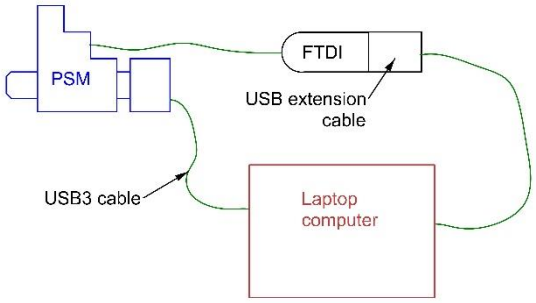
PSM Instructions

1) As shipped the PSM Align software should boot up as soon as all the cables are connected per the diagram in Fig. 1, and the PSM2 icon is double clicked.



2) Double click the PSM2 icon on the Desktop. Be patient as it takes a bit to load**. To exit PSM Align, use the stop button.** (This saves the current page settings to an .ini file so next time PSM Align is started everything will look the same as when it was exited. If the red X is used to exit, everything reverts to default settings and the page layout will have to be manually fixed.

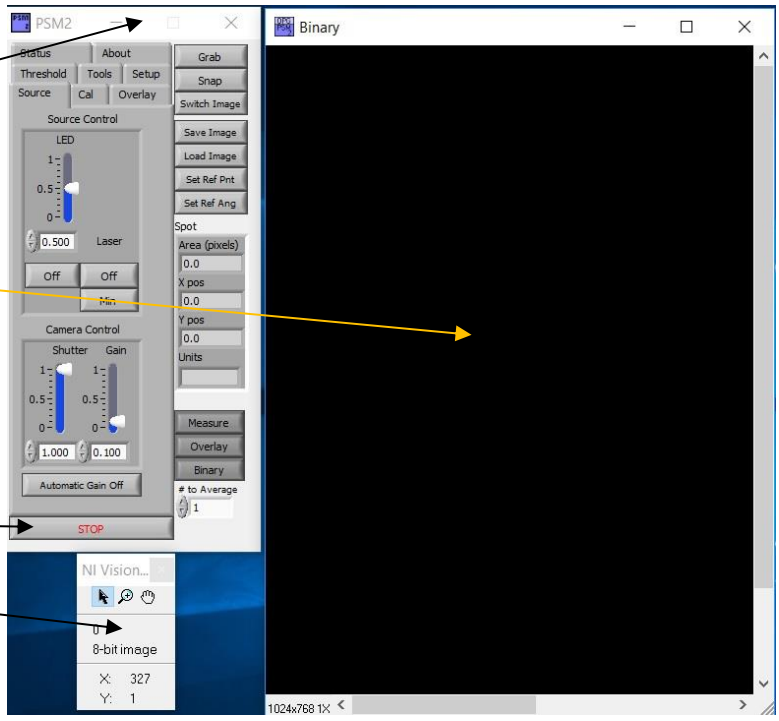
The first GUI to come up will be a box labeled PSM2 with a bunch of tabs and buttons. This is followed by a small box called NI Vision Tools and finally video and binary screens. During this process, if no error messages have appeared, the PSM is set to go. If error messages occur, refer to the end of these Instructions for a Trouble shooting section. (The video screen can sometimes disappear. Go down to the Grab button at the bottom of the screen and click maximize and work from there to resize the screen.)

PSM2 Box, really the control panel for all the PSM2 software

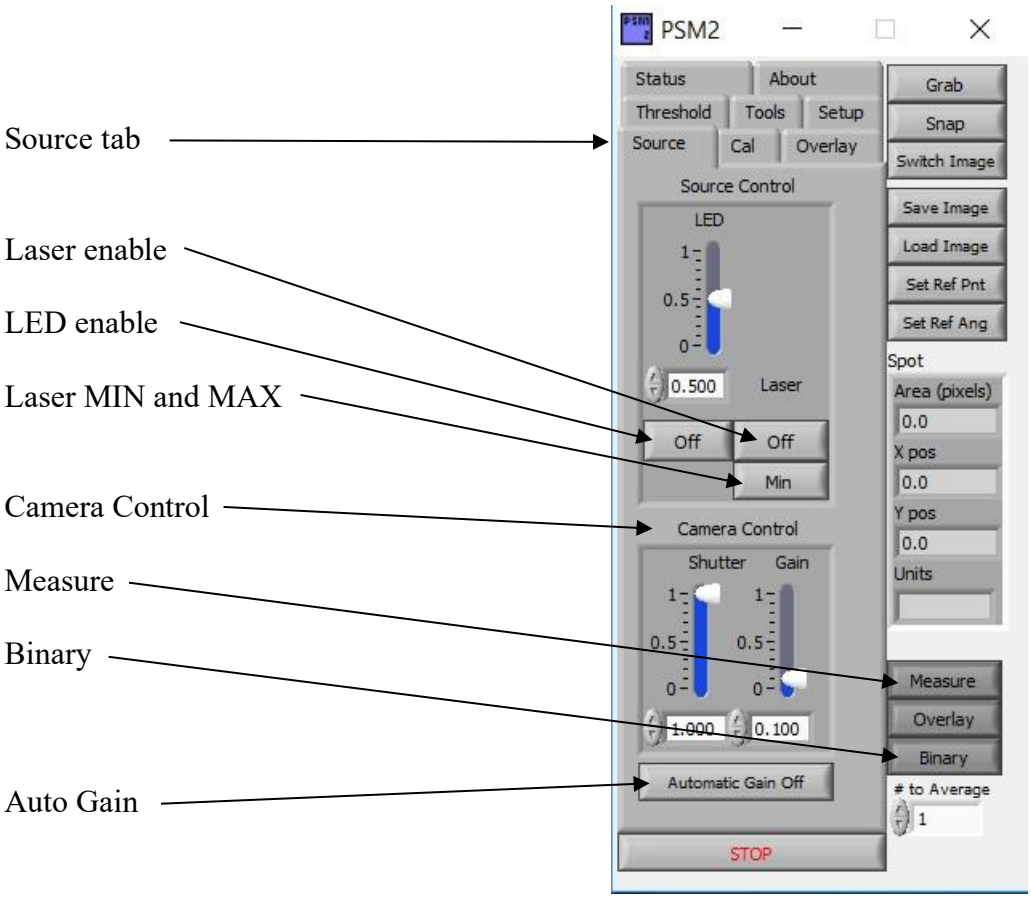
Video screen

STOP button

NI Vision Tools Box



2) On the PSM Align box the most immediately useful tab is **Source**. In the upper right is the **Grab** tab. This must be selected to view the video screen. This tab also allows control of the light sources and camera gain; overall how brightly features will appear on the video screen. The 2 buttons under **Source Control** turn the LED and Laser diode (Point Source) on and off. The LED used for full field imaging has infinity variable intensity control using the slider. The laser diode has only 2 levels of brightness, MIN and MAX. In MAX mode the light is bright enough to see under most ambient light conditions and is use to get the reflected light back in the objective. Once in the objective the MAX mode will saturate the camera in most cases, and the Laser must be set to MIN.



(The illumination control has been updated so see the Appendix for new options here. Everything above works as described but can be optimized with the new instructions.)

3) On the same tab under **Camera Control** are the Shutter and Gain controls with sliders. The Shutter slider controls the shutter speed to 0.1% and it is precise to 1 part in a 1000. It can be used for radiometric measurements. The Gain control is not as precise and amplifies noise already in the image. It is recommended that the Shutter be first run up to 1.0 before advancing the Gain from 0 to have the most noise free measurements.

Under Camera control there is an **Auto Gain** button. This feature is very useful when looking for centers of curvatures and Cat's Eye reflections from the lens elements in a lens assembly, for example. The gain and shutter will be set to 1 until the PSM focus approaches a center of curvature or Cat's eye. Then the gain and shutter are backed off to keep the brightest pixel just under the 8-bit saturation. In so doing, it is quite easy to find best focus at these conjugates. The **Measure** and **Binary** buttons must be

selected for the Auto Gain to work.

4) On the right of the box are a series of buttons that are active if a dark gray and inactive if lighter gray. The **Grab** button must be active to get real time, or live, video images. The **Snap** button will freeze a single frame, and this frame can be saved by selecting the **Save Image** button. A file directory screen will appear so that a file name and path can be assigned. The **Load Image** button recalls a saved image to the video screen. When using any of these buttons to snap, save or load an image, the Grab is inactive and must be clicked to get live video again.

The **Switch Image** button switches between the grey scale video and binary screen. Those pixels that are red in the binary image have an intensity greater than the threshold set on the **Threshold** tab and are the pixels used by the centroiding algorithm. If there are no red pixels there is no information for the centroiding algorithm. Also, if there are lots of red pixels the frame update rate will be slowed. The binary screen is useful for setting limits on the threshold tab when setting up a new optical configuration on which to use the PSM.

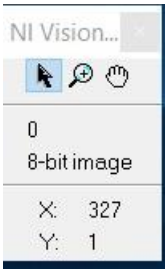
5) In the middle of the right hand side are 4 data windows. If the light reflected back into the PSM is approximately round the windows will say Spot and the upper most window will give the spot size in μm. The 2 windows below this give the centroid of the spot in x and y relative to the overlay crosshair in μm. The bottom box tells the units as either μm or μradians.

The units will be angles in two cases, the reflected image is largely linear, that is, like a line in which case the box will be labeled Line with width x position and angle (in degrees) relative to the camera pixel axis, or if on the Cal tab the Calibration box has been set to No Objective/Autocollimation when the units will be μradians of tilt of the surface producing the reflection.

6) At the bottom right of the box are **Measure, Overlay** and **Binary** buttons. The Overlay button simply toggles on and off any symbols or scales applied to the image. If the image is saved while there are overlays on the image, the overlays will be stored with the image, if the overlays are turned off when the image is stored the overlay is lost forever.

The Measure and Binary buttons must be active in order for the centroiding to function. These could be combined into one button because Measurement will not work without the Binary button being active. Generally, the Measure button can be left on all the time. Because Measure operates on all the pixels displayed, Measure can slow down the data rate. However, computers have gotten so much faster that with the standard, roughly Mpixel, cameras this is seldom a problem.

7) Next, consider the **NI Vision Tools** box. These tools help in using the video image. The most useful is the Zoom tool indicated by the magnifying glass icon. The video screen will zoom in a factor of 2 centered on the magnifying glass each time it gets a left click. **To zoom out, hold down the Shift key and left click.** Unfortunately there is no single handed way of doing this. It is a National Instruments thing. The Hand icon is used to pan while the arrow is used to add cross hairs that have coordinates associated with them on the Threshold tab page.



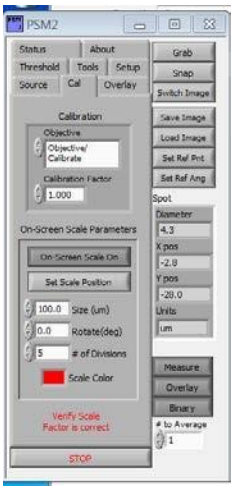
In the lower part of the box is a single number that is the 8-bit intensity of the pixel under the cursor. To make this feature active the blue bar at the top of the video screen must first be selected and it will turn bright blue. The lower 2 numbers then give the pixel coordinates of the pixel whose intensity is being displayed. This feature is useful when establishing thresholds for certain operations or to locate a

particular feature.

8) The next least complex PSM2 tab is the **Overlay** tab. The overlay tab controls the size of the crosshairs displayed. In the screen shot, on the next page below, the crosshairs have an inner diameter of 11 µm and an outer diameter of 31 µm. These may be made any convenient size and are sometimes used as tolerance boundaries. For example, if aligning a spot, if it falls within the inner diameter it can be considered well enough aligned to move on to the next step of alignment.

Below this is a box in which text may be placed to annotate a saved image. Enter the text after "Snapping" an image but before "Saving" the image. The annotation will appear in the same color as set on the Cal tab and is located at the upper left of the full, or zoomed out, screen. This is a handy way of documenting the content of an image file since most of the time there will be little of interest in the image except right in the center, but all images of small, round spots look about the same, so having some annotation is quite useful. Note: all saved images contain all Mpixel plus pixels. Also, check to see if the image is actually saved. Sometimes the images is not saved, and must be re-saved.

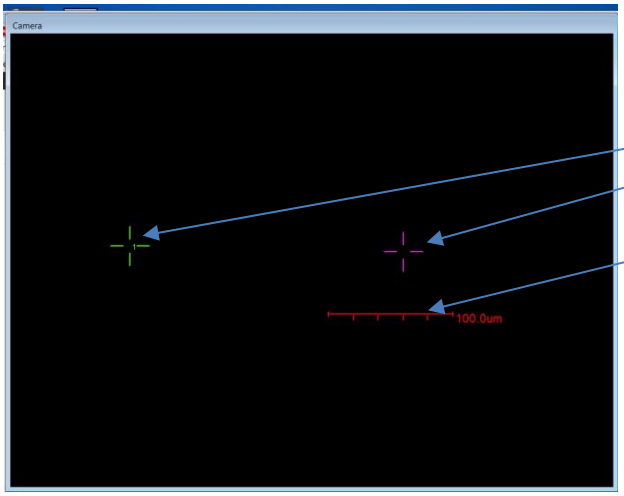
9) The **Cal** tab should be visited before any quantitative measurement are made with the PSM. This tab is where the real units in object space are defined. In the upper part of the window is a box that allows the selection of use with an objective, in which case the PSM should be calibrated, or without an objective where it is used as an autocollimator and the calibration is fixed depending on the camera pixel size and the angular reading is the angle of the reflected beam displayed in µradians.



Below this switch is a **Calibration Factor** window. The nominal calibration factor for the Nikon 10x objective normally supplied with the PSM is 1.000. This 10x objective has a 20 mm efl and is designed to be used with a 200 mm efl tube or camera lens. If the PSM is used with the Nikon 10x objective and the Calibration Factor is 1.000 the units are correctly displayed in µm as shown on the right of the tab where the position refers to the distance of the centroid of the focused spot from the purple electronic crosshairs on the screen.

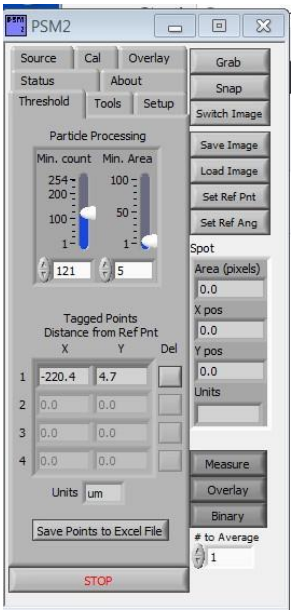
As a very rough rule of thumb, the calibration factor should be such that when multiplied by the objective magnification the product should equal 10. For example, if a Nikon 20x objective is used then the Calibration Factor should be 0.500 since 0.5*20 = 10. On the other hand, if the objective being used is designed for a different focal length tube lens then a specific calibration must be done. This is easy to do. View an artifact with a known distance between features such as a Ronchi ruling. Use the arrow cursor from the NI Vision Toolbox window to place a green crosshair on one feature and a second crosshair on the other feature. On the **Threshold** tab look at the difference in the locations of the features. Change the Calibration Factor until the distance between the known features matches the difference in locations on the Threshold tab. This calibration assures the correct units in object space and is the only sure way to know the PSM is calibrated for scale correctly.

Below the calibration part of the window is an option to place a scale bar on the screen that shows object space dimensions. First, set the length of the scale bar in the Size box. The next box allows the rotation of the scale bar with 0° being horizontal. The next box permits the selection of subdivisions of the length of the bar, and finally an option of color to make the bar more visible. Once these boxes are filled in click the **Set Scale Position** button, and then using the arrow cursor position the scale bar. The tip of the arrow will be at the left end of the bar.



The screen shown illustrates what is produced by the settings above on the Cal tab. The magenta cross hair is the one to which all distances are referenced, and the green cross is typical of those entered with the arrow cursor for doing calibration, for example. The green cross locations are shown on the Threshold tab. The scale bar is shown in red.

10) When using the **Threshold** tab, the lower part of the tab shows an example of what one would see after using the arrow cursor to put a green crosshair on the screen. The coordinates of the green cross are shown with respect to the magenta "zero reference" cross as being 220.4 µm to the left and 4.7 µm above it. Up to 4 crosses may be displayed at a time and the crosses are numbered for easy correlation to their values. The **Del** button removes the entries.



The upper part of the tab labeled **Particle Processing** controls the intensity level above which pixels are used in the centroiding operation of the software that makes the distance measurements. The left hand Min count slider is set at 121 meaning that any pixels more intense than an 8-bit 121 will show up red in the Binary screen and be used as part of the centroid calculation. The centroiding operation seems to work best with this slider set about at half maximum intensity, say 120 to 180. Depending on circumstances a different setting may give more stable results; it will take some experience with the PSM and your particular application to pick the best range of settings.

The right hand slider sets the area of the group of pixels to be considered in the calculation. Since well-focused spots are small this slider must be set to a fairly small number otherwise no group pixels will meet the criteria for spot size. In this case it is set to 5, a reasonable value but this too may depend on the application and may want to be set smaller yet. A better number is 2 or 3.

At the bottom of the tab is a button "**Save Points to Excel File**" that will do just that when the button is pushed assuming Excel has been loaded on the computer. Excel does not come with PSM2 Align and must be purchased separately. If Excel is installed, clicking the button will first display a window so a file name can be chosen and then the points are saved to a new line each time the button is pushed. This feature is very useful in a production environment.

11) The **Setup** tab is almost never used except when it appears something is working incorrectly. Then it is the only tab, along with the **Status** tab that will help get things set right. It may make more sense to look at the Status tab first in that it may help isolate the problem. There are 3 small boxes along the left side of the status tab and they should all have green check marks if things are working correctly. A red x in any of the boxes indicates a problem.

The most likely problem if the hardware has been changed is with the camera. If there is a red x under the Camera Status tab, see what camera number is shown in the Setup tab under Camera. The camera number must match the camera number in the National Instruments Measurement & Automation Explorer. Under All Programs choose National Instruments, then open NI MAX, the Measurement &

Automation Explorer. Under **My System** on the left click **Devices & Interfaces**. Wait for a few seconds and an icon will appear for NI-IMAQx Devices, and 1 or more cameras will appear by number. A camera that says integrated camera is the one built in the laptop if it has one. This is not the camera on the PSM and should be ignored.

(If your PSM has a Firewire camera then another possible problem if error message "Unable to initialize camera" pops up when PSM2 Align is booted is that the FireWire hub is not supplying power to the camera. Make sure the green light on the back of the camera is a steady green indicating power. Sometimes the plug from the wall power source is not fully seated in the hub. Realize too the software can be used without the camera for example to look at video files in memory. Just click Continue and proceed. Almost all new PSM's use a USB3 camera so this will not be a problem.)

The camera usually on the PSM is a Point Grey (now FLIR), either Firewire or USB3 and should automatically be indicated under camera type on the Setup tab. The number on this camera should match the number in the Setup tab. If it does not, change the Setup choice to the camera in the NI list, and hit the **STOP** button at the bottom of the PSM2 Control Window. Also, close the NI IMAQx program. (More about cameras and drivers under Trouble shooting). This will close the software but put the correct camera number in the initialization file. Re-boot PSM2 Align. The red x should be gone from the Status box under camera, and the error message gone about the camera. **Be sure the Grab button is pushed if it appears there is no live image on the screen.**

Next on the tab is the AGC range. This sets the range of pixel values the Auto Gain function uses to control the Shutter speed and Gain. To get full dynamic range of the display the upper limit should be set to 255 and the lower limit to about 10 units less, about 245. If the range is too narrow the Auto Gain becomes a bit noisy. Obviously for a particular need there is full freedom to choose an appropriate range from 255 to 1. The best limits may be 245 upper to 230 lower.

Under Illumination Control Selection, the PSM will operate with several different controls. The most usual is the PSM Interface which is the gray box with a USB input from the computer. This interface works with PSM2 Align or with PSM Illum, a stand-alone program that only controls the light sources in the PSM. If the PSM is used with 4D Technologies 4Sight software, 4Sight will turn on the light source when 4Sight is booted. The No Illumination Control position can be used if there is external illumination and the PSM is used only with the camera.

Finally the Interface board # is the number of the I/O board in the gray box, and is set in the Measurement Computing software called InstaCal. If the PSM2 software is booted up but the light sources will not turn on it is possible InstaCal is looking for the wrong board. Stop PSM2 Align and find Measurement Computing under All Programs. Clicking this will show a tab for InstaCal; click this and a screen will appear that will say "USB-1208LS with serial # xxx is stored in CB.CFG but has not been detected". This may mean the gray box has not been plugged in to the computer, or the gray box has been swapped with another. If the box is plugged in, click "ok", and InstaCal will find the serial number of the box. Once InstaCal has confirmed it has the box number InstaCal may be closed and now the light sources should work when PSM Align is re-started. The correct board number should appear in the PSM Interface Board # box.

12) The about tab tells how to get in touch with OPG and what version of PSM2 Align is installed on the computer. This is necessary for hunting down errors and should be noted somewhere other than the computer in case the computer is lost or won't boot.