Laser Alignment Procedure

This procedure is to be used as a guide for the initial system installation, or as a reference for optics replacement, or for re-alignment if necessary. It is assumed that the gantry is square to the x-axis, all support equipment is in place and properly working, and all of the necessary safety precautions are strictly followed. It is strongly suggested that at least two people be involved in the alignment procedure.

The MultiCam laser system utilizes a flying optics beam path. The laser head is stationary and the optics guides the laser beam to the work surface. The components that make up the laser beam guidance system are specially designed to give a consistent beam diameter at any location across the cut bed when properly aligned. The system relies on the alignment of its beam path components to accurately and consistently cut materials. Occasionally, the beam path components must be realigned due to conditions that impact the alignment like severe vibration movement around the machine, shifts in the floor, or other uncontrollable conditions. The complete optical system is pre-aligned at the MultiCam factory and then the laser head is removed for shipping. When re-assembling the laser optical system, minimal adjustments will have to be made if this procedure is strictly followed.

Optics used in beam path

Collimator/beam expander
The laser beam is a diverging source. The farther away from the source that you get, the larger the beam diameter becomes. This optical device is used for two purposes. 1) to collimate the diverging beam to insure a consistent beam diameter throughout the cutting area and 2) to expand the beam so that the beam diameter is roughly 70-80% of the beam path optical components clear aperture. A 2X beam expander is commonly used in the laser beam path giving an output beam diameter of 8-10mm. It consists of two focusing lenses positioned to give the proper beam diameter at the output. Loosening the clamp ring fastener and sliding one lens in reference to the other is how the adjustment of the collimator is done.

Diode pointer/Beam dump
The diode pointer is used as an aid in doing the laser beam alignment and used as a laser beam reference at the work surface when aligning materials or locating the focused laser beam. The beam dump is used as a safety component for the removal of unwanted laser radiation. Alignment of the diode pointer is done using the two sets of adjusting screws. One set is used for positioning in the near field and the other for the far field.

Beam Benders
The beam benders used in the optical path are made up of a beam bender base, mirror block assembly, and the mirror holder. The mirror block assembly is designed to allow adjustment in the vertical and horizontal planes as indicated by the arrows on the mirror block assembly. The mirror block assembly mounting screws are spring loaded allowing
for thermal expansion and should be tightened and then loosened by ½ turn. The mirrors used are designed to give 99.9% reflectivity and are coated with an abrasion resistant material for safe and easy cleaning. (Refer to Optics Cleaning Instructions)

**Focusing lens**
The 2000L series system standard configuration includes a 5”FL lens as a default. A 2.5”FL lens is supplied as an option and should be requested on the initial order but can be retrofitted in the field at a later date. The 5”FL lens is a very good general-purpose lens that gives a focus range of approximately 0.09” with a spot size of 0.005-0.007” in diameter. The 2.5”FL lens is generally used for faster cut speeds in thin materials, metal processing, or to achieve higher resolution on raster images. This lens has a focus range of approximately 0.05-0.06” and a spot size of 0.003-0.006”. The lens used in the MultiCam are made from ZnSe and proper cleaning (Refer to Optics Cleaning Instructions), handling, and disposal (Handling broken/burned lens document) should be followed.

**Tools needed for this alignment procedure (all tools are included in the distributor laser installation kit)**
- Collimator alignment tool kit
- Beam bender crosshair
- Breakaway head alignment crosshair
- Gas Jet Manifold alignment crosshair (capacitive head only)
- Tip Retainer Crosshair (non-capacitive head only)
- Lens alignment crosshair
- Laser burn cards (used for making laser burn marks)
- Standard ball nose Allen wrench set
- ½” – 1” Roll Clear cellophane tape (Scotch Tape)
- Dust free rubber, latex, or cloth gloves (for handling optics)(contained in optics cleaning kit)

**Other tools for that may be necessary**
- Calipers for collimator/beam expander adjustment
- Laser burn paper (used for collimator adjustment)
- Optics cleaning kit

**Definitions:**

**Near/far field:**
Near field refers to the location that is closest to the source of adjustment.
Far field refers to the location that is farthest from the source of adjustment.
Crosshair burn pattern:
The crosshair uses a small diameter copper wire to form a cross at the center of the OD of the crosshair. The laser beam reflects from the surface of the copper. A laser burn card is placed at the output side of the crosshair and the laser is pulsed. The result is the laser beam will leave a mark on the card that represents its location in respect to the crosshair. By making adjustments to the source, (i.e. Beam bender mirror assembly adjusting screws) changes are made to the point of the laser beam thus affecting its location in reference to the crosshairs.

Pulsing the laser:
During the alignment procedure it is necessary to pulse the laser so that the laser beams physical location can be determined. On the handheld keypad the TEST button allows the technician this capability. When the TEST button is pressed the power is entered and then the pulse duration (how long the laser is on) and the start button is used to pulse the laser for the power and time that is entered. The power and duration are determined by how much is needed to get an adequate burn on the paper. This function stays active until the CANCEL button is pressed on the keypad.

Laser Alignment Steps:
Follow these steps in order and you will have a successful beam alignment. As you gain experience some can be combined or skipped.

1) Remove collimator/beam expander, all mirror assemblies except BB2, and lens holder from system
2) Install laser head
3) Install collimator alignment tool
4) Align laser head to BB1 using the collimator alignment tool
5) Install collimator/beam expander
6) Check adjustment of collimator/beam expander
7) Remove collimator alignment tool
8) Install BB1 mirror block assembly and adjust for x-axis parallelism to BB2
9) Install BB3 mirror block assembly and adjust beam to BB4
10) Install BB4 mirror block assembly and adjust for y-axis parallelism to BB5
11) Install BB5 mirror block assembly and adjust beam to BB6

The next steps are specific to the head style. MultiCam offers a **non-capacitive** and **capacitive** head option. Follow the steps that pertain to the head style your system has.

**Non-capacitive head option:**
12) Install BB6 mirror block assembly and tip retainer crosshair and adjust BB6 for z-axis parallelism and adjust tip retainer crosshair for center
13) Test alignment (four corner test)
14) Install the tip retainer, tip, and insert lens holder and adjust for center
15) Test system

**Capacitive head option:**
16) Install BB6 mirror block assembly and adjust for z-axis parallelism for capacitive cutting head design
17) Install lens holders and adjust center
18) Test system

**STEP 1: Remove Optics**

**NOTE:** Proper care must be taken when removing all mirror block assemblies and lens from the optical path to avoid any contamination or damage. The use of dust free rubber gloves is recommended.

Remove the collimator/beam expander, all of the mirror block assemblies (except BB2), and lens holder and inspect for damage. Clean per the optics cleaning section or replace as necessary. Place the collimator/beam expander, mirror block assemblies, and lens holder in a safe place and number the mirror assemblies per their position in the optical path.

**STEP 2: Install Laser Head**

Install the laser head on the mounting pads provided using the proper fasteners and bevel washers. Only hand-tighten the fasteners to allow movement of the laser head during the alignment procedure. Adjustments will be made to the laser head leveling screws for vertical adjustments and to the mounting pads for horizontal adjustments to insure the laser beam is parallel and centered to the first beam bender. **Note:** the mounting screws will have to be loosened if adjustments are made to raise the laser head.

**STEP 3: Installation of the collimator alignment tool**

The collimator alignment tool is installed, using the supplied fasteners (stored on the beam bender base attached to the alignment tool), to BB1 as shown in the following pictures. Pay special attention to the inside machined surfaces of the alignment tool and verify that they are seated against the beam bender surfaces.

**STEP 4: Alignment procedure of the laser to collimator alignment tool**

Once the alignment tool has been installed onto BB1, the beam bender crosshairs are used to verify that the laser beam is parallel and centered to BB1. Place the crosshairs into BB1 as shown (near field). Position the laser burn paper or equivalent in a position near the output side of the crosshairs in BB1. Pulse the laser (adjust power and duration to give a visible burn only) and note the location of the burn in reference to the crosshair. Move the crosshair to the BBT output side at the other end of the alignment tool (far field). Position the laser burn paper or equivalent in a position near the output side of the crosshairs in BBT. Pulse the laser and note the location of the burn in reference to the crosshair.

Adjust for vertical using the setscrews in the laser base first to achieve the same burn pattern in the vertical axis and adjust the horizontal using the jackscrews located on the steel pads (the fasteners holding the steel plates to the base frame must be loosened to make adjustments). The laser head is aligned by alternately moving the crosshairs
between near/far field and making adjustments to aim the laser beam to be in the center of the crosshair in both near and far field.

(\textit{Be patient, this may take some time to do but it is most critical that this step be done correctly. Improper alignment will result in the laser beam not entering the collimator/beam expander perpendicular and centered, which will cause poor cutting results.})

Once the laser beam is centered and perpendicular to BB1, remove the crosshair and install the mirror block assembly onto BBT at the end of the alignment tool if there is not enough available distance for the collimator/beam expander check. (There should be a free unobstructed distance of 2X the total beam travel measured from the output side of BBT. The mirror block assembly is used to redirect the laser beam to allow for a different beam path. The mirror block assembly may have to be adjusted so the beam path is unobstructed.)

\textbf{STEP 5: Installation of the collimator/beam expander}

Install the collimator/beam expander on the input side of BB1 using the three SHCS 6-32x3/4”.

\textbf{NOTE:} If the collimator does not have the alignment dowel pins, position as close as possible to the center of the beam bender input side.

\textbf{STEP 6: Check adjustment of the collimator/beam expander}

Adjustment of the collimator/beam expander is factory preset. Using the laser burn card or equivalent, check the near field at 3FT(1M) from the collimator output and the far field at a distance equal to 2X the total beam travel if possible. It will also be necessary to check at 3FT (1M) intervals between the near and far field locations. It may be necessary to increase the laser power after the laser beam is collimated to get an adequate burn. The laser burn should be 8-10mm in diameter at any point along the beam path. If the results from this check are not within the 8-10mm specification, the collimator/beam expander will have to be adjusted per that section of this document. If the results are within specifications go to the next step.

\textbf{STEP 7: Remove collimator alignment tool}

Remove the mirror block assembly from the alignment tool and return to its safe place. Remove the mounting screws holding the collimator alignment tool and store in threaded holes in beam bender base attached to the alignment tool and store the collimator alignment tool for future needs.

\textbf{STEP 8: Install mirror block assembly on BB1}

Install the mirror block assembly onto BB1 using the three mounting screws. Tighten the screws then loosen one full turn to allow for adjustment during this procedure. Using the hand held keypad move the gantry to the rear of the table. The mirror block assembly should be on BB2. Insert the beam bender crosshair into the input side of BB3 as shown in. During this part of the procedure it will be necessary to hold or support a laser burn card near the output of the crosshair while pulsing the laser. Great care should be taken to avoid excessive radiation exposure. Pulse the laser and mark this card as near field. Move the gantry approximately 12 inches towards the home position, pulse the laser and
verify that the beam path is within the crosshairs. It is not important if the burn is not centered in the crosshair as you are only using this as a location reference at this time. If the beam starts to move from the reference location found in the near field it would be necessary to make adjustments to the mirror block assembly. Continue this process until you have reached the home position or the far field. Move the gantry back to the near field, mark another card. This will be the new near field reference. Make longer moves towards the far field making mirror block assembly adjustments as necessary. Continue this process until you are making only one move from the near field to the far field and the beam location in the crosshair is the same at both locations. It may take several times of moving from the near to far field before they become the same. Once the location is the same, the beam is now parallel to the direction of travel, the x-axis. Move the gantry to the far field (home position) and use BB2 mirror block assembly adjustment to steer the beam into the center of the crosshair. Move back to the near field mark a card and then to the far field and mark another. Using BB1 mirror block assembly adjustment screws make the marks the same again. Repeat the steps of using BB1 to make the marks the same and then use BB2 to bring it to center. Once the beam path is aligned parallel to the x-axis the next step can be taken. Take the time to get this as accurate as possible. A small error at this point will be magnified when you reach the focus lens. Once finished, tighten the mirror block assembly mounting screws and then loosen ½ turn and then recheck near and far field. Remove the crosshair and go to the next step.

STEP 9: Install mirror block assembly on BB3
Install the mirror block assembly on BB3 using the three mounting screws. Tighten the screws then loosen one full turn to allow for adjustment during this procedure. Insert the crosshair in BB4 at the input side of the beam bender. Hold the card near the output side of the crosshair and mark the card and make adjustments to BB3 as necessary to bring the laser beam into the center of the crosshair. Once complete, tighten the mounting screws on BB3 and loosen ½ turn and recheck alignment. Remove the crosshair and go to the next step.

STEP 10: Install mirror block assembly on BB4
Install the mirror block assembly on BB4 using the three mounting screws. Tighten the screws then loosen one full turn to allow for adjustment during this procedure. Insert the crosshair in BB5 at the input side of the beam bender. Move the y carriage to the park position (near field). Hold the card near the output side of the crosshair and mark the card and note the location of the mark in reference to the crosshair. Move the y carriage 12 inches towards the home position and mark a card. It may be necessary to make adjustments to BB4 to keep the mark in the same reference spot as the first. It is not important at this time to be centered in the crosshair just the same location. Continue to make 12 inch moves checking the location of the beam at each step. Once you have reached the home side (far field) and have adjusted the mark location start back at the near field and start the process again but this time make 24 inch moves checking the mark at each stop. Now move back to the near field and mark a card then move to the far field and make a mark. Only minimal changes to the BB4 should be needed at this point to make the two marks the same. Move between the near and far fields until the marks are the same. If the mark is in the center of the crosshair, tighten the mounting screws on
BB4 and loosen ½ turn and recheck alignment. Remove the crosshair and go to the next step. If the mark is not in the center of the crosshair at this point, move to the y carriage to the far field and use the adjusting screws on BB3 to bring the mark into the center of the crosshair. Now move the y carriage to the near field and make a mark then move to the far field make a mark and adjust BB4 as necessary to bring the mark to the same location as in the near field. You may have to do this part of the process several times until the mark is centered in the crosshair, but be patient and persistent. Once complete, tighten the mounting screws on BB3 and BB4 loosen ½ turn and recheck alignment. Remove the crosshair and go to the next step.

**STEP 11: Install mirror block assembly on BB5**

Install the mirror block assembly on BB5 using the three mounting screws. Tighten the screws then loosen one full turn to allow for adjustment during this procedure. Insert the crosshair in BB6 at the input side of the beam bender. Hold the card near the output side of the crosshair and mark the card and make adjustments to BB5 as necessary to bring the laser beam into the center of the crosshair. Once complete, tighten the mounting screws on BB5 and loosen ½ turn and recheck alignment. Remove the crosshair and go to step 12 for non-capacitive cutting heads and step 20 for capacitive cutting heads.

Steps for Non-Capacitive Cutting Head:

**STEP 12: Install mirror block assembly on BB6 and insert tip retainer crosshair**

Install the mirror block assembly on BB6 using the three mounting screws. Tighten the screws then loosen one full turn to allow for adjustment during this procedure. Remove the tip retainer by moving the z-axis to the up position and unscrew it from the cutting head. Insert the tip retainer crosshair into the cutting head. With the z-axis in the full up position place a burn card near the output side of the crosshair and mark the card then move the z-axis to the full down position (far field) and mark a card. Make adjustments to BB6 as necessary so that the near and far field marks are the same with reference to the crosshair. If the marks are in the center of the crosshair, tighten the mounting screws on BB6 and loosen ½ turn and recheck alignment. If the marks are not centered in the crosshair use the four adjusting screws to move the tip retainer so that the crosshair is centered in the beam. **NOTE:** the adjusting screws on BB6 are used for parallelism and the tip retainer adjusting screws are used to center the crosshair in the beam. Once complete, tighten the mounting screws BB6 then loosen ½ turn and recheck alignment. Go to the next step.

**STEP 13: Test alignment (four corner test)**

With the tip retainer crosshair in move the y-carriage to the home position. Place a burn card below the crosshair and pulse the laser. Label this mark as LR (lower right). Move the y-carriage to the farthest left position. Place a burn card below the crosshair and pulse the laser. Label this mark as LL (lower left). Move the gantry to the farthest x-axis position. Place a burn card below the crosshair and pulse the laser. Label this mark as UL (upper left). Move the y-carriage to the y-axis home position. Place a burn card below the crosshair and pulse the laser. Label this mark as UR (upper right). You should now have four marks each representing the four corners of the cut bed. Remove the tip
retainer crosshair and go to the next step if all marks are similar. If there is any difference, the alignment procedure will have to be redone. If all of the marks are not the same the cuts will be different throughout the cutting bed. Thin materials will not show this error as much as thick materials. In thick materials the cut will be angled.

**STEP 14: Install tip retainer, tip and insert lens holder and align**
Install the tip retainer, tip, and lens holder. Adjust the air pressure to zero. Place a strip of the clear tape on the output side of the tip and slightly depress into the tip opening. Set the laser power to 5% power and pulse duration of 0.01 seconds. Pulse the laser. Remove the tape and note where the laser burn is in reference to the tip opening. If the laser burn is located in the center of the tip opening, move to the next step. If it is not in the center use the two adjusting screws to move the lens holder to a new location and retest. Move the lens holder in the direction that you want the laser burn to move. For example, if the laser burn is towards the front of the tip opening move the lens holder towards the back. Loosening the adjusting screws does this.

**STEP 15: Test system**
The alignment procedure is now complete and you are ready to run the system.
OPTICS CLEANING INSTRUCTION

These instructions are provided as a guide only. MultiCam cannot be held responsible for any damage to optics resulting from improper cleaning or handling. Cleaning instructions supplied by the optics manufacturer should always be followed.

Read the instructions completely before starting.
If possible optics should be cleaned in a dust free air-conditioned room.
Always clean with alcohol all gloves or finger cots before handling any optics.
Always handle optics by their edges, never touch the optical surfaces.

Supplies needed:
1. Latex/non-latex rubber gloves or finger cots
2. High purity Isopropyl alcohol
3. Reagent Grade Acetone
4. Lens tissue
5. Lint free cloth
6. Cotton swabs
7. Glass containers with droppers.

Cleaning Procedure:
1. Wash hands with soap to remove all oils, then, put on gloves or finger cots.
2. Clean gloves/finger cots with lint free cloth saturated with alcohol.
3. Hold the optic by its edges or secure the optics mount from moving and blow any dust off with low-pressure dry nitrogen (2 to 5 PSIG), air from a blow bulb, or clean dry air from air compressor. CAUTION: Do not use air from a shop air compressor if water or water vapor is present.
4. Soak a clean lens tissue with isopropyl alcohol and place on the optic. If using a cotton swab, soak with reagent grade isopropyl alcohol and apply to the face of the optic.
5. With the soaked lens tissue wipe the optic in one direction. If using a cotton swab, rotate the swab while moving it across the face with a maximum of 350 degrees of rotation.
6. Repeat steps 3 and 4 three times using a clean lens tissue or cotton ball.
7. Inspect the optic. If there is any contaminant on it or it appears cloudy repeat steps 4 through 5. If it is clean, proceed to step 8.
8. While holding the optic by its edges or securing the optics mount from moving, place a clean piece of lens tissue over the optic, then apply a few drops of acetone to the lens tissue.
9. Slowly drag the lens tissue off the surface of the optic in one direction.
10. Repeat step 8 & 9 three times.
11. Rotate the optic 90° and repeat steps 8 & 9 three times.
12. Inspect the optic to make sure that it is clean.

If cleaning a lens turn the optic over and repeat steps 3 through 11 if required.
Instructions for Handling a Broken or Burned ZnSe Lens

The MultiCam laser uses one ZnSe lens at the cutting head to focus the laser beam onto the material and provide a clean cut. This lens may suffer damage from repeated use. Proper maintenance of the lens will lengthen its working life, but operators may be required to replace and properly dispose of a broken or burned lens.

Broken ZnSe Lens

When encountering a broken ZnSe lens, operators should gather up the large pieces of the broken ZnSe lens and place those pieces in an appropriate container. Any small or dust-size pieces should be wiped up with a paper towel or wet cloth. Operators may dispose of the broken or scrap pieces of ZnSe lens per the local ordinances.

Operators should wash their hands immediately after handling the ZnSe lens since the ZnSe dust may be transferred from the hands onto food and inserted into the mouth. The ZnSe material itself is not toxic, but the toxicity studies did not examine the long-term effects of ZnSe dust inhalation. As always, operators should observe good work practices when handling materials.

Burned ZnSe Lens

When encountering a burned or melted ZnSe lens, operators should wipe the area with a paper towel or wet cloth to clean up the decomposed ZnSe, which breaks down into ZnO and SeO2. Occasionally, the decomposed ZnSe may require abrasive materials such as wet sandpaper for proper cleaning. Operators may dispose of the materials used to clean ZnO and SeO2 from the lens per the local ordinances.

Operators should wash their hands immediately after handling the cleaning materials since the dust from decomposed ZnSe may be transferred from the hands onto food and inserted into the mouth. The ZnSe material itself is not toxic, but the toxicity studies did not examine the long-term effects of ZnSe dust inhalation. As always, operators should observe good work practices when handling materials.