High-Precision Optical Path Alignment (RD)

RSD-SUNMAX Series

SUNMAX LASER

About this document: This is an English translation of the Japanese original prepared by SUNMAX LASER for reference purposes. In case of any discrepancy, the Japanese original shall prevail. Specifications are subject to change without notice.

High-Precision Optical Path Alignment (RD)

The optical path alignment method described in the laser machine's instruction manual is intended to make laser irradiation possible across the entire work area; it does not address the tilt of the cut cross section. This document explains how to align the optical path so that the laser beam strikes the workpiece material perpendicularly.

Note: Depending on the model and production lot, the actual machine may differ from the images in this document. Interpret them accordingly.

Note: The method described in this document does not guarantee that the cut cross section will be perpendicular to the workpiece material. Perpendicularity is judged solely by the operator's visual inspection.

Note: The high-precision optical path alignment method presented here shows a procedure; it does not guarantee a result within a limited number of steps. Fine adjustments must be repeated over and over (until you judge the result to be OK). Therefore, the required time and labor cannot be stated in advance. In general, the larger the machine, the longer the work takes. It also depends heavily on the machine's installation environment.

> **Caution:** If you stop with the adjustment only partially completed, the tilt may become worse, or optical path problems may make proper processing impossible. Once you begin this adjustment, reaching a proper final state may take considerable time depending on the machine's condition and the operator's skill. Secure sufficient working time before starting.

Note: This document does not describe the relationship between the rotation direction of the adjustment screws and the resulting mirror angle when changing the angle of each reflection mirror. This is because the relationship between screw rotation direction and mirror angle change differs by model and lot. Check the machine's instruction manual, or turn the adjustment screws yourself during alignment and observe how the optical path changes. Because this work requires fine angle adjustments, we recommend — although it takes some effort — confirming the angle changes yourself as you work, so that you get a feel for how screw rotation relates to angle change.

Procedure

① Preparing for Optical Path Alignment

Prepare the machine so that the laser beam path can be checked.

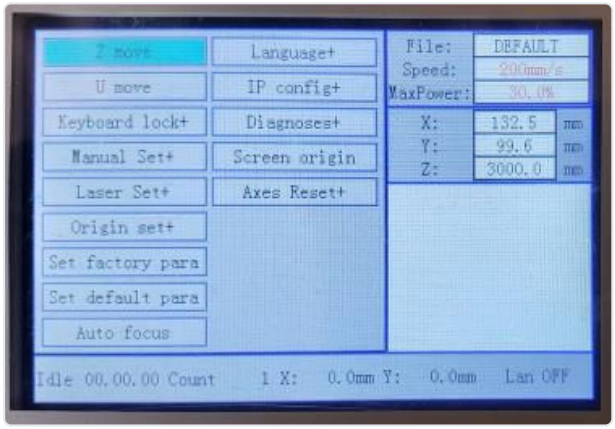
1. Adjusting the Laser Output

For optical path alignment, set the laser irradiation time and laser output that will be applied when the Pulse button on the control panel is pressed.

Setting the Laser Irradiation Time

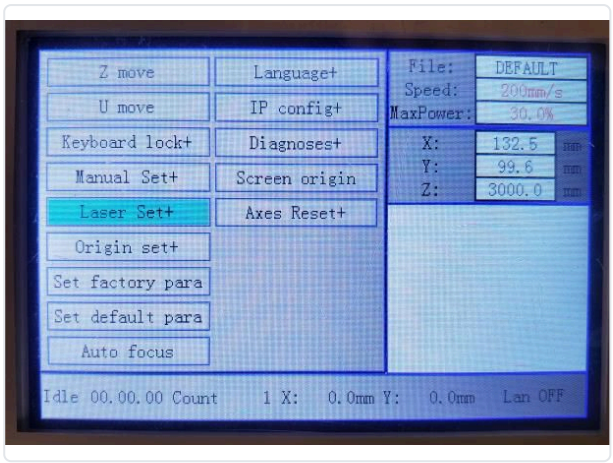
Set the irradiation time with "Laser Set" on the control panel.

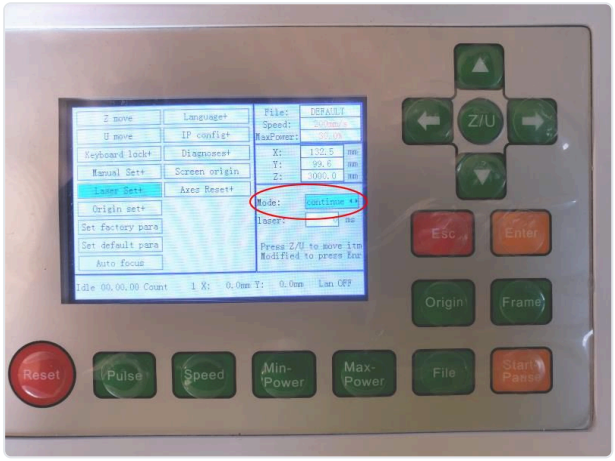
Press the Z/U button to display the option screen.



Use the down-arrow button to move the cursor and select "Laser Set+."

With the cursor on "Laser Set+," press the Enter button.





If Mode is set to "continue," press any of the arrow buttons (up, down, left, or right) to change it to "manual."

After setting Mode to "manual," press the Z/U button to move the cursor to "laser."

Once the cursor is on "laser," use the arrow buttons to set the laser irradiation time.

The left and right arrow buttons change which digit is edited.

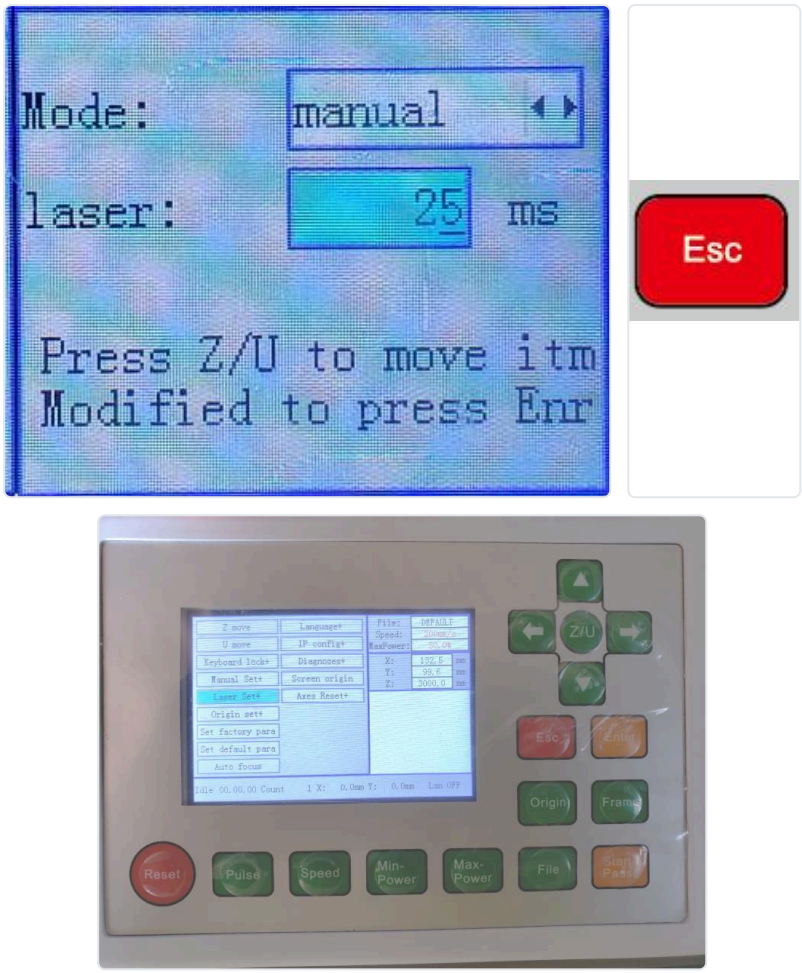
The up and down arrow buttons increase or decrease the value of the current digit. The currently selected digit is indicated by an underscore.

Set the value within a range of about 20–30 [ms]. The appropriate value varies with the condition of the laser tube, mirrors, and lens, so set it to 25 [ms] for now and change it later if adjustment is needed.

After setting the value to 25, press the Enter button to finish the setting, then press the Esc button to return to the normal screen.

Press the Enter button.

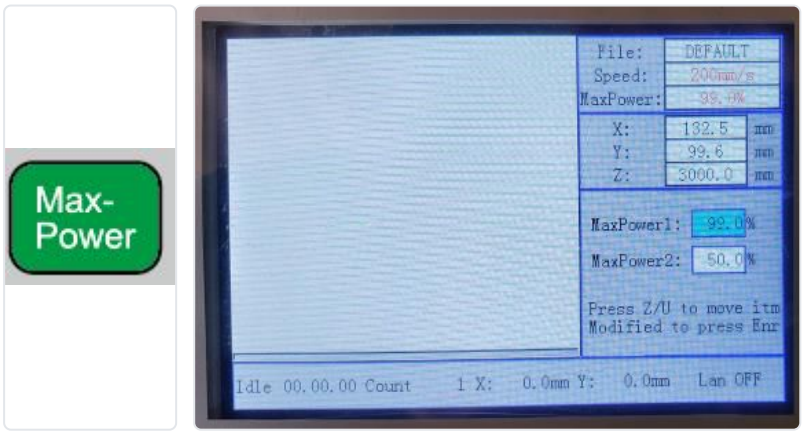
Press the Esc button.



Setting the Laser Output

Set the laser output with "Max-Power" on the control panel. Set the MaxPower value to 99.0 [%].

Press the Max-Power button to display the MaxPower setting screen.



Use the arrow buttons to set "MaxPower1" to 99.0. Do not change "MaxPower2."

The left and right arrow buttons change which digit is edited.

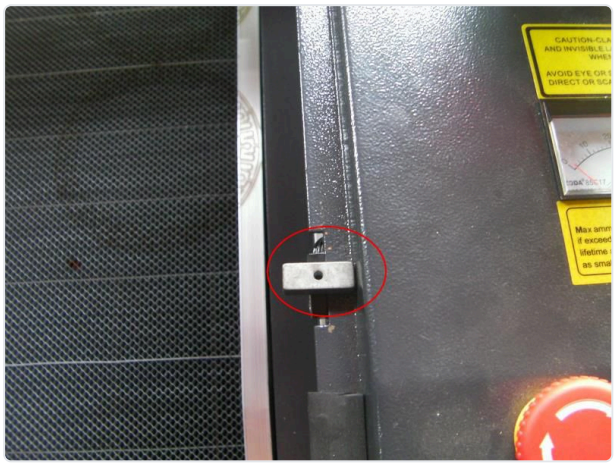
The up and down arrow buttons increase or decrease the value of the current digit. The currently selected digit is indicated by an underscore.

After changing the setting, press the Enter button to return to the normal screen.

The laser irradiation time and laser output are now set.

2. Placing a Magnet on the Safety Switch

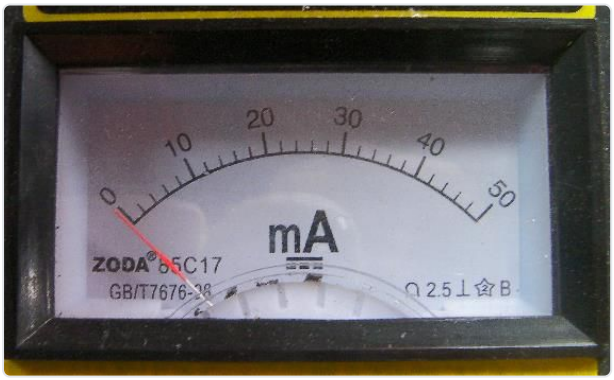
Place a magnet on the safety switch so that the laser can fire while the machine's top door is open.

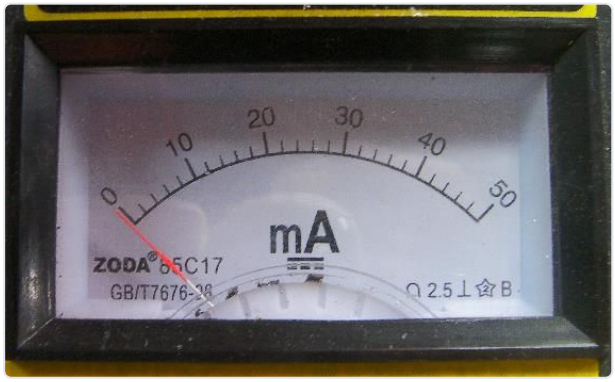


After placing the magnet, press the Pulse button on the control panel and check whether the laser fires.

> **Warning:** When the Pulse button is pressed, the laser fires with the top door open. Pay close attention to safety around the machine.

Use the ammeter to confirm that the laser is firing.





When you press the Pulse button on the control panel, the needle moves for an instant and then returns to zero.

Note: If the needle does not immediately return to zero while you hold down the Pulse button, redo the laser irradiation time setting. Normally, the needle swings momentarily to around 5 mA.

The photo on the left shows a meter with a scale up to 50 mA; depending on the model, some machines use a meter with a maximum of 30 mA. There is no difference in this procedure between the two.

3. How to Make Paper Strips for Checking Burn Marks

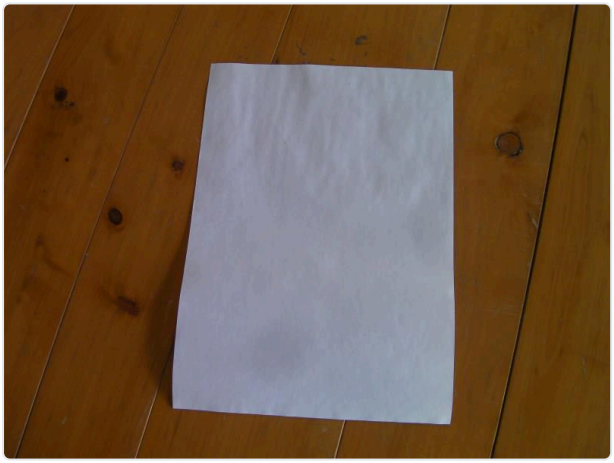
The laser beam path is checked by firing the laser at a strip of paper and examining the burn mark.

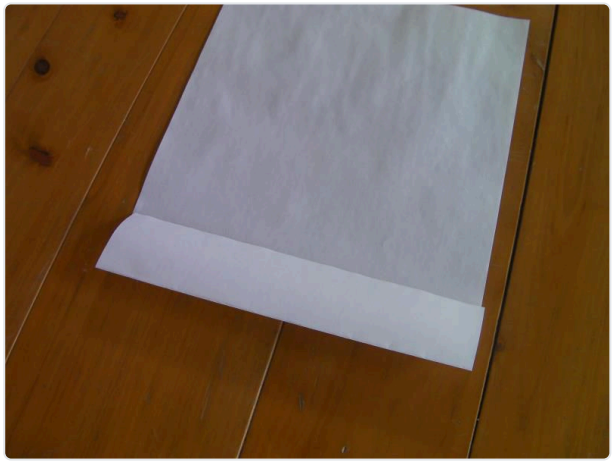
Use ordinary copy paper for the strips. Paper that is too thin, too thick, or easily flammable is not suitable.

Colored or patterned paper makes burn marks hard to distinguish, so plain copy paper or something similar is best.

It is also best to avoid reusing paper that has already been printed on.

Cut the prepared copy paper into strips roughly 3–4 cm wide. The width does not need to be measured precisely, but strips that are too wide or too narrow make the work harder.





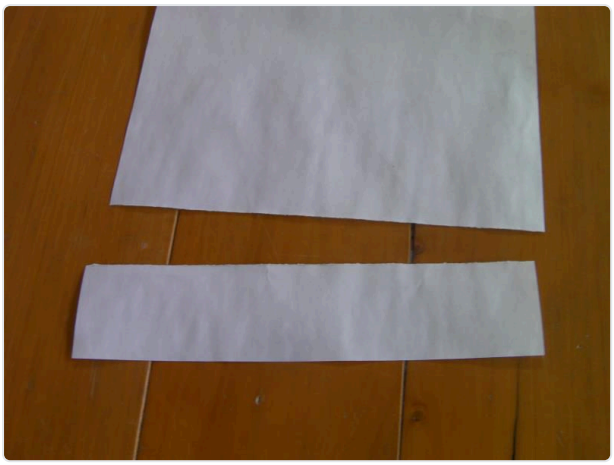
A4 copy paper. Plain, unused paper is preferable.

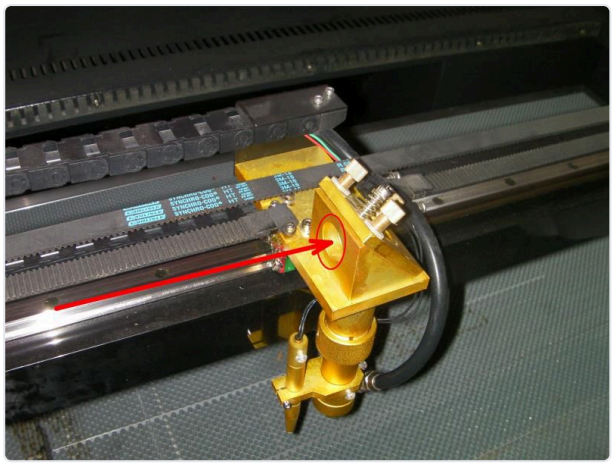
Cut it into strips roughly 3–4 cm wide.

There is no need to use scissors. Crease the paper and tear it along the fold. Slightly irregular shapes are not a problem.

4. How to Check the Burn Mark in Front of the 3rd Reflection Mirror

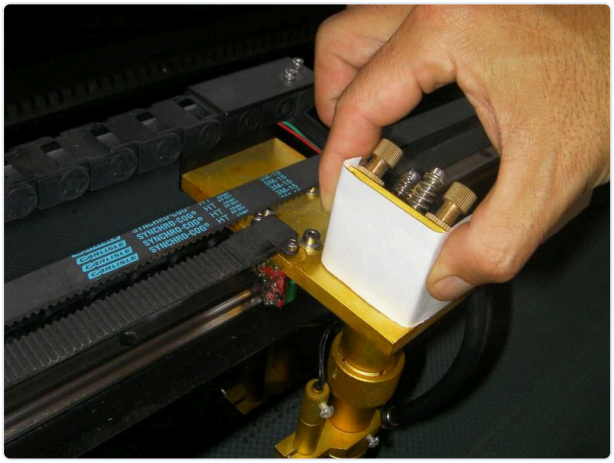
Check where the laser passes through the round hole in front of the 3rd reflection mirror on the laser head.

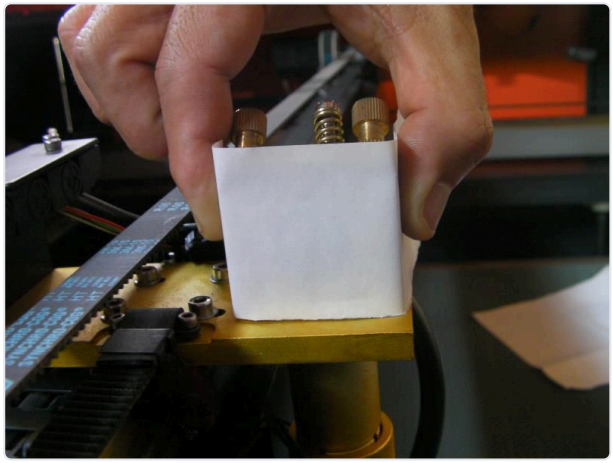


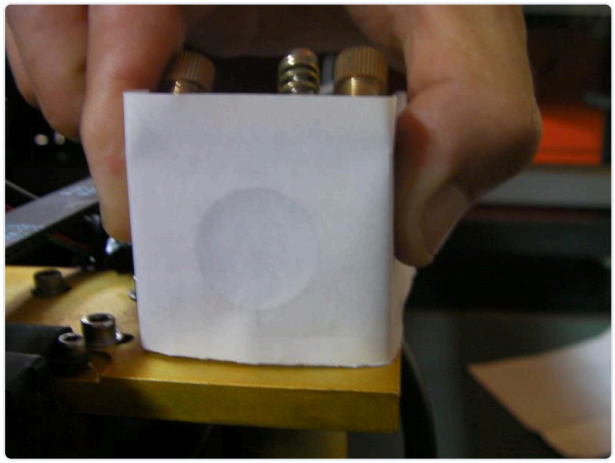


Place the paper strip you made in “3. How to Make Paper Strips for Checking Burn Marks” over the round hole.

Press the entire paper strip lightly so that it takes an impression of the round hole and its shape can be seen.







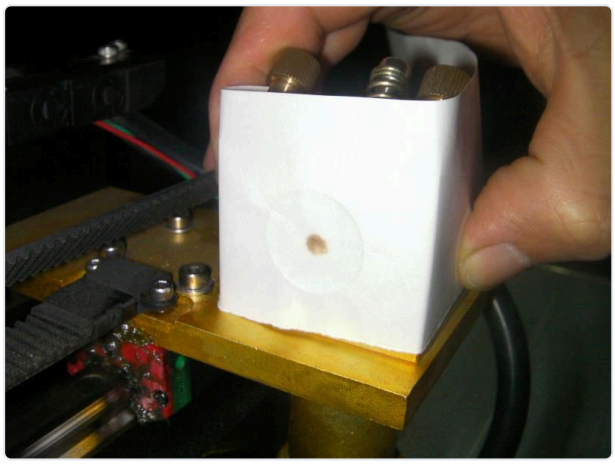
- The paper strip will be used many times for checking laser burn positions, so start using it from one edge.
- Hold the paper down from both sides of the laser head.
- Pull the paper strip slightly toward the rear so that it fits as tightly as possible, with no slack or wrinkles.

- Once the impression of the round hole is made, hold the paper strip firmly in place so the impression does not shift.
- If the paper strip moves and the round-hole position shifts, slide the paper strip over a little and start again.
- Even a slight misalignment will prevent you from getting correct results.

With the paper strip held in place, press the Pulse button on the control panel.

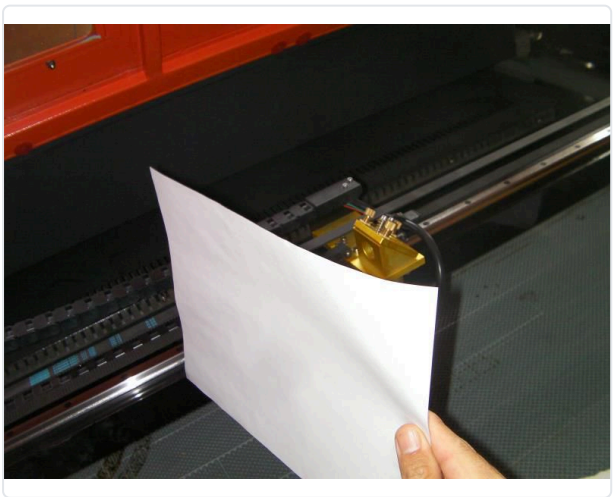
The laser fires and leaves a burn mark.
If no burn mark appears, press the Pulse button two or three times.

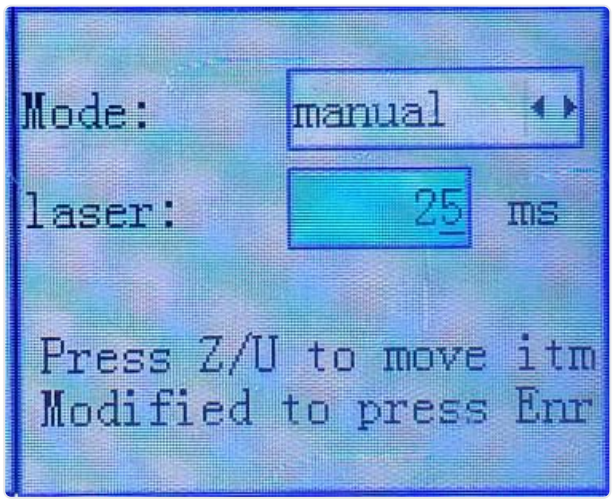
> **Warning:** The laser beam passes close to your hands. Take great care not to block the laser beam with any part of your body.



> **Caution:** If the optical path is not properly adjusted, the beam may not fall within the area of the paper strip. Depending on the beam path, it may strike the hand holding the paper. To avoid contact between the laser beam and your body, if you are unsure roughly where the beam path is, hold a larger sheet of paper in front of the laser head, fire the laser, and check where the beam arrives.

If the laser does not enter the round hole in front of the 3rd reflection mirror, roughly adjust the optical path at this point.





The burn mark is acceptable as long as it is clearly visible to the eye. If the paper flares up (too strong) or no mark appears (too weak), go back to “Setting the Laser Irradiation Time” and change the “laser” value under “Laser Set.”

If the paper flares up, decrease the value. If you make the value extremely small, the laser will no longer fire.

If a burn mark appears only after pressing the Pulse button several times, increase the value. Setting a much larger value all at once may set the paper on fire, so raise the value in steps of about 3, checking the burn mark as you go.

Ideally, a single press of the Pulse button should leave a clearly distinguishable burn mark.
Adjust the “laser” setting value while checking the burn marks.

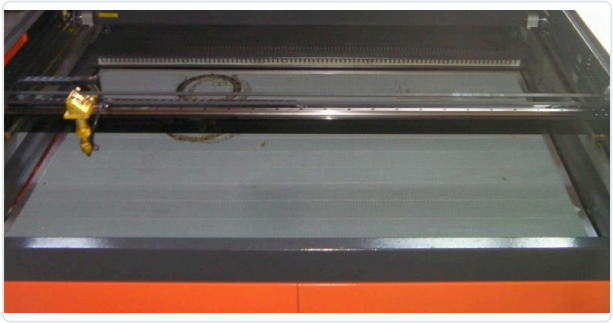
② Adjustment Across the Entire Work Area

After completing “① Preparing for Optical Path Alignment,” check the laser beam path and make sure the beam passes through the same point across the entire work area.

1. X-Axis Direction

Adjust the optical path in the X-axis direction.

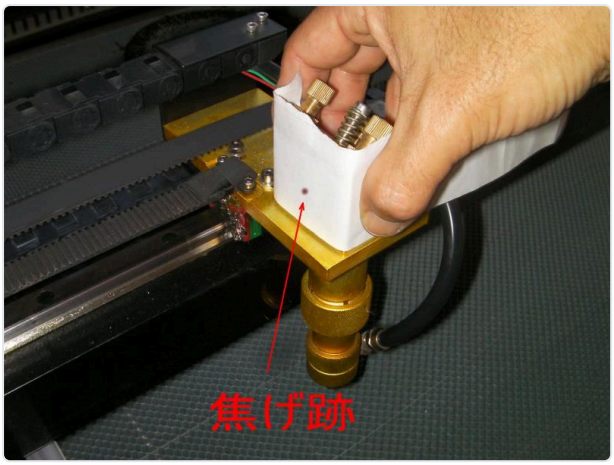
The X-axis beam path is evaluated by comparing the laser head positioned at the right with the laser head positioned at the left.
If the burn-mark position differs between the right and left positions, adjustment is required.



Laser head at the left side

Laser head at the right side

First, check the burn mark with the laser head at the left side.
After making a burn mark on the paper strip in front of the 3rd reflection mirror, move the laser head to the right, taking care not to shift the position of the paper strip.
After moving the head to the right, fire the laser again to make another burn mark.



Laser head: left

Laser head: right

Move the laser head to the right

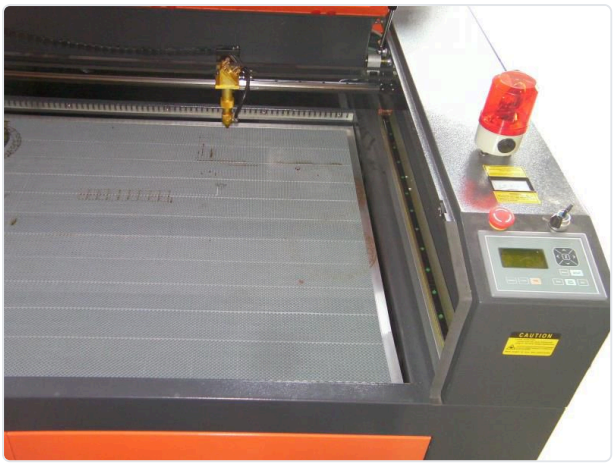
If the burn positions differ between the right and left laser-head positions, there is a problem with the angle of the 2nd reflection mirror.
The goal of this step is to make the burn-mark positions match between right and left, regardless of where the burn mark falls.

If the burn-mark positions do not match between right and left, refer to the machine's instruction manual and adjust the angle of the 2nd reflection mirror so that they match. The method for adjusting the angle of the 2nd reflection mirror varies by model.

2. Y-Axis Direction

Adjust the optical path in the Y-axis direction.

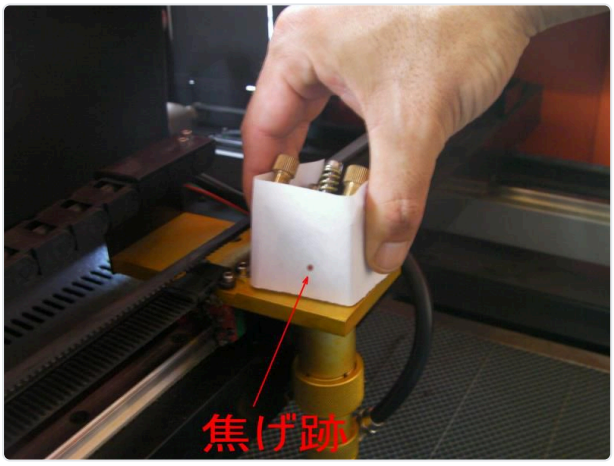
The Y-axis beam path is evaluated by comparing the laser head positioned at the rear with the laser head positioned at the front.
If the burn-mark position differs between the front and rear positions, adjustment is required.

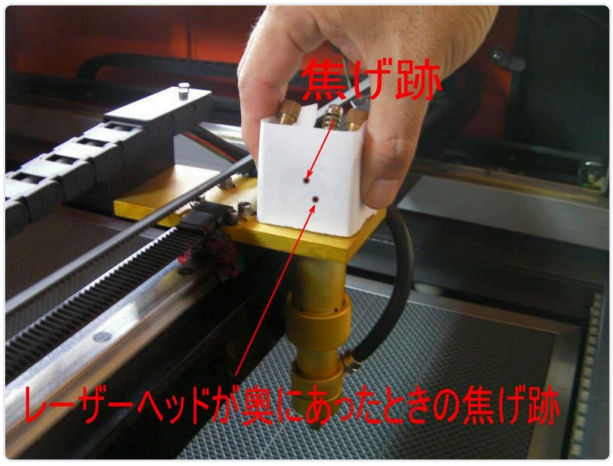


Laser head at the rear

Laser head at the front

First, check the burn mark with the laser head at the rear.
After making a burn mark on the paper strip in front of the 3rd reflection mirror, move the laser head toward the front, taking care not to shift the position of the paper strip.
After moving the head to the front, fire the laser again to make another burn mark.





Laser head: rear

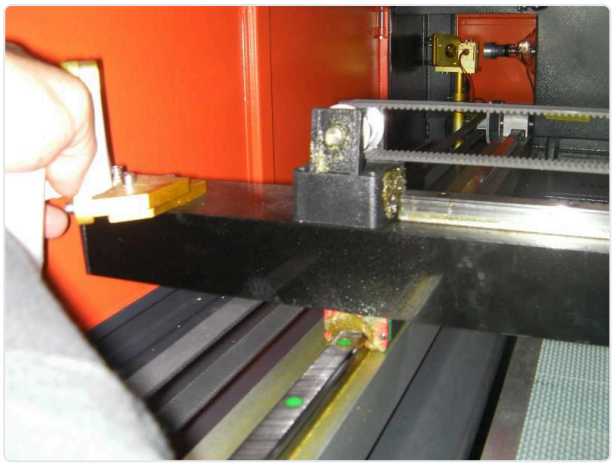
Laser head: front

Move the laser head toward the front

If the burn-mark position differs between the laser head's front and rear positions, there is a problem with the angle of the 1st reflection mirror.

If the burn marks are offset between the front and rear positions, the 1st reflection mirror is misaligned.

To adjust the angle of the 1st reflection mirror, hold a paper strip in front of the 2nd reflection mirror and check the offset between the beam positions when the laser head is at the rear and at the front. Adjust the angle of the 1st reflection mirror until the offset is eliminated.



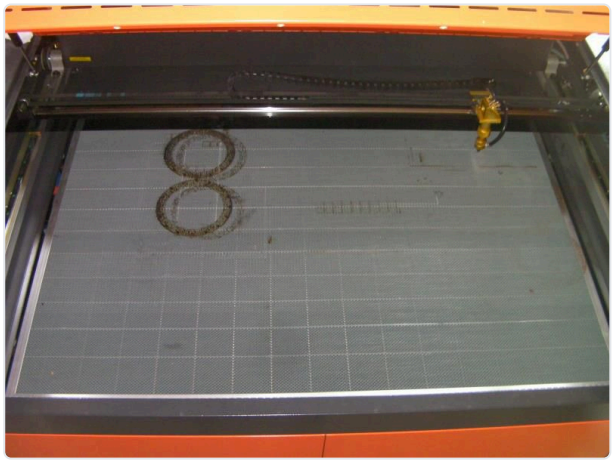
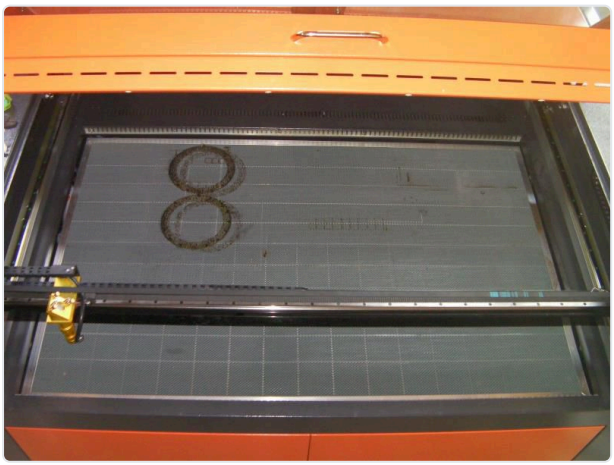
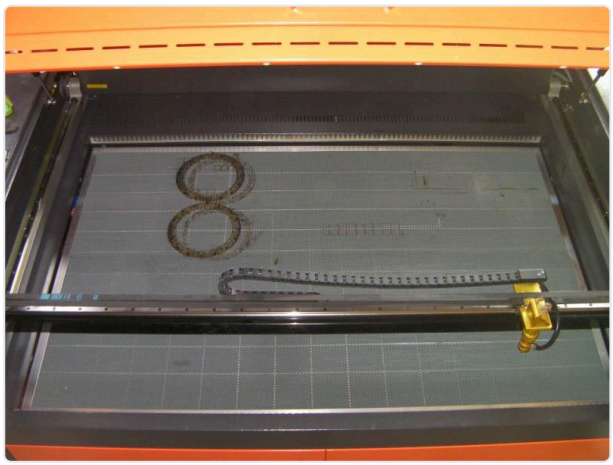
Laser head: rear / Laser head: front — move the laser head toward the front.

Once the burn marks in front of the 2nd reflection mirror coincide between the rear and front positions, they will also coincide in front of the 3rd reflection mirror.

The goal of this step is to make the burn-mark positions coincide between the front and rear positions, regardless of where the burn mark falls.

3. Checking the Entire Work Area

Once the adjustments for both the X axis and the Y axis are complete, confirm that the burn marks land on the same point at all four corners of the work area (rear left, rear right, front left, and front right).

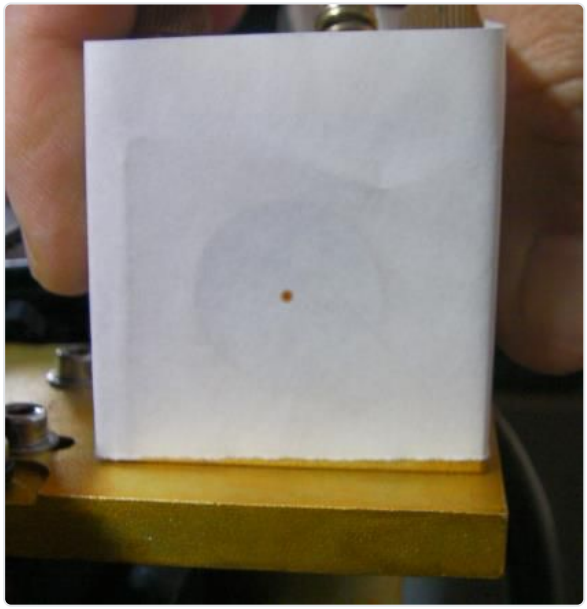





Rear left / Rear right / Front left / Front right

③ Centering the Beam in Front of the 3rd Reflection Mirror

After finishing "① Preparing for Optical Path Alignment" and "② Adjustment Across the Entire Work Area," check the laser beam path and adjust it so that the beam strikes the center of the round hole in front of the 3rd reflection mirror.

If the burn mark is already at the center of the round hole of the 3rd reflection mirror, the procedure in "③ Centering the Beam in Front of the 3rd Reflection Mirror" is not needed. Proceed to "④ Adjusting the 3rd Reflection Mirror."



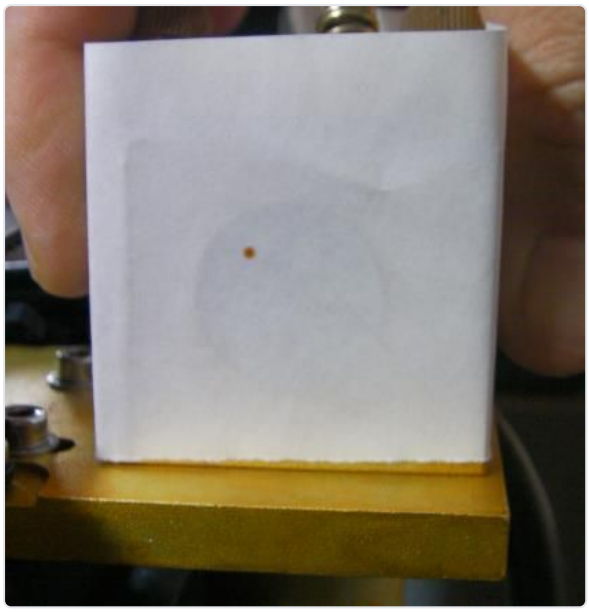
The burn mark is at the center of the round hole.

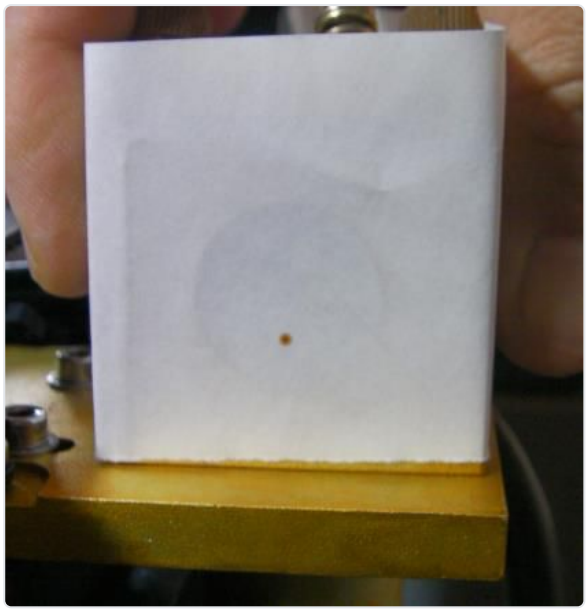
1. Height Adjustment

Adjust the beam position in the height direction.

Even if the beam is not centered horizontally, this step is not needed as long as it is centered in the height direction.

In the example below, the beam is not centered in the height direction, so adjustment is required.



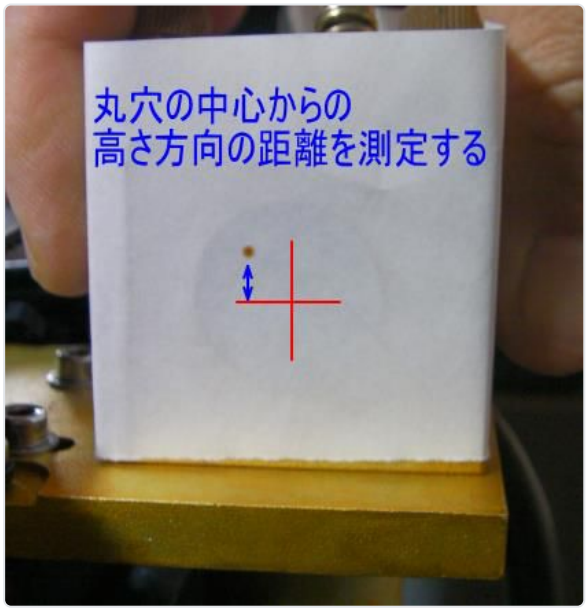


In the example below, the beam is centered in the height direction, so "1. Height Adjustment" is not needed. Proceed to "2. Adjusting the Left-Right Position."

Height adjustment is performed by changing the position of the laser tube.

First, use the burn mark to measure how much the height must be changed.

In the example above, if, for instance, the vertical distance between the burn-mark position and the center of the round hole is 3 mm, you need to lower the laser tube by 3 mm.



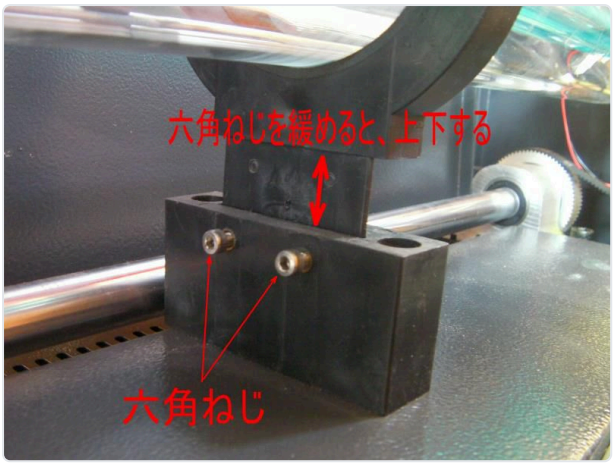
Open the rear door.

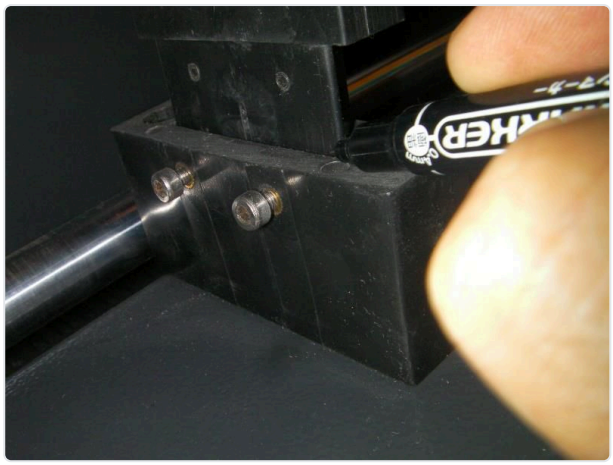
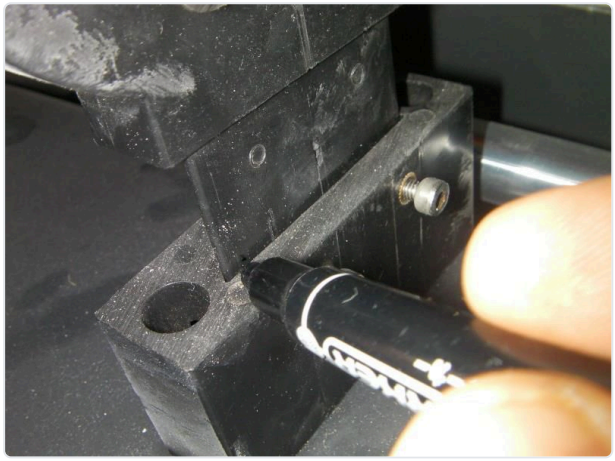
Note: The shape of the laser tube and of the machine body varies by model, but the procedure is the same.

The laser tube is secured by two mounting bases.

Note: The shape of the mounting bases varies by model and production lot. Whichever type of mounting base is installed, the mechanism and the procedure are the same. Read the steps below as they apply to the mounting bases on your machine.

Each mounting base allows height adjustment by loosening its two hex screws.



Adjust the height of each of the two mounting bases. Change the height by exactly the vertical distance between the burn-mark position and the center of the round hole.

Marking the position with a felt-tip pen or similar before adjusting makes it easier to set the height accurately.

> **Caution:** The laser tube is secured by two mounting bases. If you change the height of only one mounting base, the laser tube will be tilted and optical path alignment will become difficult. When changing the height, always change the height of both mounting bases.

After changing the height of the mounting bases, perform "② Adjustment Across the Entire Work Area." Align the optical path so that the burn marks land on the same point across the entire work area.

If the coincident burn mark now falls at the vertical center, the adjustment is complete.

If it does not fall at the vertical center, fine-tune the mounting-base height again and repeat "② Adjustment Across the Entire Work Area" — keep repeating this cycle until the burn mark is centered in the height direction.

This work may require many rounds of fine adjustment; in some cases it is finished after a single height adjustment. As a rule, the larger the machine's work area, the more difficult and time-consuming this becomes.

Repeat the adjustment until the burn mark is centered in the height direction.

> **Caution:** Be sure to confirm that the burn marks coincide across the entire work area. An adjustment that is correct only at one spot within the work area will not allow proper processing.

2. Adjusting the Left-Right Position

Adjust the beam position in the left-right direction.

Before performing this step, "1. Height Adjustment" must be completed.

If the burn mark is at the center of the round hole, this step is not required. Proceed to "④ Adjusting the 3rd Reflection Mirror."

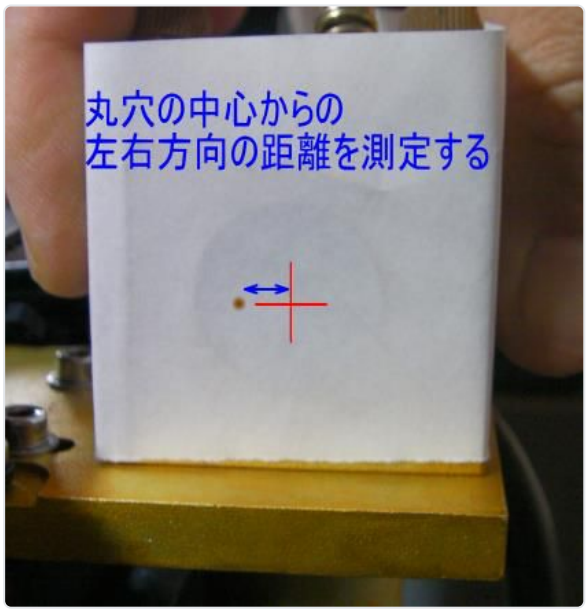
In the example below, the mark is not centered in the left-right direction, so adjustment is required.

In the example below, the mark is at the center of the round hole, so "2. Adjusting the Left-Right Position" is not required.

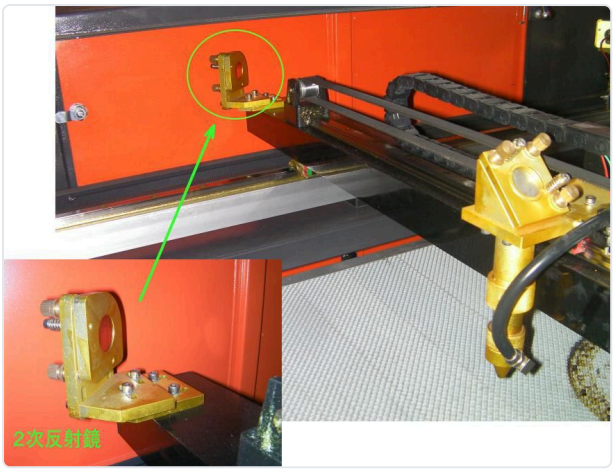
The left-right position is adjusted by changing the position of the 2nd reflection mirror.

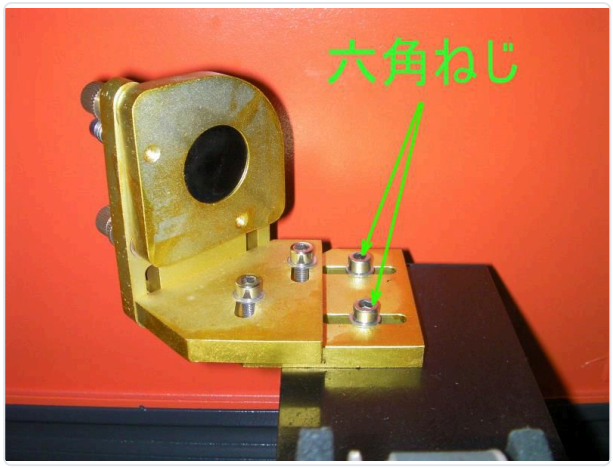
First, measure the required amount of left-right movement from the burn mark.

In the example above, if the left-right distance between the burn mark and the center of the round hole is, for example, 3 mm, you need to move the 2nd reflection mirror by 3 mm.

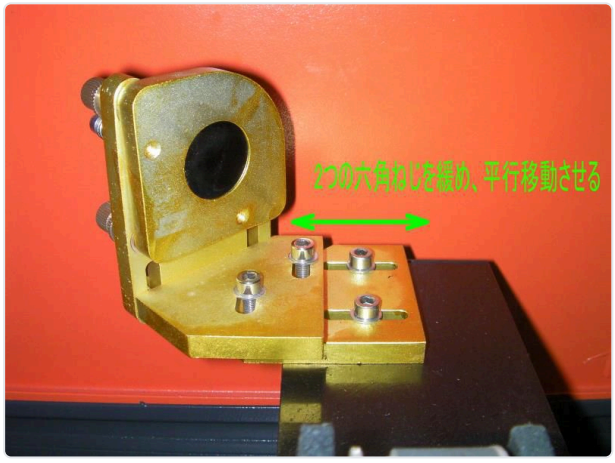


Loosen the hex screws that secure the 2nd reflection mirror, and move the mirror.





Loosen the hex screws and move the mirror by the same distance as the offset observed at the round hole in front of the 3rd reflection mirror.



After changing the position of the 2nd reflection mirror, perform "② Adjustment Across the Entire Work Area." Adjust the beam path so that the burn marks land on the same point everywhere in the work area.

If the coinciding burn marks are now at the center of the round hole in front of the 3rd reflection mirror, the adjustment is OK.

If they do not reach the center of the round hole, fine-tune the position of the 2nd reflection mirror again and repeat "② Adjustment Across the Entire Work Area." Keep repeating this cycle until the marks reach the center of the round hole.

This work may require many rounds of fine adjustment; in some cases it is completed in a single move. Since a perfectly parallel shift is difficult, the mirror angle may change as well, and adjusting the movement amount alone may not be sufficient.

Repeat the adjustment until the marks reach the center of the round hole.

The adjustment is complete when the burn marks coincide with the center of the round hole across the entire work area.

> **Caution:** Always confirm that the burn marks coincide across the entire work area. An adjustment in which the marks coincide only at a certain location within the work area will not allow proper processing.

④ Adjusting the 3rd Reflection Mirror

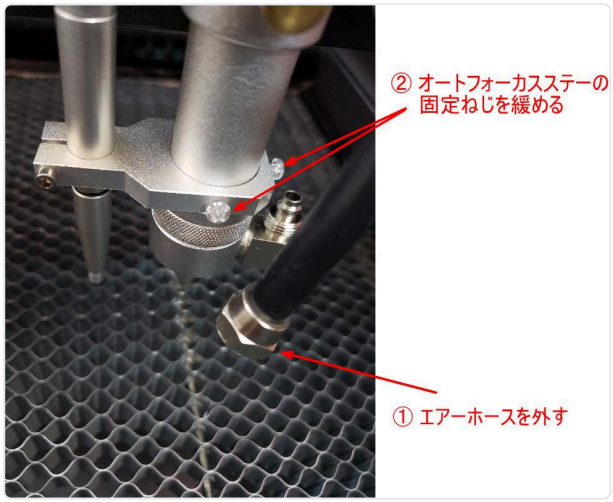
After completing "③ Centering the Beam in Front of the 3rd Reflection Mirror," check the laser beam path and adjust the angle of the 3rd reflection mirror.

To adjust the angle of the 3rd reflection mirror, check the position of the burn mark after the beam passes through the focus lens. Follow the steps below.

1. Removing the Emission Outlet

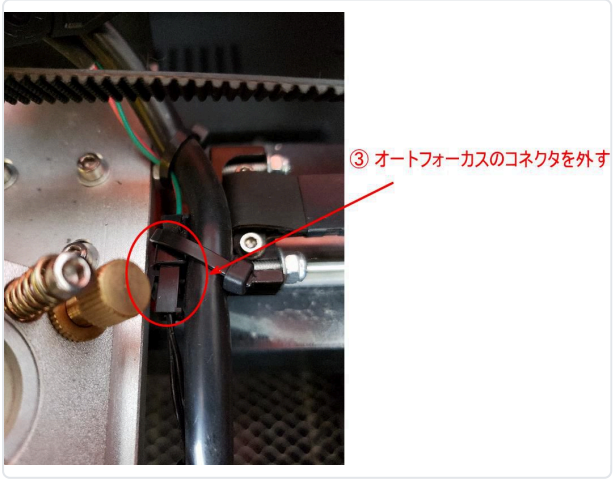
Remove the emission outlet from the laser head cylinder.

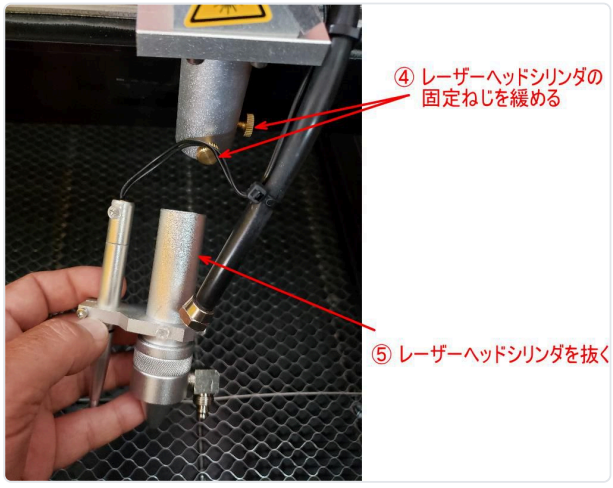
First, disconnect the air hose, then loosen the fixing screw of the autofocus stay.



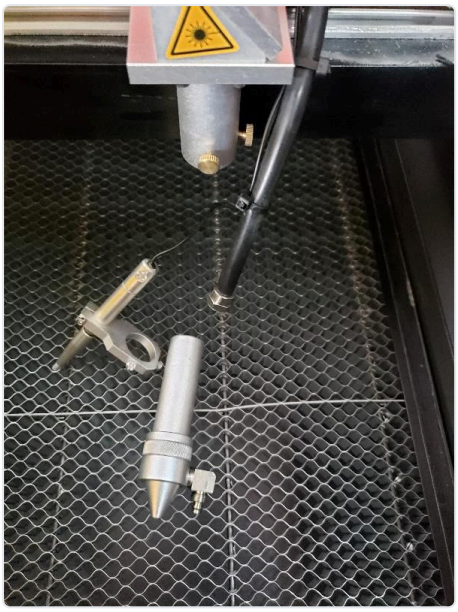
Next, disconnect the autofocus connector.

Loosen the fixing screws of the laser head cylinder and pull out the laser head cylinder.





After pulling out the laser head cylinder, remove the autofocus unit and detach the emission outlet.

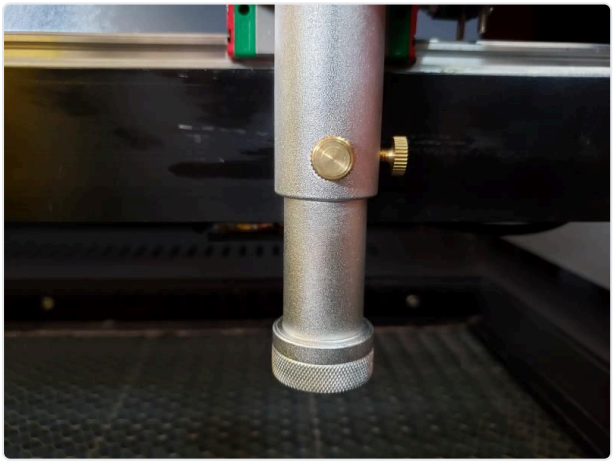


Attach only the laser head cylinder to the laser head.

2. Checking the Beam Path

Hold a paper strip for checking burn marks against the bottom face of the laser head cylinder and fire the laser.

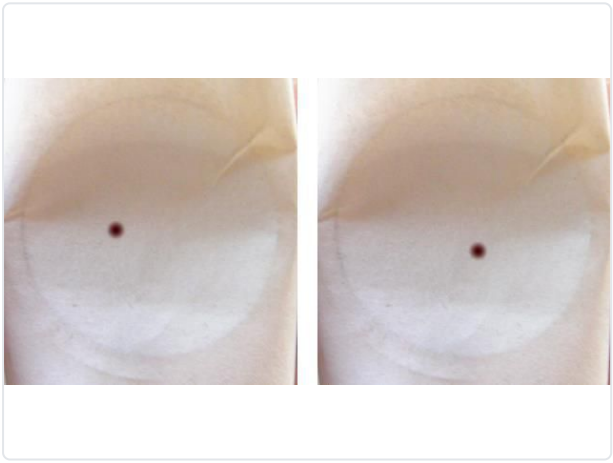
Press the paper against it as in "② Adjustment Across the Entire Work Area" so that the round outline of the laser head cylinder is imprinted on the paper.



With the machine in this state, fire the laser and check the position of the burn mark.

As shown in the figure below, adjust so that the burn mark falls at the center of the circle.

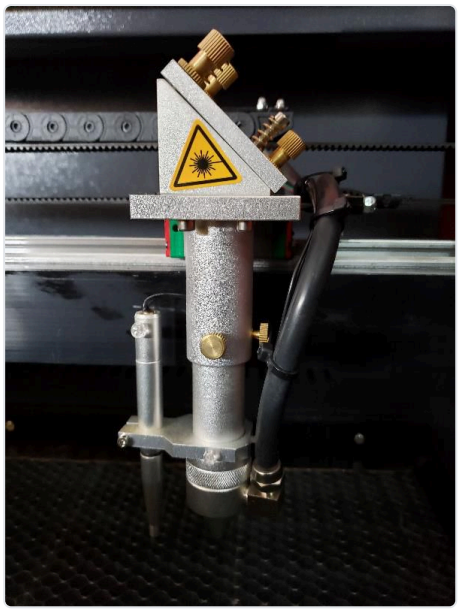
If the burn mark is not at the center of the circle, adjustment is required.



The position of the burn mark is changed by adjusting the angle of the 3rd reflection mirror.

Once the burn mark is at the center of the circle, the adjustment is complete.

Reattach the emission outlet and the autofocus unit to restore the machine to its original condition.



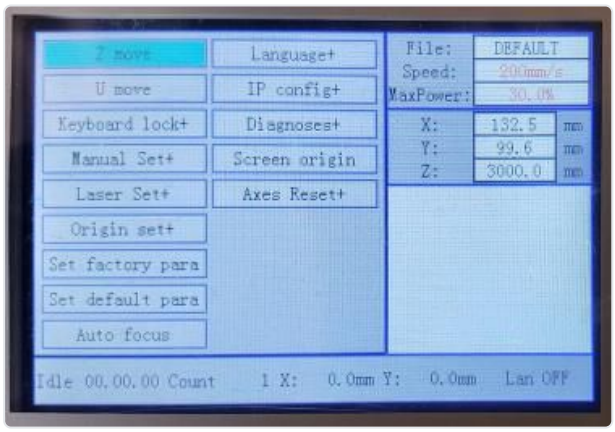
⑤ Checking Perpendicularity

The perpendicularity of the laser beam is checked using the side face of a thick wooden board.

For this check, change the "Laser Set" setting on the control panel to "continue".

1. Change the "Laser Set" Setting to "continue"

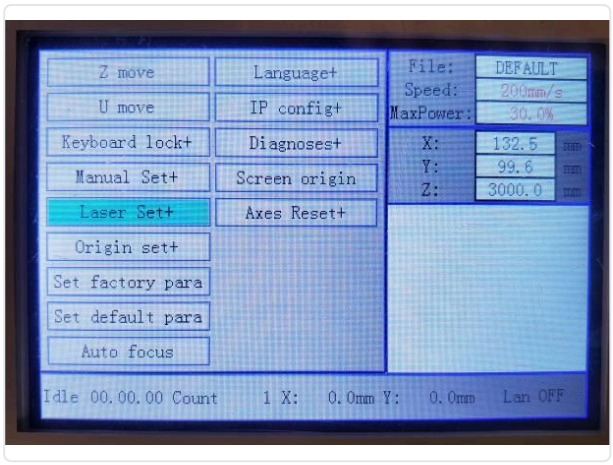
Press the Z/U button to display the options screen.

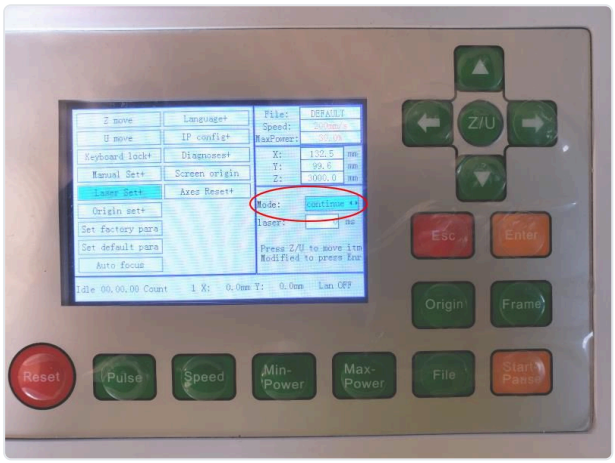


Use the down-arrow button to move the cursor and select "Laser Set+".

With the cursor on "Laser Set+", press the Enter button.

Press one of the arrow buttons (up, down, left, or right) to change the Mode setting to "continue".





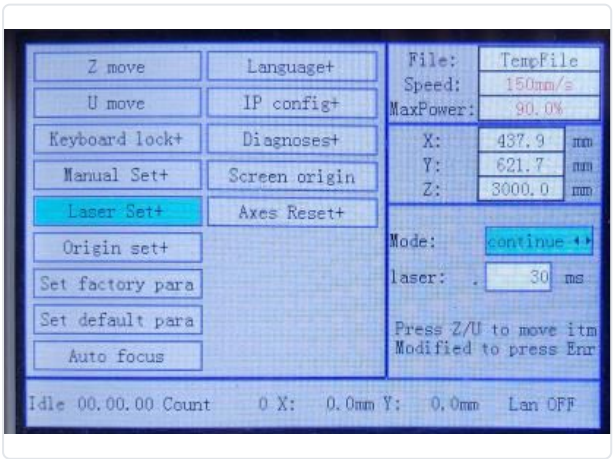
2. Check Perpendicularity

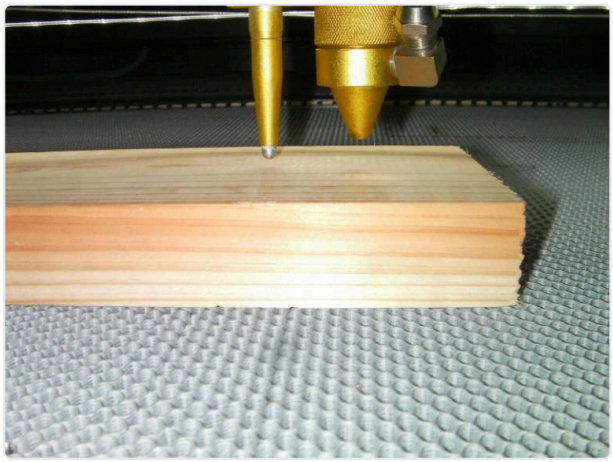
The most appropriate way to check that the laser beam is perpendicular to the workpiece is to use the actual material and data that will be processed.

If for some reason the actual workpiece material cannot be used, you can check perpendicularity by preparing a thick wooden board. A board thickness of about 2 cm or more makes the result easier to see.

When checking with a wooden board, follow the steps below.

First, set the focus on the surface of the wooden board.

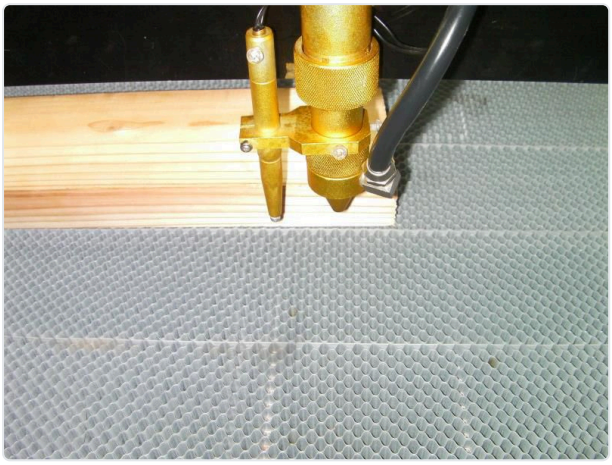


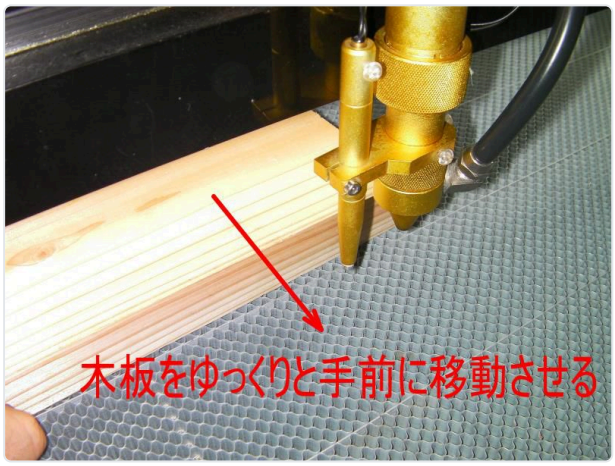


Begin by checking the tilt in the left-right direction.

With the laser beam not hitting the wooden board, press and hold the "Laser" button on the control panel so that the laser is being output.

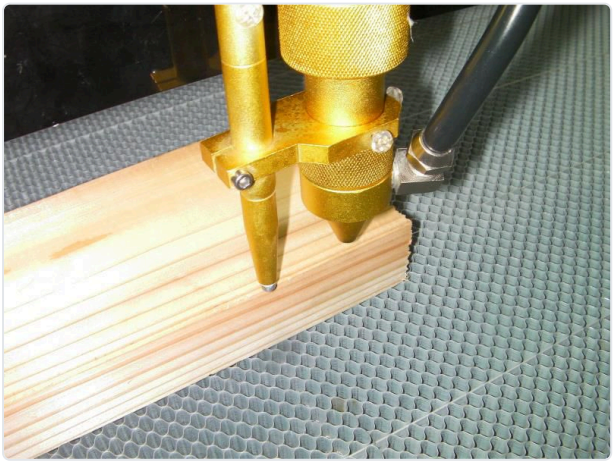
While the laser is firing, move the wooden board toward you so that a burn mark is made on the side face of the board.

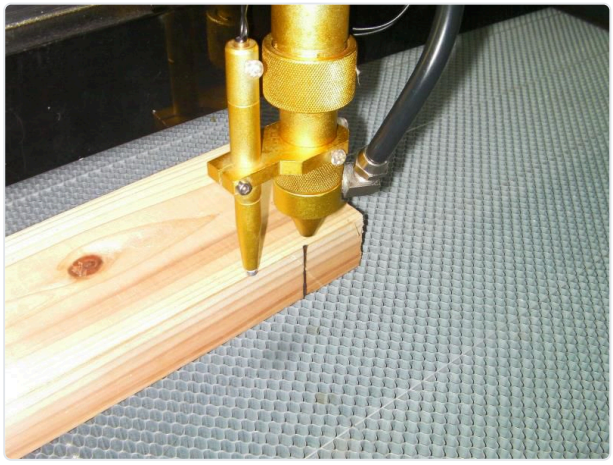




With the laser not hitting the wooden board, press the "Pulse" button. Move the wooden board toward the rear from beneath the emission outlet so that it is not struck by the laser even while the laser is being output.

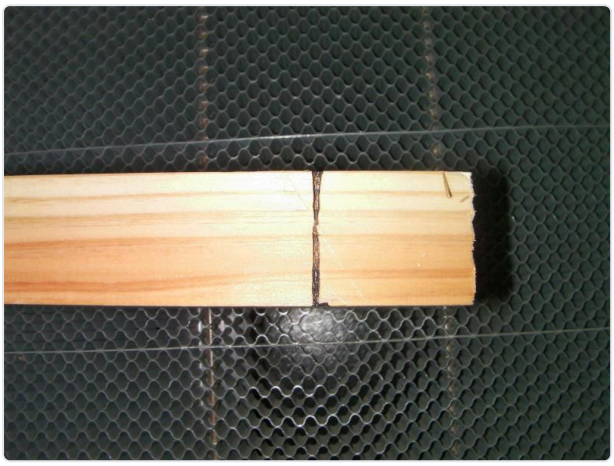
Slowly move the board forward, and once a burn mark has been made on the side face of the wooden board, stop the laser output and check whether the burn mark is vertical.

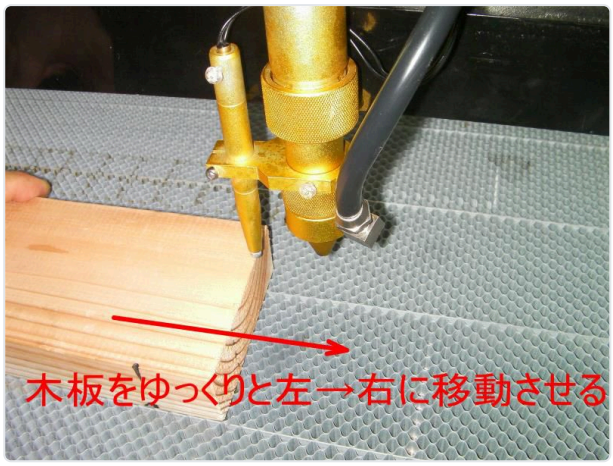




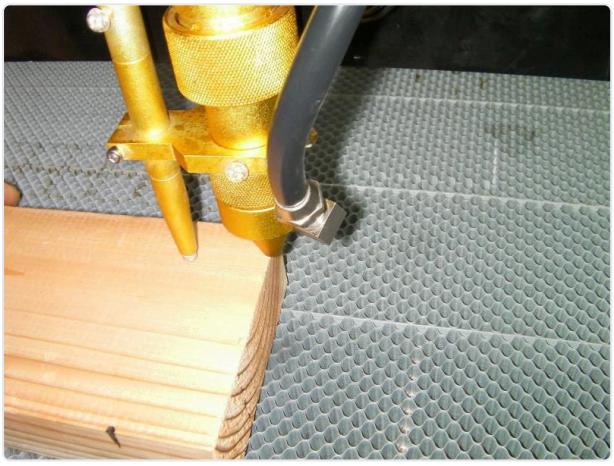
Check that the burn mark is vertical.

Next, check the tilt in the front-back direction.





Slowly move the board to the right. Once a burn mark appears on the side face of the wooden board, stop the laser output and check whether the burn mark is vertical.



Check that the burn mark is vertical.

⑥ If the Beam Does Not Become Perpendicular

If the beam is still tilted after completing all of the adjustments through ⑤ above, first fine-tune the tilt of the 3rd reflection mirror so that the beam becomes perpendicular.

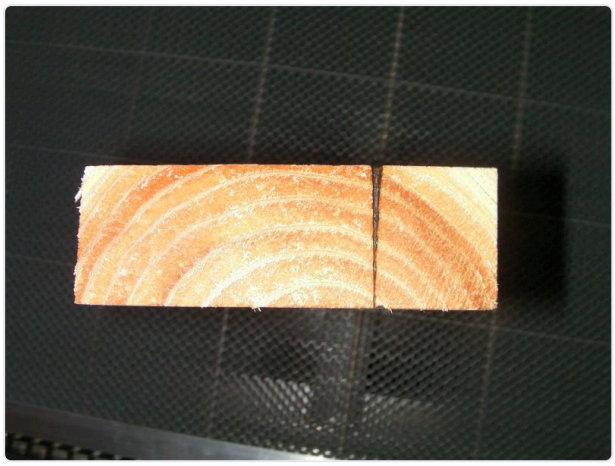
If fine-tuning the 3rd reflection mirror alone does not make the beam perpendicular, the cause may be a mechanical accuracy issue. Try the following.

1. Check That the Laser Head Cylinder Is Secure

If the laser head cylinder is tilted, the laser will not be emitted perpendicularly.

The laser head cylinder may be tilted, or it may not be firmly fixed in place. Loosen the laser head cylinder once and re-secure it.

Loosen the fixing screws, move the laser head up and down, and then tighten the screws again.

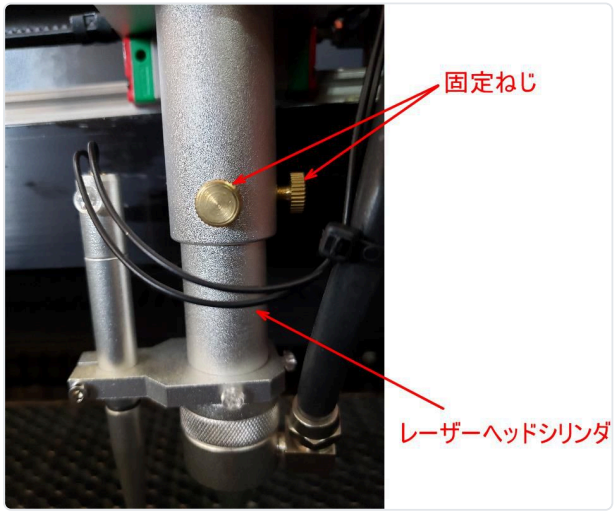


2. Check the Focus Lens

If the focus lens is mounted at an angle, the laser will not be emitted perpendicularly.

Referring to the machine instruction manual, remove the focus lens and inspect both the lens and its mounting.

- When installing the focus lens, check that no fine debris or foreign matter is caught between the lens and the laser head cylinder.
- Check that the lens is not installed in the wrong orientation. The focus lens is a plano-convex lens: the convex side faces up and the flat side faces down.
- Check that the silicone ring is not installed incorrectly. Viewing the laser head cylinder from above, the order is: lens, silicone ring, then retaining ring.
- Check that the lens has no scratches, chips, or cracks, and that the surface coating is not peeling. A problem with the lens itself can prevent the beam from being perpendicular.



3. Check the Table for Tilt

If the table on which the workpiece material is placed is tilted, the beam will appear tilted relative to the workpiece even when the laser itself is emitted perpendicularly.

If the table is tilted, correct it.

- Note: A properly installed cutting table gives the most level surface. However, if even one slat of the cutting table is not fully seated, the material placed on it will no longer be level.
- Note: Honeycomb tables and engraving tables are often not level, so check them carefully.
- Note: Since it may be unclear whether the laser machine itself is level, when checking with a spirit level, use the level readings on the X-axis and Y-axis rails as the reference for checking the levelness of the table.

4. Changing the Beam Position in Front of the 3rd Reflection Mirror

If steps 1 through 3 above do not resolve the problem, it may be necessary to change the beam position in front of the 3rd reflection mirror.

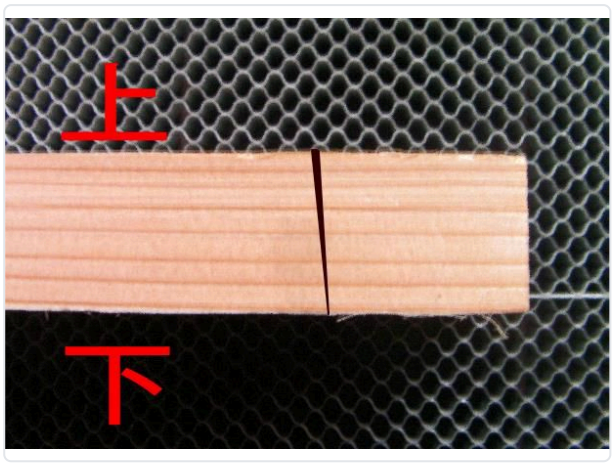
Due to variations in the machining accuracy of the laser head itself, the optical path may need to be brought to a position slightly offset from the center of the round hole, rather than the exact center used in "③ Centering the Beam in Front of the 3rd Reflection Mirror."

Because this is caused by variations in the machining accuracy of the laser head itself, there is no way to know in advance how far from the center the beam should be shifted. It varies from machine to machine, so adjustment is required. The direction of the shift can be determined from the check performed in "2. Check Perpendicularity."

To adjust the optical path offset from the center of the round hole, fine-tune the amount of shift (the distance from the center of the round hole) while repeating "② Adjustment Across the Entire Work Area," "④ Adjusting the 3rd Reflection Mirror," and "⑤ Checking Perpendicularity" until the laser beam becomes perpendicular.

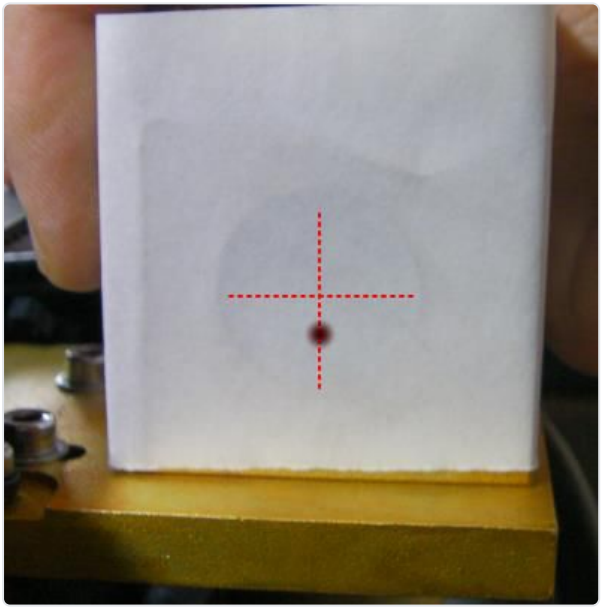
> **Caution:** When performing the tilt assessments below, attach the emission outlet, adjust the 3rd reflection mirror, and work with the laser being emitted from the outlet. If the laser is striking and reflecting inside the laser head cylinder, proper adjustment is not possible.

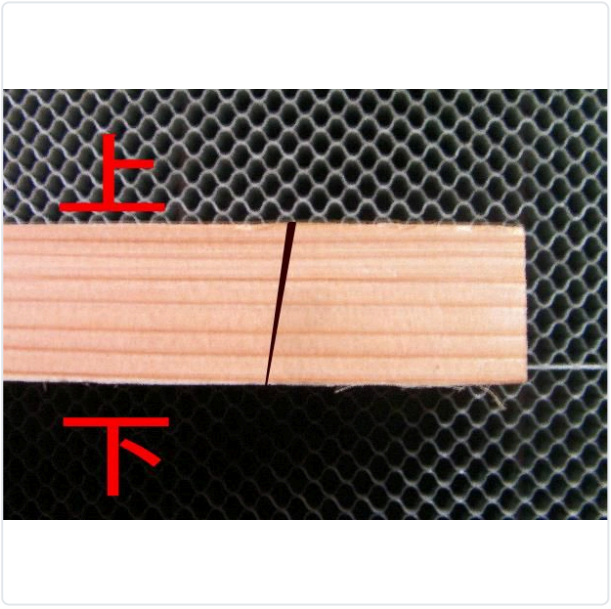
Judging the Tilt When the Wooden Board Is Moved from the Rear Toward the Front



Viewing the side face of the wooden board from the front: if the laser beam tilts to the right as it goes downward:

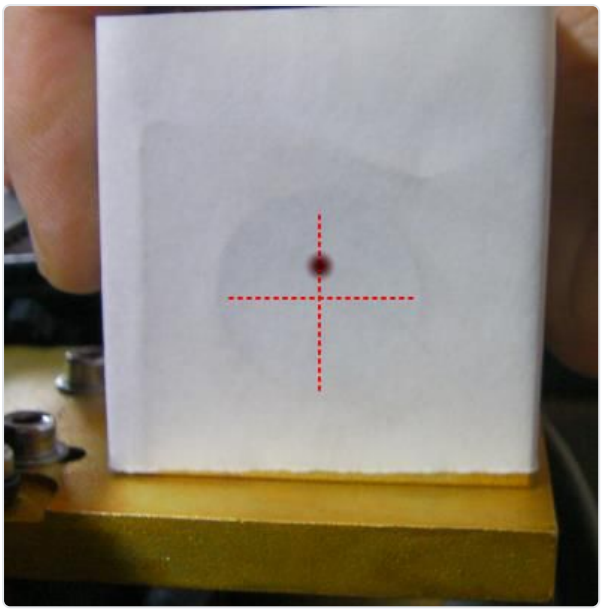
Shift the point where the beam passes through the round hole in front of the 3rd reflection mirror downward.





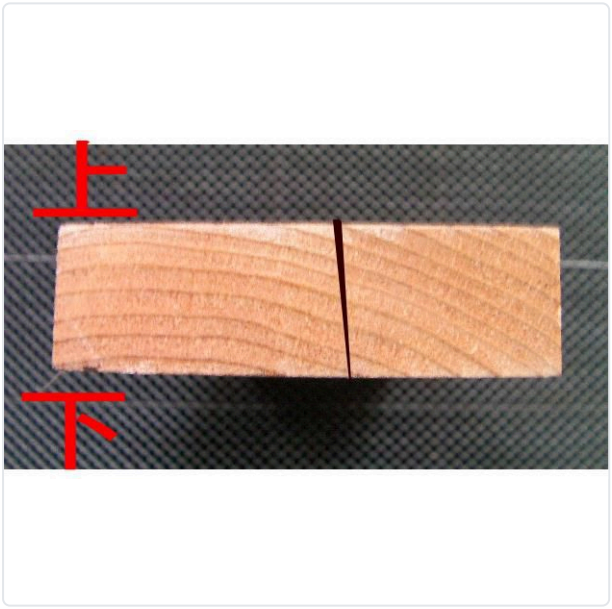
Viewing the side face of the wooden board from the front: if the laser beam tilts to the left as it goes downward:

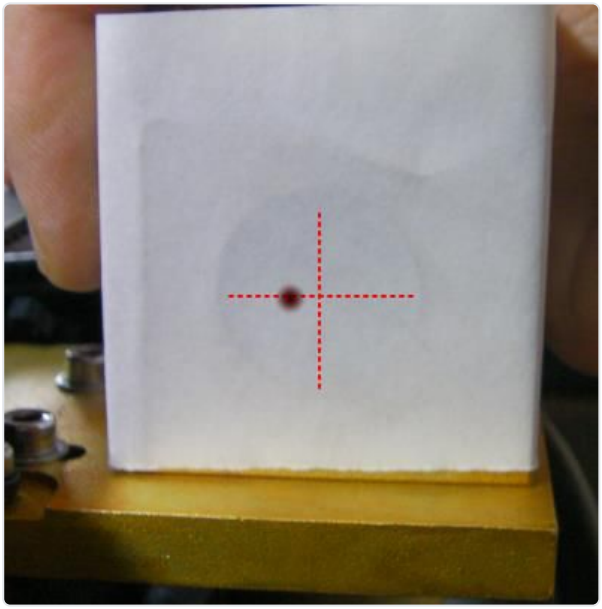
Shift the point where the beam passes through the round hole in front of the 3rd reflection mirror upward.



Judging the Tilt When the Wooden Board Is Moved from Left to Right as Seen Facing the Machine

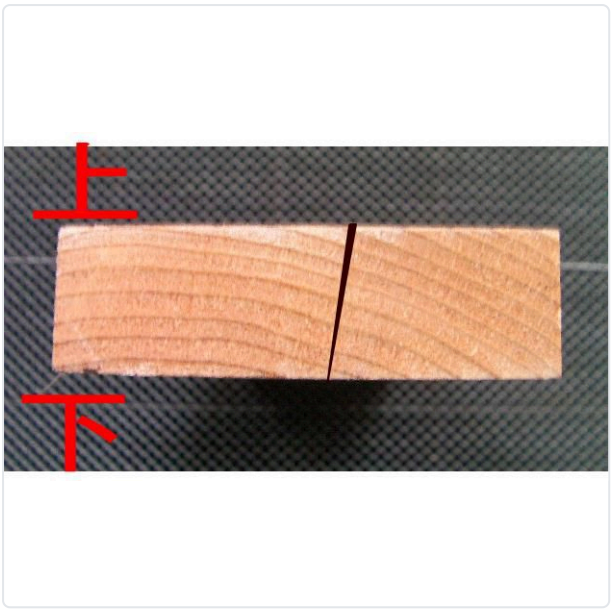
Viewing the side face of the wooden board from the front: if the laser beam tilts toward the rear as it goes downward:

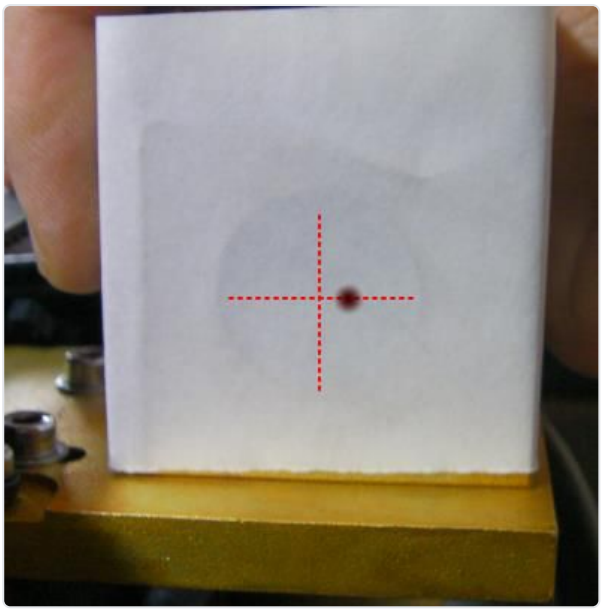




Shift the point where the beam passes through the round hole in front of the 3rd reflection mirror toward the rear.

Viewing the side face of the wooden board from the front: if the laser beam tilts toward the front as it goes downward:





Shift the point where the beam passes through the round hole in front of the 3rd reflection mirror toward the rear.
