RAYTOOLS

GF501 SERIES (4kW)

5-Axis 3D Laser Cutting Head - User Manual

Document History

Edit date	Version	Topic, revision, action taken
2024/5/21	V1.0	First edition

Thank you for choosing our product!

This manual describes the installation and commissioning of laser cutting head in details so that you can use this product quickly. You can consult us directly for more details.

Due to the continuous updating of product functions, the product you receive may differ from the introduction in this manual in some aspects.

If you find any errors in this document, please inform us as soon as possible. The data contained in this manual is only used to describe the product and shall not be regarded as a statement of security interest.
For the benefit of our customers, we will constantly try to ensure that the products we develop comply with the latest technology.

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Disclaimer

- We reserve the right to change the design in order to improve the quality or expand the application or comply to manufacturing workmanship.
- We will not bear any responsibility for losses and accidents caused by wrong operation or improper handling of our products.
- Dismantling of product will lose all warranty claims excluding the normal replacement of worn parts and components required for maintenance or commissioning operations.
- Unauthorized modification of products or use of non-original spare parts will directly lead to the invalidation of warranty and liability exemption.
- It is recommended to only use the spare parts provided by us or submit them to us or the designated professional team for installation.

Use Regulations

- Ensure that the product is used in a dry environment.
- Ensure that the product is used in the environment required by EMC standards.
- The product is only allowed to run within the parameters specified in the technical data.

Personnel Responsibilities

- Be familiar with the basic provisions of work safety & accident prevention and have received equipment operation guidance.
- Read and understand basic safety instructions and operations.
- You must have studied the relevant regulations and safety instructions and understand the possible hazards.
- Comply with relevant regulations and implement corresponding protective measures.

Safety Instructions

Prevent Electric Shock

-  Parts of the laser head such as nozzle, sensor, sensor interface and attached fasteners may not be fully protected by the ground wire due to function fault. These parts may have low voltage. When installing electrical equipment, please pay attention to taking anti electric shock measures for relevant personnel.
-  Note that the equipment shall be grounded as specified.

Guard against Danger

- Never put your hands or other body under the laser head.
- Repair and maintenance work can only be carried out after the power is turned off.
- Do not exceed the specified maximum pressure.
- It must be ensured that the laser head is in normal condition at all times.
- All fasteners such as bolts and nuts must be tightened.

 **Laser Caution**

- Avoid direct laser radiation or scattering to the skin.
- Do not stare at the laser beam even when wearing optical equipment.
- Use special laser protective eyeglasses that meet the requirements of safety standards IEC 60825-1.

Prevent Waterway Corrosion

- In order to avoid corrosion, use the specified coolant and comply with relevant requirements and specified maintenance intervals.

Noise Prevention

- The corresponding measures shall be specified or explained and observed in order to prevent personnel from being harmed by noise when the cutting air pressure is high.

Storage and Transportation

- Observe the storage temperature range allowed by the technical data.
- Take reasonable measures to prevent fire, vibration or impact.
- Do not store in or near the magnetic field.

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1. Overview

1.1 About this manual

This manual gives an introduction of GF501 laser cutting head, including optional accessories and additional configuration, so please read it carefully before commissioning and operating the cutting head. This manual is suitable for personnel professional in mechanics, electrics, installation and CNC system.

Our product is still undergoing continuous iterations and upgrades, and we will update user manual timely.

Please keep this manual well. If the cutting head is resold, please turn over all relevant files to the buyer.

1.2 Relevant File

Please turn over following delivery files if reselling cutting head:

- Product graph
- Wiring diagram
- Parts list
- Factory test report
- Other manuals about optional accessories (e.g. collimation, focus, etc.)

1.3 Application

GF501 5-Axis 3D laser cutting head is mainly used for 3D cutting of workpieces with complex structures, including tube cutting, stamping sheet metal parts cutting and piercing, etc.

1.4 Product Features

- Optimized optical configuration and smooth airflow design;
- 3 independent CNC direct drive motors with high torque and zero backlash;
- AO (Adaptive Optics) mirror pneumatic focusing: +9～-9mm, accuracy: 0.25mm;
- Add cover glass on collimation lens to prevent dust from falling on the surface of the lens and causing damage;
- Drawer type cover glass holder to facilitate replacement;
- Modular design and skinny nozzle structure to reduce interference among workpieces;
- Various fiber interfaces to work with different fiber lasers;
- Reliable sealing design.

1.5 Factory Test Report

Raytools has tested all electromechanical functions of GF402 cutting head, and test reports are included in delivery files.

2. Sign and Description

- "Danger": Serious dangers with death or severe injury possibly;
- "Warning": Moderate disability and permanent injury possibly;
- "Caution": Mild disability but not permanent injury possibly;
- "Note": Material damage possibly;

- To avoid personal injury and device damage, please read this manual carefully before using the cutting head for the first time, and relevant operators should note all risks and dangers in operating process.
- Ensure to use clean and undamaged lenses.
- Prevent dirt, smoke, water or other impurities into the optical system.
- Parts of the cutting head should only be removed in a clean environment, as particles on the lens can affect the function of cutting head and the processing effect.

3. Start-up Preparation

3.1 Power Supply

GF501 cutting head uses 3-phase synchronous frameless motors, each with different power requirements. The motor operating data are as follows:

Max. voltage for C-axis motors: 420V AC (600V DC);

Max. voltage for A-axis motors: 230V AC (300V DC);

Max. voltage for H-axis motors: 230V AC (300V DC);

Caution: Only drives listed can be applied to meet different voltage requirements of motors.

3.2 Motor Safety Module

Each motor has two temperature sensors to ensure safe operation:

1. KTY83-122 sensor (refer to Chapter 7.5)

KTY monitors real-time temperature of the motor and gives the corresponding resistance signal.

2. PTC1kΩ sensor

When the motor temperature rises beyond the threshold, PTC sensor will output a resistance signal, leading control system to cut off the motor power in an emergency.

To protect motor, it is not recommended to use motor without temperature sensors, or use one of the sensors alone. The motor safety module monitors temperature in real time, while providing an alarm signal to trigger power off before the motor burns out.

3.3 Motor Working Temperature

The working temperature of motor (including under continuous load) should be less than 70°C. Therefore, the alarm threshold of CNC system should be about 60°C. When the temperature rises to 100°C, the motor may be damaged.

Motor	Damage Threshold Temperature	Recommended Working Temperature
C-axis	~100°C	<<70°C
A-axis	~100°C	<<70°C
H-axis	~100°C	<<70°C

Caution: Please check the factory temperature thresholds of motors and set proper values. Failure temperature values may cause operating faults and overheating of motor.

3.4 Working Environment

As a sensitive optical product, cutting head requires suitable working temperature and humidity to avoid contamination from liquid substances, slag and dust. Before commission, please keep cutting head in original package. Ensure commission and maintenance of any parts in a clean environment.

Storage temperature	-15°C ~ +50°C; +60°C (within 24h)
Working temperature	10°C ~ +45°C
Humidity	<80%

3.5 Water Cooling

Before connecting cutting head to water circuit of chiller, users can acquire more information about the connection and cooling function from the supplier. Cooling power of chiller should be more than 1kW to ensure good cooling effect.

Caution: To avoid reducing the mechanical performance and damage to the cutting head parts (such as frameless motors), please note the following aspects:

1. Connect cutting head to water cooling system before motor/laser power on.
2. Cutting head must be connected in series with other water cooling parts (such as QBH) to water circuit.
3. Ensure that the cooling water flows smoothly and does not leak inside the cutting head.
4. Don't use any liquid other than the specified cooling water.
5. The cooling water must be filtered.
6. Regularly check the water quality circulating within the water cooling system to prevent deteriorating or even polluting the environment.

3.5.1 Technical Data

Name	Content
Temperature	Nominal range: +15°C ~ +35°C / >dew point
Water pressure	Min. 2 bar / Max. 6 bar (0.2/0.6 MPa)
Flow speed	>1L/min (recommended: 2L/min)
Filtration degree	<100μm
Water quality	Deionized water with corrosion inhibitor. Add biological additives if necessary (refer to use instructions of chiller), without abrasive material.

Minimum flow speed	1.8 l/min (0.48 gpm)
Entry pressure	170-520KPa (30-60psi)
Entry temperature	≥room temperature />dew point
Hardness (relative to $CaCO_3$)	<250mg/liter
PH range	6 to 8
Particle size allowed	Diameter less than 200 microns

Caution: If cooling water temperature is higher than 20°C, reduce Tc and Lc in the parameter setting.

3.5.2 Dew

The cooling water temperature should be adjusted according to air humidity. Lower temperature will lead to dewing of parts of cutting head, especially optical parts inside it. Check correct temperature range of cooling water in dewpoint temperature table.

3.5.3 Anti-rust

Cooling water in the cutting head contacts with different metallic and non-metallic materials, such as Al, Cu or SS. Therefore, corrosion inhibitor is required in cooling water to avoid corrosion of cutting head parts, and for details, refer to user manual of chiller.

3.5.4 Water Contamination

Please refer to user manual of chiller to add biological agents to avoid water contamination.

3.6 Water Leakage

Electric Shock.

Ensure no water in electrical parts.

3.7 Clean Gas (Protective Gas)

Gas flow should guarantee internal optics system at positive pressure to avoid pollution (gas interface: GAS 2 or G2).

Independent gas interface above collimation module can provide positive pressure protection of lenses, when checking the holder of collimation lens or cleaning and replacing cover glass.

Caution: Gas must be filtered and dried without contaminated liquid and mechanical particles, meeting the requirements of Class 3 in ISO 8573-1:20 2010:

Particle size : <5μm/<<5mg/m³; Water/Pressure dewpoint: ≤ -20° C; Oil: <<1mg/m³.

Only gas protection can't meet cleaning requirements of cutting head. Users also need to avoid all contamination when removing the cutting head.

3.8 AO Mirror Gas

The gas requirements for focusing system depend on the air pressure proportional valve of AO mirror. It's recommended to use SMC proportional valve "ITV2050-RCF2S", which is used for factory testing in our company.

The gas must meet requirements in Chapter 3.7 Clean Gas.

3.9 Brake Gas

When connecting compressed air to gas interface with BREAK mark, 2 pneumatic actuators open the brake and the A-axis can move normally.

The gas must meet requirements in Chapter 3.7 Clean Gas.

Note: Only when the gas pressure meets running conditions of pneumatic brake, the A-axis can bevel. Otherwise, brake parts, the A-axis motor and encoder may be damaged.

3.10 Cutting Gas

GAS 2 /G2: gas interface; max. gas pressure: 25bar

Note:

1. Ensure clean gas and its source. Any contamination of cover glass and focus lens will cause damage and affect cutting effect.

2. All parts in contact with pure oxygen must be free of oil, grease or dust.

3. Improper use of oxygen may lead to explosions.

3.11 Beam Alignment

Beam of cutting head is pre-aligned (Positional tolerance: ±0.05 mm), and this pre-aligned record is a part of delivery files when reselling the cutting head.

Note: Confirm that beam penetration is located at the nozzle tip center before beaming.

3.12 Checklist before Power on

Normal checking	Signature after conformation	Measured values when commissioning		
Check information of electromechanical parts in this manual.				
Check water Leakage				
Check water flow speed		Flow speed: L/min		
Check dewing		Worst dewpoint temperature: ℃		
Check cooling water and compressed air quality		Cooling water temperature: ℃		
Rotate all axis manually to confirm that they can move and without interference with hoses or cables				
Ensure don't contaminate collimation lens when inserting fiber (QBH, QD, etc.).				
Check earthing of cutting head				
Check electrical connectors before connecting to CNC control system				
Beam alignment				
Motor Drive	Confirmation of signature	C-axis	A-axis	H-axis
Confirm motor parameter		Torque	Torque	Torque
Confirm encoder parameters		Absolute value	Absolute value	Absolute value
Confirm drive voltage of motor		600V AC	300V DC	300V DC
Confirm cables connecting to cutting head connector and CNC system connector		C-C	A-A	Z-Z

Confirm checklist before laser and machine power on.

4. Technical Data

S/N	Parameters	Value	Annexes
1	Clear Aperture	35mm	
2	Water ▪ Water in ▪ Water out	 2-6 bar (cooling/max. 6 bar) 2-6 bar (cooling/max. 6 bar)	 Pipe dia. Ø6mm Quick connector G1/8
3	Gas ▪ Protective gas for replacing top cover glass ▪ Cutting gas (cutting protection) ▪ Assist gas (optional) ▪ Brake gas ▪ AO mirror gas ▪ Boosting gas (optional)	 ▪ Dry clean gas (max. 1 bar) ▪ Process gas (max. 25 bar) ▪ Process gas (max. 10 bar) ▪ Compressed air (max. 8 bar) ▪ Compressed air (max. 6 bar) ▪ Dry clean gas (max. 1 bar) (optional pressure detection of cutting gas and boosting gas)	 ▪ Quick connector, pipe dia. Ø6mm M5 ▪ Quick connector, pipe dia. Ø6mm G1/8 ▪ Quick connector, pipe dia. Ø6mm G1/8 ▪ Quick connector, pipe dia. Ø6mm G1/8 ▪ Quick connector, pipe dia. Ø6mm G1/8 ▪ Quick connector, pipe dia. Ø6mm G1/8 (Cutting gas pressure detection: Quick twist connector G1/4)
3	Optical lenses	▪ Oblique Mirror with water cooling ▪ AO mirror ▪ Bottom cover glass: Φ37mmx7mm ▪ Top cover glass: Φ38.1mmx1.6mm ▪ Collimation lens: biconvex lens Φ37-F100 meniscus lens Φ37-F100 ▪ Focus lens: biconvex lens Φ37-F150 meniscus lens Φ37-F150	Focusing range: +9mm ~-9mm
4	Mounting accuracy	+/- 1.25°	

S/N	Parameters	Value	Annexes
5	C-axis ▪ Rotation angle ▪ Max. rotation speed ▪ Max. rotation acceleration ▪ Drive method ▪ Measurement method	 ▪ +/-540° ▪ 100rpm ▪ 20 rev/s^2 ▪ Torque motor ▪ Absolute value	
6	A-axis ▪ Bevel angle ▪ Max. rotation speed ▪ Maxi. rotation acceleration ▪ Drive method ▪ Measurement method ▪ Braking method	 ▪ +/-135° ▪ 120rpm ▪ 30 rev/s^2 ▪ Torque motor ▪ Absolute value ▪ Pneumatic brake	
7	H-axis ▪ Travel ▪ Max. speed ▪ Acceleration ▪ Drive method ▪ Measurement method ▪ Anti-collision method	 ▪ +/- 17,5mm (2° /1mm) ▪ 20 m/min ▪ 2.5g (depending on focal length) ▪ Torque Motor ▪ Absolute value ▪ Collision safety switch	
8	Weight	About 35kg	

5. Installation and Commissioning

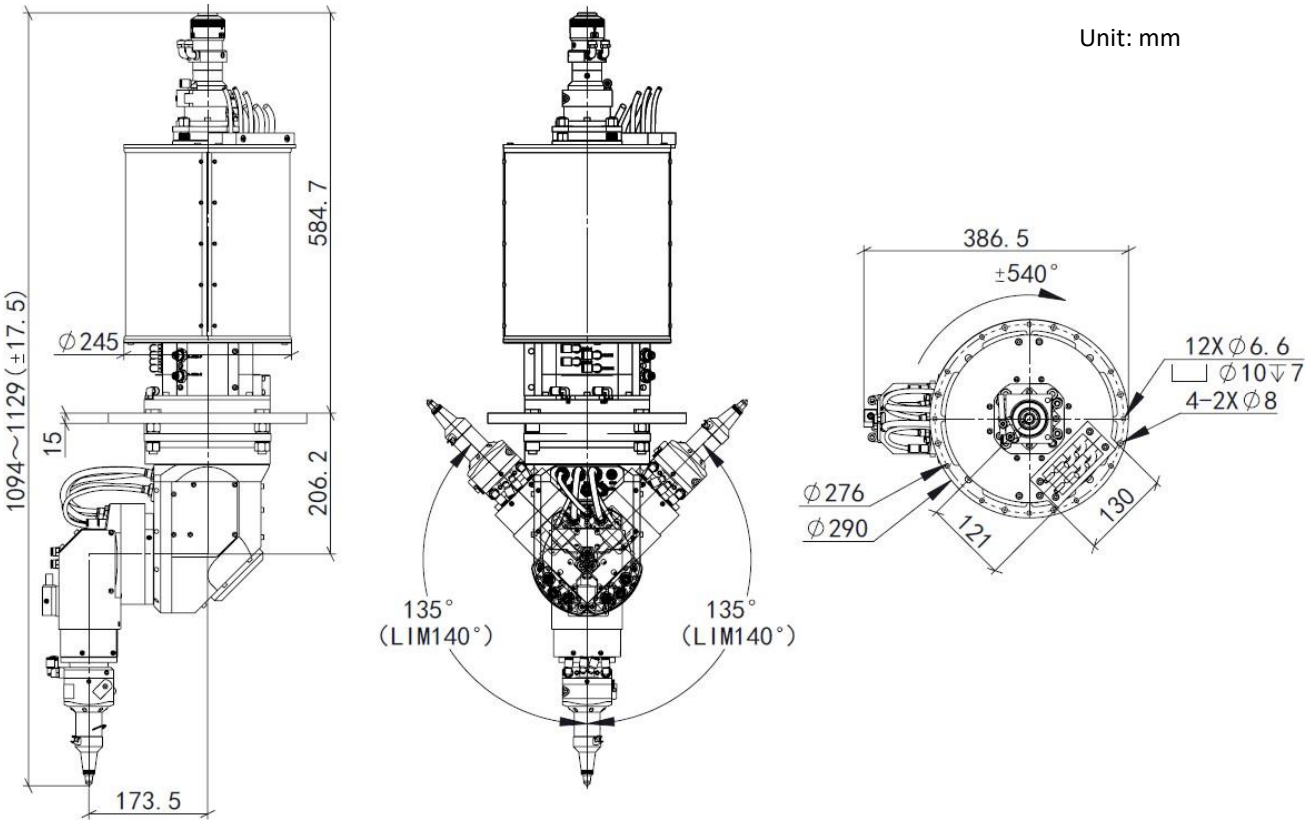
Considering that transport, storage or working environment temperature may cause some deviation of the optical parts, professionals on site or Raytools after-sales personnel can adjust these parts properly according to this manual, in order to maximize processing effect.

Caution: Only remove cutting head in a clean environment.

5.1 Mounting of Laser Cutting Head

The mounting of laser cutting head to machine tool is shown below. Users are advised to install the cutting head perpendicular to the bed surface as requested through a 12Xϕ6.6 countersunk hole.

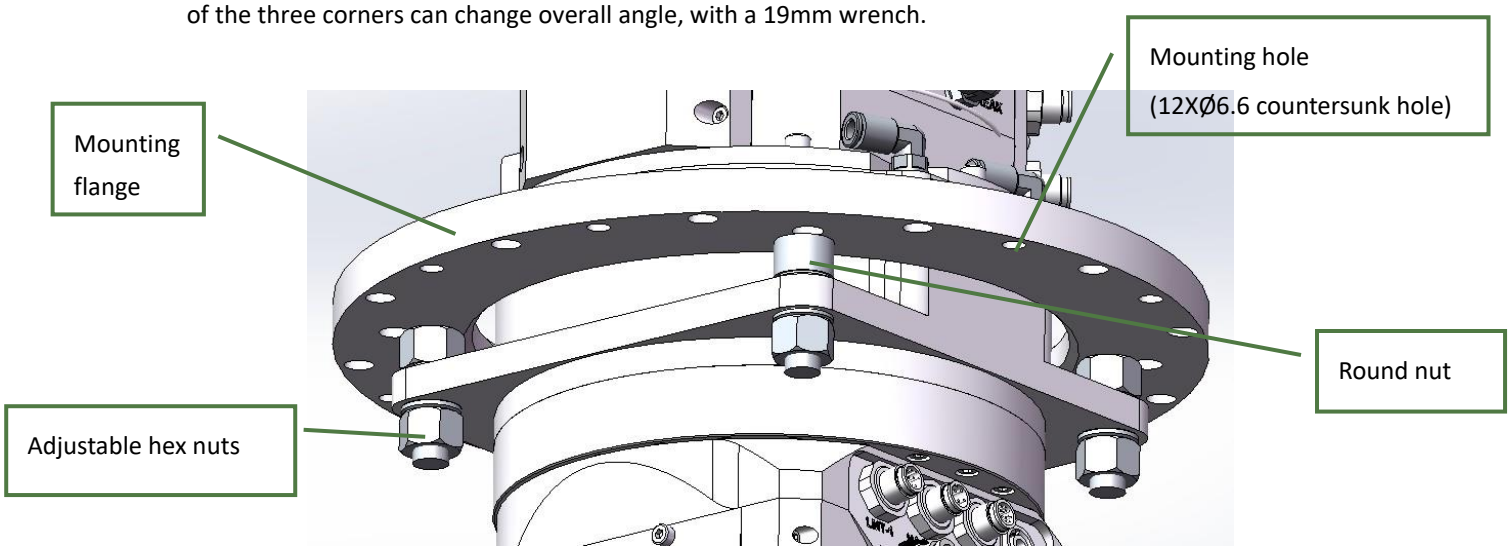
Unit: mm



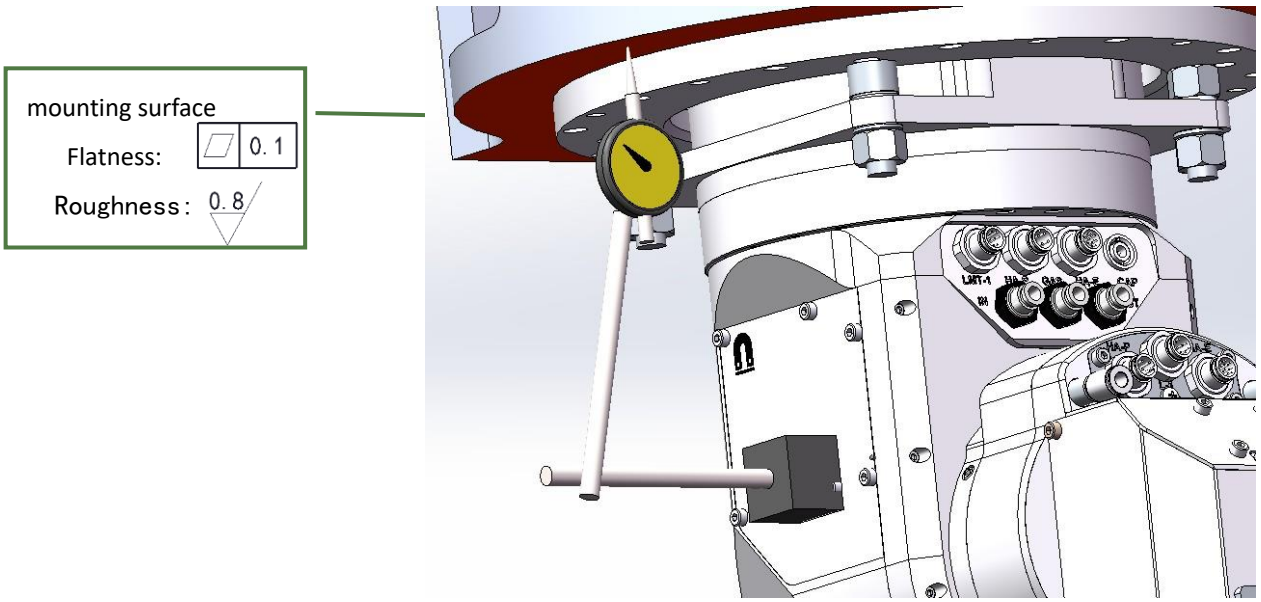
Leveling is required when mounting laser cutting head.

5.1.1 Levelling Preparation

1. The leveling mechanism mainly consists of a round flange and a square flange on the body shell, interconnected by bolts on four corners. One corner is fastened by a round nut (top) and a hex nut (bottom), and the other three corners are fastened by 2 adjustable hex nuts respectively. Adjusting the vertical height of the three corners can change overall angle, with a 19mm wrench.



2. Attach a dial indicator to the side plate with the mark  . The probe of micrometer points horizontal processing surface of flange. So mounting surface of the cutting head needs to leave areas for probe running a circle. Required flatness: 0.1mm; roughness: Ra0.8μm.



3. Attach one textured tape on the outer of flange for marking.
4. Ensure that there are no obstructions in the place where the micrometer rotates.

Note: Only loose nuts of a corner at a time to adjust its angle.

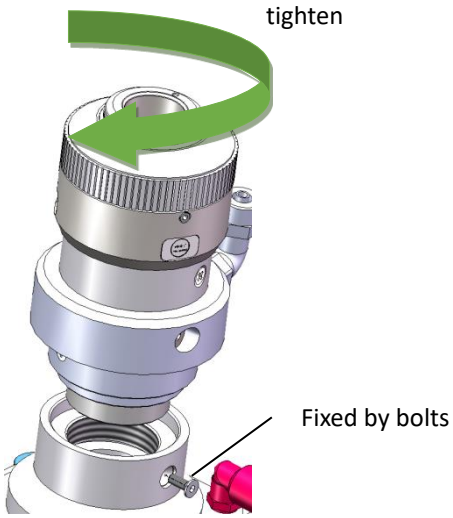
5.1.2 Levelling Method:

1. Manually rotate C-axis until the probe reaches the round nut, and mark the dial value as 0;
2. Manually rotate C-axis in a circle (to ensure enough travel for circular rotation) at a speed of about 5 to 6 rpm.
3. Record the dial value on the textured tape of the flange, at intervals of about 30 to 60° (note ± direction of deviation);
4. Adjust the corner of the diagonal of the round nut. Manually rotate C-axis until the probe arrives here, and adjust hex nuts to make probe changing approach 0 (If necessary, users can slightly loosen the nuts in other positions, but don't move the round nut);
5. Turn the probe to the other 2 corners, and adjust hex nuts to make probe changing approach 0 (don't move hex nuts of other corners);
6. Leveling could be finished by repeating step 4&5. Required runout tolerance: ±0.02.

5.2 QBH Interface

5.2.1 Removal and Installation of QBH Interface

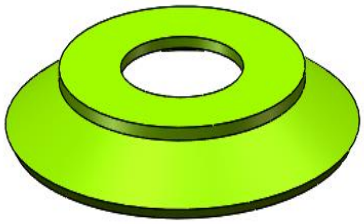
QBH interface and the main body of the cutting head are screwed by thread, and then tightened with countersunk head bolts.



5.2.2 Connection of Laser

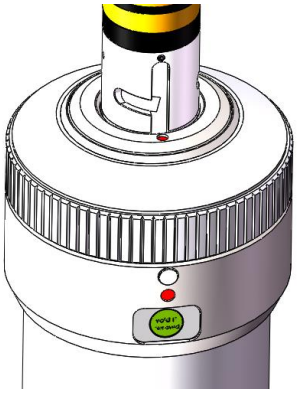
WARNING: The optical components must be dust free and all dusts must be cleaned before use. The fiber shall be horizontally inserted into fiber interface to prevent dust from entering the interface and falling on the surface of the lens. Upper limit in the fiber before fixing the laser head.
Cover fiber interface with a white plastic dustproof cover when not using it to ensure a clean environment.

1. Blow QBH interface and protective cap with clean gas. (place protective cap in a clean environment when it's not used).

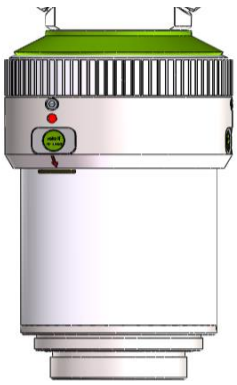


2. Align the protective cap to the fiber and insert the cap.

3. Align the red mark of male fiber end to red mark on female QBH of cutting head when you insert the fiber end straightly to the bottom of QBH interface of cutting head.



4. Turn the QBH handwheel clockwise to complete 1st locking, then pull the handwheel up and rotate it clockwise to complete 2nd locking.
5. Shake the fiber gently to confirm it is tightened prior to use.
6. Check if the tightened scale is within the standard range under the red point.

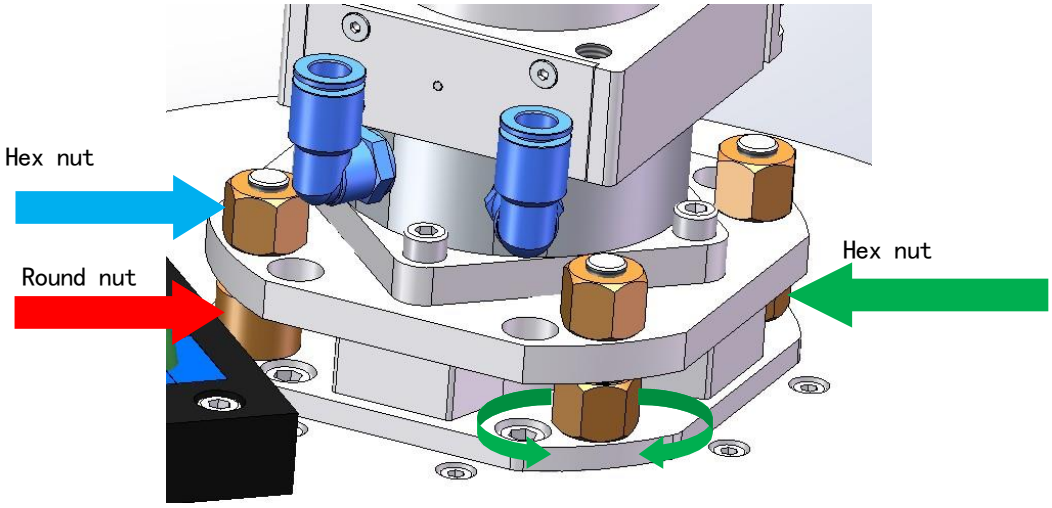


5.3 Optics System Adjustment

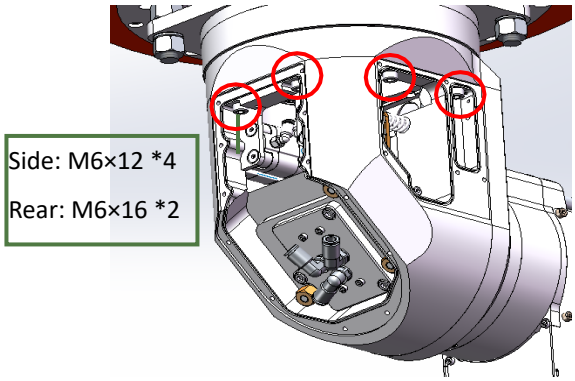
Note: Adjust optical path in a clean environment.

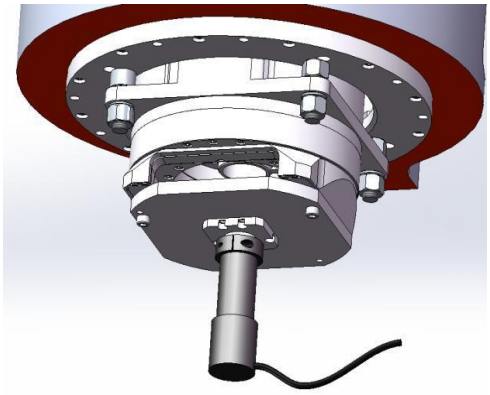
5.3.1 Collimation Module Adjustment

1. The collimation mechanism mainly consists of 2 flanges, interconnected by bolts on four corners. One corner is fastened by a round nut (top) and a hex nut (bottom), and the other three corners are fastened by 2 adjustable hex nuts respectively. Adjusting the vertical height of the three corners can change the angle of collimation module, by a 15mm wrench.



2. Remove C axis rotating assembly. Install the beam inspection device through the adapter plate, insert QBH and import the infrared beam. Then adjust the beam direction according to the device.



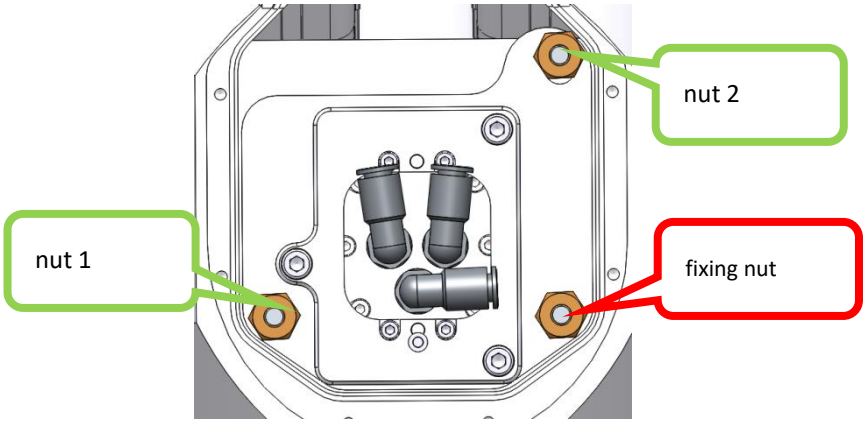


3. Loosen hex nuts gently to adjust beam direction and collimate laser beam parallel to C axis (don't move round nut).

5.3.2 AO Mirror Adjustment

Adjust nuts to reflect the parallel beam from collimation lens into a beam parallel to A-axis.

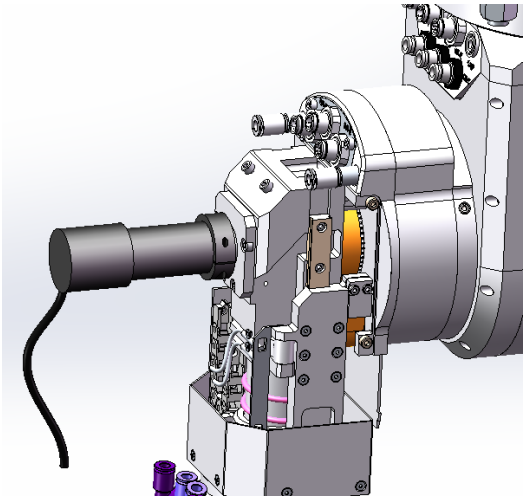
Caution: This operation requires lens tools and should be started after collimation leveling.



Fixing nut can't be rotated as the reference point for adjustment. Loose nuts to adjust AO mirror by light-adjusting device:

Turn nut 1 clockwise to increase the Y-axis light point position.

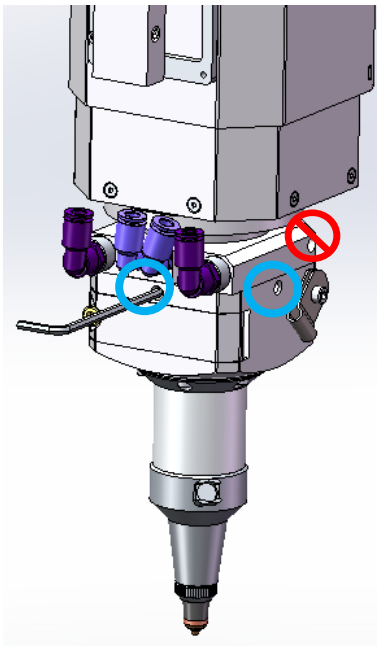
Turn nut 2 clockwise to increase the X-axis light point position.



Process:

1. Enable A-axis and rotate it slowly within limit bevel angle;
2. Refer to data from light-adjusting device to confirm angle error and adjustment direction;
3. Adjust leveling assembly of AO mirror assembly;
4. Adjust several times until the error is proper.

5.3.3 Focus Lens Alignment

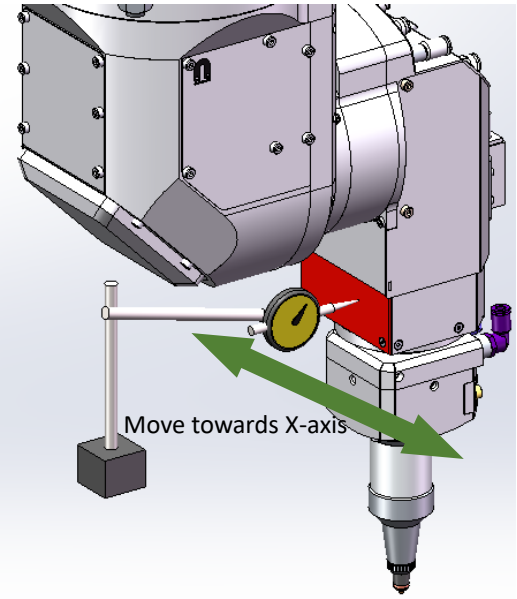


Loose screws (blue area) of focus lens module with a 3mm hex wrench to adjust focus position at the nozzle tip center. (The connecting hole of focus lens module (red area) can't be screwed).

5.4 C-axis Zero Correction

5.4.1 Adjustment Preparation

1. Attach the dial indicator on the workpiece clamping pallet and adjust the head until A-axis bevel plane is paralleled with XZ plane;
2. Adjust the probe to point to the surface (red area) near the C axis;



3. Attach one textured paper near running range of the probe for marking;
4. Ensure that the machine tool does not interfere with the dial indicator when moving towards X-axis.

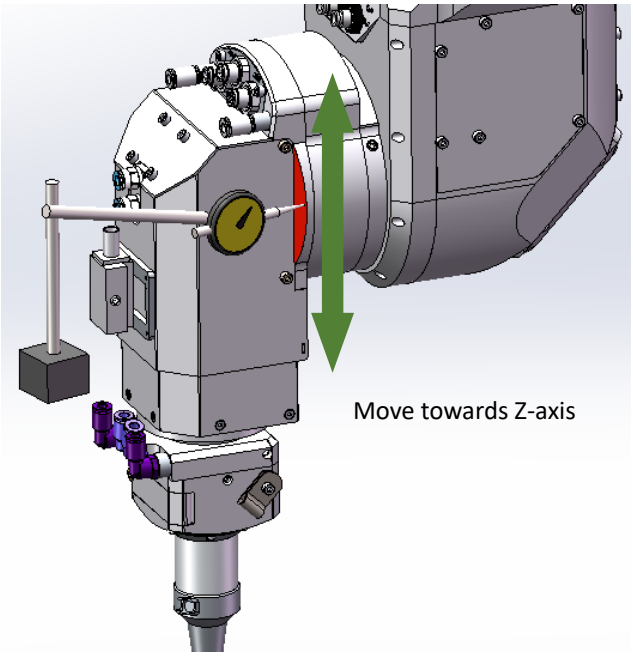
5.4.2 Adjustment Method

1. Operate machine tool to move towards X-axis at a speed of 0.01m/s, with proper range to ensure that the probe can run on the test surface (travel: 50mm). And record the deviation values at different positions;
2. Adjust C-axis gently (jogging interval: 0.02°) to reduce deviation value, and make A-axis bevel plane and XZ plane meet the tolerance requirement (Requirement: ±0.02).

5.5 A-axis Zero Correction

5.5.1 Adjustment Preparation

1. Attach the dial indicator to the workpiece clamping pallet and adjust A-axis to bevel downward;
2. Adjust the probe to point to the surface of follow assembly (red area);
3. Ensure that the machine tool does not interfere with the dial indicator when moving towards Z-axis.



5.5.2 Adjustment Method

1. Move towards Z-axis through the machine tool at a speed of 0.01m/s, with proper range to ensure that the probe can run on the test surface (travel: about 50mm). And record the deviation values at different positions;

2. Move A-axis gently (jogging interval: 0.02°) to reduce deviation value, and make paralleling level of H-axis and Z-axis meet the tolerance requirement (Requirement: ±0.02).

6. Function

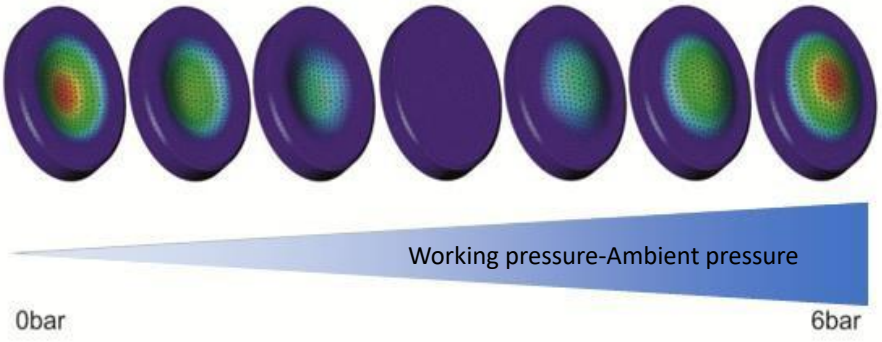
6.1 AO Mirror focusing

6.1.1 Gas Pressure and Focus Position

There is a film on the surface of AO mirror, separating its internal and external environment. Different gas pressure can be applied inside to deform the mirror surface: when internal pressure is equal to the ambient pressure, the surface is concave; when two types of pressure reach an equilibrium state within the specified working range, the surface is flat; when internal pressure continues to rise, the surface turns into convex.

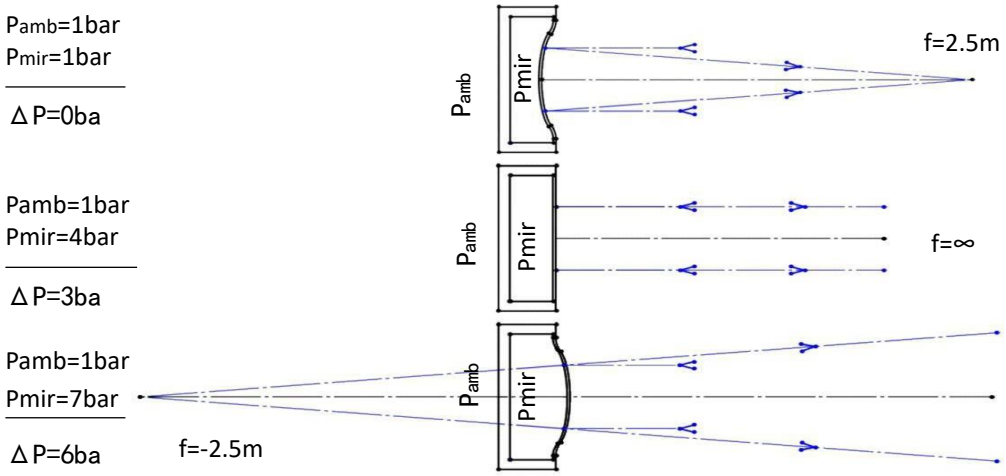
Overall, gas pressure of AO mirror and focus position is a linear relation: $\frac{1}{f_A} = \frac{3-P}{7500}$

Applied pressure: 0-6 bar; focus range: ±9mm



Take following graph for reference:

Pressure Difference (Bar)	Focus Length (m)	Surface
0	2.5	concave
3	∞	flat
6	-2.5	convex



6.2 Anti-collision Mechanism

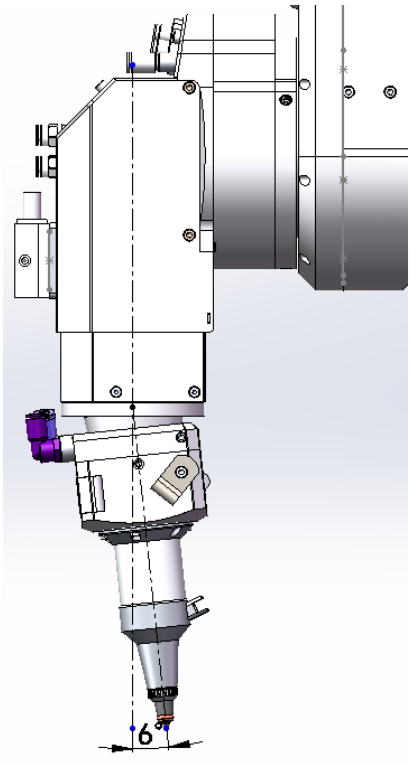
The H-axis assembly is designed with an anti-collision mechanism at the bottom connecting flange.

Bevel angle is limited within 6° and anti-collision mechanism will trigger inductive NC sensor to output a signal when horizontal collision occurs.

The connecting flange will auto reset after clearing collision. But it is still necessary to manually check if cutting head returns to zero point position, and if parts of cutting head have abnormalities after collision.

Caution: 1. In maintenance or mounting process, users should check if the sensor communicates properly with CNC controller, and if this safety function can stop running machine immediately when abnormalities happen.

2. Collisions angle larger than 6° will cause irreversible damage to H-axis and bottom cover glass assembly.



6.3 Gas and Water Interface

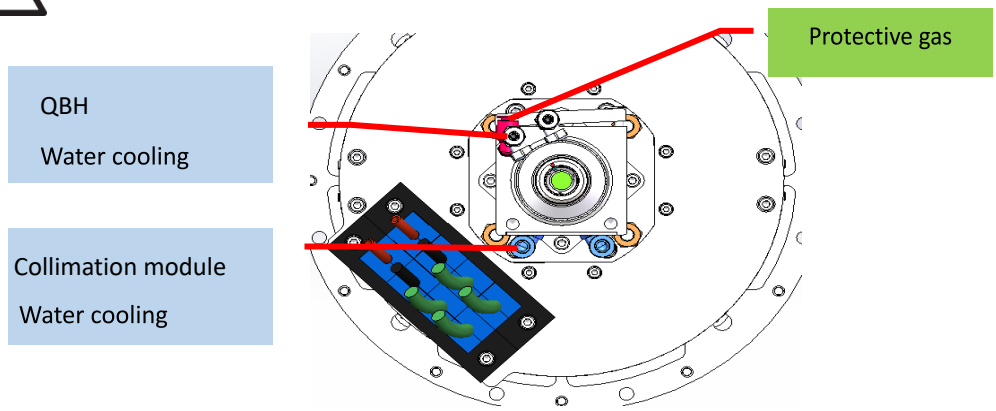
6.3.1 External Gas and Water Interface

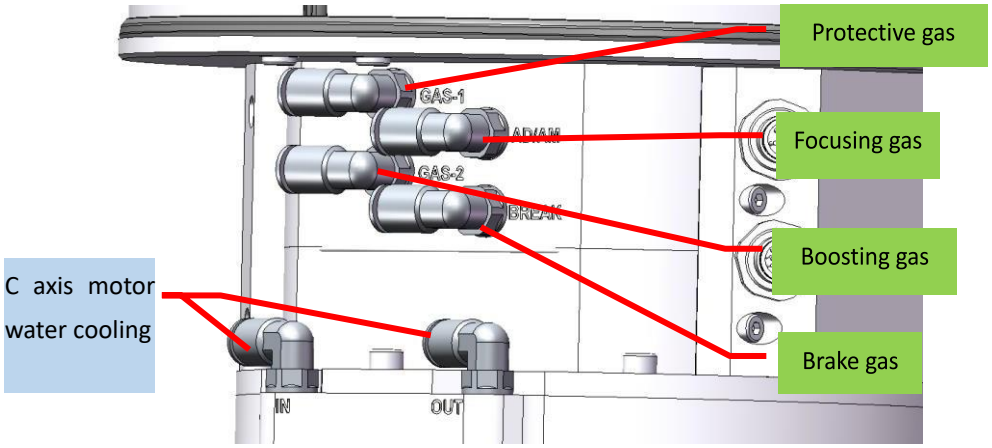
The external gas and water interfaces of the cutting head are located on the top and side of C-axis, with quick connectors. Connections should refer to marks on the cutting head and it's recommended to add corresponding labels to gas/water pipes. Size of water/gas pipes are shown below:

Interface Definition	Mark	Medium	Work Pressure	Reference	Annexes
Water inlet	Water IN/IN	Cooling water	2-6 bar	Chapter 3.5	Pipe dia. Ø 6mm G1/8 connector
Water outlet	Water OUT/OUT				
Cutting gas	GAS-1/G1	Cutting gas	Max. 25 bar	Chapter 3.10	Pipe dia. Ø 6 mm G1/8 connector
Brake gas	BREAK	Compressed air	6-8 bar	Chapter 3.9	Pipe dia. Ø 6 mm G1/8 connector
Focusing gas	AD/AM	Compressed air	Max. 6 bar	Chapter 3.8	Pipe dia. Ø 6 mm G1/8 connector
Boosting gas	GAS-2/G2	Clean air	0.05-0.1 bar	Chapter 3.7	Pipe dia. Ø 6 mm G1/8 connector

If maintain or replace gas/water pipe, please use a standard plug fitting to prevent contaminants from entering the fitting and causing a blockage.

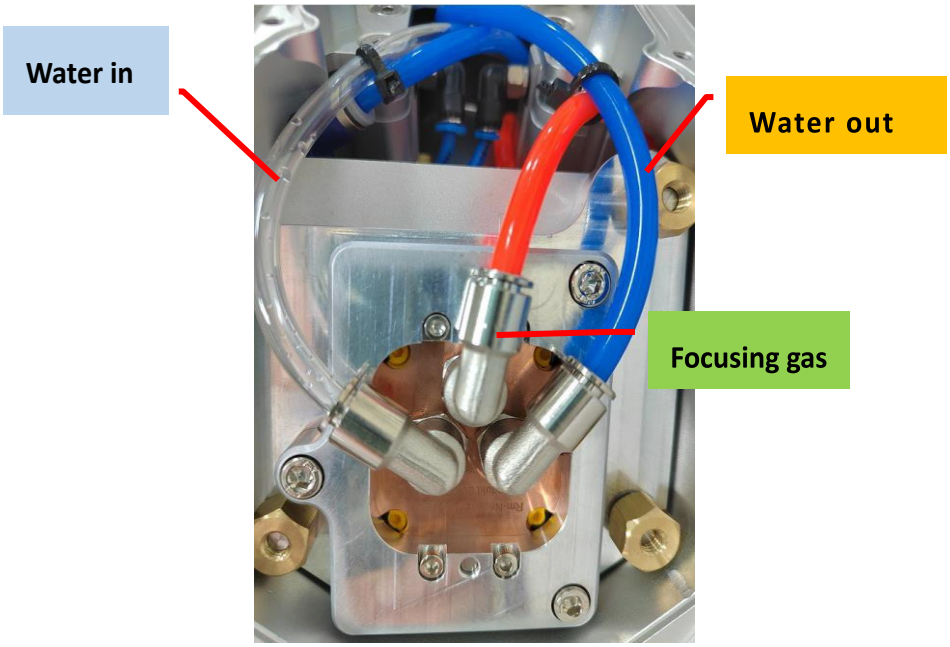
Note: Do not run axes of the cutting head before connecting water cooling interface.





Caution: To avoid overheating of the motor and affect from heat effect, each axis and optical parts must use water cooling.

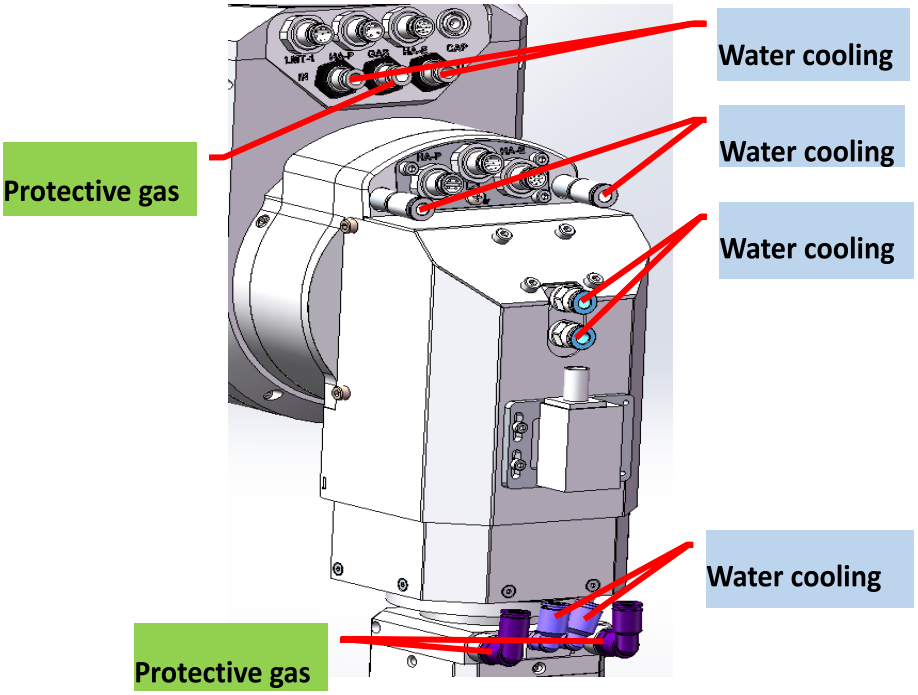
6.3.2 Gas and Water Interface of AO Mirror



6.3.3 Gas and Water Interface between Internal Axes

There is the interface panel on A-axis shell, used for connecting H-axis or height sensor.

Please deliver connecting cables and hose when reselling the cutting head.



7. Motor and Encoder

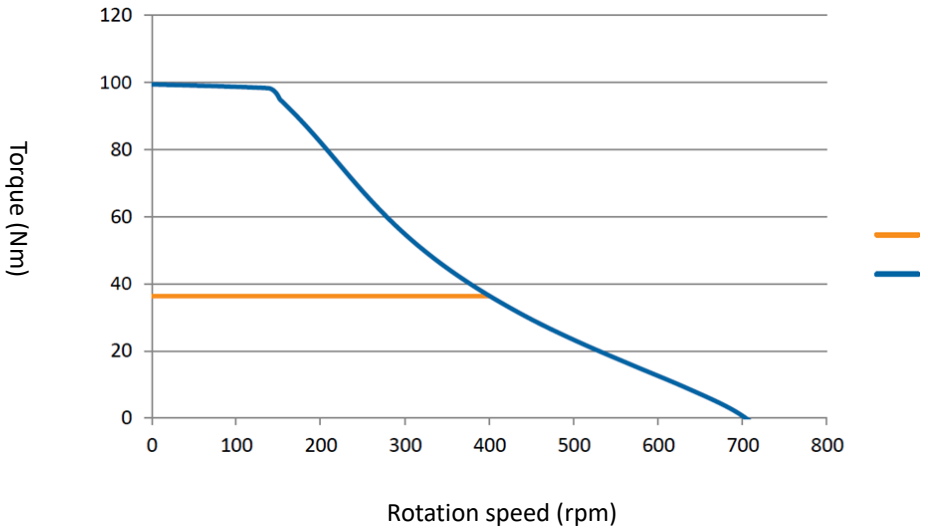
7.1 C-axis Motor Datasheet

Item		Remark	Symbol	Unit	Value
Motor Performance	Coil type				N
	Motor type				Three-phase synchronous frameless motor
	Power supply voltage				AC 420V (DC 600V)
	Breakdown torque (temperature rise 20℃/s)	When the temperature of permanent magnet is 25° C	Tu	Nm	91.6
	Peak torque (temperature rise 6℃/s)	When the temperature of permanent magnet is 25° C	Tp	Nm	58.3
	Rated torque	When the temperature of induction coil is 100° C	Tc	Nm	(36.3)①
	Max. speed	Rated torque	nmax	rpm	(385)②
	Torque parameters	Max. current	Kt	Nm/Arms	9.20
	Motor constant	When the temperature of induction coil is 25° C	Km	$(Nm)_2/W$	2.29
Electrical Performance	Rated current	When the temperature of permanent magnet is 70° C	Iu	Arms	13.5
	Peak current	When the temperature of permanent magnet is 25° C	Ip	Arms	7.4
	Max. continuous current	When the temperature of induction coil is 100° C	Ic	Arms	(3.95)①
	Peak back emf constant		Ke	V/krpm	787
	Average back emf constant		Ke	V/krpm	556
	Coil resistance per phase	When the temperature of induction coil is 25° C	R	Ω	12.3
	Coil inductance per phase		L	mH	47.9
	Electrical time constants	When the temperature of induction coil is 25° C	Te	ms	3.88
	Number of poles		Nmgn	nr	36(=18 pole pair)
Safety Performance	Power loss	When the temperature of induction coil is 100° C	Pc	W	750
	Coil thermal impedance		Rth	℃/W	0.1
	Thermal time constant	Up to 63% of induction coil temperature	Tth	s	29
	Cut-off temperature sensor				PTC 1kΩ
	Temperature monitoring sensor for CNC system				KTY83-122

① The values in parentheses only apply to the motor mounting surface with cooling water temperature of 20°C. For higher cooling water temperatures, Tc and Lc values must be reduced in the CNC setting.

② The max. speed available for C-axis is lower than following values:

Water cooling temperature	Rated torque	Rated current
20°C	Tc=36.3Nm	Lc=3.95A
25°C	Tc=35Nm	Lc=3.8A
30°C	Tc=33.8Nm	Lc=3.7A
35°C	Tc=32.6Nm	Lc=3.5A
40°C	Tc=31.1Nm	Lc=3.4A
45°C	Tc=29.8Nm	Lc=3.2A



Max. speed of C-axis<<Max. speed of motor

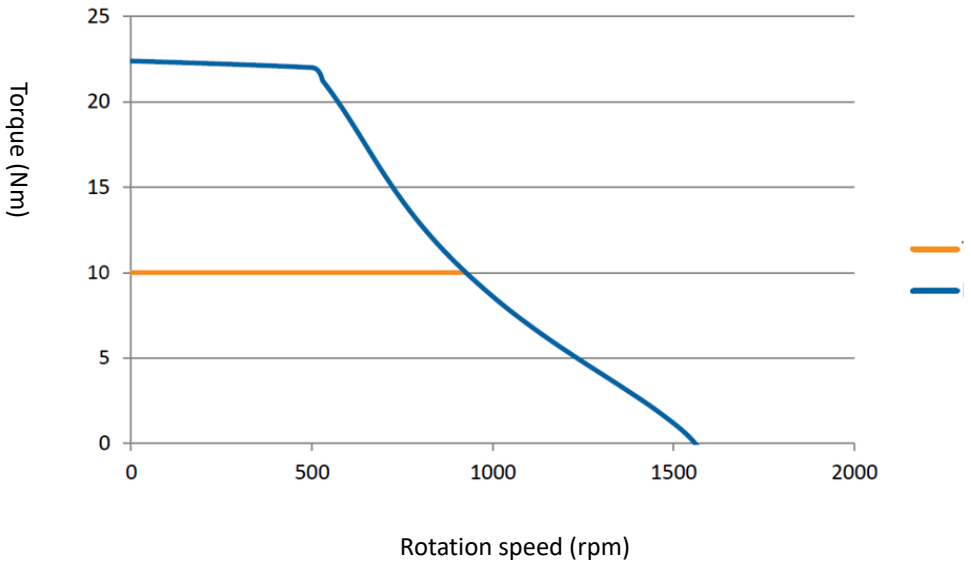
7.2 A-axis Motor Datasheet

Item		Remark	Symbol	Unit	Value
Motor Performance	Coil type				N
	Motor type				Three-phase synchronous frameless motor
	Power supply voltage				AC 230V (DC 300V)
	Breakdown torque (temperature rise 20℃/s)	When the temperature of permanent magnet is 25° C	Tu	Nm	20.6①
	Peak torque (temperature rise 6℃/s)	When the temperature of permanent magnet is 25° C	Tp	Nm	13.1
	Rated torque	When the temperature of induction coil is 100° C	Tc	Nm	(10)①
	Max. speed	Rated torque	nmax	rpm	(910)②
	Torque parameters	Max. current	Kt	Nm/Arms	2.09
	Motor constant	When the temperature of induction coil is 25° C	Km	(Nm)2/W	0.344
Electrical Performance	Rated current	When the temperature of permanent magnet is 70° C	Iu	Arms	13.3
	Peak current	When the temperature of permanent magnet is 25° C	Ip	Arms	7.31
	Max. continuous current	When the temperature of induction coil is 100° C	Ic	Arms	(4.77)①
	Peak back emf constant		Ke	V/krpm	179
	Average back emf constant		Ke	V/krpm	126
	Coil resistance per phase	When the temperature of induction coil is 25° C	R	Ω	4.23
	Coil inductance per phase		L	mH	11.5
	Electrical time constants	When the temperature of induction coil is 25° C	Te	ms	2.72
	Number of poles		Nmgn	nr	28(=14 pole pair)
Safety Performance	Power loss	When the temperature of induction coil is 100° C	Pc	W	375
	Coil thermal impedance		Rth	℃/W	0.20
	Thermal time constant	Up to 63% of induction coil temperature	Tth	s	19
	Cut-off temperature sensor				PTC 1kΩ
	Temperature monitoring sensor for CNC system				KTY83-122

① The values in parentheses only apply to the motor mounting surface with cooling water temperature of 20°C. For higher cooling water temperatures, Tc and Lc values must be reduced in the CNC setting.

② The max. speed available for A-axis is lower than following values:

Water cooling temperature	Rated torque	Rated current
20°C	Tc=10Nm	Lc=4.77A
25°C	Tc=9.7Nm	Lc=4.6A
30°C	Tc=9.3Nm	Lc=4.4A
35°C	Tc=9Nm	Lc=4.3A
40°C	Tc=8.7Nm	Lc=4.1A
45°C	Tc=8.4Nm	Lc=4A



Max. speed of A-axis<<Max. speed of motor

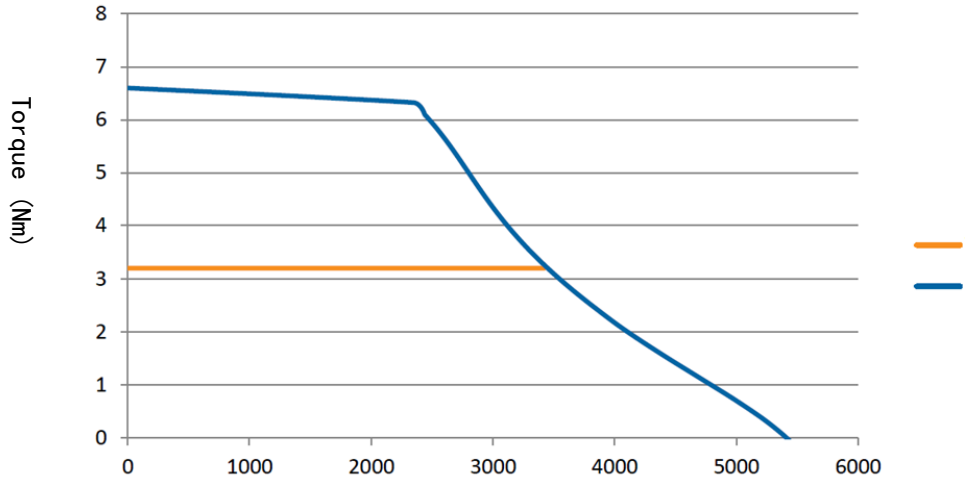
7.3 H-axis Motor Datasheet

Item		Remark	Symbol	Unit	Value
Motor Performance	Coil Type				N
	Motor type				Three-phase synchronous frameless motor
	Power supply voltage				AC 230V (DC 300V)
	Breakdown torque (temperature rise 20℃/s)	When the temperature of permanent magnet is 25° C	Tu	Nm	6.1
	Peak torque (temperature rise 6℃/s)	When the temperature of permanent magnet is 25° C	Tp	Nm	3.9
	Rated torque	When the temperature of induction coil is 100° C	Tc	Nm	(3.2)①
	Max. speed	Rated torque	nmax	rpm	(3579)②
	Torque parameters	Max. current	Kt	Nm/Arms	0.595
	Motor constant	When the temperature of induction coil is 25° C	Km	(Nm)2/W	0.061
Electrical performance	Rated current	When the temperature of permanent magnet is 70° C	Iu	Arms	13.8
	Peak current	When the temperature of permanent magnet is 25° C	Ip	Arms	7.56
	Max. continuous current	When the temperature of induction coil is 100° C	Ic	Arms	(5.34)①
	Peak back emf constant		Ke	V/krpm	51
	Average back emf constant		Ke	V/krpm	36
	Coil resistance per phase	When the temperature of induction coil is 25° C	R	Ω	1.93
	Coil inductance per phase		L	mH	4.05
	Electrical time constants	When the temperature of induction coil is 25° C	Te	ms	2.1
	Number of poles		Nmgn	nr	20 (=10 pole pair)
Safety Performance	Power loss	When the temperature of induction coil is 100° C	Pc	W	214
	Coil thermal impedance		Rth	℃/W	0.35
	Thermal time constant	Up to 63% of induction coil temperature	Tth	s	16
	Cut-off temperature sensor				PTC 1kΩ
	Temperature monitoring sensor for CNC system				KTY83-122

① The values in parentheses only apply to the motor mounting surface with cooling water temperature of 20°C. For higher cooling water temperatures, Tc and Lc must be reduced in the CNC settings.

② The max. speed available for H-axis in the cutting head configuration is lower than following values:

Water cooling temperature	Rated torque	Rated current
20°C	Tc=3.20Nm	Lc=5.34A
25°C	Tc=3.11Nm	Lc=5.2A
30°C	Tc=3Nm	Lc=5.0A
35°C	Tc=2.9Nm	Lc=4.8A
40°C	Tc=2.75Nm	Lc=4.6A
45°C	Tc= 2.65 Nm	Lc=4.4A



Max. speed of A-axis<<Max. speed of motor

7.4 Encoder Data

Each motor axis of the cutting head is equipped with an absolute angle encoder.

Type: RESOLUTETM absolute encoder system with RESA circular grating

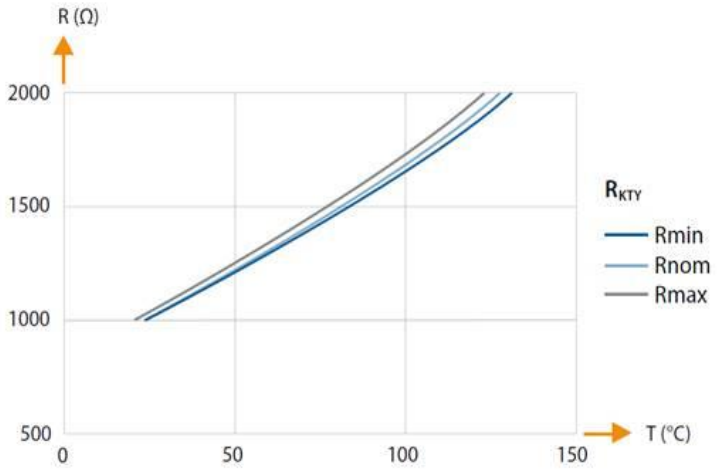
Item	remark	Value
Power supply	5V±10% Fluctuation	Max1.25 W（5V;250 mA） Max200mvpp, @frequency: Max 500khz
Working temperature		0℃～+80℃
Working humidity		Relative humidity (no dewing): 95%, complying with IEC60068-2-78
Protection class		IP64
Acceleration of reading head	Working Collision	500m/s^2 1000m/s^2
Max acceleration of the scale relative to the reading head		2000m/s^2
Vibration	working	Max. 300m/s^2 (55Hz～2000Hz)
Max reading speed		14600rpm
Accuracy	H-axis A\C 轴	±3.82 as ±2.44 as
Resolution	Yaskawa	24 bit（16777216/r，≈0.077 as）

7.5 Cut-off Temperature Sensor PTC and Temperature Monitoring Sensor KTY

The sensor detects temperature signals based on the change in resistance value.

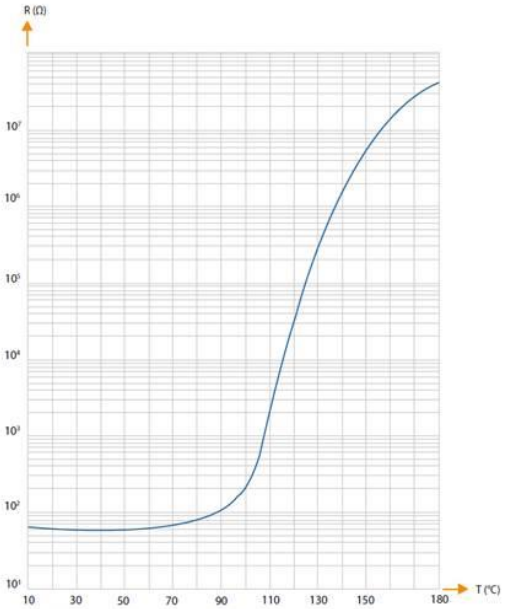
The resistance value of KTY83-122 is proportional to the temperature, so the temperature can be calculated by measuring the resistance value.

T(℃)	20	25	30	40	50	60	70	80	90	100	110	120	130
RNOM Ω	972	1010	1049	1130	1214	1301	1392	1487	1585	1687	1792	1900	2012



KTY83-122 Resistance-Temperature curve

The resistance value of the PTC increases abruptly at 110° C, used to provide threshold alarm for CNC system.



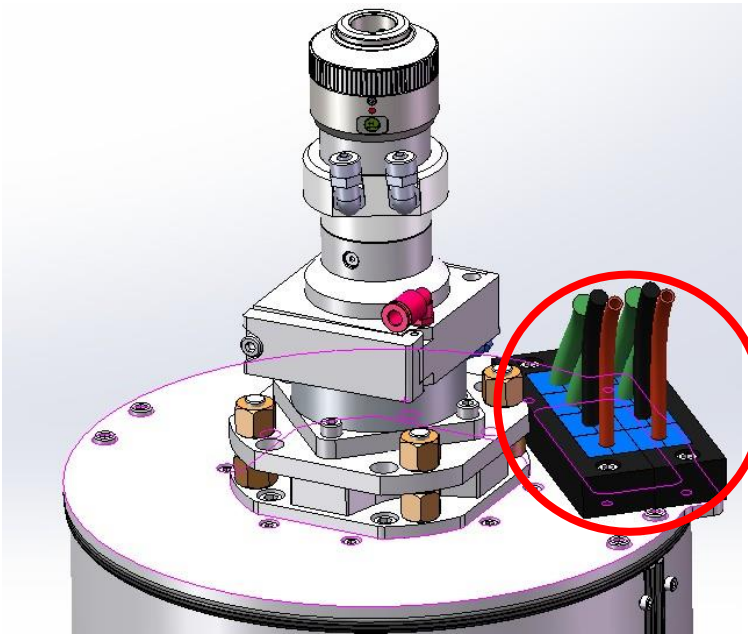
PTC-1K Resistance-Temperature curve

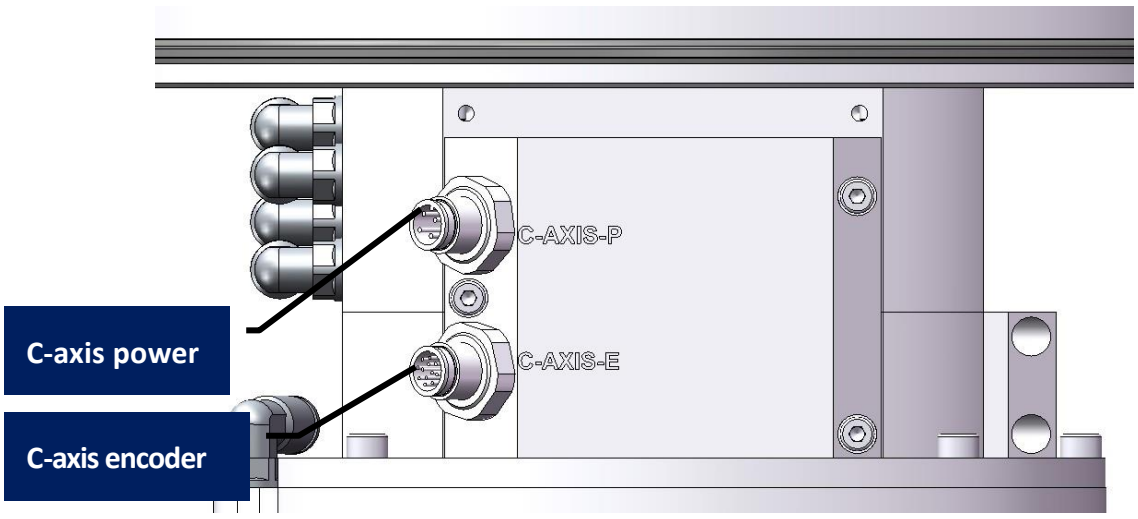
7.6 Connection of Electrical Interface and Cable

Reselling the cutting head requires delivering following cables:

- 3x power cables (C\A\H axis);
- 3x encoder and temperature sensor signal cables (C\A\H axis);
- 1x sensor signal cable;
- 1x follow signal CAP cable.

One connector of above cables is connected to equipment of users, and the other connector is placed in the cutting head as below:





Internal connection cables of H-axis include:

- 1x H-axis power cable;
- 1x H-axis encoder and temperature sensor signal cable;
- 1x limit sensor signal cable;
- 1x follow signal CAP cable

Connector and Cable Description		
C\A\H axis power cable connector	C\A\H axis encoder cable connector	Coaxial cable connector
		

8. Troubleshooting

Failure	Cause	Solution	Remark
CNC system stops with an alarm when starting the axis.	Cable disconnected; A-axis brake not released.	Checking electrical interface connections; Check if brake air pressure is properly supplied	
Motor don´t move and The measured resistance values between L1->L2, L1->L3 and L2->L3 are not equal.	Motor is burnt through.	Measure the resistance between L1->L2, L1->L3 and L2->L3 and compare with the recorded values in the report "Electrical measurement".	The motor must be replaced at LT Ultra.
Water runs out of the leakage hose.	The sealing in the feed-through is damaged.	Collect the cooling water and record the leakage per hour.	The feed-through must be replaced by LT Ultra or trained staff.
Nonsensical detected motor temperature (e.g. -200°C / constant 20°C / or others).	Broken wire for KTY-temperature sensor in the extension cable. KTY-sensor is damaged. KTY-sensor is not evaluated correctly in	Measure the resistance for KTY-sensor and compare with the value in the report "Electrical measurement". Check the parametrization in your CNC system.	Replace the cable. The motor must be replaced at LT Ultra.
Encoder alarms of A- or Z-axis.	Polluted encoder read head or scale ring. Broken wiring. Disturbed signal transmission in the slip ring.	Check if problem occurs Only at defined C-axis positions. Check the electrical wiring. Check if problem occurs only when C-axis rotate and switch direction of rotation quickly.	The encoder must be repaired or replaced at LT Ultra. The encoder wiring must be repaired or replaced at LT Ultra. Ask LT Ultra staff for detailed information how to clean the slip ring carefully with "B10"-spray.

9. Maintenance

9.1 Maintenance List

S/N	Content	Frequency
1	Clean and inspect all optical lenses.	Don't expose optics system to outside.
2	Check water/gas/electrical circuit for damage or leakage.	At least once a week
3	Check if connection of drive parts is loosed.	Once a month
4	Replace damaged parts if collision occurs.	Must replace

9.2 Cleaning Lens

It's necessary to maintain lenses regularly because of the characteristic of laser cutting process. Cleaning to the cover glass once a week is recommended. The collimating lenses and focusing lenses are recommended to be cleaned once every 2~3 months.

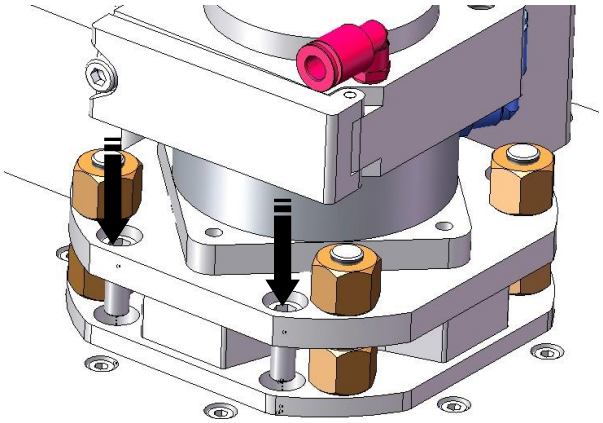
9.2.1 Tools

Tools: Dust-proof gloves or fingertip, polyester swab, absolute ethanol, rubber gas blow (purely compressed air).

9.2.2 Cleaning Instruction

- To put fingertip onto left thumb and index finger.
- Spray absolute ethanol onto the polyester swab.
- Hold the edge of the lens with left thumb and index finger gently. (note: avoid touching the surface of the lens by fingertip in case of trace)
- Hold the lens to face eyes by left hand and hold the polyester swab by right hand. Wipe the lens gently in single direction, from bottom to top or from left to right (Should not wipe back and forth in case of secondary pollution to lens) and use rubber blow (purely compressed air) to blow the surface of the lens.
- Both surfaces should be cleaned. After cleaning, make sure that there is no residual like detergent, floating ash, foreign matters and impurities.

9.3 Removal and Installation of Collimation Module

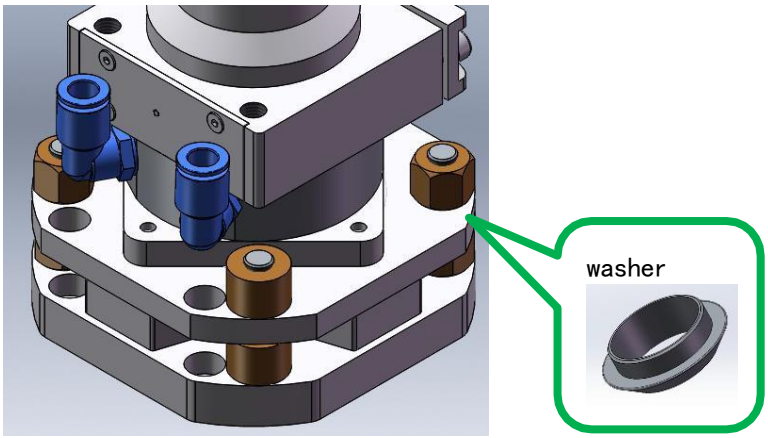


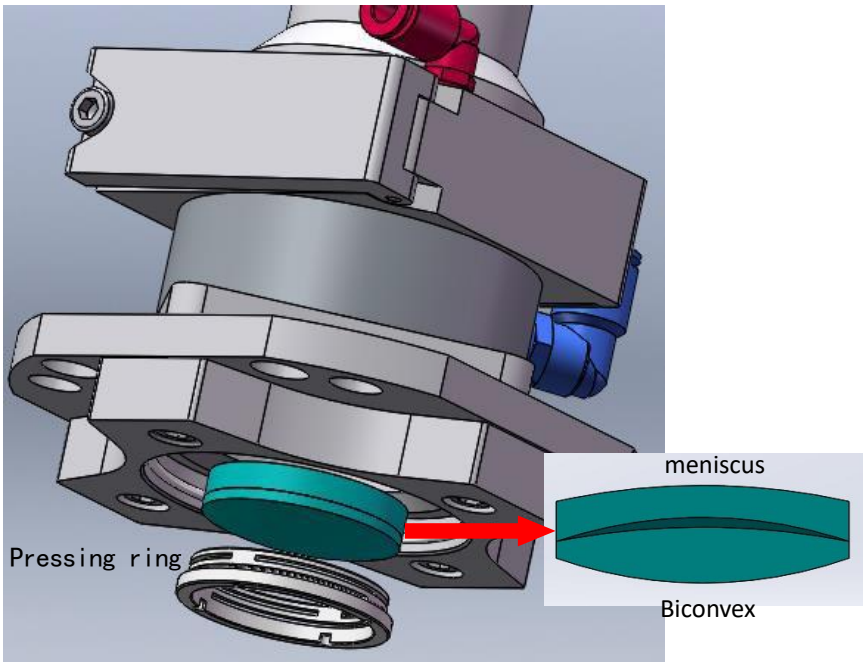
- Remove the laser head and move to a dust free room. Clean all dusts on the laser head surface;
- Loose the 4 bolts to pull out whole module;
- Seal the mounting openings by textured tape immediately;
- Mount the module back to the cutting head and tighten the bolts.

Warning: when moving the fiber, damage to the interface may cause the fiber to deflect. It's recommended to cover it with light shield.

Keep the lens holder upright while moving it to prevent the lens from falling off.

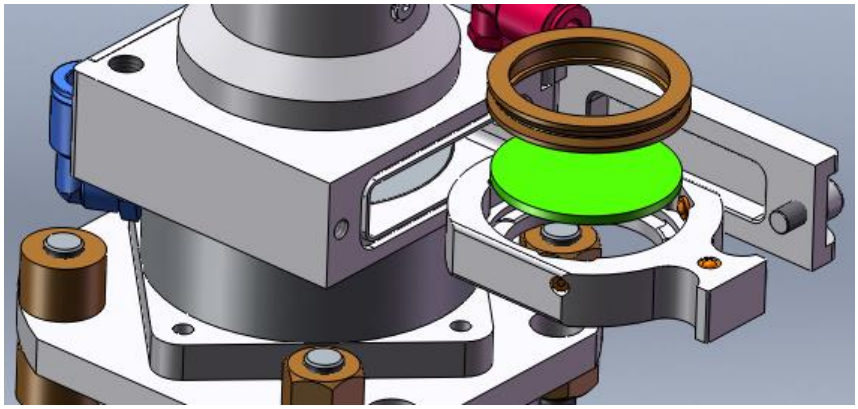
9.3.1 Removal and Installation of Collimation Lens





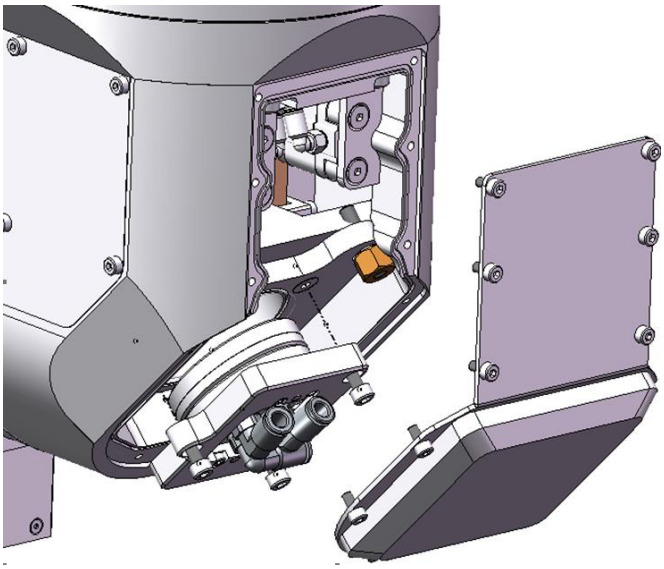
- Move the module to a dust free room;
- Loosen 4 nuts of the collimation module;
- Remove the connecting plate and 8 washers;
- Remove pressing ring;
- Replace or clean collimation lenses;
- Mount meniscus lens, biconvex lens and pressing ring back in sequence.

9.3.2 Removal and Installation of Top Cover Glass



- Move the cover glass assembly to a dust free room;
- Loose bolts of cover to pull out cover glass holder;
- Blow clean and dry air to the top cover glass assembly through gas interface near the QBH interface;
- Remove the pressing ring;
- Clean or replace the cover glass;
- Insert the cover glass holder back to the laser head and tighten the bolts.

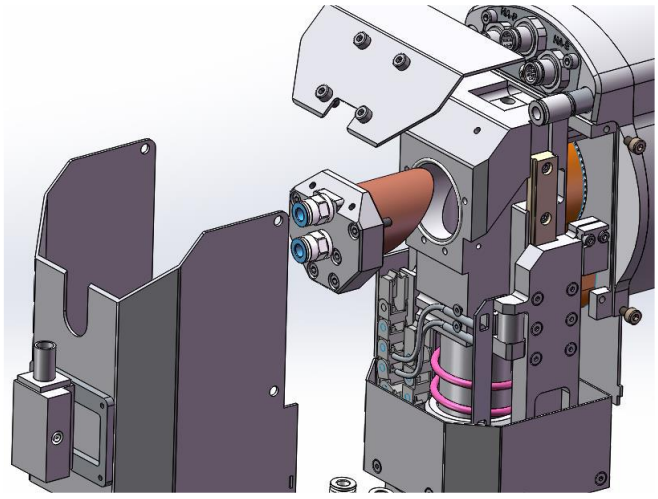
9.4 Removal and Installation of AO Mirror

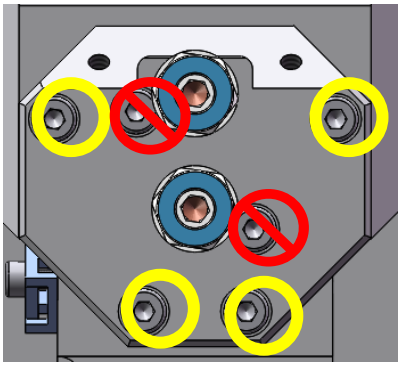


- Move AO mirror assembly to a dust free room;
- Loosen 12 bolts of the back cover to remove the cover;
- Remove gas/water pipe after stopping gas input and closing chiller (if there is cooling water dropped, clean it);
- Loosen 3 bolts of the mounting plate and pull out it perpendicular to the mounting surface;
- Seal the mounting openings by textured tape immediately.
- Clean or replace AO mirror;
- Mount the assembly back to the cutting head.

After replacing/cleaning AO mirror, please check if water pipes are properly connected and if there is water leakage.

9.5 Removal and Installation of Oblique Mirror

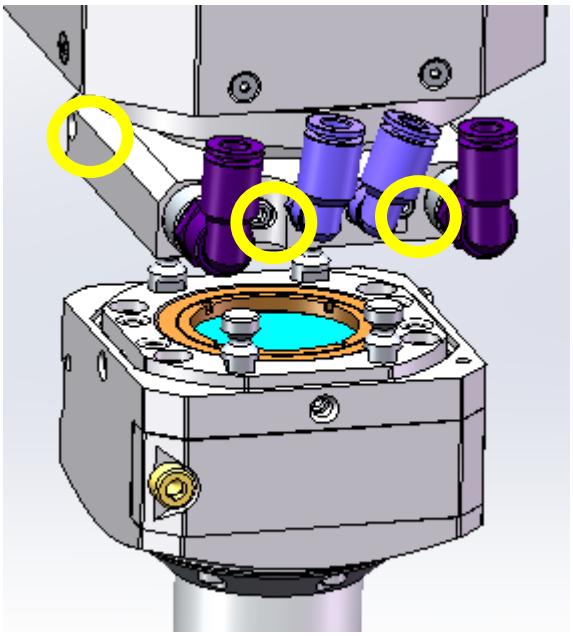




- Move the oblique mirror assembly to a dust free room;
- Remove water pipe after closing chiller (if there is water dropped, clean it);
- Loosen fixing bolts of the sheet metal parts on the H-axis assembly;
- Loosen 4 bolts on the cover (yellow area);
- Seal the mounting openings by textured tape immediately;
- Mount the assembly back to the cutting head.

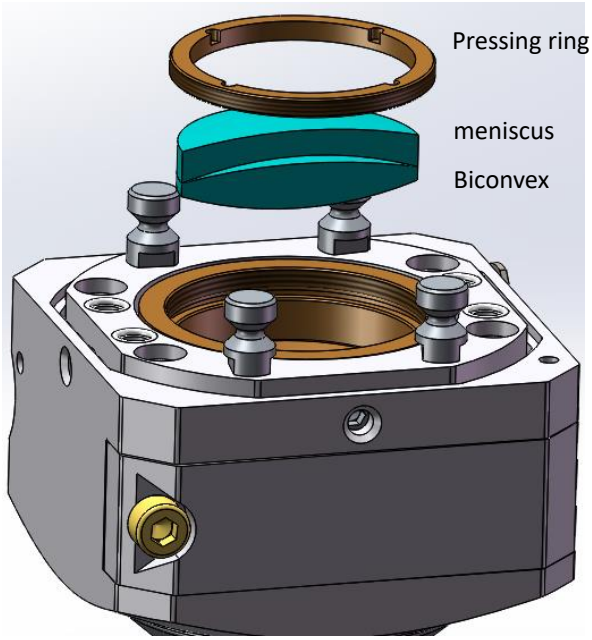
Note: The 2 bolts (rea area) are used to fix the oblique mirror to the cover and must not be loosened before step 2, otherwise the oblique mirror may fall off. Both bolts can only be loosened when replacing oblique mirror.

9.6 Removal and Installation of Focus Module



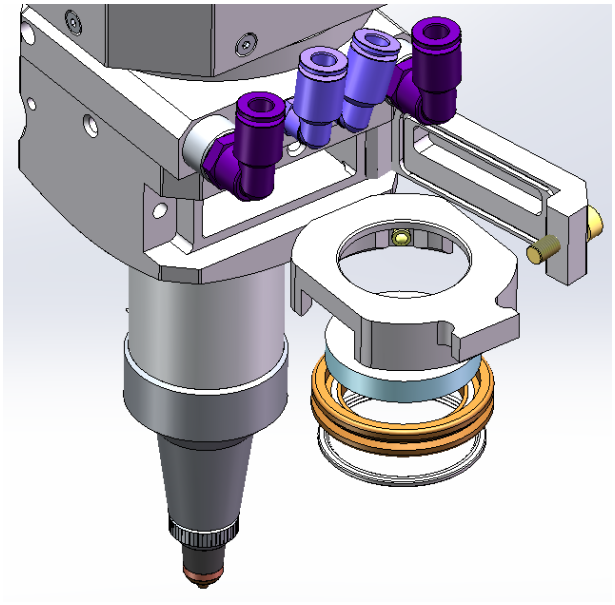
- Clean all dusts on the laser head surface;
- Loose the 4 bolts to pull out focus module downward.
- Seal the focus lens and mounting openings by textured tape immediately.
- Mount the module back to the cutting head and tighten the bolts.

9.6.1 Removal and Installation of Focus Lens



- Move the focus module to a dust free room;
- Remove the pressing ring;
- Replace or clean focus lenses;
- Mount meniscus lens, biconvex lens and pressing ring back in sequence.

9.6.2 Removal and Installation of Bottom Cover Glass

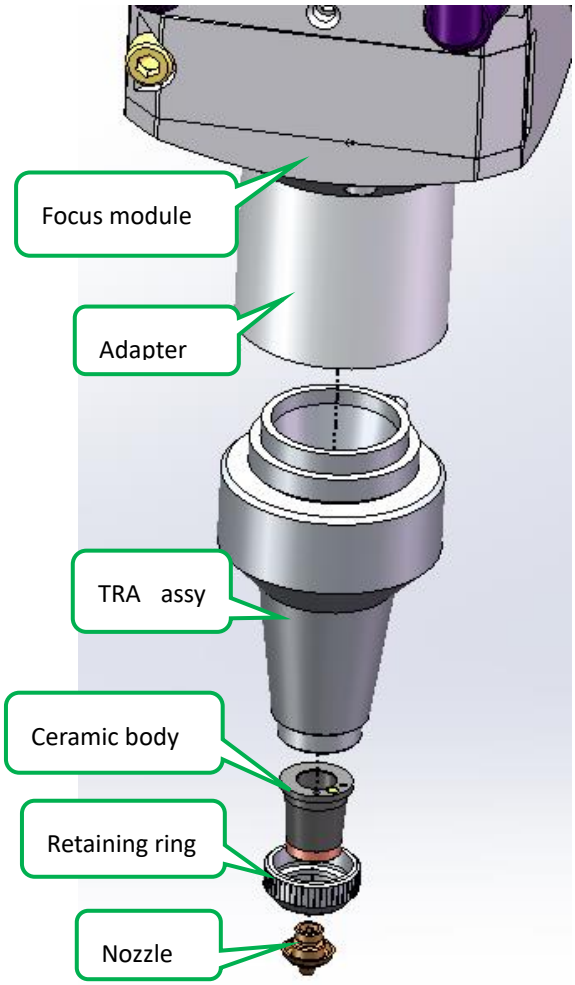


- Move the cover glass assembly to a dust free room;
- Loose bolts of cover to pull out cover glass holder;
- Seal the mounting openings by textured tape immediately.;
- Remove the pressing ring;
- Clean or replace the cover glass;
- Insert the cover glass holder back to the laser head and tighten the bolts.

Note: It is forbidden to use nails or hard objects to directly remove the elastic seal ring above the cover glass, which will seriously cause damage to the elastic seal ring, air leakage or even damage to the cover glass, focus and collimation lens.

Keep seal ring properly as any small scratch will cause air leakage and affect the cutting effect.

9.7 Replace Nozzle Assembly



The nozzle is required to be replaced if it gets crash or damaged by laser beam. The dirt on ceramic body is required to be cleaned or to replace the ceramic body if it gets crash.

- Unscrew the nozzle;
- Press the ceramic body upward by hand to make it fixed without deflection and then unscrew the retaining ring;
- Align the pin hole of the new ceramic body with the locating pin. Press the ceramic body upward by hand and tighten the retaining ring;
- Screw the new nozzle and get it properly tightened;
- Do the capacitance calibration once again after replacing the nozzle or ceramic body.

Only tighten the nozzle and retaining ring by hand (without tools) otherwise it could damage the ceramic body.

Keep the contact surface of all parts clean.

10. Parts List

S/N	Name	Product ID
1		
2		
3		
4		