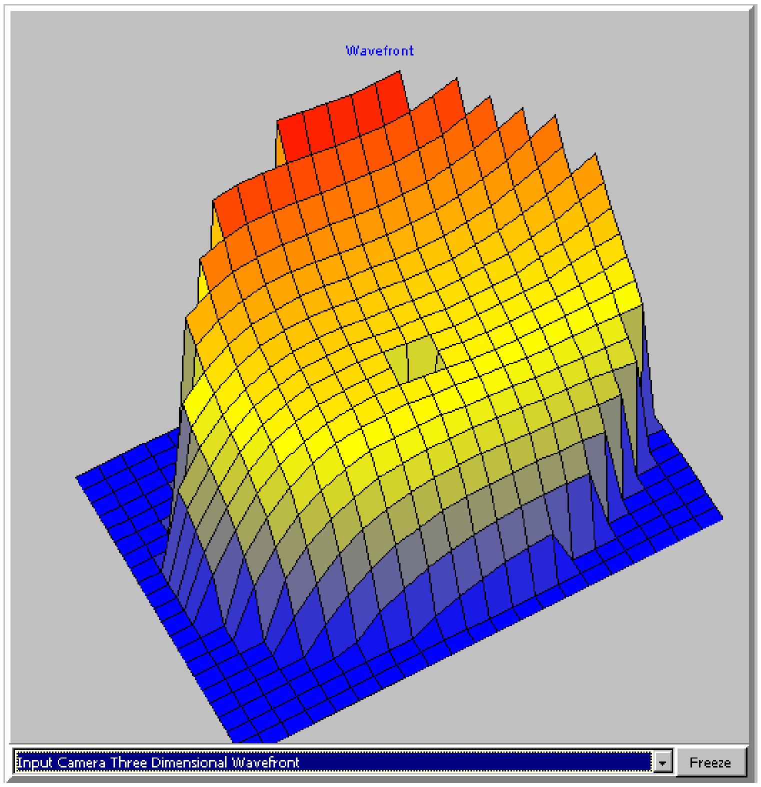


Figure 20. Main GUI Display

The Main GUI Display shows the output of AgilEye. Up to twelve displays may be active at the same time. Each one can show it's own graph or image. The image in a Main GUI Display can be "frozen", using the **Freeze** button, preventing it from changing until the user releases the frozen image by pressing **Release**. The Main GUI Display can display four different types of graphs. They are **Input Camera**, **Input Camera Three Dimensional**, **Input Camera Zernike Bars**, **and Input Camera Three Dimensional Wavefront**. The **Input Camera Three Dimensiona**l, **Input Camera Zernike Bars**, and the **Input Camera Three Dimensional Wavefront** choices have been covered in the AgilEye Layout section on page 12.

Input Camera

The Input Camera screen, when selected, shows the loaded camera's current view. Extra options become available on the left side of the image when **Input Camera** is selected. These options are as follows:

Image - **The Image radio buttons have the following effects:**

1. Gray Scale – Displays the main image in gray-scale.
2. Colorized - Displays the main image in rainbow colors based on pixel intensity. Low-intensity pixels are purple, high-intensity pixels are red, and the pixels in-

between range from blue to orange in rainbow color order. Zero-intensity pixels are colored black, while maximum intensity pixels are colored white.

3. Colored Floor – Any pixels at or below the Noise floor are colored light-blue.

4. Blank – Cannot be selected if no other Input Camera options are selected. Otherwise, it removes the camera image from the background of the image, allowing all the features of the other option(s) to be seen by themselves.

Spot Area - When HWA Display is not selected, Spot Area shows the second moment of the beam in X versus the second moment of the beam in Y. When HWA Display is selected, Spot Area shows the second moment of each beamlet in X versus the second moment of the same beamlet in Y.

Spot Center - When HWA Display is not selected, Spot Center shows the first moment of the beam. When HWA Display is selected, Spot Center shows the first moment of each beamlet in the wavefront.

Image Outline - When HWA Display is not selected, Image Outline draws a rectangle around the entire input beam. When HWA Display is selected, Image Outline draws a rectangle around each active integration area in the wavefront.

Image Center - Draws two lines that intersect at the center of the image display, not the center of the beam. This assists in centering the beam at the image center during alignment of the camera.

HWA Alignment - Draws a crosshair that, when the wavefront is aligned with the camera, should be centered on the blank integration area near the middle of the wavefront. If the crosshair is not centered on the blank integration area, the incoming beam is not aligned with the camera. Adjust the camera tip and tilt until the beam and camera are aligned.

HWA Display - When selected, HWA Display excludes from view all integration areas outside of the unit Zernike circle of the wavefront. Three more options become available when HWA Display is selected:

1. Zernike Circle – Draws the unit Zernike circle around the wavefront.

2. Slopes – Draws the slopes for each integration area inside the unit Zernike circle. The slope starting points are

centered on their integration area, with the end-point pointing the direction the beamlet is sloping in that integration area. The length of the line shows how steep the slope is.

4. Wavefront – Draws the integration areas as colored squares, with the color of the square determined by how close that integration area is to a perfect wavefront. Almost perfect integration areas are purple, while mostly incorrect integration areas are red. All integration areas in-between them range from blue for near-perfect to orange for high imperfections, in rainbow color order. Perfect integration areas are black, while completely imperfect integration areas are white.

Each of the **Input Camera** options has colors associated with it. To change the colors, right-click on the option. A new window will appear. This window contains the basic color choices. Left-click to choose one of the basic colors, or select **Define Custom Colors** to extend the colors window. The extension contains a color map, hue, saturation, and luminosity edits, red, green, and blue color edits, and a darkness slider. You can define any custom color you would like and save it as one of the 16 possible custom colors by selecting **Add to Custom Colors**. These custom colors can then be chosen just like normal colors. Select **OK** once all the colors you wanted are chosen.

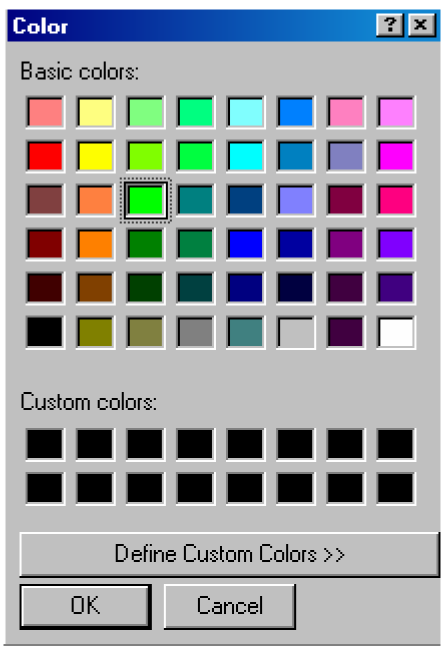


Figure 21. Basic colors screen

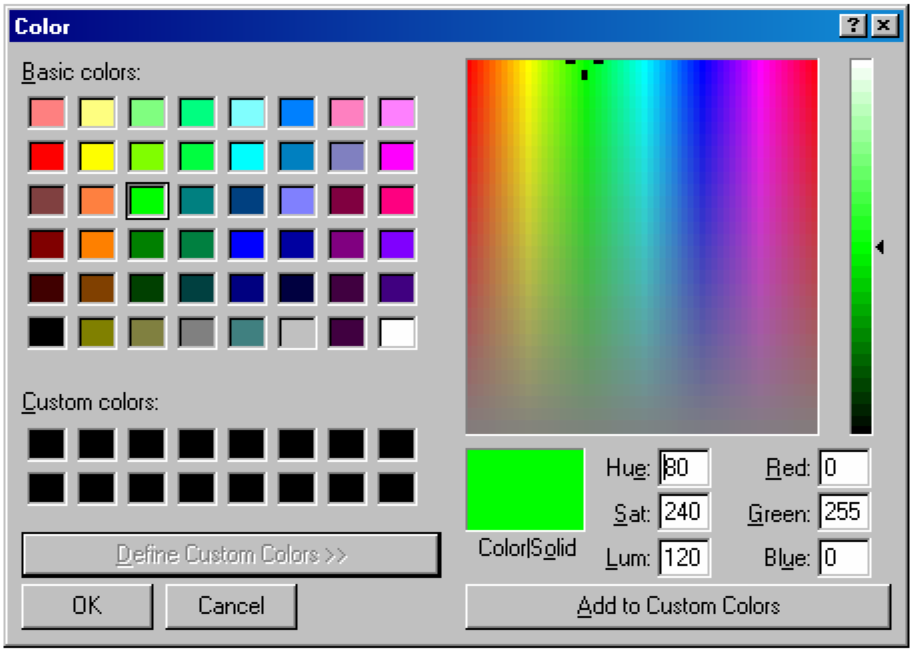


Figure 22. Custom colors screen

Quick Start Guide

The Quick Start Guide is designed to get the user familiar with the capabilities of AgilEye by taking them through every one step-by-step. The Quick Start Guide assumes AgilEye has no initialization file available, and may be used to get AgilEye up and running if no initialization file exists.

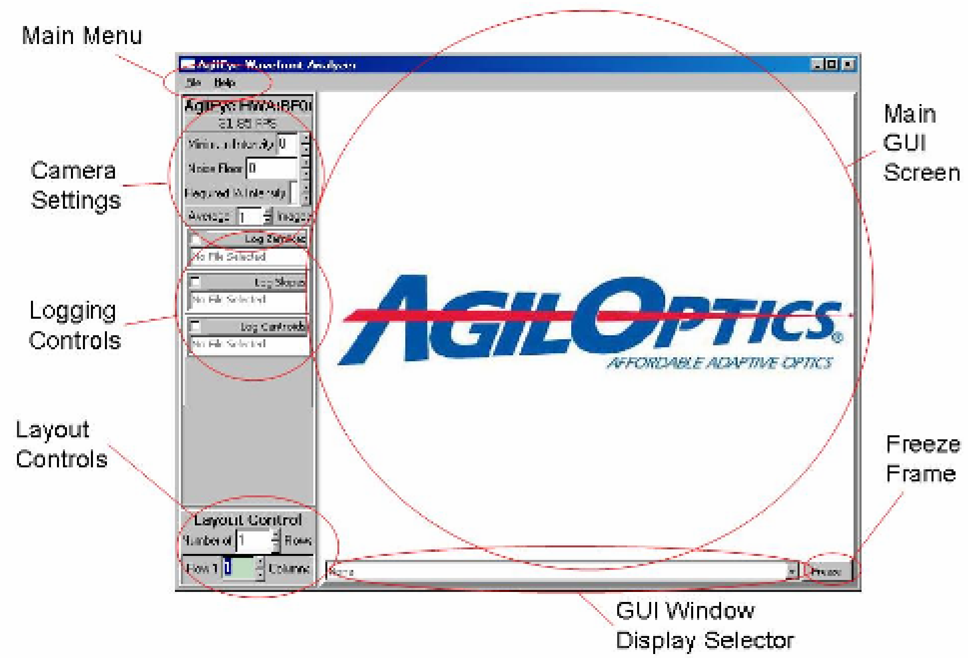


Figure 23. AgilEye Main GUI Controls

1. When you first bring up AgilEye, you will be met with the following screen:

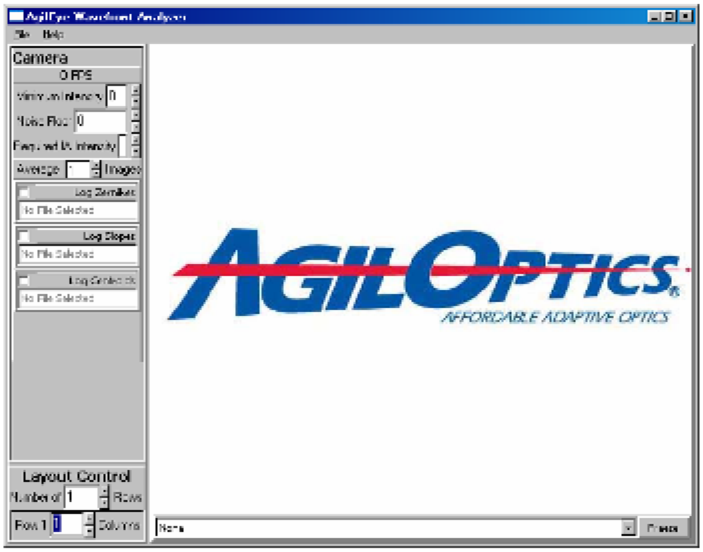


Figure 24. AgilEye Starting Screen

2. Your first task will be to initialize the camera you wish to use. Select *File->Setup* from the menu bar. The window seen in Figure 25 should pop up.

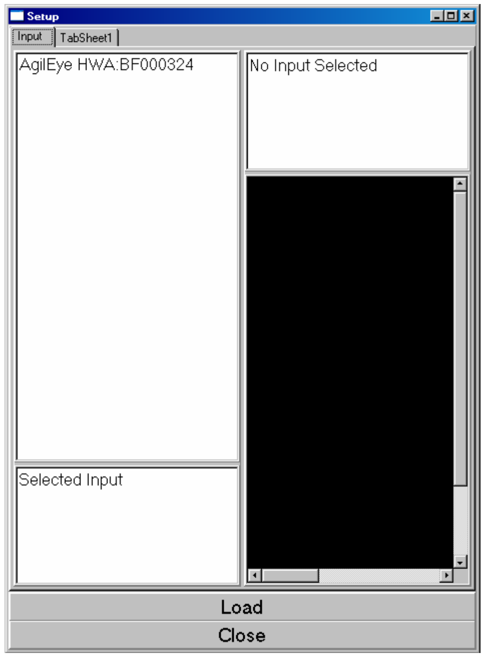


Figure 25. Camera Setup initial view

3. Under the first tab, there should be a list of available cameras. Find the one you wish to use and double-click on it. Information about the selected camera should appear in the window on the upper-right. Also, a screen should appear in the lower right, showing you what the camera currently sees. This means your camera successfully loaded.

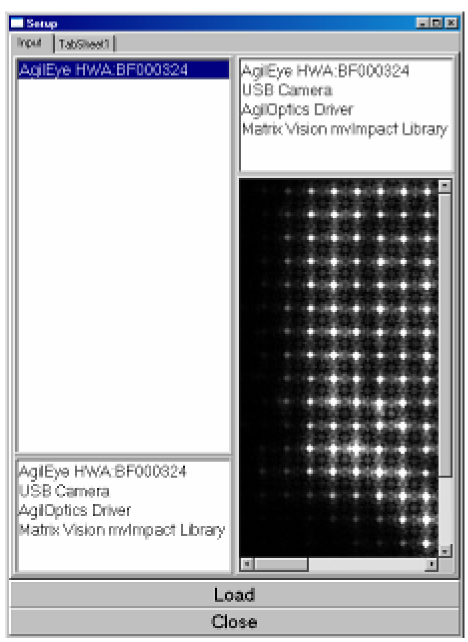


Figure 26. After loading a camera

4. Select **Close** at the bottom of the window. The main screen should now look like this:

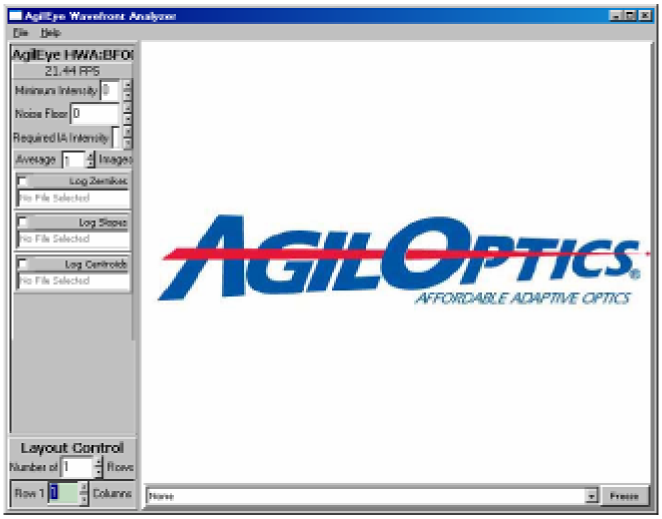


Figure 27. AgilEye Main with a camera loaded

5. Right now, we can't see what the camera shows. Using the GUI Window Display Selector, choose **Input Camera**. You should now be greeted by a screen that shows something like this:

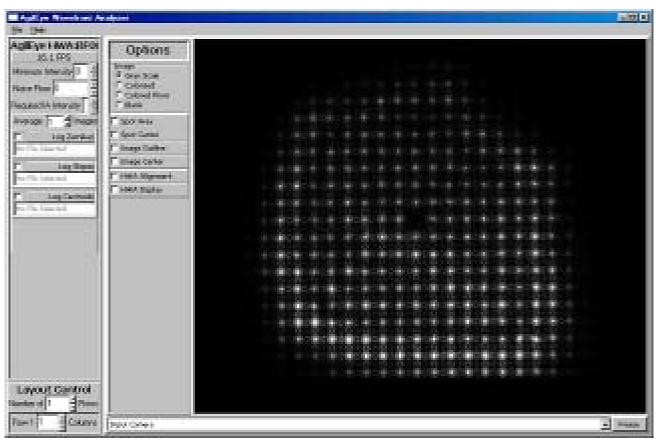


Figure 28. Input Camera Window

6. As you can see, a number of options have appeared on the left side of the GUI. Right now, only **Gray Scale** is selected under the **Image** sub-menu. Let's see what **Colorized** does. Select **Colorized** under the **Image** sub-menu. You should see similar colors to Figure 29.

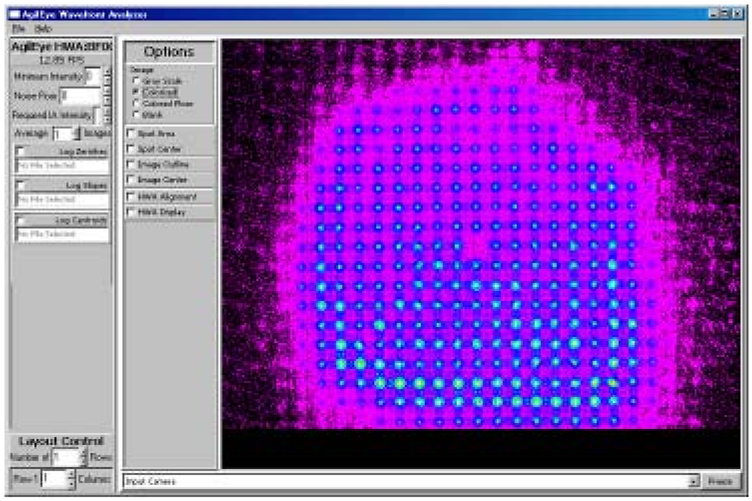


Figure 29. The Input Camera with a Colorized image

7. **Colorized** made all the different intensities of light on the camera take on the colors of the rainbow, with purple and blue representing low intensities and red and orange representing the high intensities. Let's try the next option. Select **Colorized Floor** from the **Image** sub-menu. You should see a similar image to the one below:

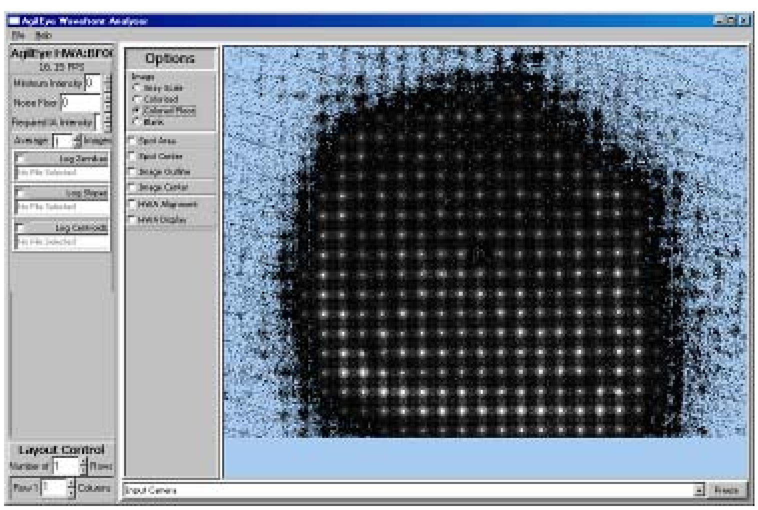


Figure 30. The Input Camera with a Colorized Floor

8. With **Colorized Floor**, all intensities less-than or equal to the floor value are colored light-blue. There's only one option left under the Image sub-menu, but it requires other **Input Camera** options to be selected, so we'll show it later. Instead, we'll go back to **Gray Scale**. Select **Gray Scale** again, from the **Image** sub-menu. We should be greeted with a familiar image.

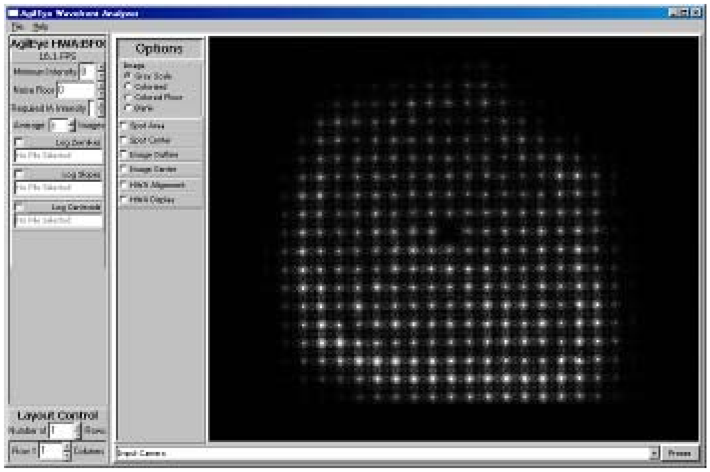


Figure 31. The Input Camera in Gray Scale

9. The next option available is **Spot Area**. Select **Spot Area** from the list of **Input Camera** options. You should see a circle appear on the image like the one shown below.

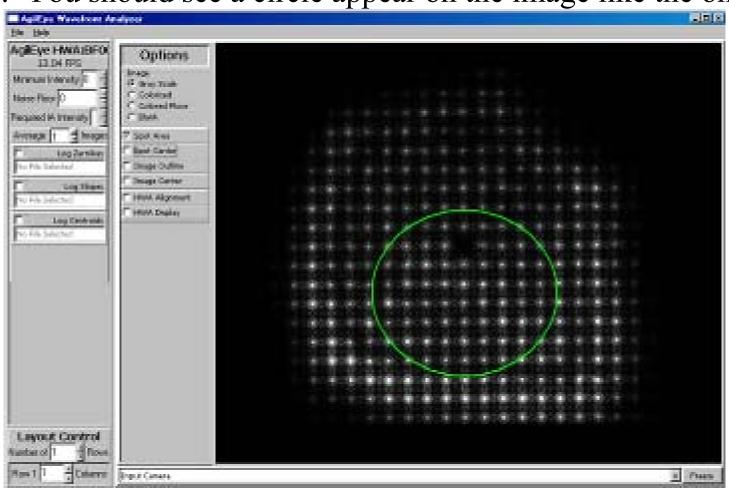


Figure 32. Spot Area

10. The **Spot Area** is the second moment of the incoming beam in X versus the second moment of the beam in Y. Deselect the **Spot Area** option and select the **Spot Center** option for our image.

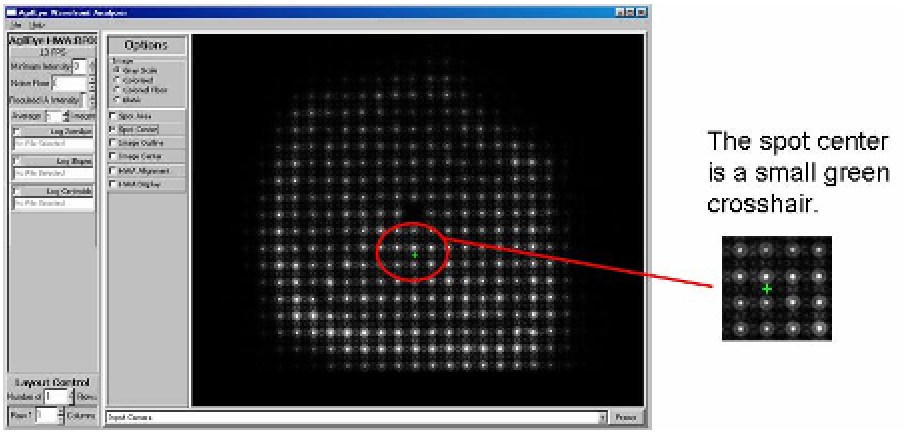


Figure 33. The Spot Center of the incoming beam

11. The **Spot Center** is the center of the beam, calculated as the first moment of the beam in X and Y. It is a very small crosshair. Deselect **Spot Center** and select **Image Outline**.

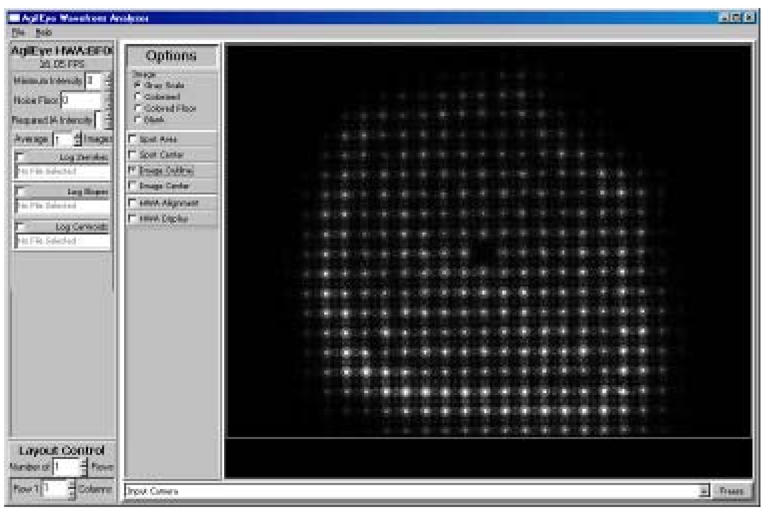


Figure 34. Image Outline outlines the whole image

12. **Image Outline** outlined the whole beam in a rectangle. Image Outline has a more important purpose that we'll see later. For now, deselect **Image Outline** and select **Image Center**.

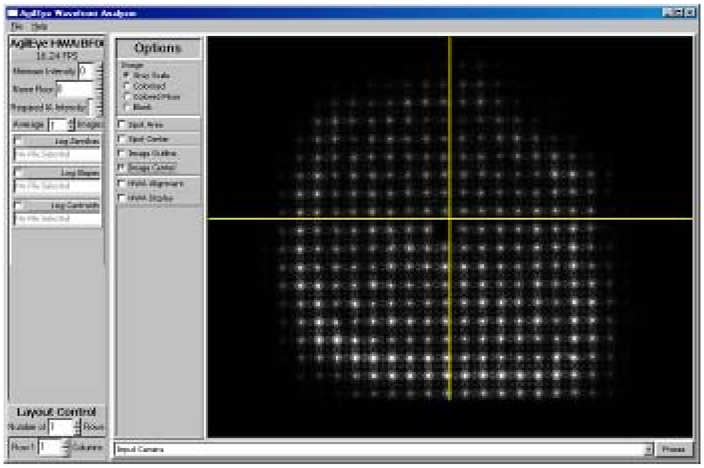


Figure 35. Image Center

13. **Image Center** puts a crosshair through the camera window. It bisects the image in both the X and Y axes. Now on to the Hartmann Wavefront Analysis (HWA) portions of the Quick Start Guide. Please deselect **Image Center** and select **HWA Alignment**.

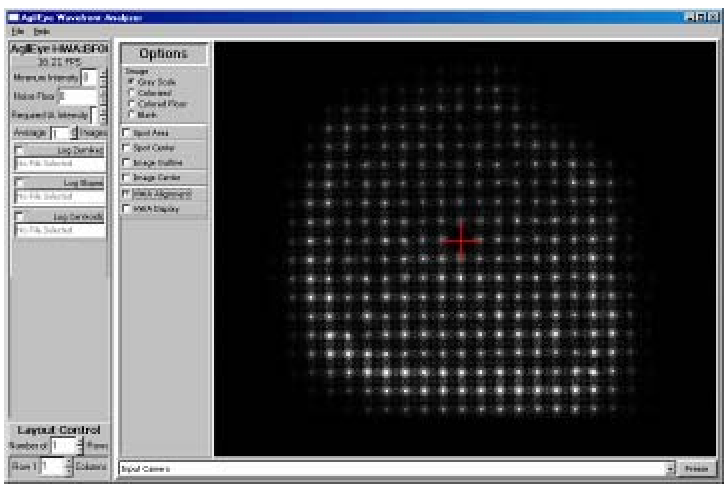


Figure 36. HWA Alignment Crosshairs.

14. The HWA alignment crosshair should be centered on the black square in your beam. If your alignment crosshair is not centered on the black square, adjust the tip and tilt of your camera until they are. Deselect **HWA Alignment** and select **HWA Display**.

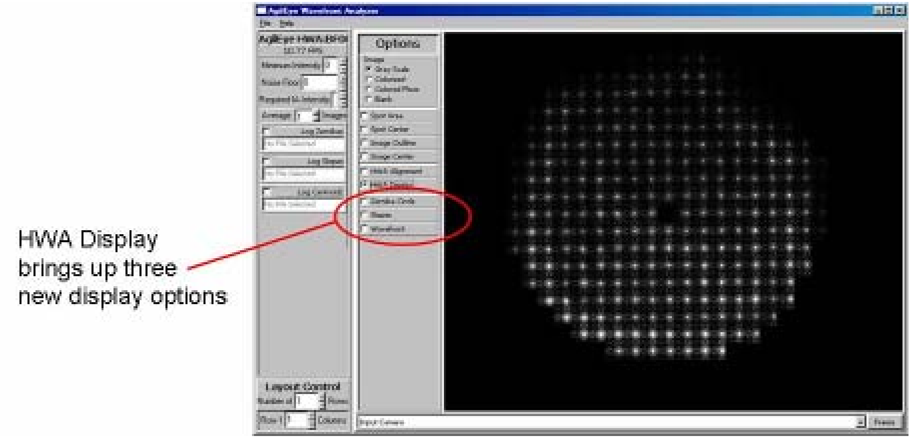


Figure 37. HWA Display

15. Some of the outer dots on the camera have been removed from the screen. These points were outside of the unit Zernike circle and won't be used for Zernike measurements. Three more options have appeared. They are Zernike Circle, Slopes, and Wavefront. For now, keep **HWA Display** selected, and select **Zernike Circle**.

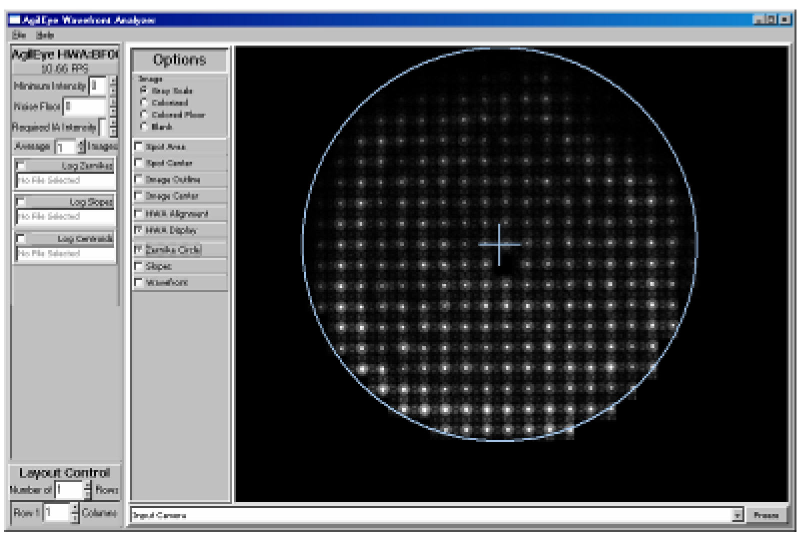


Figure 38. HWA Display and Zernike Circle

16. **Zernike Circle** shows the outline of the unit Zernike Circle. Now deselect **Zernike Circle** and select **Slopes**.

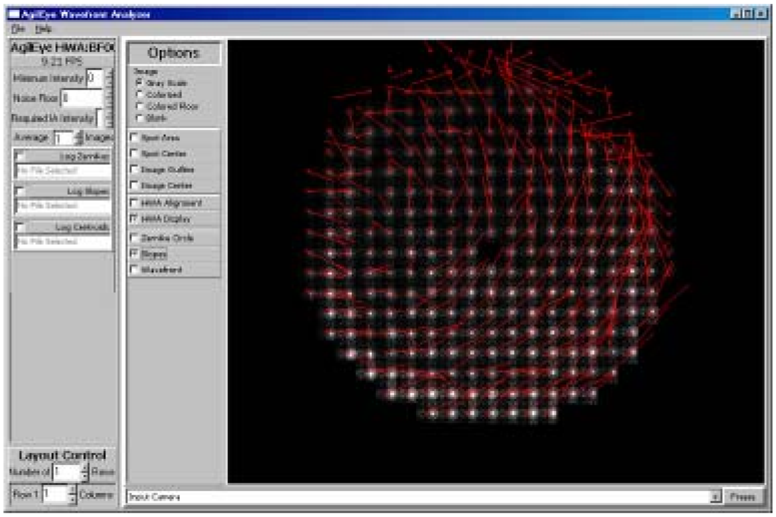


Figure 39. HWA Display slope lines.

17. The red bars are the slopes of the incoming beam at each point in the Zernike circle. Their length is proportional to the magnitude of the slope. They are five times longer than their actual magnitude. Deselect **Slopes** and select **Wavefront** to see something similar to Figure 40.

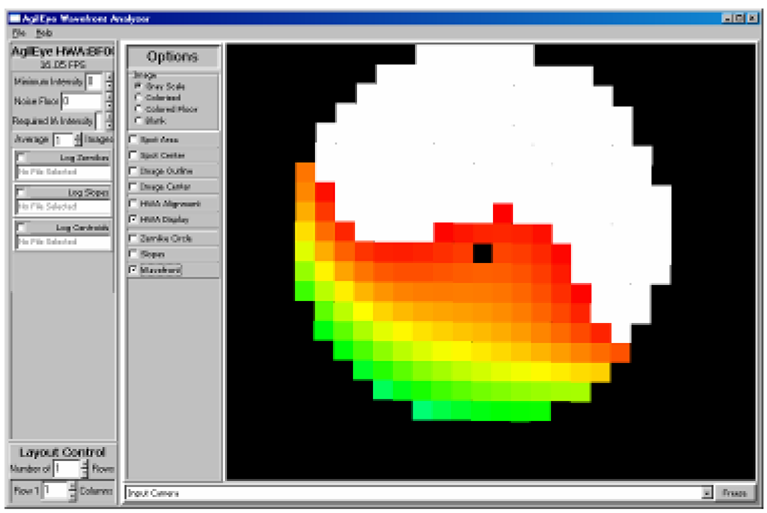


Figure 40. HWA Display and Wavefront

18. The **Wavefront** display shows the wavefront, colorized based on the offset from a perfect wavefront. A perfect wavefront would be black. The worst possible wavefront would be white, with the rest of the possible wavefront values ranging from purple, very close to a perfect wavefront, to red, very close to the worst possible wavefront, in rainbow color order. Now, deselect **Wavefront** and select **Spot Area** again.

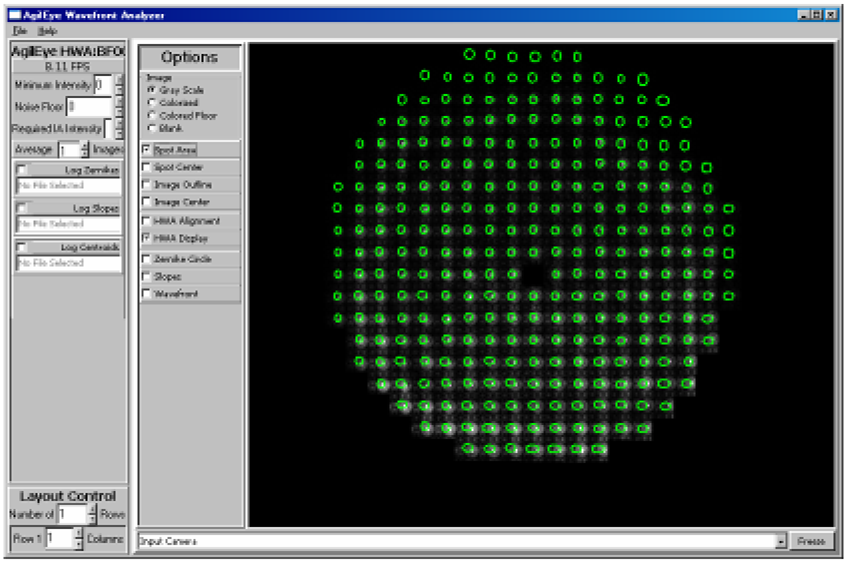


Figure 41. HWA Display and Spot Area

19. When **Spot Area** and **HWA Display** are selected, the image shows the spot area for each spot in the HWA display. The spot area is the second moment of the incoming beamlet. The reference centroid was determined upon creation of the HWS camera. Deselect **Spot Area** and select **Spot Center** instead.

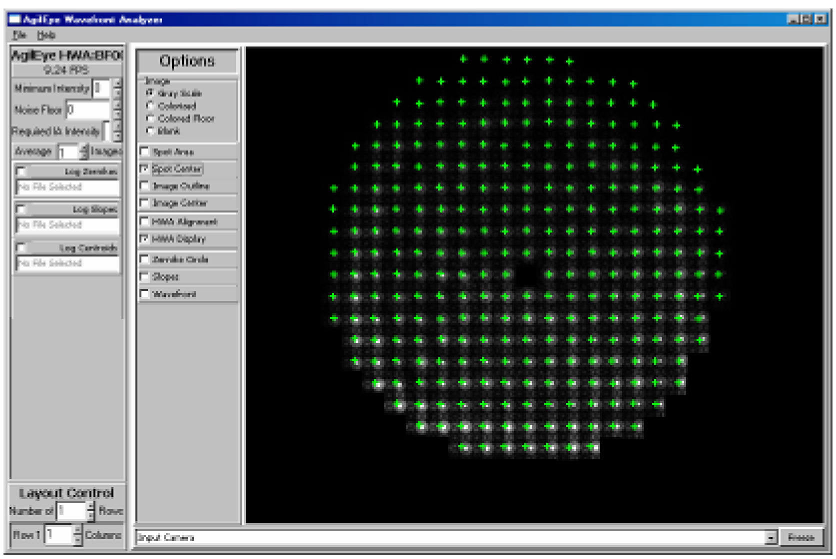


Figure 42. HWA Display and Spot Center

20. **Spot Center** and **HWA Display** show the center of each spot in the HWA display. These centers are the centroid for each integration area in the Hartmann Wavefront Sensor. If we deselect **Spot Center** and select **Image Outline** instead, we'll see more on these integration areas.

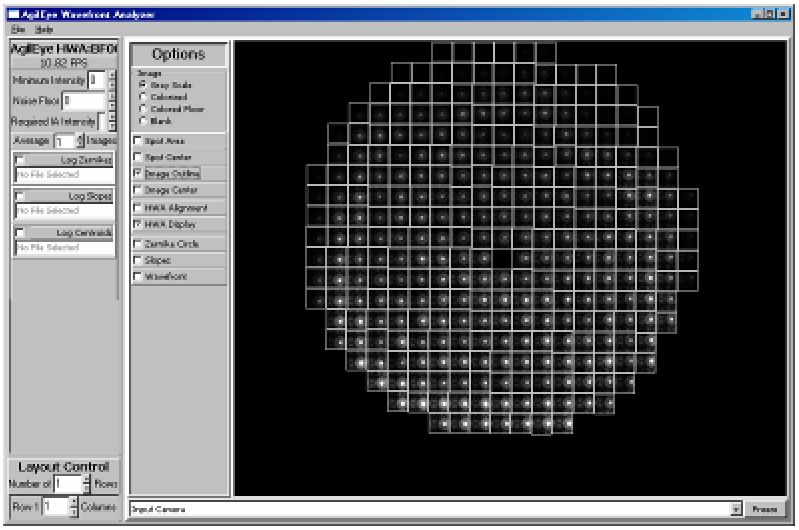


Figure 43. Boundaries appear with Image Outline and HWA Display selected

21. **Image Outline** now shows us each integration area in the Hartmann Wavefront Sensor. These integration areas are used to calculate everything from the slopes we've seen to the Zernike values for the wavefront. Now, deselect **HWA Display** and **Image Outline**.

22. Select both **Spot Area** and **Blank**.

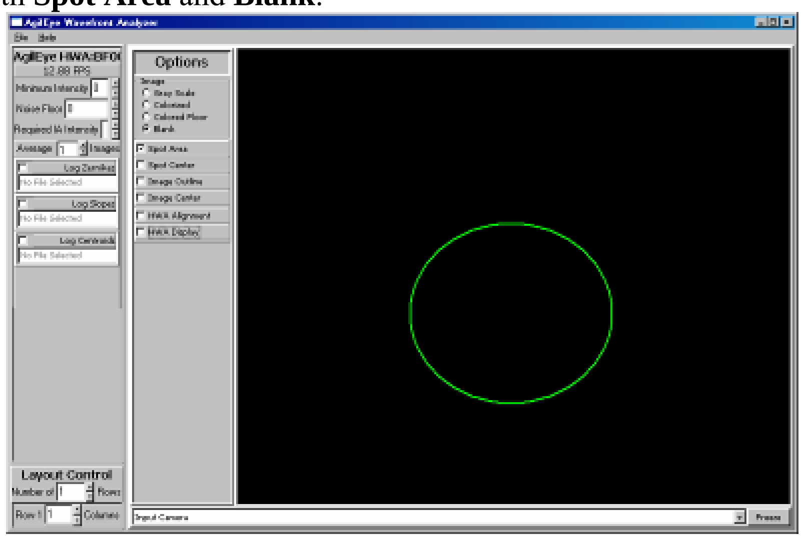


Figure 44. Spot Area and a Blank image.

23. Blank is only useable if there is something besides the image that is being displayed. It removes the camera image and only shows the overlay, be it slopes, spot area, or whatever. Now, let's look at some of the other displays the main window has. On the GUI Window Display Selector drop down menu, select **Input Camera Three Dimensional**.

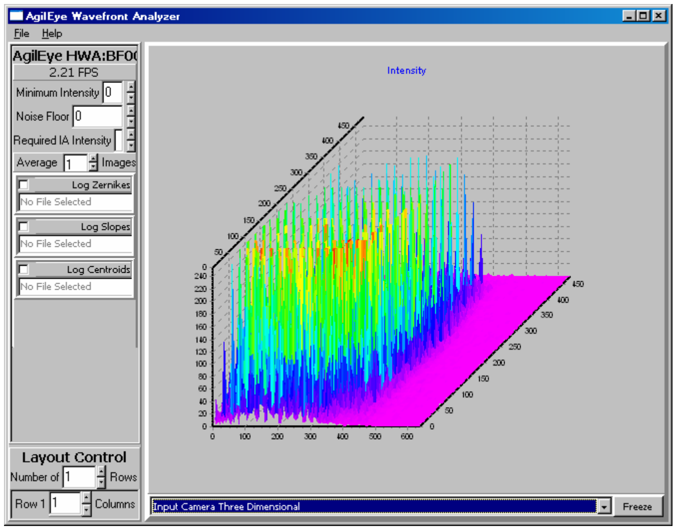


Figure 45. Input Camera Three Dimensional

24. **Input Camera Three Dimensional** shows a three-dimensional graph of the raw camera image, with the third dimension being the intensity of the image. Now, in the **GUI Window Display Selector**, select **Input Camera Zernike Bars**.

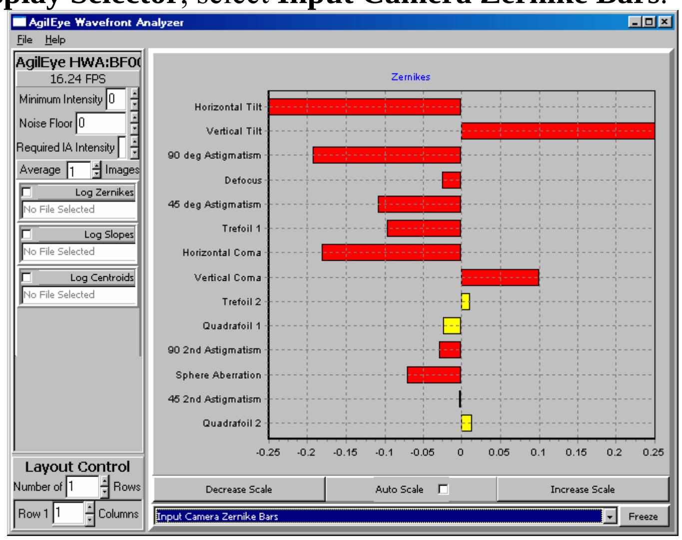


Figure 46. Input Camera Zernike Bars

25. The Zernike bars show the magnitude of each Zernike measured within the Zernike circle. Each Zernike is labeled with it's name. Negative Zernikes have bars going left from the zero line, while positive Zernike bars go right. The Zernike Bars image can be scaled with an Increase Scale button, a Decrease Scale button, and an Auto Scale button. Now, from the **GUI Window Display Selector**, select **Input Camera Three Dimensional Wavefront**.

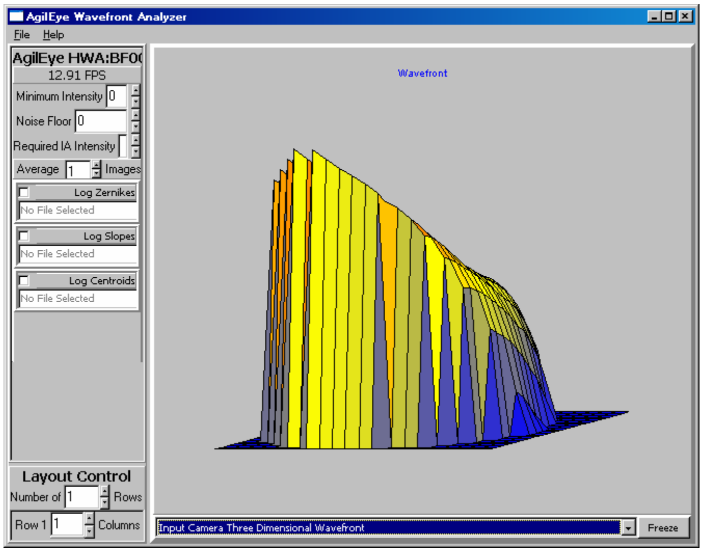


Figure 47. Input Camera Three Dimensional Wavefront

26. The **Three Dimensional Wavefront** shows the wavefront, in 3D, with height representing how close the wavefront is to a perfect wavefront. The lower the height of the wavefront, the closer the wavefront is to a perfect wavefront. You can put the mouse cursor on top of part of the Three Dimensional Wavefront, and drag it until you get a better view of the Wavefront.

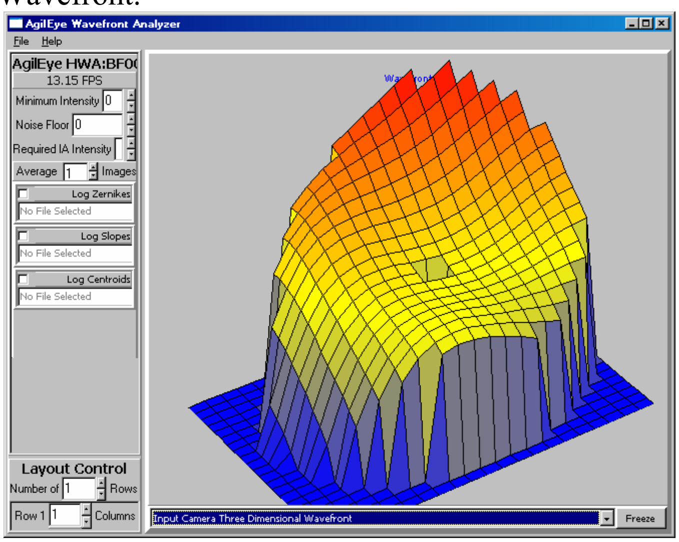


Figure 48. The Three Dimensional Wavefront, adjusted for a better view

27. Now that we've moved the wavefront around, we can see that it is a really nice 3D model. Now, let's look at some more windowing options. Under the **Layout Control**, increase the number of rows to 2.

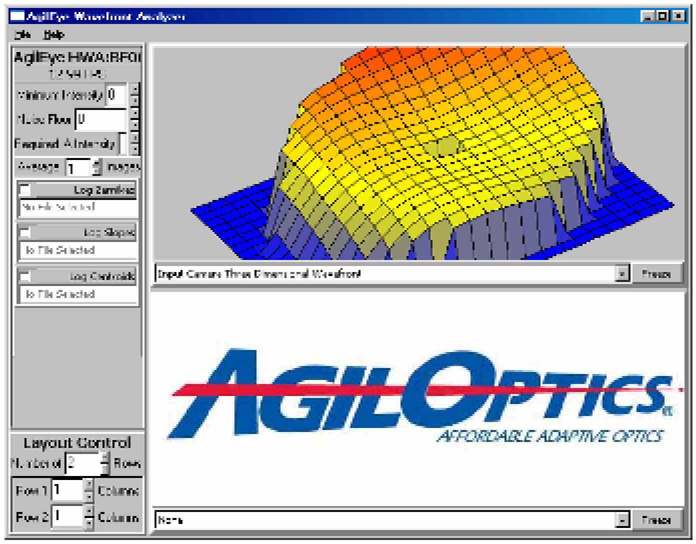


Figure 49. Two rows in the main display

28. We can increase the number of rows to 3, maximum. For now, let's leave it at two, and increase the number of columns in **Row 1** to 2.

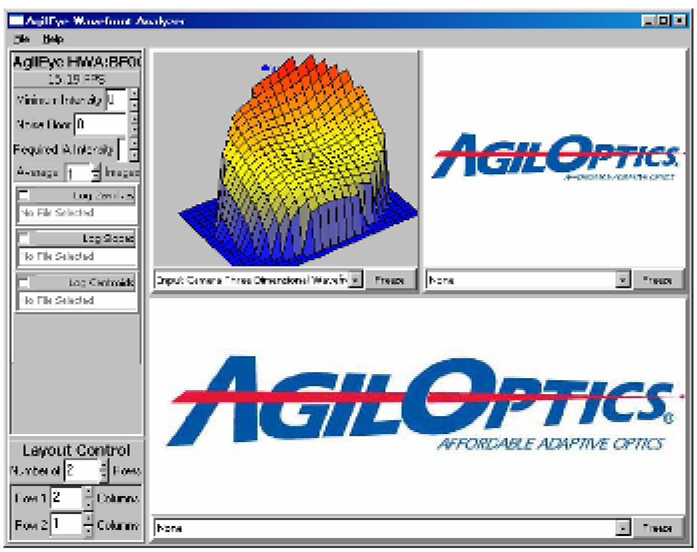


Figure 50. Two rows, with two columns in the first row

29. Each row can have up to four columns. For now, we want two columns in each, so add a column to **Row 2**. We should get the following main window layout:

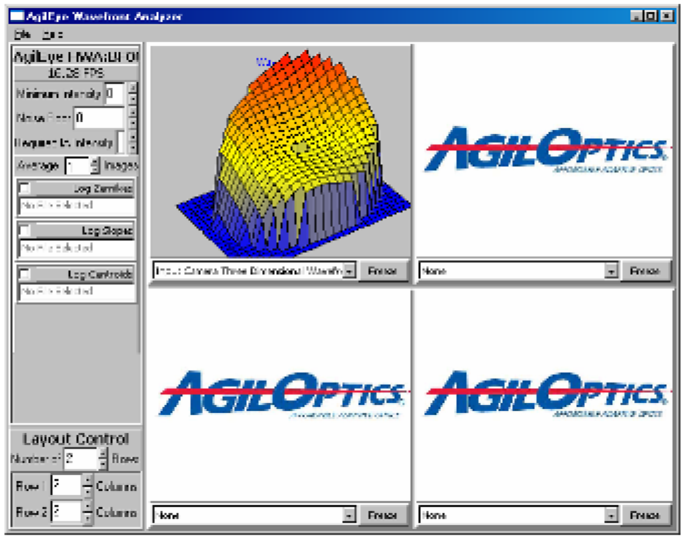


Figure 51. Main window with two rows and two columns

30. Now, let's change each of these new windows to show something different. Make the upper-right window show the **Input Camera**, the lower-left window show the **Input Camera Three Dimensional**, and the lower-right window show the **Input Camera Zernike Bars**.

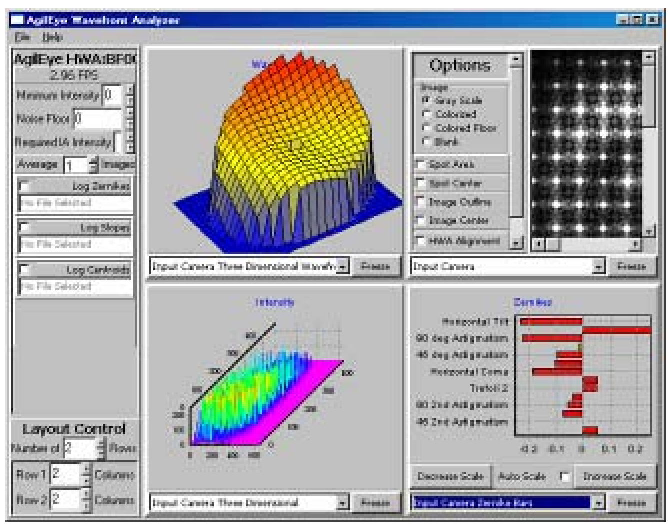


Figure 52. Main window with every window GUI showing

31. As you can see, the window layout is very flexible, allowing you to view quite a lot of data at the same time. However, it does get crowded, and extra windows slow down performance, so choose your windows carefully.

We have two more features to cover. First, right-click on **Spot Area** in the **Input Camera** screen. A new sub-window should pop up.

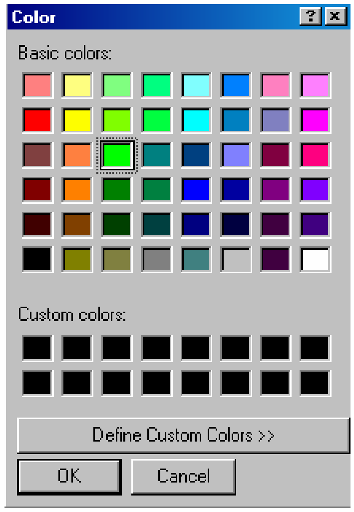


Figure 53. Color selection sub-window

32. From here, you can select any color you want for the **Spot Area**. Instead, let's select **Define Custom Colors >>.**

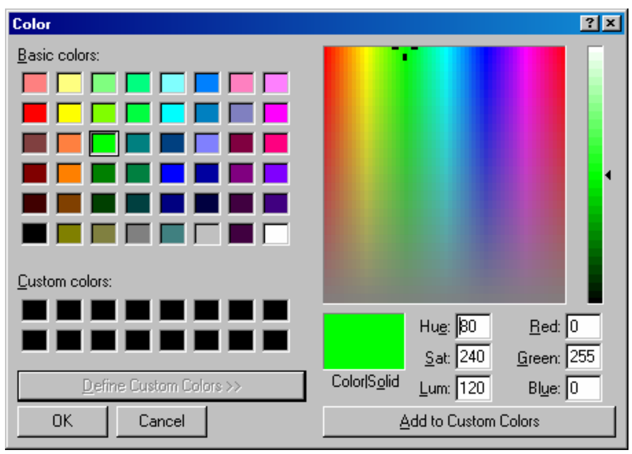


Figure 54. Custom Color screen

33. This new screen allows you to create any color you like and add it to the custom colors list. You can have up to 16 different custom colors. Any new custom colors after the first 16 will start over-writing the custom colors, starting from the upper-left custom color. For now, select **Cancel**.

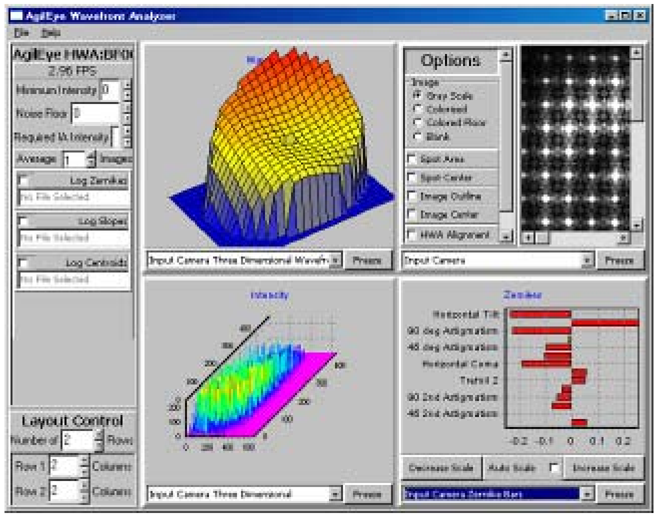


Figure 55. The main screen with four main displays

34. On the left side of the screen are three log controls.

Figure 56. Log Controls

35. The logging functions continuously log the appropriate data (Zernikes, Slopes, or Centroids) to files for later review. Select the check-box next to **Log Zernikes**.

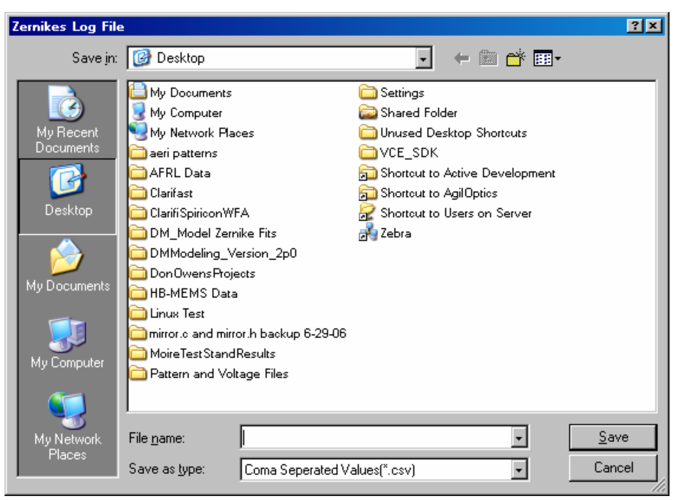


Figure 57. Zernike Log File selection

36. Choose the name quickstart_zernikes and select **Save**.

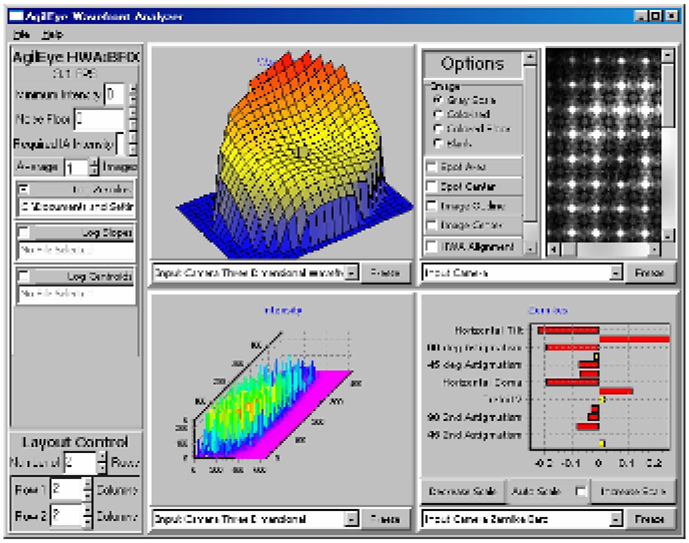


Figure 58. Zernike Logging activated

37. Now logging is activated until you deselect the **Log Zernikes** checkbox. You can check out the Zernike logging file by viewing it in Notepad or any other text editor. You are now ready to use AgilEye to its fullest capabilities. This concludes the AgilEye Quick Start Guide.