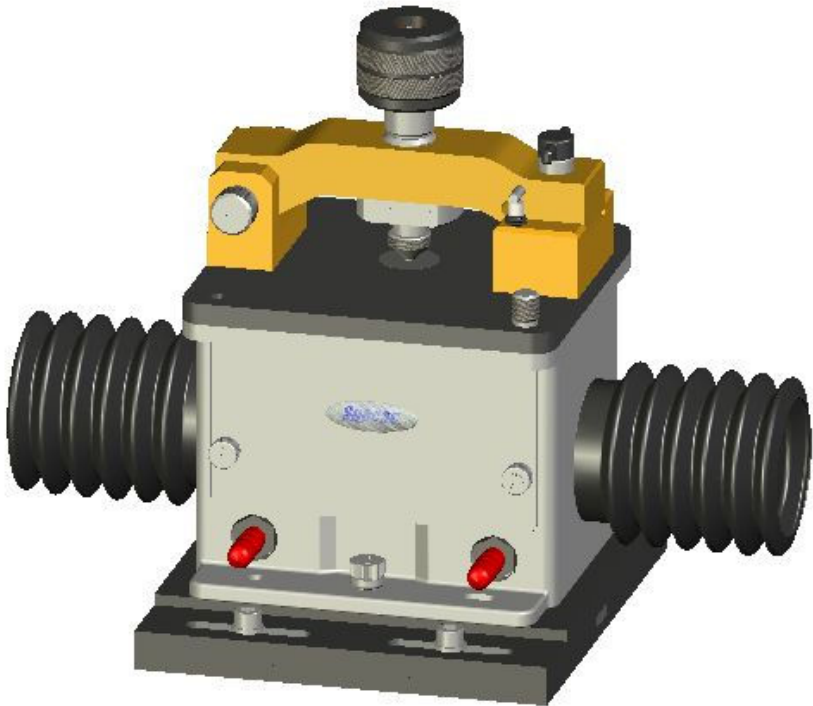




Golden Gate™ Imaging
Single Reflection ATR Accessory

*Installation Instructions For Varian
Spectrometer Systems*



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INSTALLATION INSTRUCTIONS FOR VARIAN SPECTROMETER SYSTEMS

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1. Introduction

The Golden Gate™ Imaging Single Reflection ATR Accessory is an addition to the established range of Golden Gate™ diamond ATR accessories. The sample of interest, solid or liquid, is placed into contact with the diamond ATR crystal in the usual way for the Golden Gate™ top plate, but the special optics inside the Imaging ATR optical unit allow for the selective detailed spectroscopic study of the sample surface when using a dedicated Focal Plane Array detector or “imaging” system.

This instruction manual is specifically to act as a guide for correct installation of the Golden Gate™ Imaging ATR Accessory into a Varian spectrometer system. For actual use of the Golden Gate™ accessory top plate for sample introduction and correct choice of clamp anvils, please refer to the standard Golden Gate™ ATR instruction manual 21-10500-10, supplied with any Golden Gate™ ATR accessory. For a specific top plate version (e.g. Heated Golden Gate™ top plate) please also refer to the specific instruction manual supplied for its use.

2. Unpacking and Checklist

Please check that the following items have been included to allow for installation of the accessory to be carried out.

For installation purposes a specific kit of parts are needed. These parts are used and provided by the **Service Engineer**. These parts are:-

1 P/N GS10607 Imaging Golden Gate™ Alignment Equipment. (Varian or Specac Service Engineer ONLY)

This kit consists of P/N 530-457 Alignment Baseplate for the Varian optical bench and P/N GS24500 Laser Alignment Accessory. A separate instruction manual for the Laser Alignment Accessory will be provided for its use and explanation.

On receipt of the Imaging Golden Gate™ Alignment Equipment, carefully remove the items from their packaging.

The Alignment Equipment will be used for installation of the **Customers** Golden Gate™ Imaging ATR Accessory into the Varian Spectrometer. The customer parts are:-

1 P/N GS10600 Golden Gate™ Imaging ATR accessory.

These parts consist of the Golden Gate™ Imaging optical unit and diamond top plate and the P/N 549-395 Benchmark™ baseplate for the Varian spectrometer and Golden Gate™ Imaging ATR Accessory.

The Benchmark™ baseplate is used at all times to mount both the Alignment baseplate (P/N 530-437) or the Golden Gate™ Imaging ATR Accessory into their correct positions within the Varian optical bench sample compartment.

3. Installation And Alignment

Important Note

For correct installation and optimum performance from the Golden Gate™ Imaging ATR accessory the Varian Spectrometer Stingray LS Optical Bench MUST be correctly aligned in accordance with the instructions set out in the manual entitled 'Stingray LS Optical Alignment and Installation Procedure' (Varian document no. 094-1015.)

The Benchmark™ Baseplate P/N 549-395

As mentioned in Section 2), the Benchmark™ baseplate P/N 549-395 as supplied with the **customers** Golden Gate Imaging ATR Accessory is used for correct installation of both the Alignment Baseplate and the Golden Gate™ Imaging ATR Accessory. (See Figure 1).

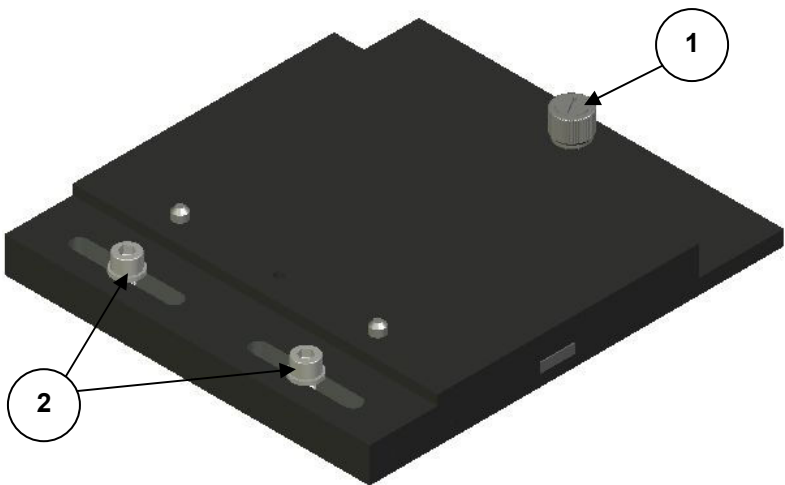


Figure 1. Benchmark Baseplate P/N 549-395.

Before any optical alignment is carried out, the Benchmark™ baseplate must be installed into the LS optical bench sample compartment. The Benchmark™ baseplate is placed into the sample compartment with the locating thumbscrew (1) towards the back. On the underside of the baseplate (not shown) there are a couple of locating pins that align with holes in the LS optical bench floor base. When these location pins and the thumbscrew (1) are aligned with their respective recess holes, push down on the thumbscrew (1) and turn clockwise to fix the baseplate to the sample compartment floor base.

The Alignment Baseplate P/N 530-457

To verify the correct beam alignment for the Varian LS optical bench sample compartment, the Alignment baseplate will be provided as part of the installation kit. (See Figure 2 for an illustration of the Alignment baseplate.)

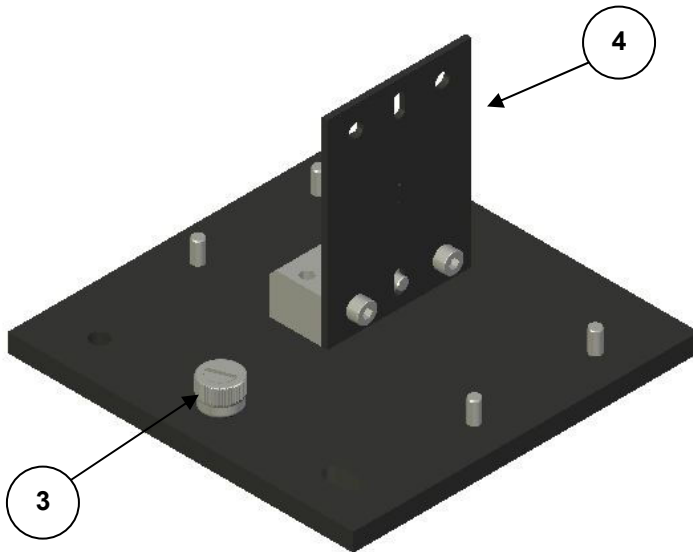


Figure 2. Alignment baseplate for the Varian Spectrometer.

The Alignment baseplate locates into the Varian LS optical bench sample compartment on the special Benchmark™ baseplate supplied for mounting of the Golden Gate Imaging ATR accessory. (See Figure 1). The Alignment baseplate attaches to the Benchmark™ baseplate by the single thumbscrew fixing (3). It is a push down and clockwise twist of the thumbscrew to fix.

The Alignment baseplate is provided with two different aperture plates (4). When the aperture plate is correctly, centrally positioned, one of them will present a small diameter aperture for the beam to pass through and the other will be a larger diameter aperture. Only one aperture plate at a time is needed to be installed on the Alignment baseplate for the Alignment check. (N.B. ensure the aperture plate (4) is located in the correct orientation as seen at Figure 2.)

Alignment Verification With Alignment Baseplate

Using the Resolutions Pro software, open the Stingray menu and bring up the Lancer control. With no accessory or aperture in the LS optical bench sample compartment, adjust the integration time on the software to obtain a band of pixels approximately half way up the oscilloscope display.

Remember that when the FPA is installed in the LS bench, the pass through optics need to be selected on the optics tab in the collect menu. Also remember that under the configurations options, on the Stingray tab, the FPA in LS selection must be checked.

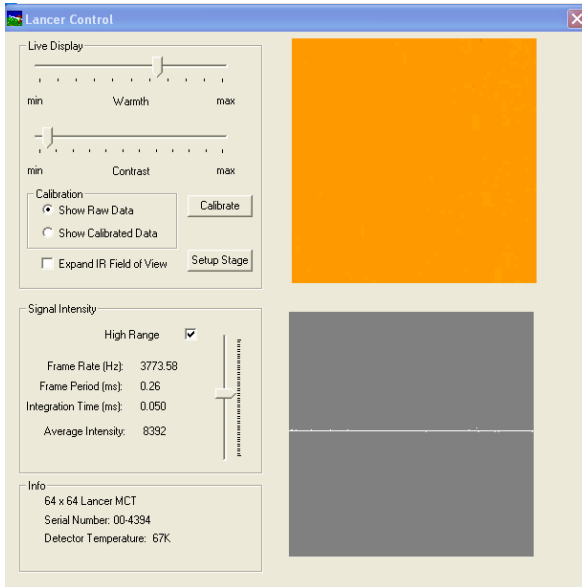
Calibrate the focal plane array using the calibrate button. On calibrating in the LS optical bench, the shutter on the left hand side must be manually closed to get a low flux number.

After calibration, a flat field will be displayed in the Lancer control. All further set up steps must be done against this initial calibration. After this alignment, please note the size of the focal plane array, the number of out of range pixels and the low flux and high flux numbers reported by the software. This information will be used later in the alignment procedure as a comparison point.

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FPA Size: 16x16 32x32 64x 64 128x128
Out Of Range Pixels: _____
Low Flux Number: _____
High Flux Number: _____

When the Benchmark™ baseplate has been installed, fix the Alignment baseplate with the smaller aperture plate (4) centrally in the position and orientation as shown from Figure 2. The aperture plate is push fitted over the retaining pins on the Alignment baseplate. Use the Varian operating software to obtain an image from the detector array. With no aperture in the sample compartment, the IR image should appear as a flat field as shown below from the Lancer control.



Also note that this accessory has been designed for a 64x 64 pixel array. Although the accessory can be used with a 128 x128 array, the array will not be fully illuminated. Windowing the focal plane array (only possible on a 128 x 128 array using Varian part number 099-2265) to a smaller size (64 x 64 or smaller) will provide fully illuminated images.

To confirm alignment, carry out the four test procedures as follows:

- 1) After placing the Alignment baseplate with the small aperture plate centrally into position, confirm that the apertures image is centered on the detector array.
- 2) Keeping the Alignment baseplate with the small aperture plate centrally in position, you can slide the Benchmark™ baseplate from side to side (left or right) via the slot locations through the fixing screws (2) – see Figure 1. The screws (2) should be loose to allow the plate to slide from side to side. Check that the best focus 'hot spot' is somewhere near the central positioning of the baseplate assembly. (i.e. when the fixing screws (2) are central in their slots).
- 3) Ensure that the 'hot spot' of the IR source is directed to the centre of the Toroidal mirror on the output side of the sample compartment by using the small Allen key supplied. Remove the aperture plate (4) and hold the Allen key vertically, immediately in front and to the center of the Toroidal mirror. Check that the shadow cast by the Allen key is centered in the image from the detector. Now repeat this procedure but hold the Allen key horizontally to check for centering of the image in this orientation.
- 4) Fit the larger aperture plate on the Alignment baseplate in the central position. Fix two human hairs across the centre of the larger aperture such that one is in the vertical and the other is in the horizontal plane. The image of both of these hairs should be in focus on the detector array.

Note: *If any of the checks in steps 1) to 4) above suggest a misalignment of the Varian Spectrometer Stingray LS Optical bench, please refer to Varian for advice on the optical bench set up, as alignment of the Stingray Optical bench must only be undertaken in accordance with the instructions laid out in the Varian document no. 094-1015.*

When correct, central focusing has been established by use of the Alignment baseplate, then the LS optical Bench is ready to accept the Golden Gate™ Imaging ATR Accessory.

Now remove the Alignment Baseplate with aperture from the sample compartment.

Alignment Of Golden Gate™ Imaging ATR Accessory

The Golden Gate Imaging ATR accessory will be factory prealigned. When factory pre-aligned this accessory should show some throughput when mounted on the baseplate in the LS sample compartment. In the event that there is no energy visible on the focal plane array or the Golden Gate Imaging ATR accessory has been accidentally misaligned please proceed to Procedure Two to realign the accessory using the laser alignment fixture and procedure

Procedure One is used for installation when the Golden Gate™ Imaging ATR has been supplied from Specac Ltd as a new item and is already laser beam aligned for installation into the optical bench. From this point it should require minimal adjustments of some of the optical components in the optical unit for fine tuning to the specific optical bench. A specific version of Benchmark™ type of baseplate is supplied with the Golden Gate™ Imaging ATR (**customer unit**) for installation into the Varian spectrometer sample compartment. (See Figure 3.) The Golden Gate™ optical unit affixes to the Benchmark™ baseplate (5) support by a single front thumbscrew (6).

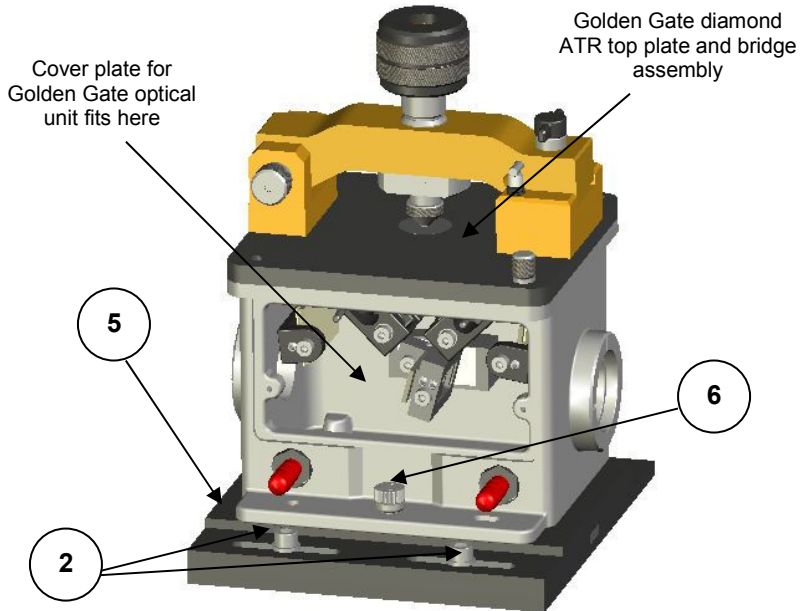


Figure 3. Front view of Golden Gate™ Imaging ATR on Benchmark™ baseplate with cover plate removed to show optical components.

Procedure One – Installation Of Golden Gate™ Imaging ATR Into The Sample Compartment And Alignment

(Please see diagram Figures 3 and 4 for reference to the procedure description).

The Golden Gate™ Imaging ATR Accessory, consisting of the diamond top plate and optical unit, is first placed onto its dedicated Benchmark™ baseplate and fixed using the single thumbscrew fixing (6). At this stage do not tighten the slide fixing screws (2) as the Golden Gate™ accessory must be left free to move from side to side (left to right) on the baseplate, to allow for final positioning of focus and optimum throughput of light.

Installation Instruction Manual

In this configuration the beam of light to the accessory enters from the source on the left hand side (input side) and emerges to the detector on the right hand side (output side) of the optical unit.

The front cover plate on the optical unit should now be removed to gain access to the optical components for adjustment. The cover plate is removed by undoing the two thumbs screws on the left and right hand sides at the front of the optical unit.

In Figure 4, both the cover plate and diamond ATR top plate have been removed for clarity, but the diamond ATR top plate **MUST** be kept in position for the actual alignment procedure to complete the beam path through the accessory. Figure 4 has been annotated with letters from A to F to indicate the optical components in the optical unit. These are:-

- A = Input mirror adjustable for rotation.
- B = Input mirror adjustable for rotation and tilt.
- C = Input lens adjustable for focus.
- D = Output lens adjustable for focus.
- E = Output mirror adjustable for rotation and tilt.
- F = Output refracting mirror adjustable for rotation.

The beam path of light through the Golden Gate™ Imaging ATR accessory relating to the optical components is as follows:-

Source to A to B to C to Diamond ATR Crystal to D to E to F to Array Detector

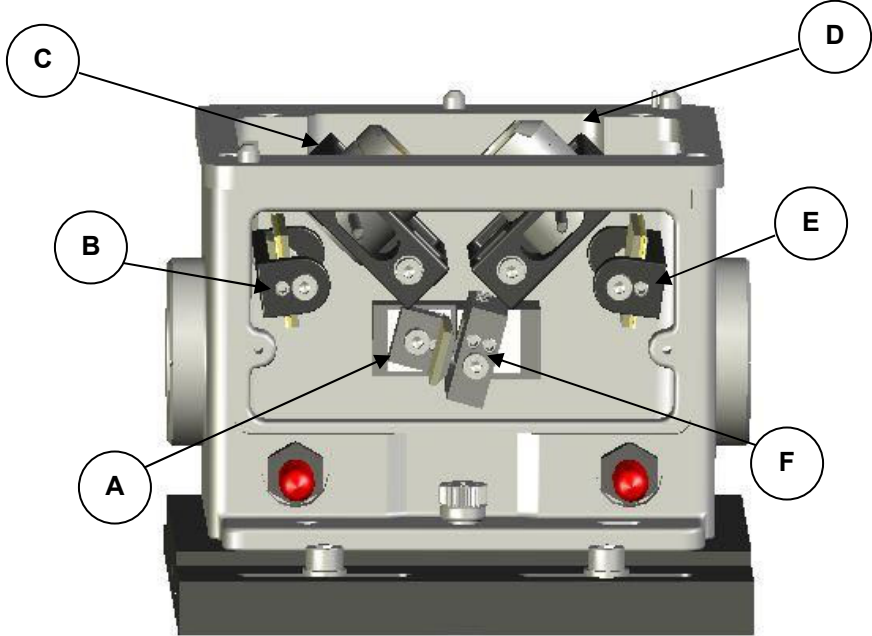
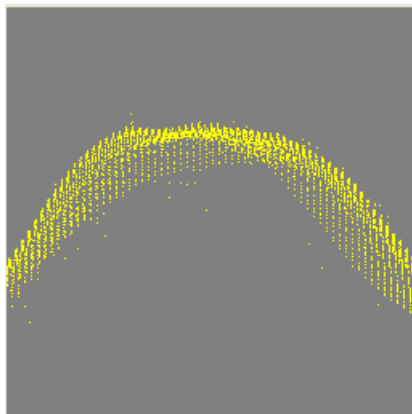


Figure 4. Front view of internal optics in the Golden Gate™ Imaging ATR accessory – cover plate and diamond ATR top plate removed.

Prior to any optical alignment after positioning of the Golden Gate™ ATR accessory in the LS optical bench, check the throughput signal via the array detector display. (This is to indicate there is some signal passing through the Golden Gate™ accessory). Adjust integration time to obtain a “band” of pixels across the center of the oscilloscope view. This “band” of pixels will show a variation in intensity due to the focusing nature of the optics in the accessory as shown on the next page. On smaller cameras, the “curve” will be shallower because of more complete illumination of the ATR crystal.

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During this alignment you are optimizing both the intensity and the position of the “hot spot” in the infrared image. To make viewing easier, you may adjust the warmth and contrast sliders on the lancer control but it is not recommended to make substantial adjustments in the integration time unless the pixels are saturated.

The overall aim of these adjustments is to center the energy in the field of view of the focal plan array and minimize the low illumination on the edges.

Alignment optimization of the Golden Gate™ Imaging ATR accessory involves both maximizing the signal throughput and insuring uniformity of illumination over the diamond ATR surface. To optimize optical alignment and signal through the Golden Gate™ Imaging ATR Accessory, start with rotation of the output mirror E. On the mirror support bracket there is a large cap head screw and a smaller grub screw. The large cap head screw is used for rotation of the mirror and the grub screw is used for tilt. Use the appropriate M4 size ball screwdriver supplied to rotate the mirror via the cap head screw. Only small rotational adjustments will be needed and during rotation, check for any changes in the signal intensity via the display for the array detector.

Now try to achieve the same optimization of signal but by carrying out rotation of the optical components B and F in turn. **Do not** start rotation

of a new optical component until you have reached an optimum throughput setting with rotation of a previous component.

Now try tilting the mirrors E and B, using the smaller Allen key on the grub screw, to maximize any throughput. There is no tilt adjustment of the mirror F. **(Do not adjust the two smaller grub screws on the F mirror bracket assembly.)**

Repeat the procedures of rotation and tilt of these optical components as necessary until a maximum throughput as registered by the signal display is achieved.

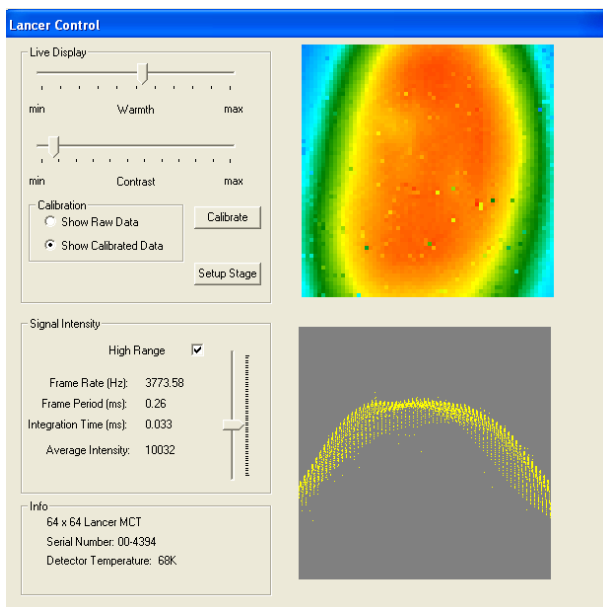
When a maximum throughput has been obtained after rotation and tilt of the optical components B, E and F, then try adjustment of the focus on the input lens C.

Note: Only carry out this focus adjustment if absolutely required.

The cap head screw holding the lens in its bracket is loosened by turning the screw anticlockwise. This allows the lens assembly to slide in its mount. Loosen the cap head screw slightly to prevent the lens from “dropping” suddenly in the holder. Using the tiller bar arm on the lens assembly, slide the lens to adjust its focus position. It should be positioned to fully and evenly illuminate the diamond surface. When in the correct position re-tighten the cap head screw to hold the lens in place.

At this point the accessory should have good illumination. In the Lancer control an image similar to the one on the next page should have been obtained.

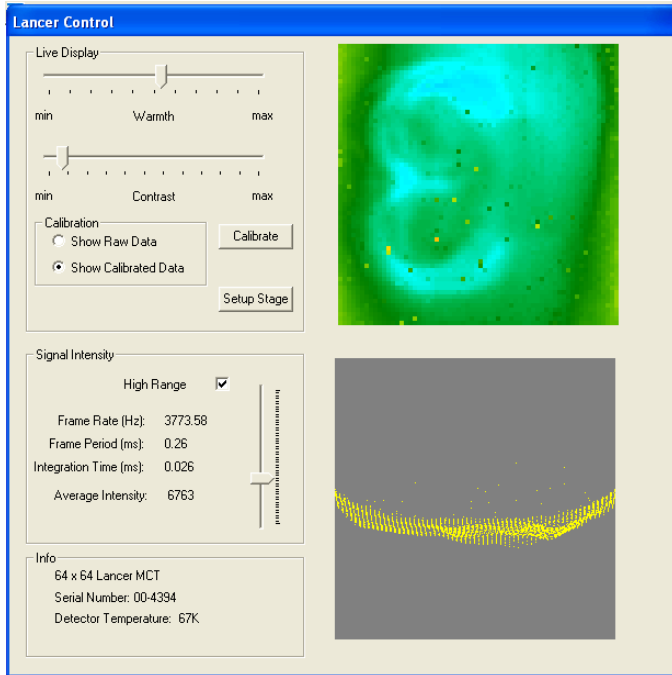
Installation Instruction Manual



Before proceeding perform a new calibration as per the instruction on page 9.

Now place a sample suitable for focusing on the diamond crystal of the top plate and clamp in position using the sapphire anvil and bridge mechanism. This sample could be an appropriate sized number from the USAF bar target (supplied with the focal plane array system) or a hair or fine fiber. TO locate the sample on the crystal, apply a sufficient amount of pressure from the anvil to the sample to make good contact with the crystal but not enough pressure to clamp the sample in position. Slide the sample on the crystal until a recognizable feature is visible in the Lance control. (Refer to the standard Golden Gate™ instruction manual 2I-10500-10 for loading a sample).

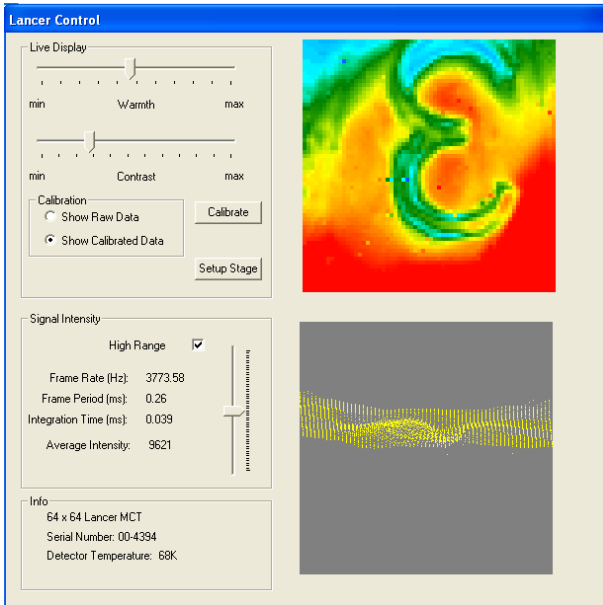
The image shown on the following page is out of focus. The aim of this step is to achieve an image in focus. Note that since the sample must be placed face down on the ATR crystal, the number shown in this image is backwards.



Now slide the complete Golden Gate™ Imaging ATR Accessory on the Benchmark™ baseplate from side to side (similar to the procedure with the Alignment baseplate) to find the optimum focus position for the hair or fiber sample clamped to the diamond. This is a **fine** adjustment for the focus point of the sample and a correct focus position will show sharp delineation on the edge or features from a fiber sample at the detector display. If this method of fine focusing (sliding accessory from side to side) does not produce a sharp image, or the focus position is at the limit of travel in one direction for the Benchmark™ baseplate, a **coarse** focus can be achieved by adjustment of the output lens D.

An example of an obtainable image is shown on the next page using a number 3 on the USAF bar target.

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For the coarse focus adjustment, re-centralise the Golden Gate™ Accessory on the Benchmark™ baseplate and adjust the output lens D. (Similar procedure as to the adjustment of input lens C).

When the coarse focus position for the output lens D has been established, re-tighten the cap head screw to hold the lens in place. Now repeat for the slide procedure of the Benchmark™ baseplate to obtain a fine focus position for the Golden Gate™ Imaging ATR Accessory.

Finally, it will now be necessary to re-check and re-optimize all of the adjustable optical components (B,E and F) as the focus position of the Golden Gate™ Accessory will have been slightly changed and the positioning of the optical components interact with each other to influence the overall throughput intensity of signal.

Procedure Two is principally to optically realign the Golden Gate™ Imaging ATR Accessory before installation into the LS optical bench using a laser light beam. If a mirror or component is moved during Procedure One whereby the signal display on the spectrometer is lost and cannot be recovered, then the Golden Gate™ Imaging ATR Accessory will have to be re-checked. For the purposes of realignment of the optical unit of the Golden Gate™ Imaging ATR Accessory itself, the Specac Laser Alignment accessory P/N GS24500 must be used to provide a form of coherent visible light. The Laser Alignment accessory is provided as part of the **Service Engineers** installation equipment.

Procedure Two – Realignment of Golden Gate™ Imaging ATR Using The Laser Alignment Accessory GS24500

(Please see diagram Figures 4, 5 and 6 for reference to the procedure description).

If the signal is lost during alignment of the Golden Gate™ Imaging ATR Accessory whilst following Procedure One, then the accessory itself will need to be checked for alignment using a reference light beam.

The Golden Gate™ Imaging ATR Accessory will need to be removed from the Benchmark™ baseplate (undo the thumbscrew (6)) and placed on the Laser Alignment accessory P/N GS24500. (Please refer to the instruction manual supplied with the Laser Alignment accessory to explain its operation).

For alignment, it will be necessary to check independently both the input and output side of the optical components within the Golden Gate™ Imaging ATR optical unit.

Note: *The input optics are the components A,B and C (before the light reaches the diamond ATR crystal) and the output optics are the components D, E and F after the light beam has left the diamond ATR crystal.*

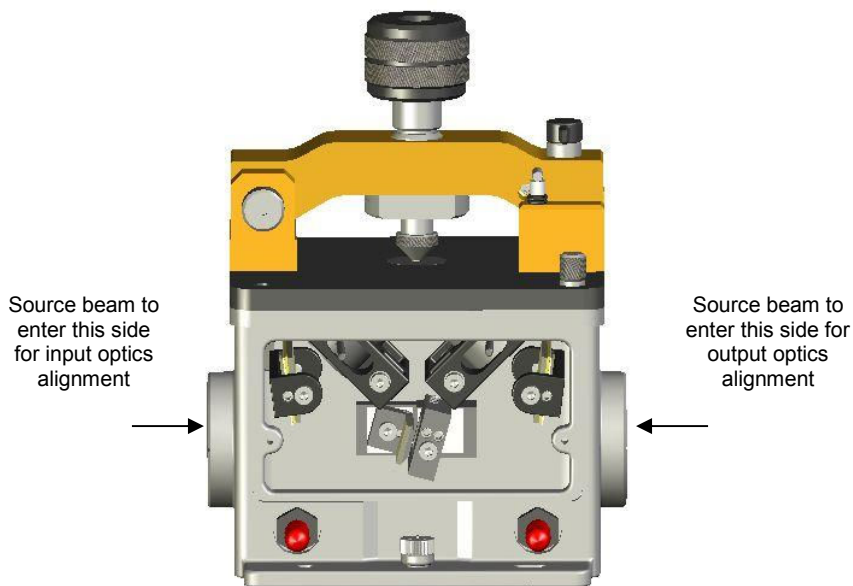


Figure 5. Laser source beam direction for alignment of input and output optics on Golden Gate™ Imaging ATR Accessory.

Output Optics Alignment

For alignment, begin with the output optics side. Place the Golden Gate™ Imaging ATR accessory onto the Laser Alignment Accessory with the front of the Golden Gate™ Accessory towards you and the laser light source on the right hand side. The cover plate to allow access to the optics should be removed.

Note: *The laser beam (visible) red light source does not follow the same light path as the Infrared light beam through the refracting mirror F. Therefore the following instructions MUST be followed carefully to ensure correct alignment.*

Mirror F must be rotated (use the large cap head screw) to send the laser light beam to the centre of mirror E. However, by rotation of

mirror F to achieve this, it will clash with the angle position set for the input mirror A. Therefore, to project the laser beam to mirror E, it is a combination of sequentially rotating mirror F slightly anticlockwise, then mirror A slightly anticlockwise, until the laser beam falls centrally onto mirror E.

When this has been achieved, mirror E needs to be adjusted to send the laser beam to lens D. The actual lens in D is opaque to the visible laser light and so the laser light will not be seen at the diamond crystal in the Golden Gate™ top plate. Therefore, mirror E is to be adjusted for both rotation (cap head screw) and tilt (grub screw) until the **reflected** laser light spot from lens D is superimposed on the initial brighter spot of laser light at mirror E. When this is achieved mirror E is in its correct alignment position for both rotation and tilt adjustments.

The refracting mirror F needs to be rotated back in a clockwise direction to its correct Infrared light transmission angular position. When rotating mirror F it will clash with the new angular position set for input mirror A, so both mirrors F and A will need to be rotated sequentially clockwise (use cap head screws) a little at a time, until correct alignment of mirror F is achieved. Correct alignment of mirror F is when the reflected beam of laser light from the refracting mirror F surface intersects with the reference alignment mark at the base of the Golden Gate™ Imaging ATR Accessory optical unit. (See figure 6. on the following page.)

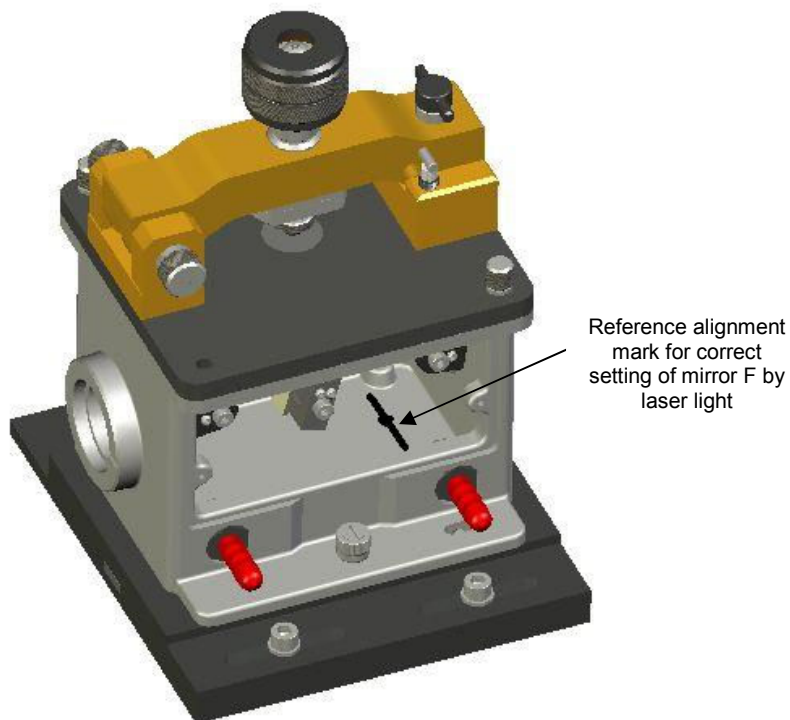


Figure 6. View of Golden Gate™ Imaging ATR Accessory to show the reference alignment mark for the refracting mirror F.

When the laser beam from mirror F strikes the reference mark, the output optics have been correctly realigned.

Input Optics Alignment

When the output optics have been correctly aligned, then the input optics must be checked. Turn the Laser Alignment accessory around with the laser light source on the left hand side and reposition the Golden Gate™ Imaging ATR Accessory, such that the front of the Golden Gate™ is facing you to gain access to the optics. The laser source will now be projected to the input optics onto mirror A.

Rotate mirror A (use cap head screw) to obtain a spot of bright light on at the centre of mirror B. Note that use of the M4 ball driver and the position of the cap head screw blocks the light beam if the ball driver is held horizontally. Although the mirror can be rotated in this way, if the ball driver is held at an angle from above in to the cap head screw, it is possible to rotate the mirror and avoid blocking the laser light beam to mirror B.

When the laser beam is centred on mirror B, rotate mirror B to send the laser light through input lens C to the diamond. In this instance the input lens C is not opaque to the laser light and so a spot will be seen at the diamond. However, it is the **reflected** beam of light from the lens C that is used to correctly align the mirror B for its rotation and tilt adjustment settings. The reflected beam should retrace the laser beam path back to the source.

A piece of white card held close to, but not obscuring, the laser light source, may be helpful in locating the reflected laser, in addition to looking for the reflected beam on the surface of mirror B. Rotate (use cap head screw) and tilt (use grub screw) mirror B until the reflected laser beam is in its correct position. When this is achieved mirror B is correctly aligned and the Golden Gate™ Imaging ATR Accessory can be re-installed into the LS optical bench for fine adjustment as described from **Procedure One**.

4. Trouble Shooting – Alignment Questions

This section is to try and answer some questions that may arise from the installation procedure.

(Q1) Why is the detector array not completely illuminated?

(A1) When correctly aligned the Golden Gate Imaging ATR accessory will image a 1.2mm by 1.0mm area of the diamond ATR surface. This will almost completely fill a 128 by 128 array, and will overfill both a 64 by 64 and 32 by 32 array. If you find the illuminated area is less than this, it may be necessary to adjust (back off) Lens C on the Golden Gate to increase the illumination area whilst adjusting Mirror B, as necessary, to keep the illuminated area centered and uniform.

(Q2) Why is the image out of focus?

(A2) The image should focus correctly. Rough focus is set by sliding Lens D forward and backwards in its mount, whilst fine focus is set by sliding the entire Golden Gate Accessory from left to right on the Benchmark™ baseplate in the optical compartment. Once the focus is set, lock the positions of both Lens D and the Benchmark™ baseplate.

(Q3) How does the image on the detector array correspond to the sample alignment on the diamond ATR surface?

(A3) The detector array is looking from the left hand side of the optical bench compartment at the underside of the ATR diamond surface. In this way the left hand side of the ATR surface is imaged to the bottom of the array display, and the right hand side to the top. Thus a sample (e.g. a human hair) lying left to right across the ATR diamond will be imaged vertically on the array display. Similarly, the near side of the ATR surface is imaged to the right hand side of the array, and the far side of the ATR surface to the left hand side of the array. Therefore a sample (e.g. a human hair) lying front to back across the ATR surface will be imaged horizontally on the array display.

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