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CypWeld User Manual

Software Version: C113.26

Document Version: V2.1.0

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Foreword

Thank you for using BOCHU FSWELD intelligent welding control system!

BOCHU CypWeld Intelligent Welding Control Software (hereinafter referred to as CypWeld) is an operating software designed for the 6-axis industrial robot teach-free arc welding system FSWELD Intelligent Welding Control System (hereinafter referred to as FSWELD System). It mainly consists of several core modules, including digital twin interface, robot motion control, arc welding technique processing, production management and statistics, intelligent processing assistance, rapid simulation, visual image information viewing, local help and remote assistance. These modules work together to assist users in completing production tasks efficiently.

Before using the software, please be sure that CypWeld is only available for actual processing when working with BOCHU intelligent welding CNC and the corresponding license. CypWeld will be in DEMO mode as any of the following three situations are detected:

- The CNC is not the one provided by FSWeld system.
- The license is not within its valid period.
- The CNC does not meet the requirement of the current product.

Please note that this manual only serves as the instruction of the main program of CypWeld. Please refer to other manuals contact technical support for FSWeld system installation or other content which requires for higher permission.

This manual is based on CypWeld C113.26. We apologize for the fact that the software you are using may differ in some respects from what is stated in this manual due to the continuous updating of system features. We make every effort to ensure that the contents of the manual are applicable, but reserve the right of final interpretation. Contents of this manual are subject to change without prior notice

For any questions or suggestions during usage, please contact us through the information provided.

Convention Symbol Explanation

- Notice: Supplementary or explanatory information for the use of this product.
- Caution: If not operated as specified, it may result in minor physical injury or equipment damage.
- Warning: If not operated as specified, it may lead to death or serious physical injury.
- Danger: If not operated as specified, it will cause death or serious physical injury.

Safety Statement

The operation of the robot/external axis and the final welding result are directly related to the welding material, welding machine, gases used, gas pressure, and the parameters you set. Please set all parameters carefully and diligently according to your welding process requirements.

Improper parameter settings or operations may result in suboptimal welding quality, equipment damage, or even personal injury. FSWELD incorporates built-in safety features; however, both equipment manufacturers and end users are required to strictly follow all operating procedures to minimize safety risks

BOCHU shall not be held liable for any direct or indirect losses arising from the following circumstances:

- Losses caused by misuse of this manual or the product;
- Losses due to non-compliance with safety guidelines;
- Losses resulting from force majeure events, such as natural disasters.

Additionally, welding systems in operation carry inherent risks. Users are responsible for ensuring that they have comprehensive fault handling and safety protection mechanisms. BOCHU assumes no responsibility for any incidental or consequential damages resulting therefrom.

Revision History

Version No.	Date	Description
V2.1.0	2025/09/05	Updated based on CypWeld C113.26.

Contents

Feature Overview

- Connects with mainstream 3D modeling software such as Tekla and SolidWorks, and supports model files in .ifc/.step/*.stp formats.
- Adopts digital twin technology to realize the synchronous movement of the robot in the software and the robot in the real workstation.
- Supports automatic calculation of welding pose and positioning pose, and displays them visually in the software interface.
- Supports automatic planning of travel paths, with both collision detector and singularity avoidance functions.
- Supports flat welding, horizontal fillet welding, vertical upward welding, vertical downward welding, continuous wrap-angle welding and continuous curve welding.
- Supports oscillating welding in sine, pendulum, L-type and triangular patterns.
- Supports multi-layer and multi-pass groove welding/non-groove welding.
- Supports quick generation of intermittent welding.
- Supports workpiece initial positioning via vision, manual three-point, and mechanical fixture methods.
- Supports multiple weld seam fine positioning methods including search-on-the-fly, scanning positioning, butt-joint positioning and lap-joint positioning.
- Supports weld seam interruption and connection at the position of weld scallop.
- Supports automatic drawing output and batch generation of weld seams.
- Supports TCP (Tool Center Point), eye-hand calibration, and automatic toolpath remapping after small-range changes in workpiece initial positioning.
- Supports automatic dirt detection on the seam tracker lens.
- Supports machine types such as fixed base, single ground rail, inverted cantilever and gantry.
- Supports interpolated movement of positioners and robot.

- Supports import and export of process parameter files, and automatic recommendation of process parameters.
- Supports breakpoint positioning for resuming processing and setting the current position as a breakpoint to resume processing after movement.
- Supports automatic torch cleaning and wire cutting.
- Supports parametric modeling of bracket, tower foot, H-beams and T-bars.

Chapter 1 Product Overview

1.1 Adaptable Machine Types

BOCHU Intelligent Welding System provides three sets of products, each adapted to different machine types. Before using the software, please make sure that the purchased system hardware is compatible with the current machine. If the hardware is incompatible, the CypWeld software will automatically enter the demonstration mode, in which only simulation operations can be performed, and the equipment cannot be actually controlled.

Table 1-1 FSWELD System Classification

Intelligent Welding System	Machine Model
2800L	Single-machine workstation, 7-axis linear track, 7-axis cantilever (all require 3D model import)
2800M	All workstations (require 3D model import)
2800T	All workstations (support 3D model import / 2D drawing import)
3800	All workstations (not require 3D model import)

1.2 Software Composition

The CypWeld software consists of the CypWeld main program and the CypConfig. During installation, the system will automatically create a shortcut icon for the CypWeld main program on the desktop; if the *CypConfig* is needed (requires advanced permissions), users must enter the software installation folder and manually launch the CypConfig program.

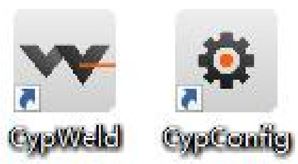

Figure 1-2 CypWeld software icon and Machine Config shortcut icon

Chapter 2 System Configuration & Procedures

2.1 Machine Tool Settings

During equipment installation, mechanical accuracy and rigidity must be ensured, with specific requirements as follows:

- Robot accuracy: Error is within 1.5 mm when moving the tip of the welding torch end around a fixed point.
- Seam Tracker accuracy adjustment: Error is within 1.5 mm for accuracy verification.
- Positioner accuracy: Error is within 2 mm for jog accuracy at zero-space points, and within 3 mm for model and actual workpiece deviation.
- The modeled neck diameter of the welding torch shall be 15 mm larger than the actual size.

Machine tool settings must be configured in the ***CypConfig***, with specific steps as follows:

Step 1 Network Scanning: Before conducting slave station scanning, ensure that all slave stations are correctly wired, powered on successfully and in a non-alarm state. Click ***Scan Slave***. If the scanning is successful, the system will correctly display all connected slaves.

Step 2 Layout Config: Select the base, robot, workbench and tool that match the equipment in sequence, and enter the corresponding zero point and DH parameters.

Step 3 Axis Config: Used to configure the motion parameters of the robotic arm and external axes. The parameters in ***Axis Config*** are mainly related to hardware such as drivers. For robot parameters, refer to the parameters on the robot teach pendant. If there is no teach pendant, contact the robot or driver manufacturer to obtain the relevant parameters.

Step 4 Welder: Select the currently supported welding machine model.

⚠ Notice: This system currently only supports welding machines with the EtherCAT communication protocol.

Step 5 Seam Tracker and Camera: If using the 3800 system, it is necessary to configure a large line-scan camera.

Step 6 Alarm: Configure custom alarm display information triggered by corresponding input ports.

⚠ Warning: The emergency stop button is only used for machine tool anti-collision protection. Improper use may cause damage to the equipment; please operate with caution.

Step 7 General Input/General Output/Resources: Configure custom input/output ports and IO board signal resources.

Step 8 WKB: Set the button functions of WKB.

Step 9 Advanced Options:

1. Primarily used for setting the system language, which currently supports Simplified Chinese and English.

2. Set the password for the expert mode entry. When accessing functions such as the ***CypConfig***, ***Procedure Table***, ***Global Parameter***, ***PLC Process***, and ***Motion Control Monitor***. After checking ***Keep Expert Mode On***, closing and reopening the above pages will directly enter expert mode.

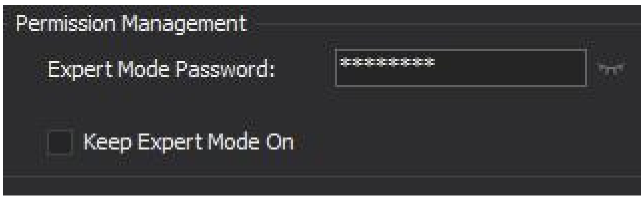

Figure 2-1 Expert mode and password settings

3. Data Permissions: When installing the software installation package, Please sign the user information authorization certificate. Later, the authorization certificate can also be reconfirmed and the authorization status modified here.

⚠ Notice:

1. For details on the above machine tool parameter settings, please refer to *FSWELD Intelligent Welding Control System Installation Manual (General)*.

2. Currently, layout parameter configuration only supports to select existing options; user-defined scene editing is not available temporarily.

2.2 Main Interface Overview

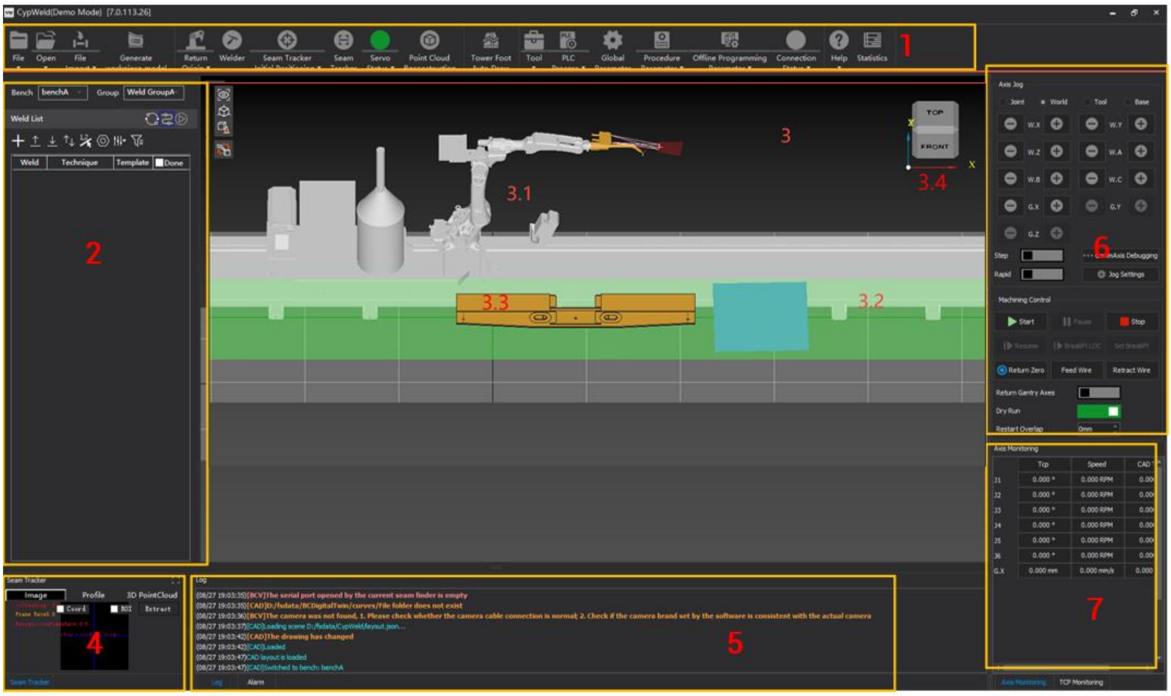

Figure 2-2 Main interface of CypWeld

The components of CypWeld main interface are shown in the following table:

Table 2-1 CypWeld Main Interface Components

No.	Module	Description
1	Toolbar	● The toolbar lists commonly used software functions, including import/export, parameter settings, technique library, calibration tools, and servo status. ● Below the toolbar there might be a banner which displays current alarm and warning information.
2	Weld Seam Settings	Used to set and modify the weld seams to be welded. It also provides functions for processing simulation, path planning, weld seam sorting, and workstation switching.

No.	Module	Description
3	Digital Twin	The digital twin interface of CypWeld is modeled at the same scale as the physical object. Movements in the physical space are fed back to this interface in real time, allowing users to intuitively view collision planning, idle movement, and welding pose of the physical object when operating on the PC. ● Part 3.1 is the main hardware devices,which includes robot, external axes, etc. It is necessary to contact BOCHU staff in advance for software modeling. ● The 3.2 green area represents the automatically calculated optimal working range of the robotic arm. ● The 3.3 yellow area is the imported workpiece model. ● The 3.4 square in the upper right corner provides view switching options.
4	Seam Tracker	Allows operation of the vision camera and adjustment of vision parameters. The camera display interface enables real-time viewing of the current image.
5	Log	Records of current processing, user operations, and error/alarm information
6	Control	Used for jog control of the robot and external axes, providing switching between four coordinate systems: World, Joint, Tool, and Base. It also controls the processing status, allowing start, pause, resume, and stop of processing, as well as controlling whether the welding machine ignites the arc during processing.
7	Axis Monitoring	Used to view the current coordinates, speed, and acceleration of each axis (including robot joints and external axes).

2.3 Acquisition of Processing Models

CypWeld supports 6 methods for obtaining processing drawings: opening/importing local 3D drawings, 2D-to-3D conversion, custom modeling, parametric generation of box columns, point cloud reconstruction, and cloud-based drawing import.

2.3.1 Open/Import

Click the drop-down box of the ***File*** icon and select ***Open*** or ***Import***, then select the target 3D processing model in the local file window. The differences between the two functions are shown in the table below:

Table 2-2 Open VS. Import

Open	Import
Supports *.step, .ifc, *.cwpt	Supports *.step, *.ifc
Clears the current processing workbench	Does not clear the current processing workbench
Supports selecting the latest 10 files	Supports selecting the latest 10 files
Only supports loading a single model	Supports box selection of multiple models in the current folder of the pop-up window for one-time loading

Using the ***File → Edit before Import*** function, you can pre-delete model plates before importing/opening the local original 3D model to the current workstation.

Procedures: Left-click to select the target plate, then use the right-click menu to execute the delete operation.

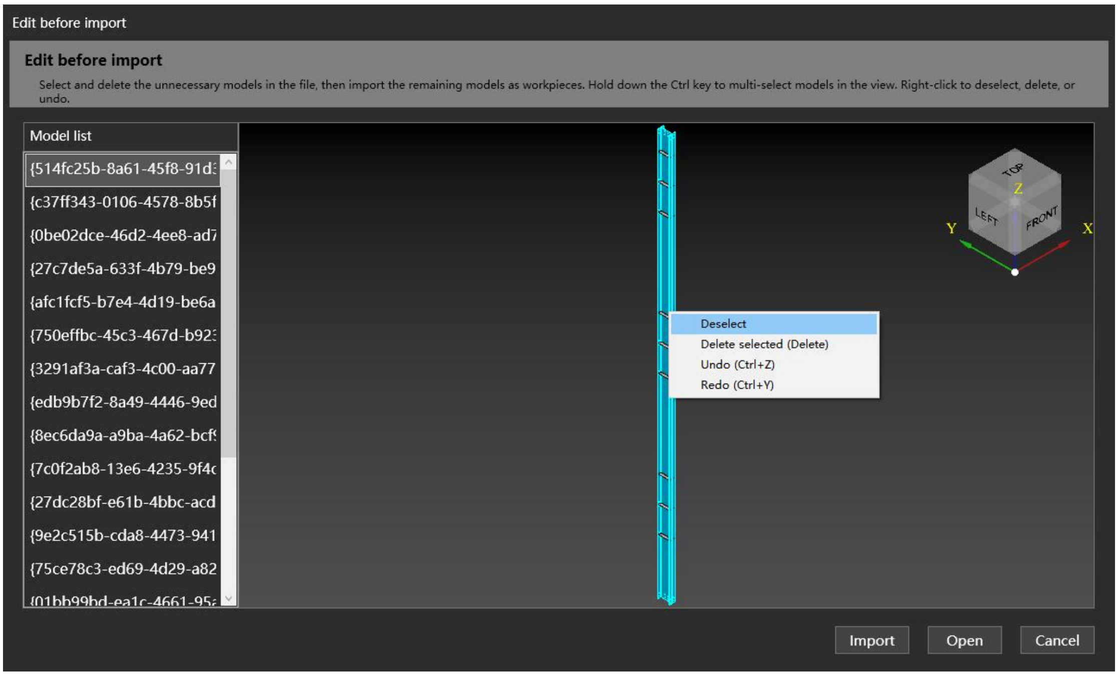

Figure 2-3 Edit before import

2.3.2 2D-to-3D Conversion (Only Compatible with 2800T System)

Supports importing industry-standard 2D drawings of tower foot and converting them to 3D processing drawings using the 2D-to-3D function. For usage instructions, refer to *2800T CypWeld Intelligent Welding Control Software User Manual.*

⚠ Notice: This function is only available for the 2800T system. The converted 3D drawings can only be used in 2800T system products; other systems do not support opening such files!

2.3.3 Custom Modeling

Open via ***File → Custom Modeling***. Currently, it supports parametric modeling of feature parts such as bracket, single-bend bracket, tower base (without stiffeners), H-beam, box columns, single V bevel, box-type column main weld seam single V bevel, and asymmetric double V bevel.

2.3.4 Parametric Generation of Box Columns

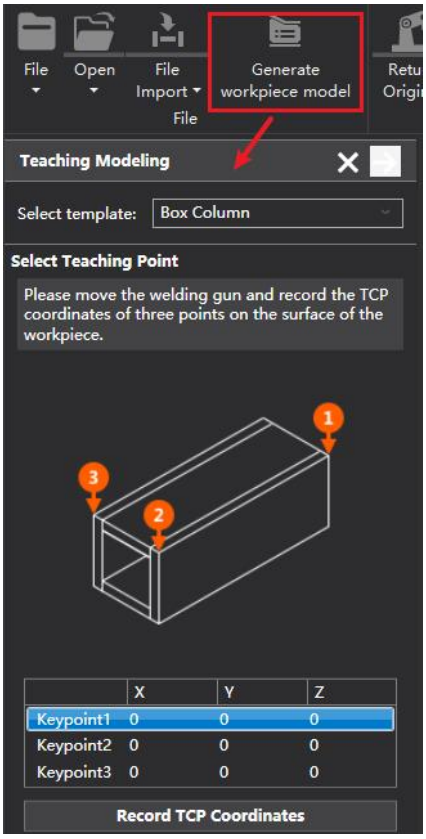

Figure 2-4 Box column teaching modeling

Step 1 Click ***Generate workpiece model*** in the toolbar to open the ***Teaching Modeling*** page.

Step 2 Teach the three vertices of the standard square box column in sequence, then click ***Record TCP Coordinates***.

Step 3 Set the thickness and height parameters of the box column.

Step 4 Complete the 3D model generation.

2.3.5 Point Cloud Reconstruction (Only Compatible with 3800 System)

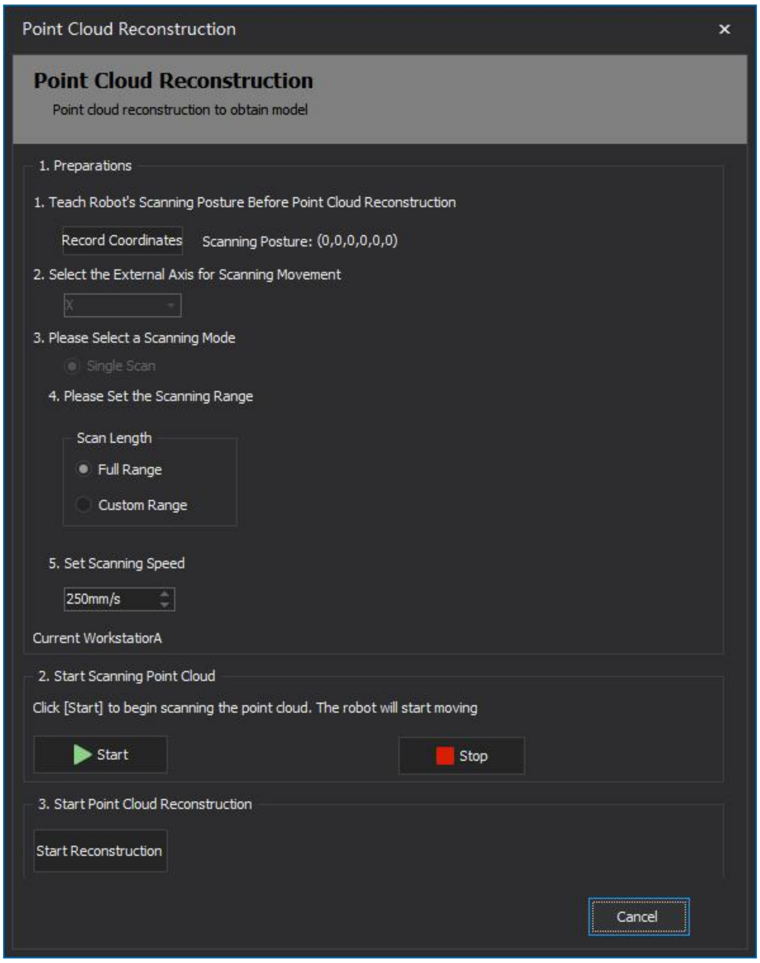

Figure 2-5 Point cloud reconstruction

Step 1 Before starting scanning, ensure that the robot pose will not collide with equipment, workpieces, or the ground during the movement of external axes. After completing the teaching of the initial pose of the robotic arm, click ***Record Coordinates*** to record the scanning pose.

Step 2 Set the scanning method and scanning speed.

Step 3 Start scanning the point cloud. The external axes will move according to the set scanning direction, while the robot pose remains unchanged.

Step 4 Enter the point cloud reconstruction interface and perform the process of reconstructing a 3D model from the point cloud.

Step 5 Save the reconstruction file and push the 3D model to the current bench.

⚠ Notice:

1. For detailed operation steps and precautions of point cloud reconstruction, refer to the *[3800] CypWeld Intelligent Welding Control Software User Manual*.

2. ***Point Cloud Reconstruction*** is only available for the 3800 system. Before use, ensure that the parameters of the large line-scan camera are configured in the ***CypConfig*** and that the large line-scan camera is properly calibrated.

2.3.6 Cloud-Based Drawing Import

For specific operation steps, refer to the *CypWeld-Tekla One-Click Drawing Splitting Plug-in User Manual.*

⚠ Notice:

1. Before use, ensure that the relevant BOCHU cloud service is purchased and the cloud account registration is completed.
2. The production line number in the ***CypConfig*** must be consistent with that set in the cloud service account.
3. The currently used equipment is connected to the Internet.

2.4 Device Jogging

CypWeld supports jogging for both robots and external axes, with three jogging modes: ***High***, L*ow*, and ***Step***.

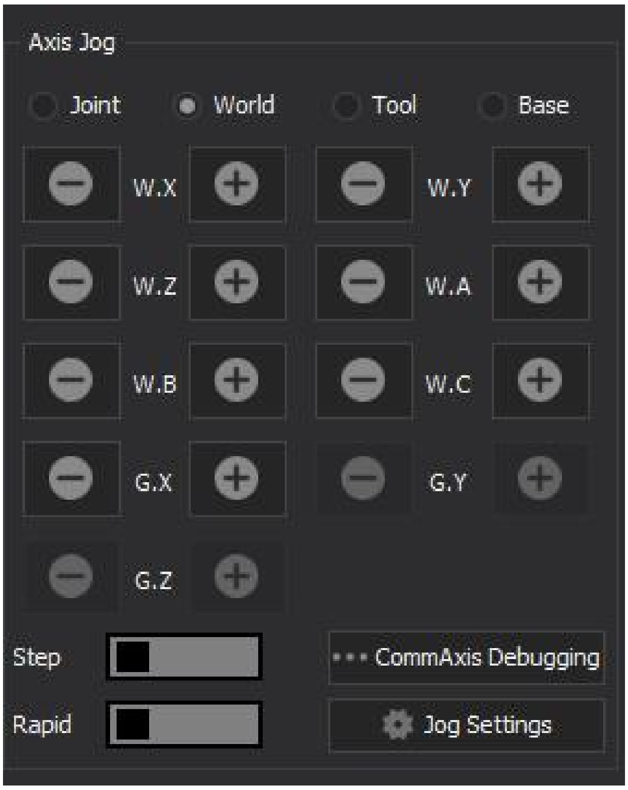

Figure 2-6 Jogging interface

2.4.1 Axis Jog

The robot can be jogged in the following ways: J1 to J6 joint jogging, world coordinate system jogging, tool coordinate system jogging, and base coordinate system jogging.

2.4.2 External Axis Jog

Below the robot jogging buttons, G.X, G.Y, and G.Z represent external axis jogging. The corresponding external axis jogging buttons are automatically displayed based on the current usage scenario. Buttons for external axes not configured in the current scenario will be grayed out.

2.4.3 Common Axis Jogging (Positioner Jogging)

Click *CommAxis Debugging* to enter the interface. If no positioner is configured in the current layout, this feature is unavailable.

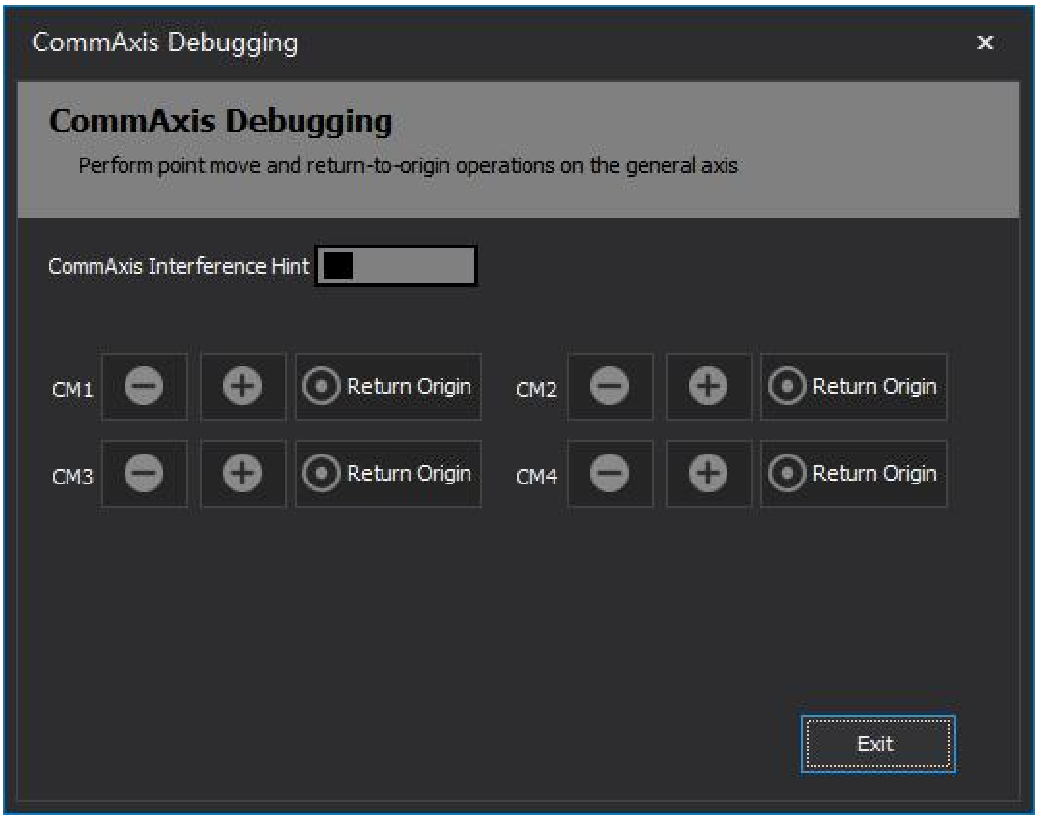

Figure 2-7 Common axis debugging

2.4.4 Jog Speed Settings

Click *Jog Settings* to enter the interface, which includes settings for the robotic arm (robot) and extended axes (external axes + common axes). The robotic arm supports independent settings for *Jog High, Jog Low*, and *Jog Coordinates* for each of its six joints. Additionally, motion algorithms can be applied in the world coordinate system to achieve high-speed, low-speed, and step-by-step control for linear and rotational movements. The same applies to extended axes.

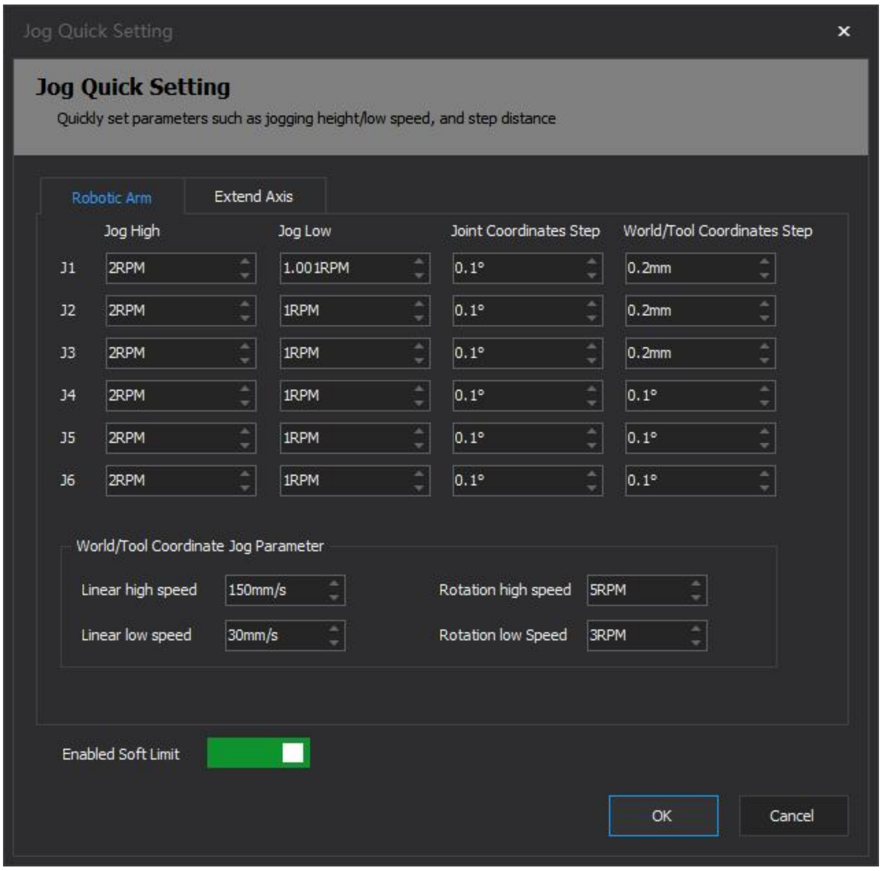

Figure 2-8 Jogging settings

⚠ Notice: The speeds set here only apply to manual jogging and do not include the rapid movement speed used during processing and production.

2.5 Machining Control

Figure 2-9 Machining control

The specific functions are described in the table below:

Table 2-3 Machining Control Functions

Buttons	Description
Start	Start processing. Before starting, the software automatically checks whether the current drawing meets the processing conditions and whether there are any breakpoints.
Pause	Pause processing. During the pause, no changes can be made to the current processing drawing.
Stop	Stop the current processing.
Resume	Corresponds to the pause function.
BreakPt LOC	If the processing process stops or is interrupted unexpectedly, the software will remember the breakpoint. As long as the workpiece model, weld information, and path planning remain unchanged, the software will automatically locate the point where processing last stopped.
Set BreakPt	Manually set a breakpoint, using the current TCP position as the starting point for the next processing.
Return Zero	Click to return the robot or external axis to the zero point.
Feed/Retract Wire	Adjust the length of the welding wire.
Return Gantry Axes	When selected, using the ***Return Zero*** function will cause the external axis to return to zero along with the robot.

Buttons	Description
Dry Run	When selected, processing will not activate the welder arc, only simulate the processing actions.
Restart Overlap	Set the distance the arc starting point will retract along the original welding path when restarting after a pause, aiming to make the joint more better looking.

2.6 **Information Storage**

2.6.1 Processing Drawing Saving

Click ***File*** → ***Save/Save As*** to save the processing drawing of the current station locally.

2.6.2 Parameter Backup

Click ***Tool*** → ***Auxiliary Tool*** → ***Parameter Backup*** to save the current scenario model, configured machine parameters, and procedure parameters.

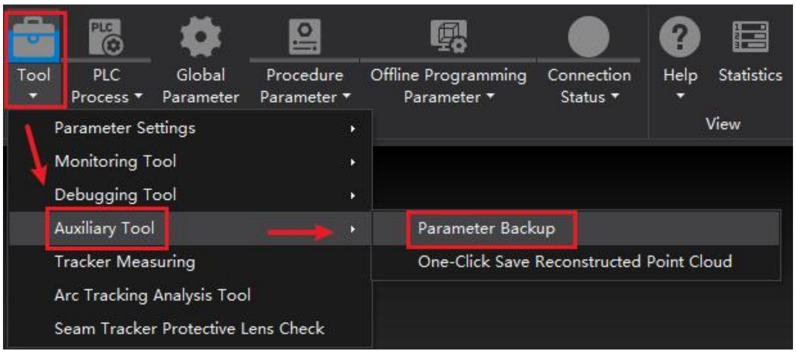

Figure 2-10 Backup parameters

2.6.3 Fault Information Saving

Click ***Help*** → ***Save Fault Info*** to save fault information.

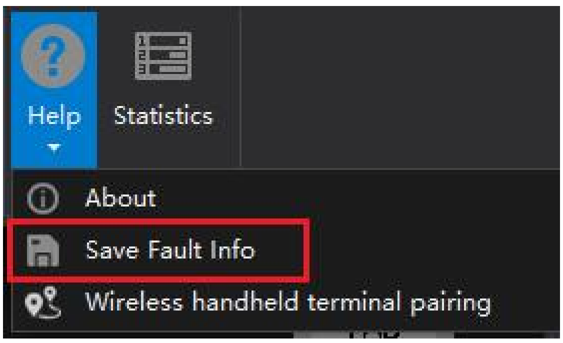

Figure 2-11 Fault information saving

Custom time ranges can be set to filter the fault information to be saved. The three preset time ranges from the old version (last two hours/last two days/last ten times) have been integrated into the current interface and can be directly selected via the ***Time Range*** drop-down menu.

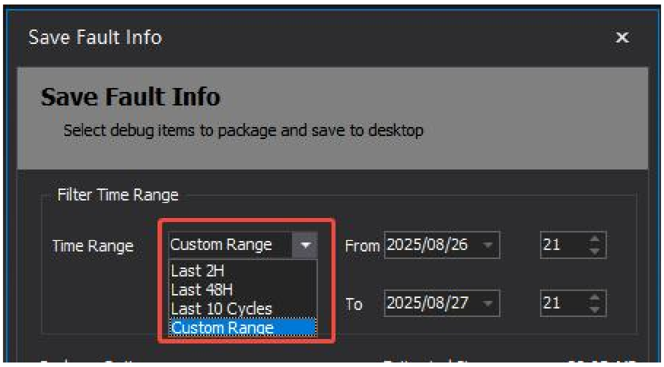

Figure 2-12 Save fault information

By default, ***System Defaults*** is selected for fault information saving, which includes all information except ***Rough Point Cloud*** and ***Precise Point Cloud***. ***Rough Point Cloud*** and ***Precise Point Cloud***. can be selected by the user based on actual feedback scenarios.

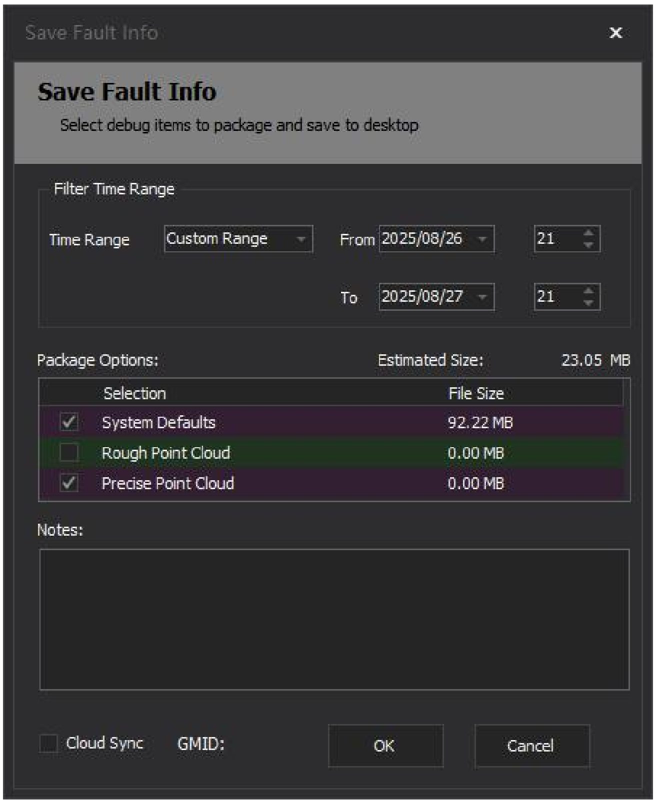

Figure 2-13 Fault information saving interface

Chapter 3 System Calibration

For detailed operational guidance on various calibration functions, it is recommended to contact BOCHU technical support personnel to obtain accompanying instructional videos for comprehensive training.

3.1 TCP/Zero Point Calibration

TCP/Zero Point Calibration Steps:

Step 1 Prepare a calibration tool with a tip (e.g., a tetrahedron calibrator). Place the calibration tool with the tip facing upward and stabilize it within the robot's movement range.

Step 2 Click ***Tool*** → ***Parameter Settings*** → ***TCP/Zero Point Calibration*** to enter the TCP/zero-point calibration interface.

Step 3 Record vertical coordinate positions. Use a 25 mm TCP calibration tip (if unavailable, a welding wire can be used instead by adjusting the stick-out to 25 mm). Jog the arm so that the torch is in the vertical direction and the end of the torch is aligned with the tip of the calibration pyramid, then record the coordinates.

Figure 3-1 Torch vertical and tip aligned with calibration point

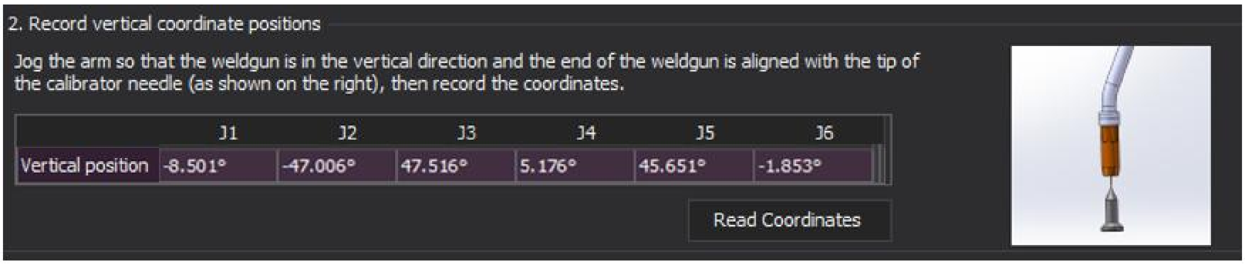

Figure 3-2 Record the vertical coordinates

Step 4 Record coordinates at different postures. Change the horizontal and pitch angles of the torch, aligning the torch module to the tip of the calibration pyramid at four different angles, and select and record coordinates as P1 to P4 for each pose.

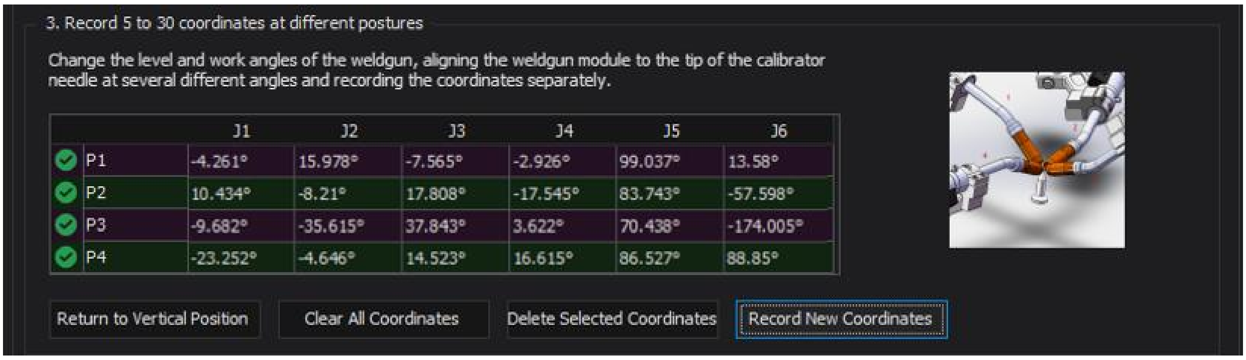

Figure 3-3 Record coordinates at different poses

Step 5 If only calibrating 4 points, click ***Calibrate TCP Only*** → ***OK***. If zero point calibration is required, record at least 8 points and click ***Calibrate TCP and zero point*** → ***OK***.

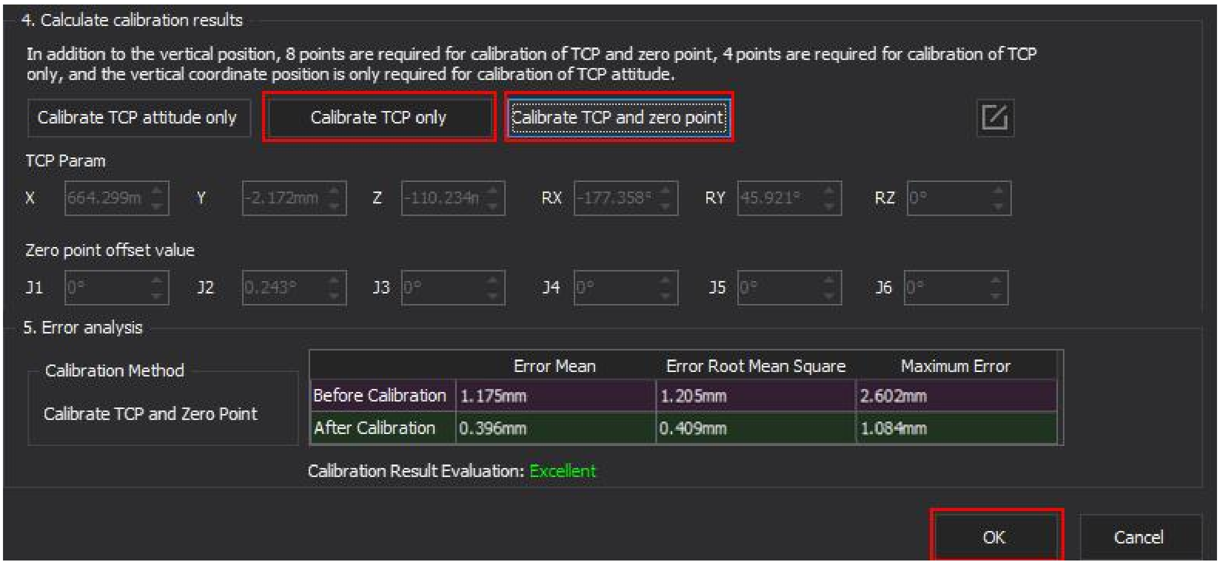

Figure 3-4 Calculate calibration results.

⚠ Notice: Only click once to calculate the TCP result. Multiple clicks may affect the accuracy.

Step 6 Accuracy verification. Adjust the robotic arm so that the robot TCP points vertically towards the tip of the calibration pyramid. Move the joints J4 to J6 incrementally in the world coordinate system to perform circular motions around a point. Observe the maximum linear distance between the torch’s end and the tip of the calibration pyramid during the circular motion. This distance represents the maximum TCP error (typically 1 mm to 1.5 mm, depending on robot brand).

3.2 TCP Automatic Calibration

Before performing TCP automatic calibration, it is recommended to consult BOCHU technical support to confirm whether the welder model supports the automatic calibration function. To ensure calibration accuracy, replace the end of the welding torch with a BOCHU standard calibration needle. Specific steps are as follows:

Step 1 Prepare a conductor plate (size at least 100 mm × 100 mm) and place it horizontally. Turn on the welder and ensure the area around the robotic arm is clear, with no unmodeled obstacles in the scene.

Step 2 Jog the robotic arm to about 10 mm above the center of the plate, ensuring the TCP is as vertical as possible. Click ***Record Coordinates*** to record the starting coordinates.

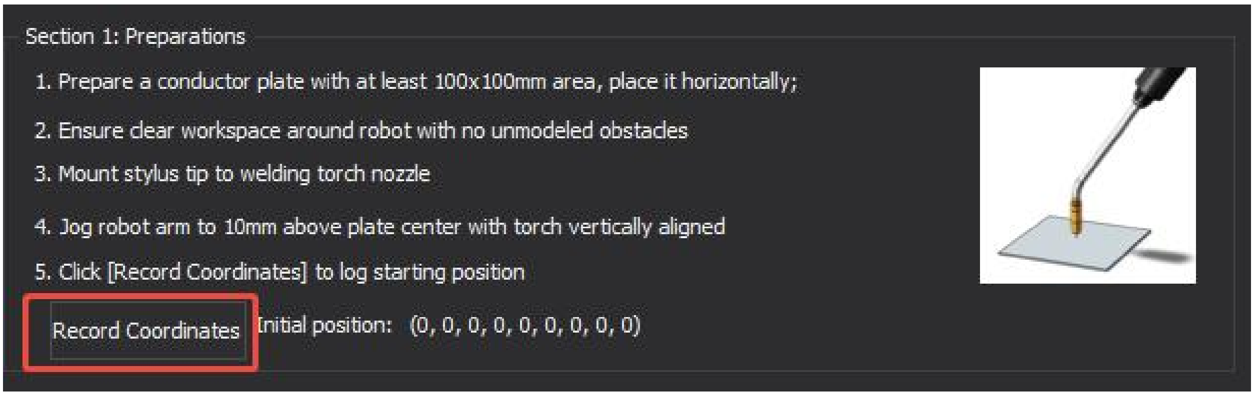

Figure 3-5 Record coordinates

Step 3 Click ***Start calibration*** to begin automatic calibration.

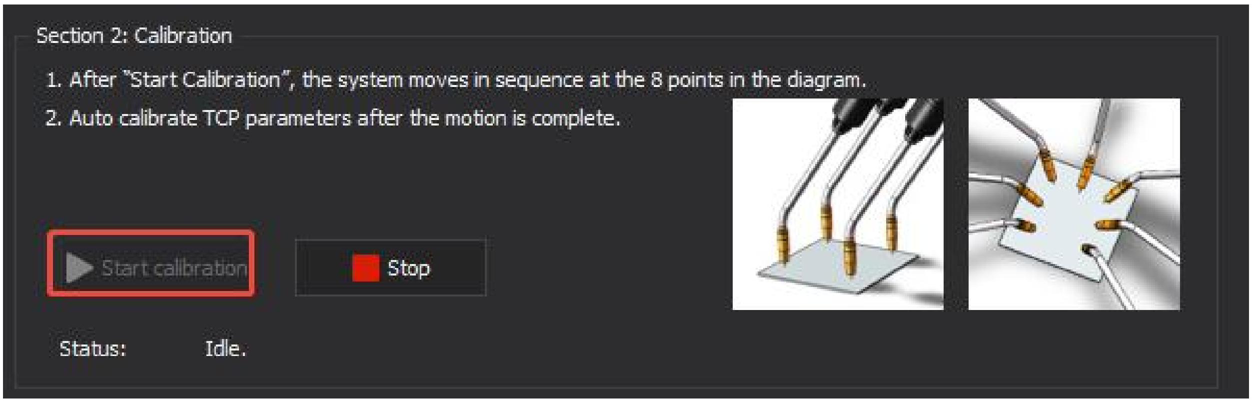

Figure 3-6 Start calibration

Step 4 After the calibration is complete, save the calibration results and set the current welding wire length to complete the calibration.

3.3 Eye-Hand Calibration

The steps of ***Eye-Hand Calibration*** are shown below:

Step 1 Prepare a calibration sample template (choose one of the following three methods):

1. Lap joint (step piece): The mark point is a fixed point set by the user on the edge of the upper step surface.
2. Tetrahedron: The mark point is the vertex of the tetrahedron.
3. Disk: The mark point is the marking point at the center of the disk.

Step 2 Adjust the robot's pose so that the lower surface of the seam tracker is parallel to the plate surface.

⚠ Notice:

1. During the subsequent eye-hand calibration process, any steps involving adjusting the robot's position must only be done in the world coordinate system, and the robot's end pose must not be changed. Only J1+, J1-, J2+, J2-, J3+, and J3- jogging in the world coordinate system is allowed.

2. Ensure the robotic arm's TCP accuracy is within 1.5 mm.

Step 3 In CypWeld software, click ***Seam Tracker*** → ***Calibration*** to enter the hand-eye calibration interface. Click ***Select*** to switch between ***Lap Joint***, ***Tetrahedron***, and ***Disk***.

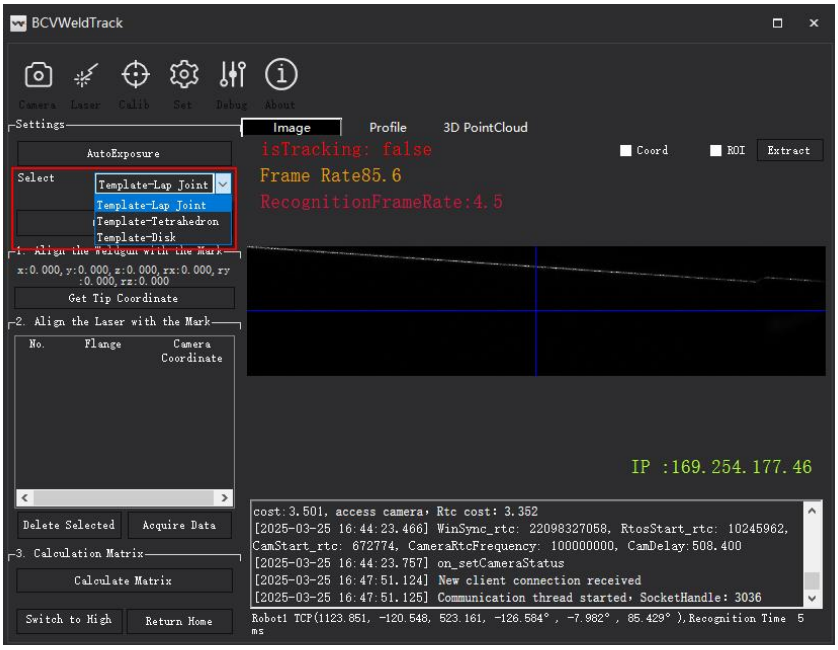

Figure 3-7 Select corresponding template

Step 4 Collect tip coordinates. Control the robot's movement in the world coordinate system to align the TCP point or welding wire tip precisely with the mark point. Click ***Get Tip Coordinate***.

Step 5 Align the laser line with the mark point to collect data.

1. Jog the position of the robot: Fine-tune the robotic arm to enable the software camera's field of view to clearly capture the features of the calibration part.

    a. Lap Joint: The endpoint of the upper straight line of the top and bottom lines.

    b. Tetrahedron: The vertex of the triangle.

    c. Disk: The protruding straight line segment.

2. Verification and Recognition: Ensure that the red cross symbol in the software remains stable and that the physical laser line accurately passes through the feature point.

3. Record Coordinates: Click ***Acquire Data*** to record the coordinates at this location. Repeat step 5 to collect data from 6 different positions.

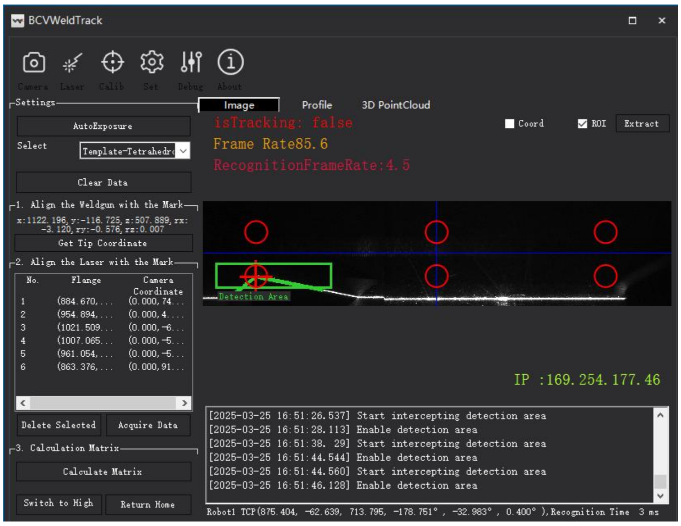

Figure 3-8 Laser line aligned with mark point (Using Tetrahedron as an example)

⚠ Notice: If the light is unclear and the mark point cannot be recognized in the window, click ***Auto Exposure***.

Step 6 Once all six data points have been collected, click ***Calculate Matrix*** to complete low visibility eye-hand calibration. Results will be shown in the log panel.

The result must meet the following accuracy requirements:

- Low visibility deviation < 1 mm.
- High visibility deviation < 8 mm.

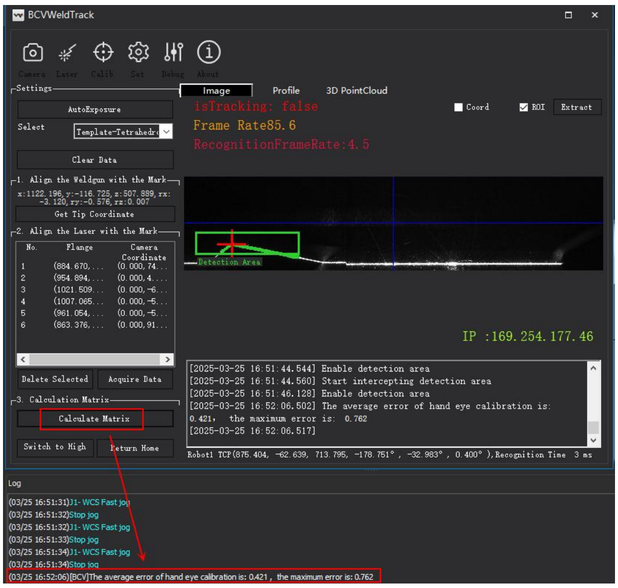

Figure 3-9 Calculate matrix (Using a tetrahedron as an example)

Step 7 Click ***High Visibility***, and repeat the above steps to complete high visibility eye-hand calibration.

⚠ Notice: High visibility may not work well with thin lap joints or tetrahedron due to limited recognition. A lap joint calibration surface with significantly different height may be required.

Step 8 Seam tracker eye-hand calibration accuracy verification. Open ***Tool*** → ***Debugging Tool*** → ***Seam Tracker Precision Debug***. Move the robot until the mark point overlaps with the laser. Click ***Record Recognized Coordinate*** → ***Start Motion***, and observe the deviation between the torch tip and the mark point at the end of the movement.

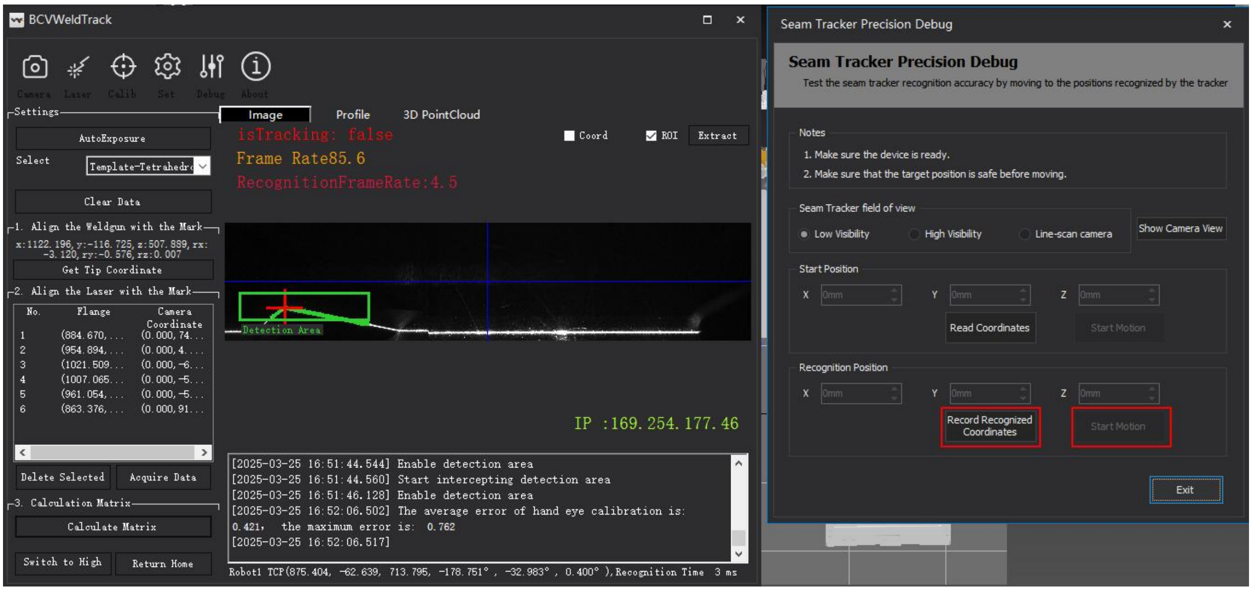

Figure 3-10 Seam eye-hand accuracy test (using tetrahedron)

⚠ Caution:

1. Before accuracy verification, check the robot's travel speed (recommended to be below 100 mm/s).

2. Hold the WKB before clicking ***Start Motion*** to prevent accidents such as collisions.

3.4 Auto Eye-Hand Calibration

The following is a brief description of the hand-eye automatic calibration steps. For detailed instructions and precautions, refer to Section 4.2.3 of *FSWELD Intelligent Welding Control System Hardware Installation Manual*.

Prepare a tetrahedron for calibration in advance. Before calibration, ensure the camera's bottom surface is roughly parallel to the ground.

Step 1 Open *Tool* → *Parameter Settings* → *Auto Eye-Hand Calibration*. Place the calibration tetrahedron in the appropriate position as shown in the interface diagram.

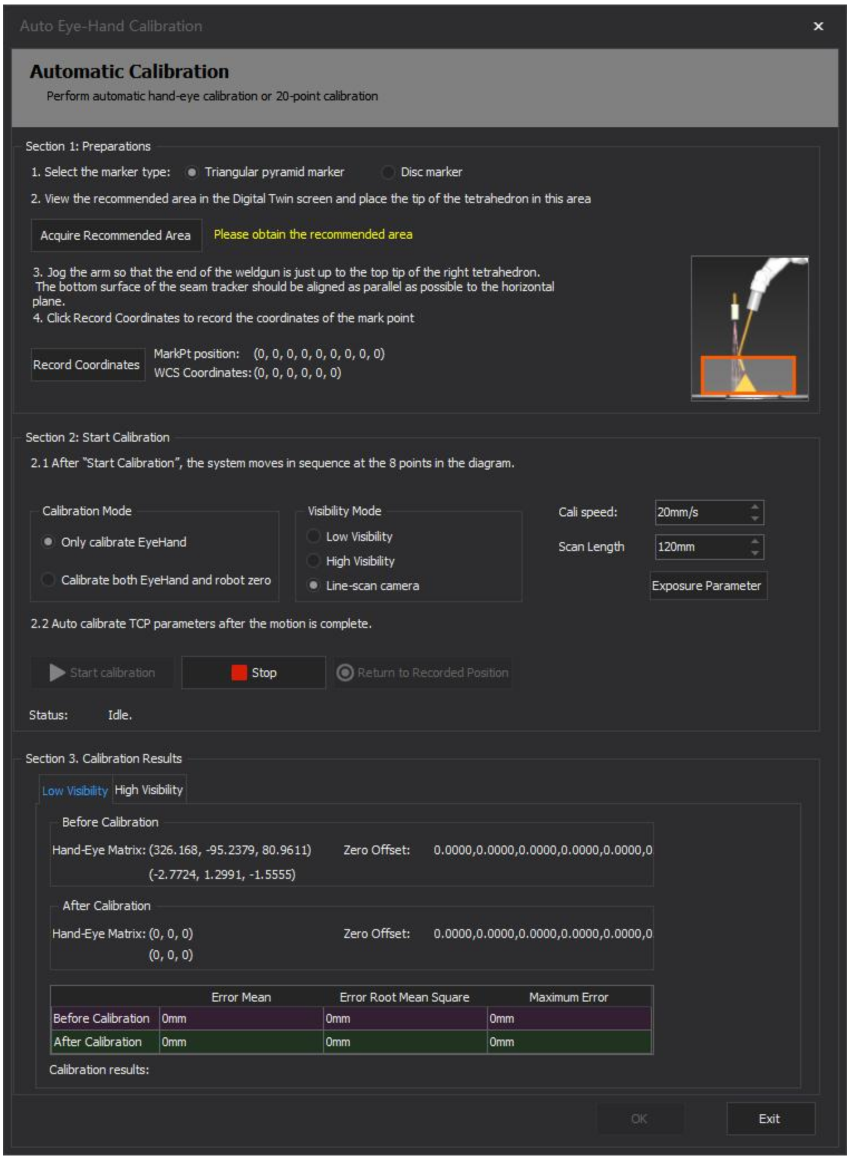

Figure 3-11 Auto eye-hand calibration

Step 2 Point the robot TCP to the vertex of the tetrahedron and start automatic calibration.

Step 3 After calibration is complete, save and apply the calibration results.

3.5 One-Click Calibration for Calibration Workstation

The following is a brief description of the one-click calibration for the calibration workbench. For detailed instructions and precautions, refer to Chapter 4, *Software Function Configuration*, of *ICS110P Automatic Calibration Workstation Installation Manual*.

3.5.1 Calibration Workstation Configuration

Before performing one-click calibration, complete the calibration workstation configuration. The configuration steps are as follows:

Step 1 Open ***Tool*** → ***Parameter Settings*** → ***Calibration workstation configuration***. You can configure the communication connection based the workbench models and serial settings.

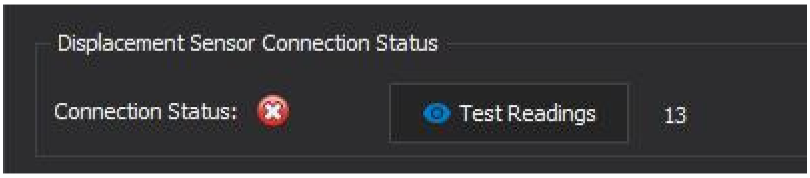

Figure 3-12 Configure the displacement sensor connection status

Step 2 Ensure that the robot's circular point accuracy error is within 1.5 mm, then click ***Calibrate Workstation***. Follow the on-screen prompts to sequentially teach and record the three marked points on the workstation using the TCP, completing the workstation pose calibration.

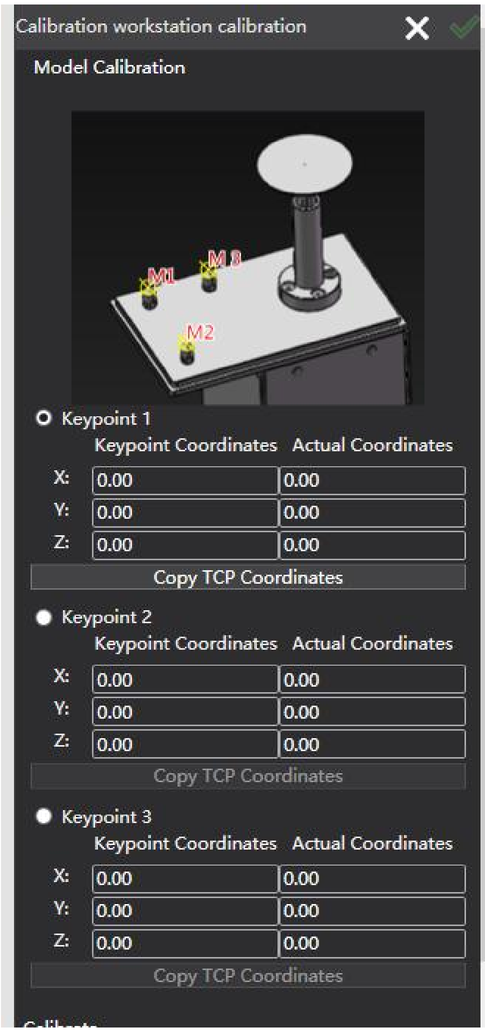

Figure 3-13 Pose calibration

Step 3 According to the calibration pose, teach the robot to position the TCP above the calibration object, click ***Record Marking Points***, and verify the error. If the error is greater than 5, it indicates that the pose calibration of the workstation is poor, and the body accuracy needs to be checked before recalibrating. Otherwise, the workstation configuration is complete.

Step 4 Similarly, verify the error of the vision calibration object.

3.5.2 One-Click Auto-Calibration

Step 1 Replace the end of the welding gun with the BOCHU standard calibration needle.

Step 2 Open ***Tool → Parameter Settings → One-Click Auto Calibration*** interface, and select the desired calibration item (calibrate all/only TCP calibration/only seam tracker hand-eye).

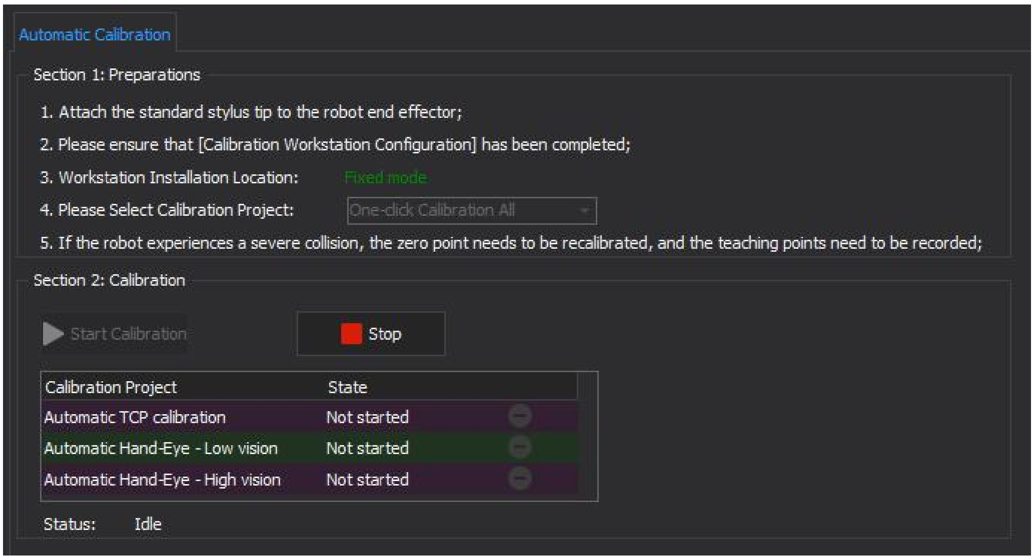

Figure 3-14 One-click automatic calibration

Step 3 Click ***Start Calibration*** and wait for the calibration action to complete.

Step 4 After calibration is complete, review the results and perform calibration result compensation.

3.6 Assembly Matrix Calibration

Assembly Matrix Calibration is used to calibrate the assembly matrix of external axes (ground rails, cantilevers, gantries), and also allows calibration of the reduction ratio of external axes. The following is a brief description of the assembly matrix calibration steps. For detailed instructions and precautions, refer to Section 4.3 of the *FSWELD Intelligent Welding Control System Hardware Installation Manual*.

Step 1 Open the interface via ***Tool → Parameter Settings → Assembly Matrix Calibration***. Before calibration, ensure that the robotic arm TCP calibration error is within 1.5 mm.

Step 2 Place a marker at a fixed position, which can be a sharp cone or a tetrahedron. Use the TCP to point to the marker and record the coordinates.

Step 3 Move the external axis by more than 100 mm, then point the TCP to the marker again and record the coordinates. Repeat the collection of at least two points.

Step 4 Complete the calibration.

Step 5 Verify accuracy. Open ***Tool*** → ***Debugging Tool*** → ***Zero-space Jog*** interface to verify accuracy. The maximum straight-line error of the external axis moving 1 m should be around 2 mm.

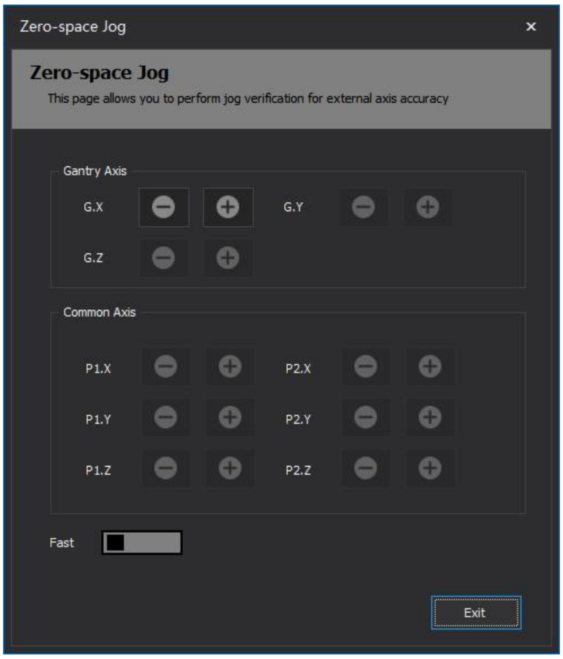

Figure 3-15 Zero-space jog

3.7 Move Worktable

Right-click the worktable (blue square) or the positioner model, then click ***Move Worktable*** to enter the move worktable interface.

The move worktable function is only used for the preliminary determination of the worktable or positioner position and orientation and should not be used as the final step. The worktable/positioner must be calibrated to determine the final pose.

3.8 **Worktable/Positioner Calibration**

During calibration, note the following:

- The calibration methods for fixed worktables and single-axis/dual-axis positioners are different and must be strictly distinguished.
- If there are multiple positioners, calibrate each one independently.
- Ensure TCP circular point accuracy ≤ 1.5 mm before calibration.
- In multi-station scenarios, only the current station's worktable or positioner can be calibrated. To calibrate other worktables or positioners, switch stations.

3.8.1 Worktable Calibration

Worktable calibration steps are shown below.

Step 1 Right-click the worktable, click ***Calibrate Worktable*** to open the worktable manual calibration interface, and confirm the worktable dimensions.

Step 2 Sequentially select three marked teaching points on the worktable surface, and click ***Copy TCP Coordinates***.

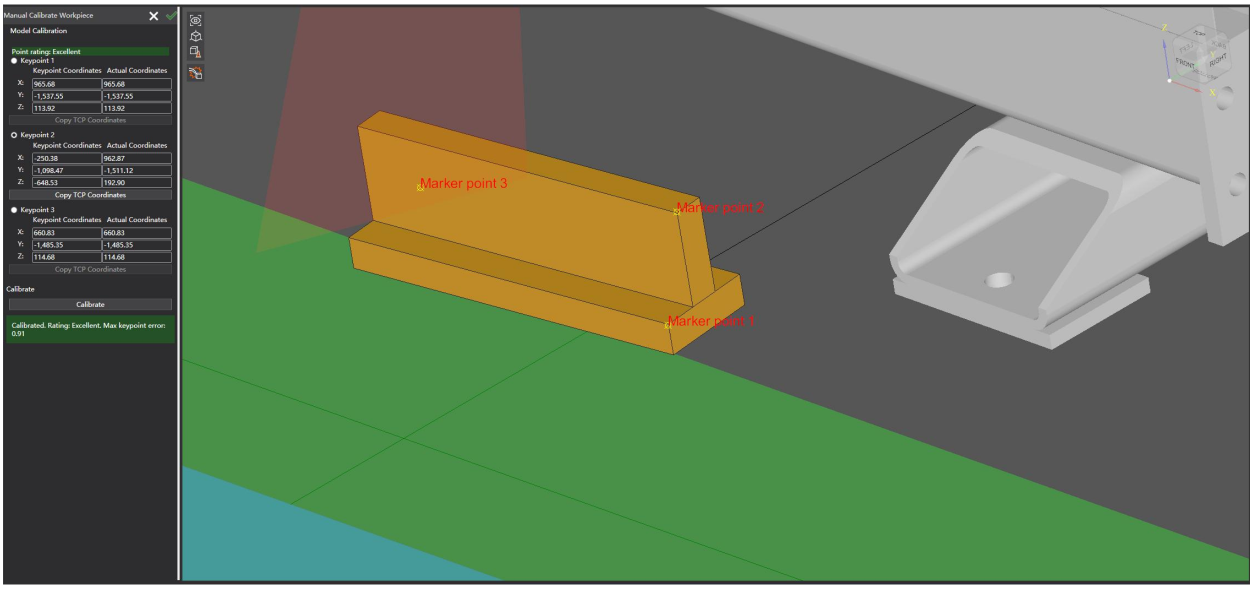

Figure 3-16 Mark point teaching

Step 3 Click ***Calibrate***, then confirm and save in the upper right corner. In the digital twin interface, the worktable will move to the calibrated position.

3.8.2 Single-Axis/Dual-Axis Positioner Calibration

Step 1 Pre-calibration preparation:

1. Ensure the orientation of each axis of the positioner matches the real-world direction.
2. Ensure the robot body accuracy is good, with TCP circular point accuracy ≤ 1.5 mm.
3. If the robot base has movable external axes, keep the them stationary during calibration.

Step 2 Open ***Tool*** → ***Parameter Settings*** → ***Positioner Calibration***. Fix the calibration cone on the positioner, move the positioner so that the positioner coordinates in the main interface axis monitoring match the recommended axis coordinates in the ***Record Coordinates*** column.

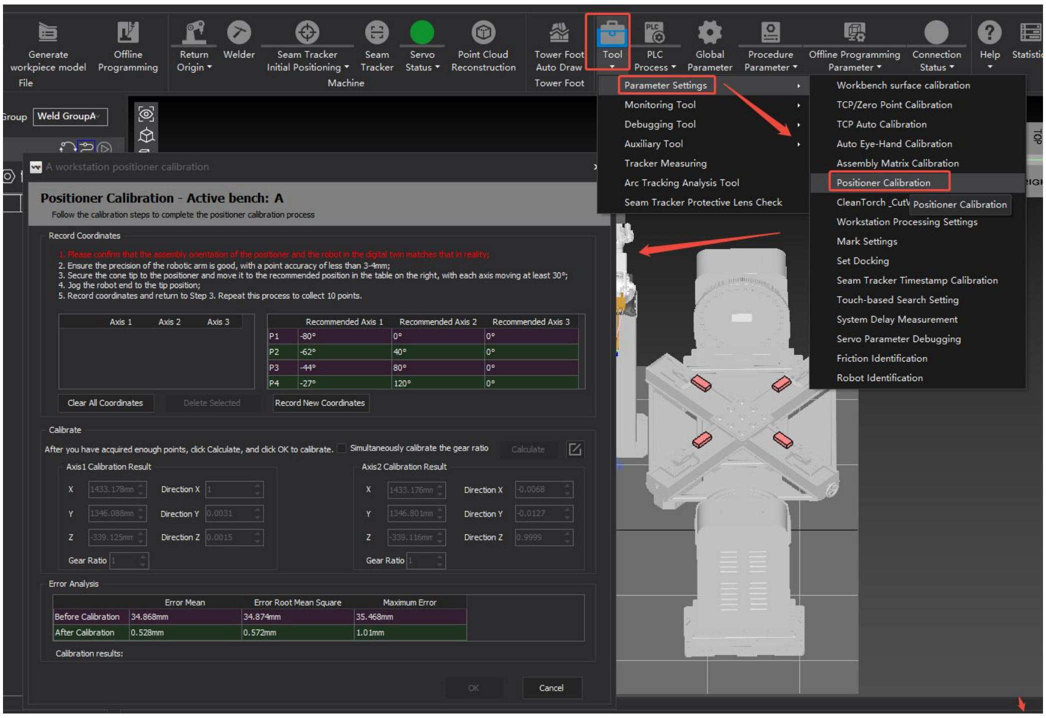

Figure 3-17 Record coordinates

Step 3 Teach the robot TCP to the tip of the cone, click ***Record New Coordinates***.

Step 4 Repeat the above operation to teach and record the coordinates for all recommended values in the right table of the ***Record Coordinates*** column.

Step 5 After coordinate collection is complete, click ***Calculate*** to view the calibration results, then click ***Confirm*** to complete the calibration.

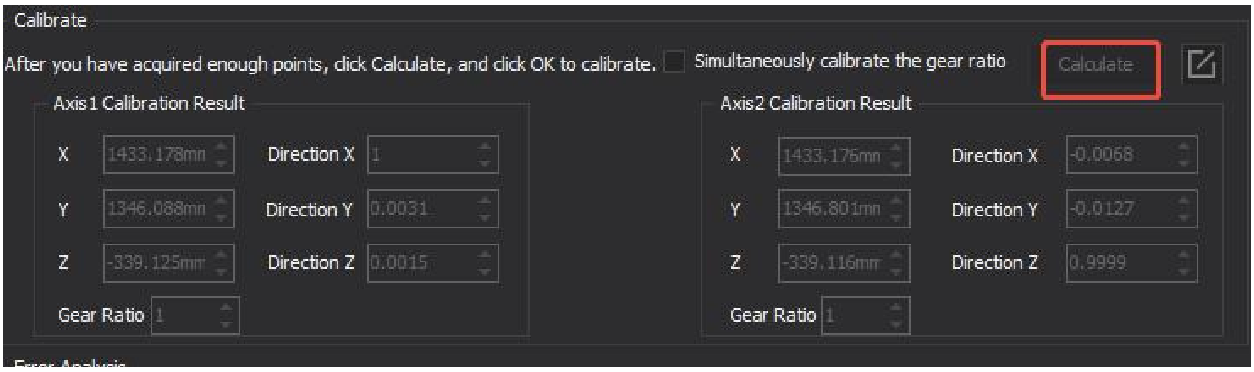

Figure 3-18 Calculate calibration results

Step 6 Accuracy verification. Open ***Tool*** → ***Debugging Tool*** → **Zero-space Jog** interface, and jog the axis jog buttons on the interface. During positioner movement, observe the follow-up movement of the robot end. The maximum error should be around 2 mm.

⚠ Notice: If both robot base external axes and positioners are present in the current scenario, verify the calibration separately.

3.9 Workbench Surface Calibration

Step 1 Ensure the robot's circular point accuracy is within 1.5 mm before calibration.

Step 2 Use the robot TCP to poke three points on the worktable upper surface and record them. The three points must not be collinear.

Step 3 After recording the three points, click ***Calculate upper surface***. After calculation, click *OK* to save the result.

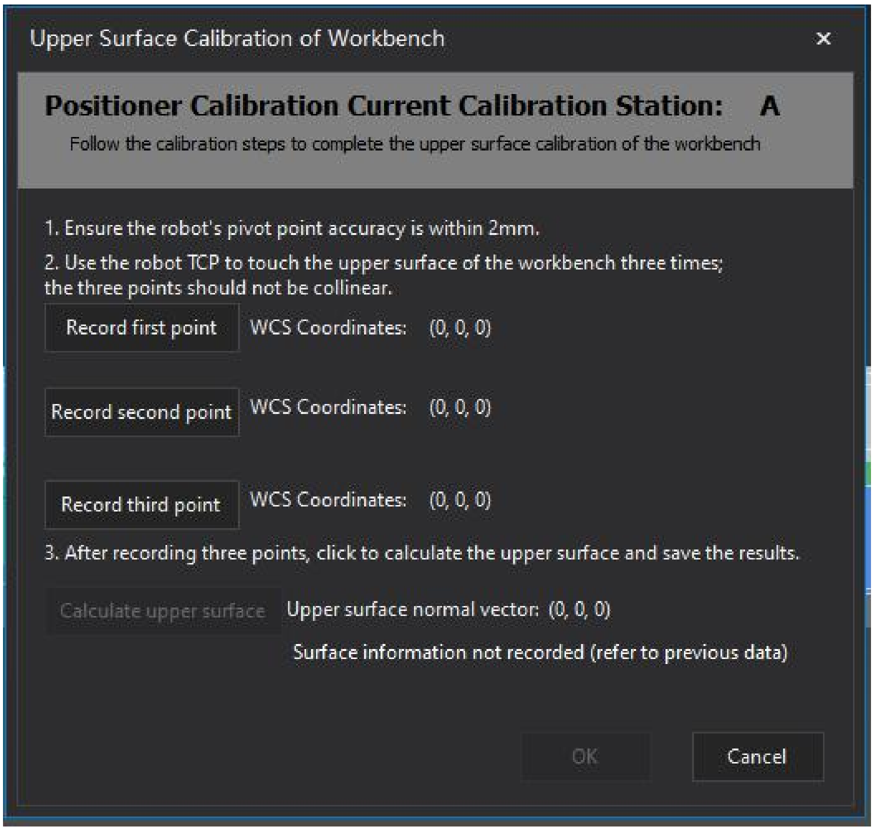

Figure 3-19 Workbench upper surface calibration

3.10 Fence Calibration

By calibrating the two fence surfaces of the fence, workpiece docking can be facilitated, ensuring accurate workpiece positioning. The calibration steps are as follows:

Step 1 Right-click the workbench or positioner, click ***Add Fence (New Datum)*** to open the calibration interface.

Step 2 Select three positions on ***Fence Surface 1*** with significant differences in Z-direction height, move the TCP to each point, and record the coordinates.

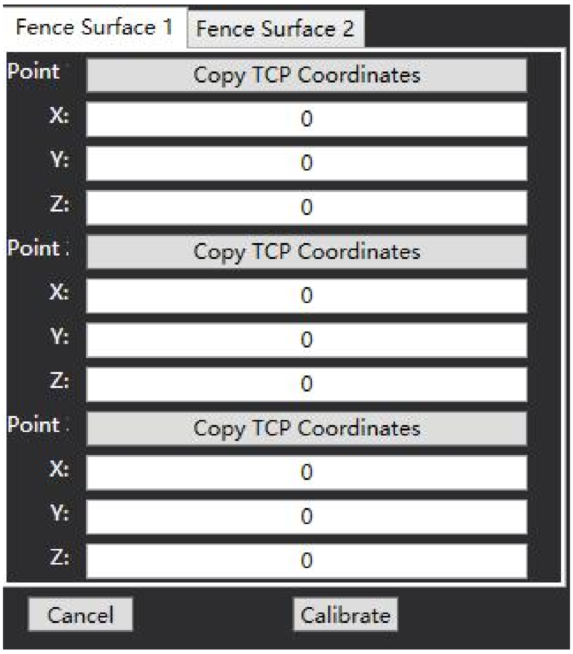

Figure 3-20 Fence surface calibration

Step 3 Repeat the above operation to complete the calibration of three positions on ***Fence Surface 2***.

Step 4 Click ***Calibrate*** to complete the fence calibration.

Chapter 4 Workpiece Positioning

4.1 Manual Three-Point Initial Positioning

This is a universal workpiece positioning method suitable for all working conditions. Specific steps are as follows:

Step 1 Pose adjustment:

1. Right-click the workpiece model, click ***Adjust Pose***.
2. Manually adjust the workpiece model in the software to roughly match the position and pose of the physical object. If the workpiece needs to be flipped, reselect the bottom surface to adhere to the workbench.

Step 2 Workpiece manual positioning:

1. Right-click the workpiece model, and select ***Manual Calibrate Workpiece***.
2. Use the mouse to select one point of the workpiece, jog the robot, and teach the TCP to the same point as the workpiece, and record the coordinates.

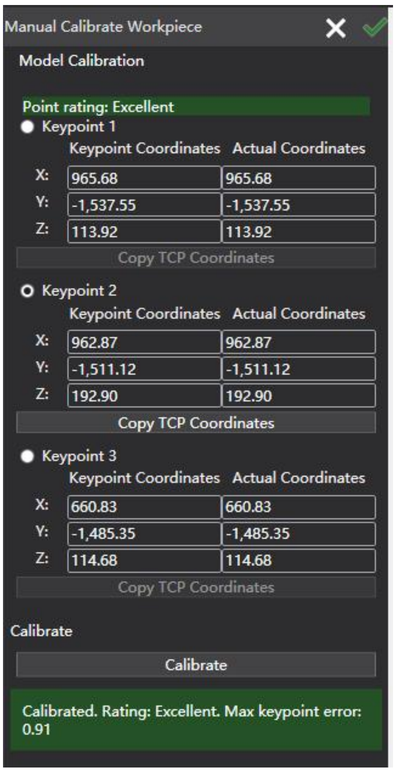

Figure 4-1 Workpiece manual positioning

Step 3 Repeat the above operation to record three sets of different coordinates. Click ***Calibrate***, and the software will automatically correct the model position to the same position as the physical object.

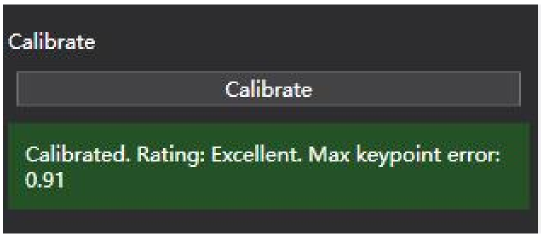

Figure 4-2 Calibration result

⚠ Notice:

1. The three selected feature points will prompt a selection score. A low score (e.g., points on the same horizontal plane, points too close) will prevent calibration.

2. The calibration result will also be given as a score. A low score will cause calibration failure, and the workpiece position will not move.

3. This positioning method depends on the match between the model and the physical object, requiring good assembly accuracy of the workpiece.

4.2 Fence Positioning

This method requires prior fence calibration. For specific calibration methods, refer to Section 3.10 Fence Calibration. The fence positioning steps are as follows:

Step 1 Right-click the workpiece model, click ***Dock Workpiece***.

Step 2 Select the two surfaces to be docked, corresponding to the two surfaces of the calibrated fence.

Step 3 Complete workpiece positioning.

4.3 Seam Tracker Automatic Initial Positioning

Automatic initial positioning uses a vision camera to scan point clouds and register them with the model, eliminating the need for manual precise point alignment. To ensure registration accuracy, the following conditions must be met:

- Point cloud requirements: Sufficient point cloud data must be collected as a basis for registration.

- Equipment configuration: Currently, only scanning with base external axes is supported. Standalone or positioner workstations are not supported.
- Workpiece size: The workpiece length should be ≥ 1 m to ensure sufficient point cloud information is scanned.

The steps for seam tracker automatic initial positioning are as follows:

Step 1 Pose adjustment. Use pose adjustment to move the workpiece model to a position where the initial deviation from the physical object is ≤ 1 m. If the deviation is too large, the system cannot automatically adapt the scanning length, resulting in insufficient point cloud data and affecting registration accuracy.

Step 2 Mode selection. Click ***Seam Tracker Initial Positioning*** to enter the seam tracker initial positioning interface, and select single-workpiece or multi-workpiece mode.

1. Single workpiece: Manually move the robotic arm to position the TCP at one end of the workpiece bounding box, and set the scanning direction according to the world coordinate system.

2. Multi-workpiece: The default scanning range is the entire workbench.

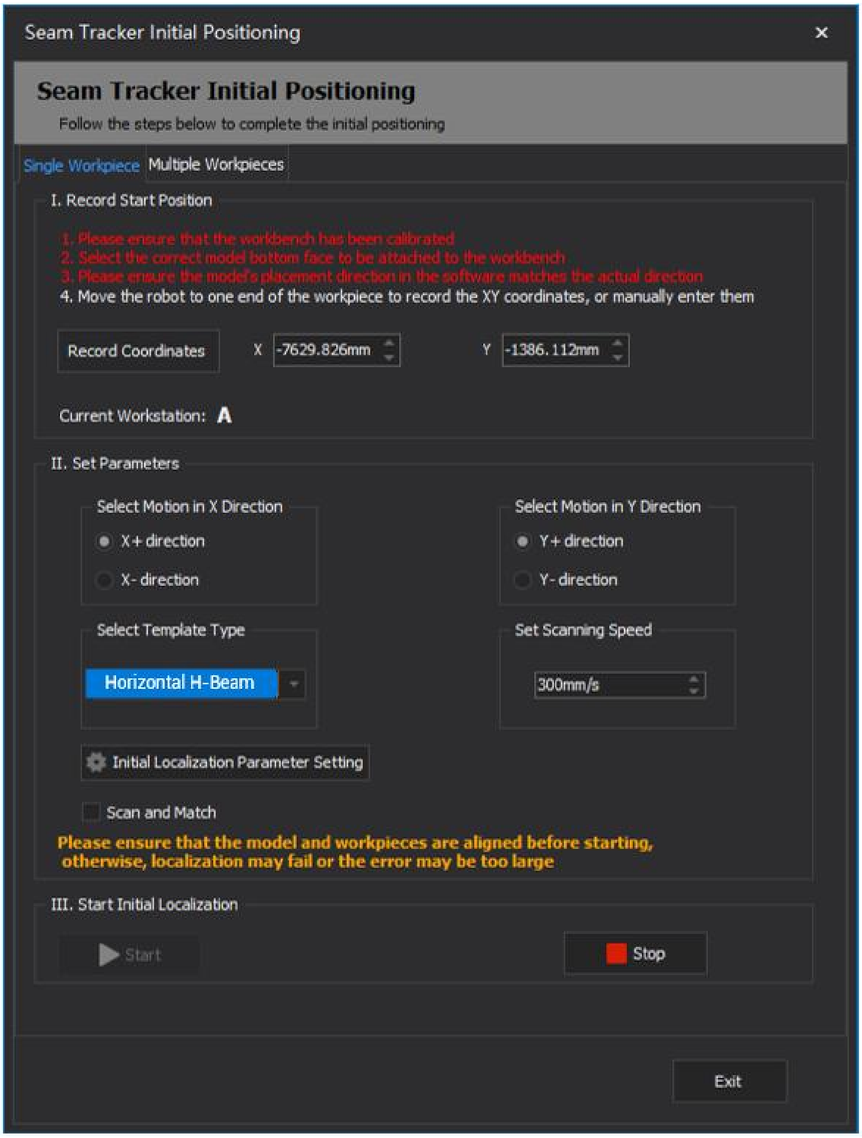

Figure 4-3 Seam tracker initial positioning

Step 3 Set the scanning speed, default 400 mm/s to 500 mm/s. Select the template based on the physical workpiece type.

Step 4 Check ***Scan and Match*** as needed.

Step 5 Click ***Start*** to begin initial positioning. The initial positioning result and calculated error will be displayed on the interface.

Step 6 If the workpiece is symmetrical, initial positioning may produce ambiguous solutions, and the system will automatically enter the registration solution selection interface. You should manually select the correct solution based on the matching situation in the digital twin interface:

1. Point cloud color indicators:
   a. White represents the physical workpiece point cloud.
   b. Red represents parts where the physical workpiece has more than the model.
   c. Blue represents parts where the model has more than the physical workpiece.
2. The interface displays key deviation values between the model and the physical object for reference.
3. Check ***Measure*** to manually measure distances for verification.

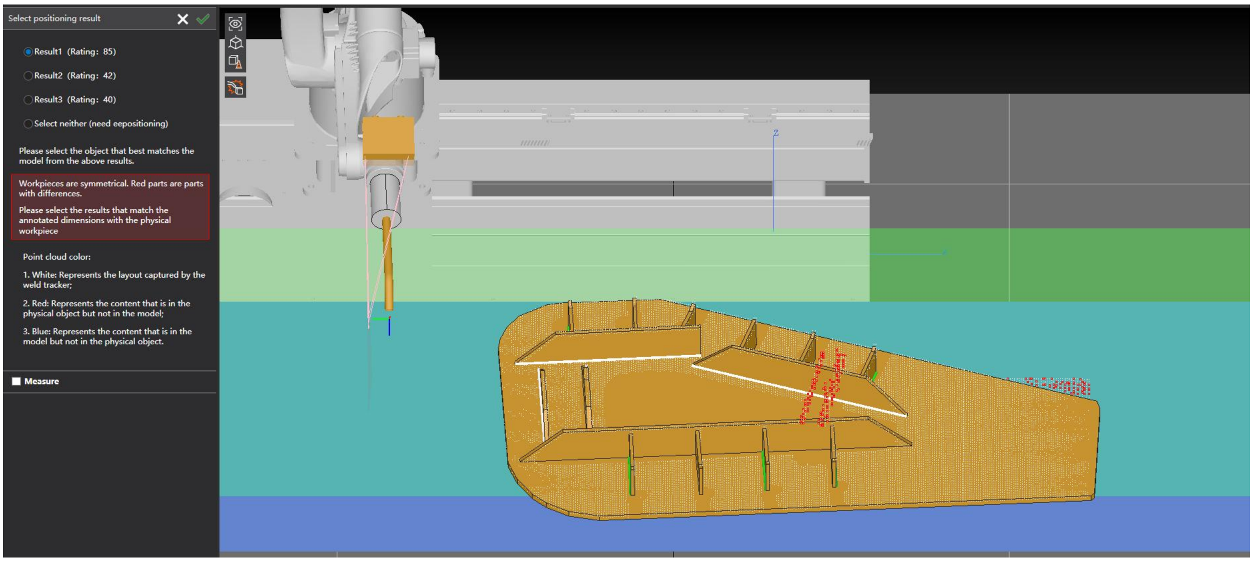

Figure 4-4 Automatic initial positioning ambiguity

4.4 Line Scan Camera Initial Positioning

Based on the seam tracker initial positioning method, the large line-scan camera has a wider field of view and can complete registration with fewer scans, improving positioning efficiency.

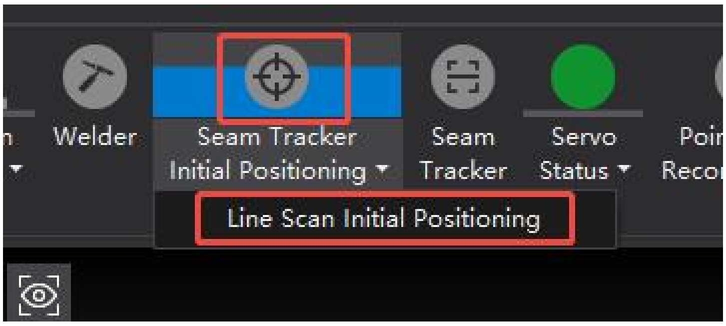

Figure 4-5 Open line-scan initial positioning

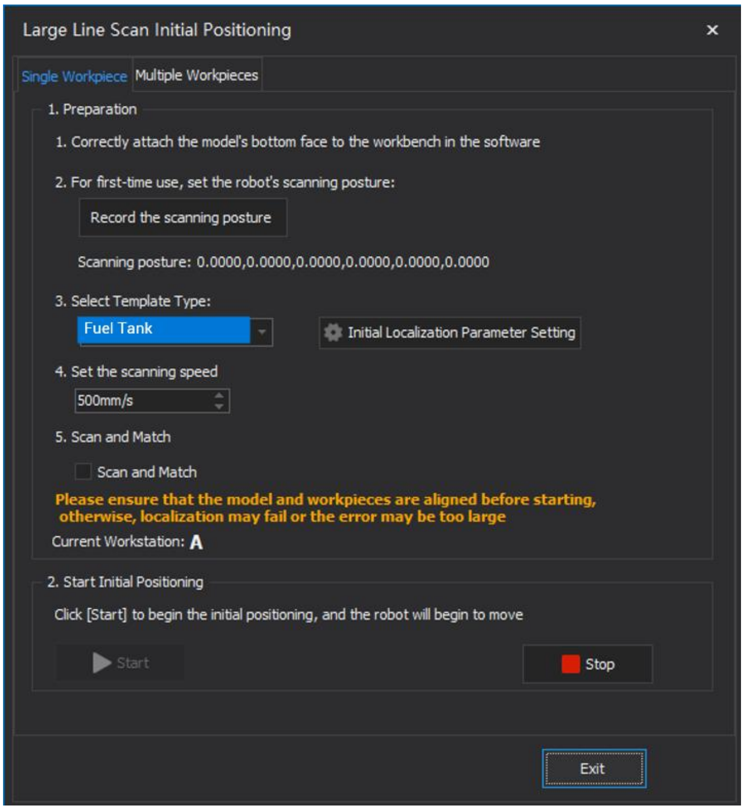

Figure 4-6 Large line-scan initial positioning

Step 1 Open via ***Seam Tracker Initial Positioning*** → ***Line Scan Initial Positioning*** in the function bar.

Step 2 Before starting initial positioning, jog the robot to the initial pose to ensure the line-scan camera's field of view is not obstructed, and there is no collision risk during external axis movement. Click ***Record Scanning posture***.

Step 3 Set the scanning speed and workpiece template. Default scanning speed is 500 mm/s.

Step 4 Check ***Scan and Match*** as needed.

Step 5 Click ***Start*** for initial positions. The entire workbench will be scanned by default. After successful initial positioning, ***Scan successful*** will appear, and the model will automatically move to the same position as the physical object. Ambiguity resolution is the same as for seam tracker initial positioning. This concludes the large line-scan initial positioning process.

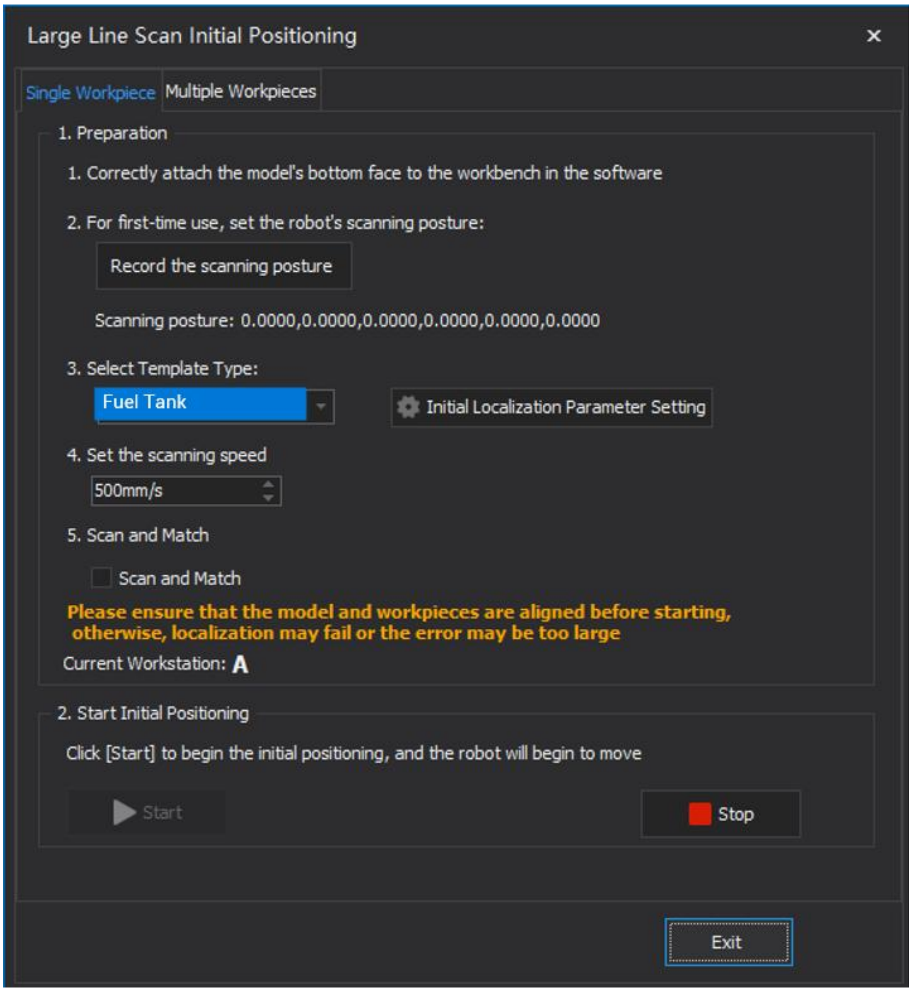

Figure 4-7 Successful initial positioning

Chapter 5 Preparation Before Welding

5.1 Procedure Parameter Settings

In *Procedure Parameter* (also known as procedure library), you can set the procedure parameters corresponding to each layer. Import and export of parameter packages is also supported. For multi-layer multi-pass welding, parameters of each filter pass can be set individually. For certain weld types (e.g., box-column main welds), the software provides recommended offset parameters for multi-layer multi-pass filter pass.

The *Help* button (top right) provides troubleshooting tutorials. Scan the QR code with WeChat to access the My Machine mini program for troubleshooting Q&A documents.

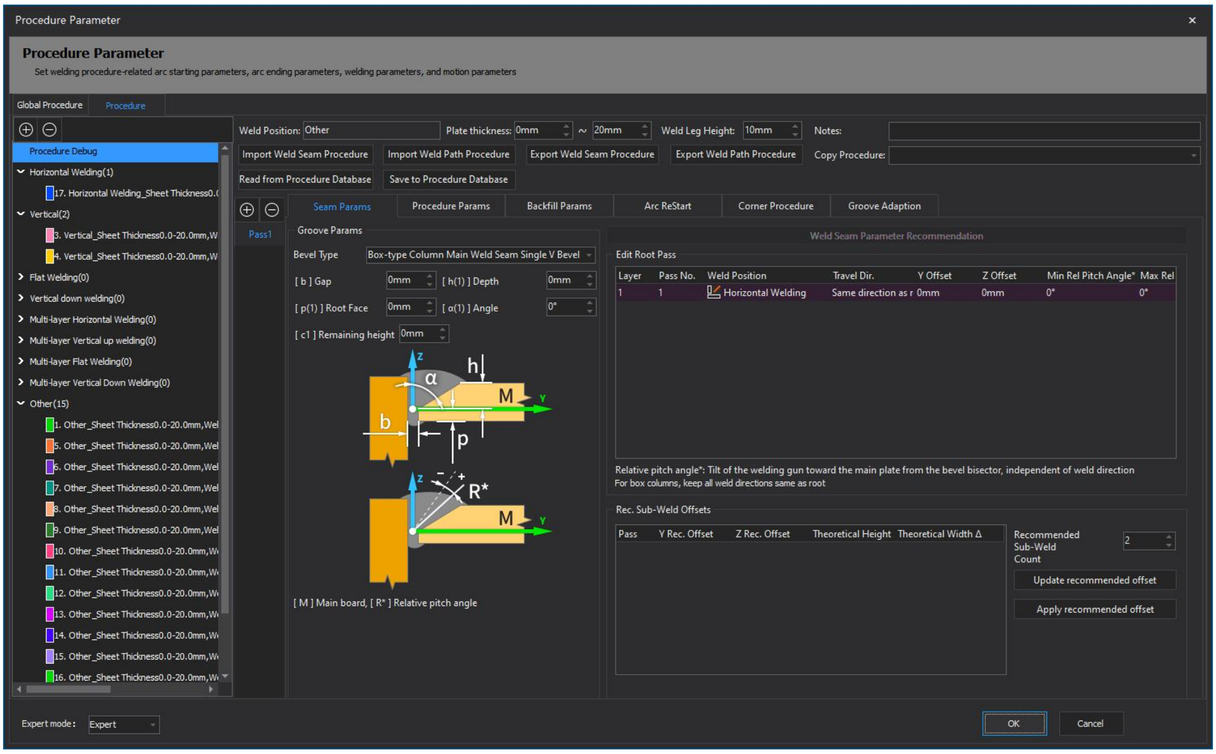

Figure 5-1 Procedure parameter interface

5.1.1 Seam Params

Set the groove type according to the diagram. If no groove is required, default all parameters to 0.

For multi-layer multi-pass welding, the welding position of each filter pass can be set. However, if the set position does not match the actual workpiece placement, it will not take effect. Filter pass positions different from the root pass are only valid in positioner layouts.

Offset and starting point of each pass can be configured. The reference frame for Y/Z-axis offsets is consistent with the diagram.

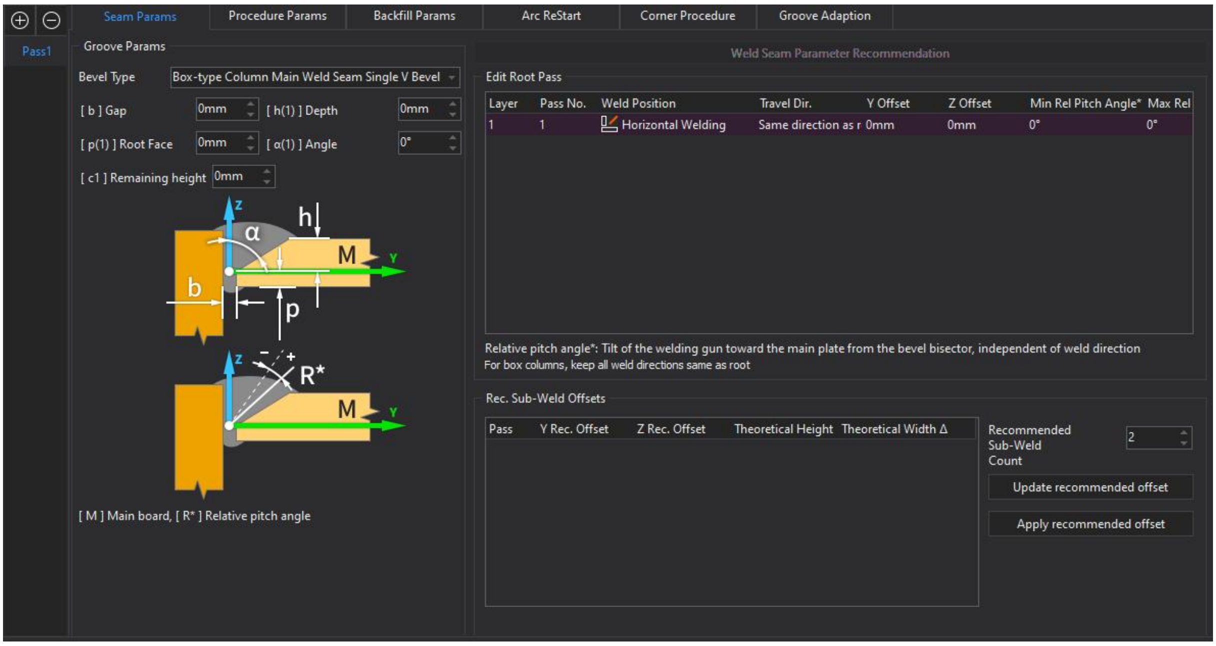

Figure 5-2 Seam params

5.1.2 Procedure Params

Set the welding machine parameters, including current, voltage, oscillation params, etc. For details, refer to the *Welding Process Debugging Manual*.

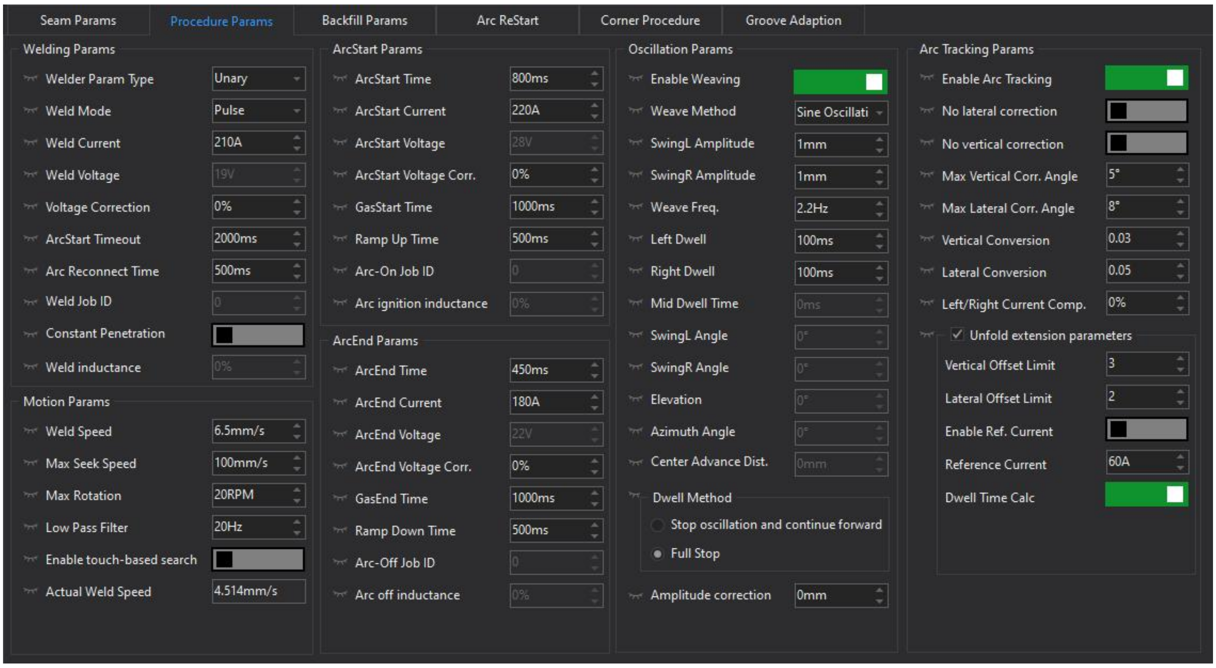

Figure 5-3 Procedure params

5.1.3 Backfill Params

If welding speed is too fast, undercut or crater defects may form at the start/end points of the weld. To address this, the software provides backfill parameters. By backtracking a defined distance along the weld seam, sufficient molten pool fill is ensured. After crater filling, the system automatically switches back to the ***ArcEnd Params*** of the ***Procedure Params*** and keep on welding.

This feature only applies in drawing execution mode, not in teaching mode.

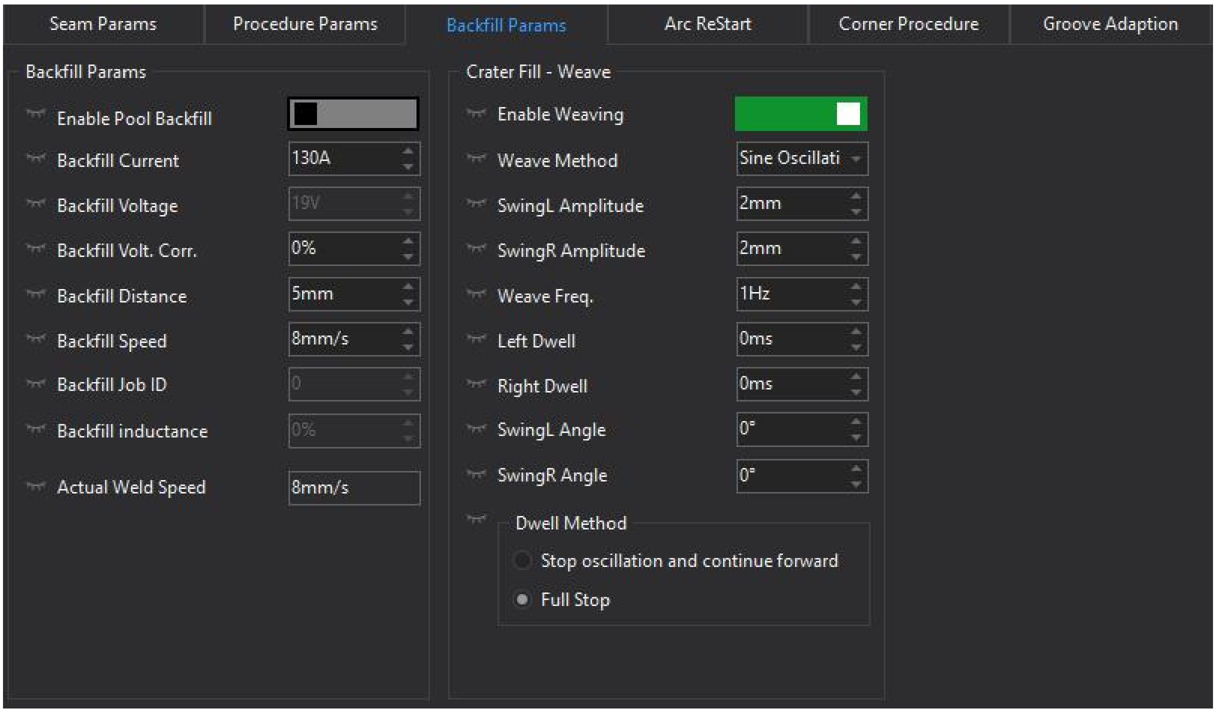

Figure 5-4 Backfill params

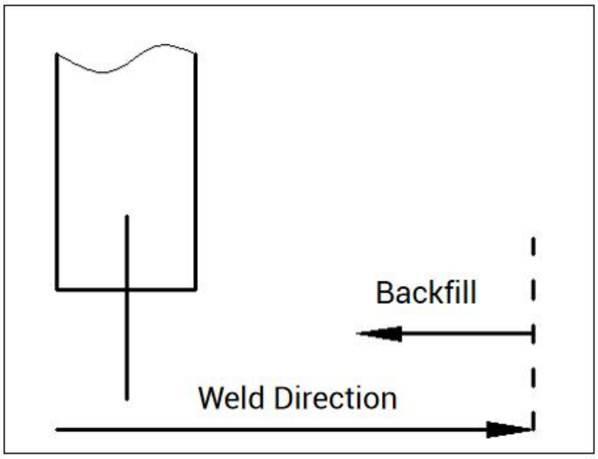

Figure 5-5 Backfill motion path

5.1.4 Arc ReStart

Arc start may fail due to rust, gaps, or inaccurate seam recognition. Two recovery methods are available:

- Scratch Start: Arc start at the position without coating within scratch distance. The torch moves forward a defined scratch distance, strikes arc, then reverses back to the start point. Weaving can be enabled during scratch start.

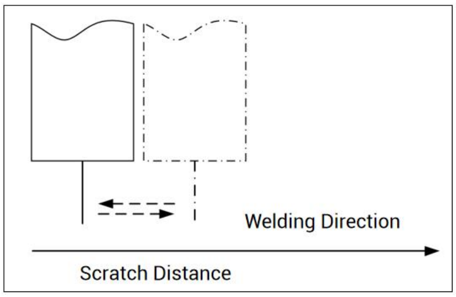

Figure 5-6 Scratch start motion path

- Arc Restart: Retracts and extends the wire in place to remove oxide film before reigniting.
  - ReStart WireBackward: When the arc fails, the wire will be retracted for a period of time to prepare for the next arc. Retracting too long will lead to the wire melt ball plugging the conductive nozzle.
  - ReStart Time: Reconnect time after retraction, generally consistent with the ***Arc Reconnect Time*** of ***Procedure Params***.

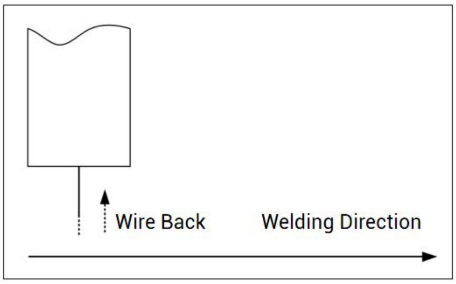

Figure 5-7 Reconnect motion path

⚠ Notice:

1. If both methods are enabled, the system attempts ***Arc Restart*** first; if it fails, ***Scratch Start*** is triggered.

2. This feature only applies in drawing execution mode, not in teaching mode.

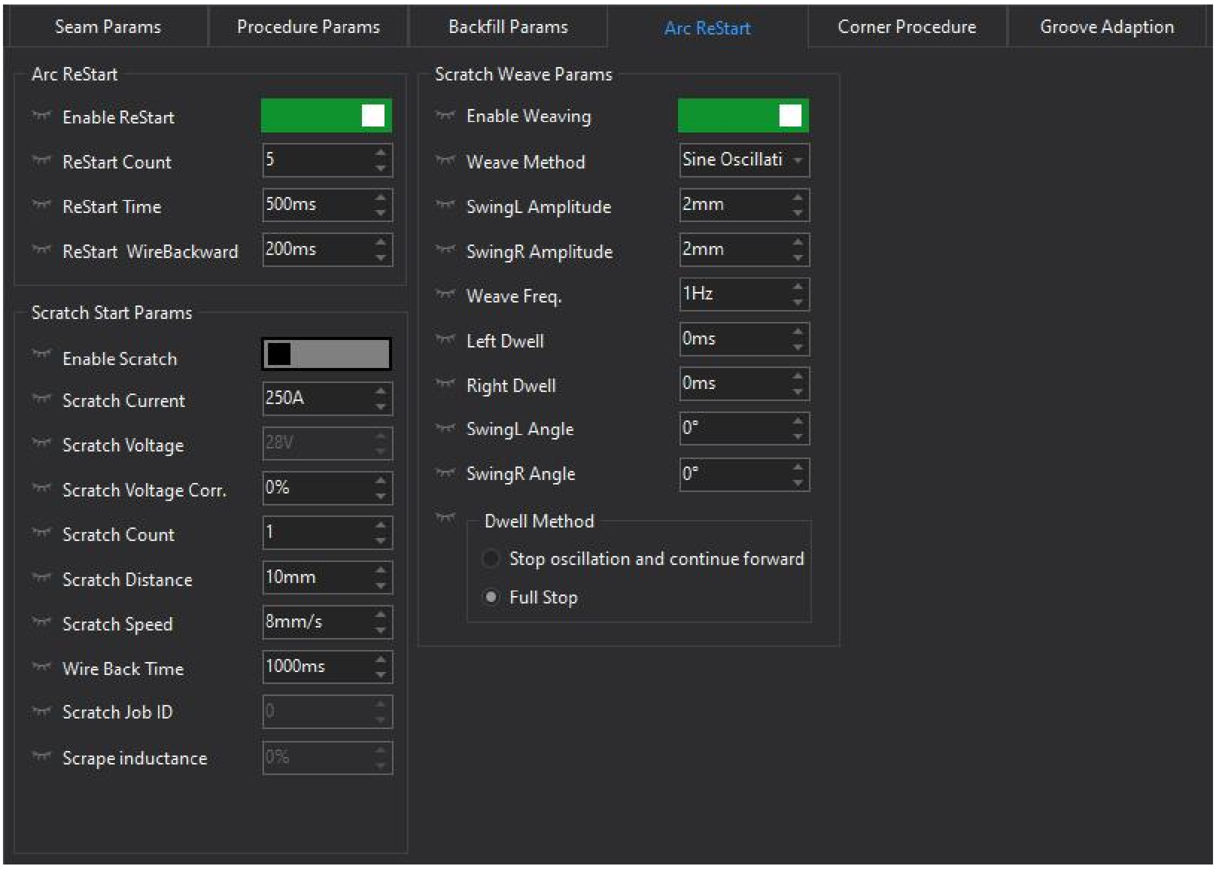

Figure 5-8 Arc restart parameters

5.1.5 Corner Procedure

Defines parameters for continuous corner welding.

When transitioning from Weld 1 to Weld 2, the system applies Weld 1's corner parameters. You can configure ***Before-Corner Dist*** and ***After-Corner Dist*** to define the effective range.

Since torch posture changes significantly at corners, limiting maximum rotation speed stabilizes movement (recommended 5 RPM to 20 RPM).

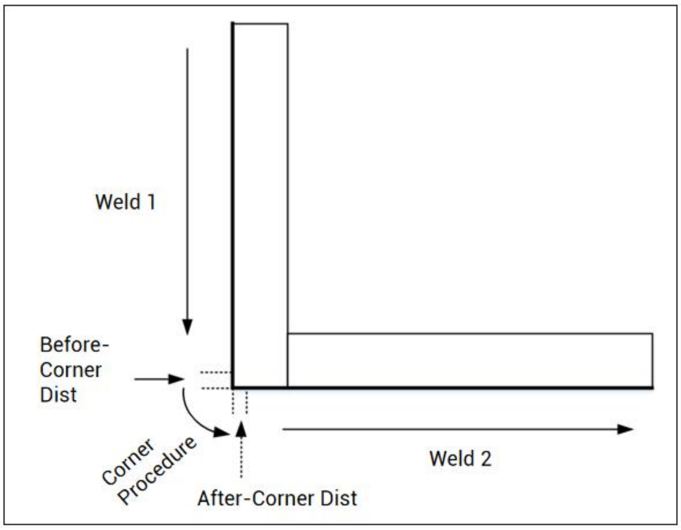

Figure 5-9 Corner procedure diagram

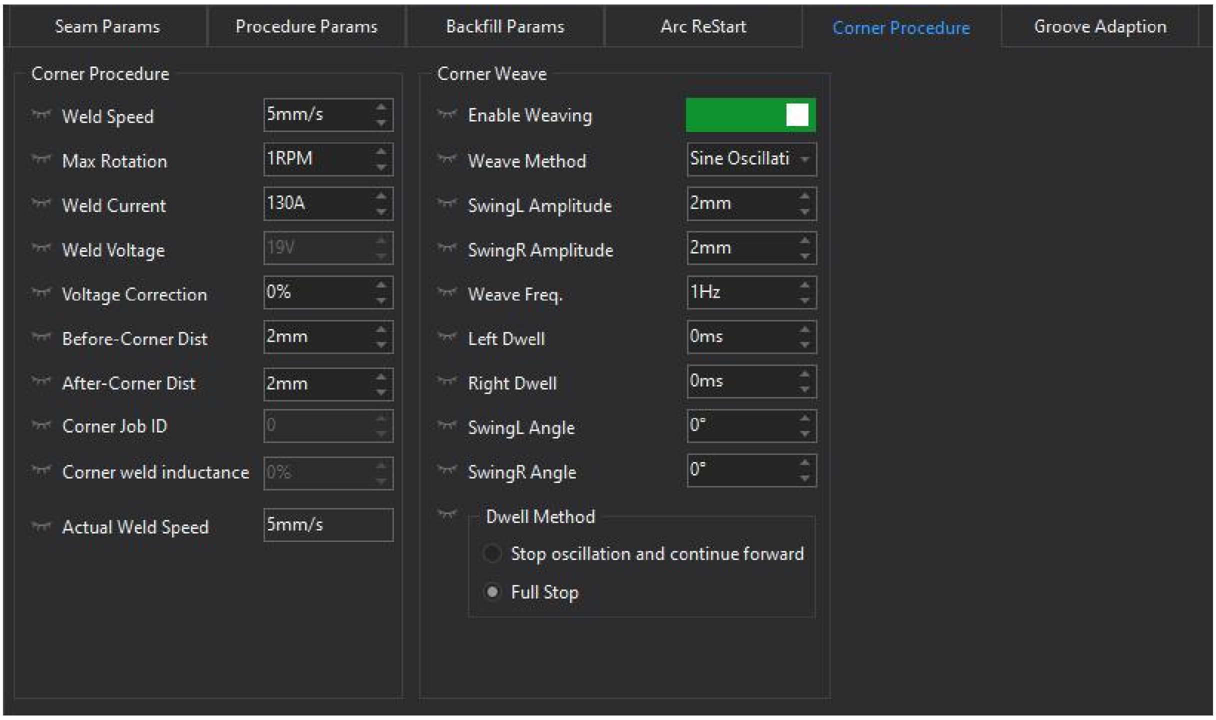

Figure 5-10 Corner procedure params

5.1.6 Groove Adaption

For upward groove butt joint welds in box-column main seams with variable groove types, visual scanning can be applied to measure the groove profile and enable adaptive welding.

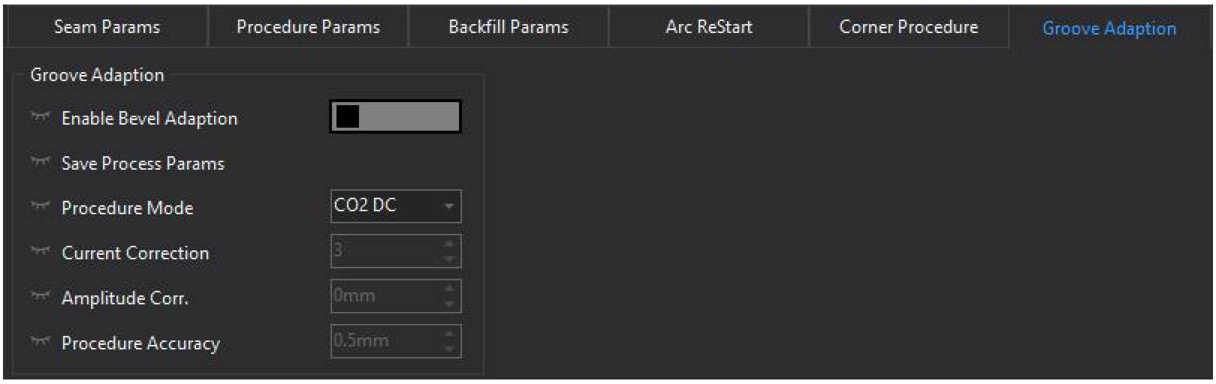

Figure 5-11 Groove adaption params

5.2 Procedure Table Setting

In the ***Procedure Parameter*** drop-down menu, click ***Procedure Table***. When using the automatic or manual weld generation, the software can automatically match the corresponding procedure layer based on the weld position and plate thickness of the current workpiece.

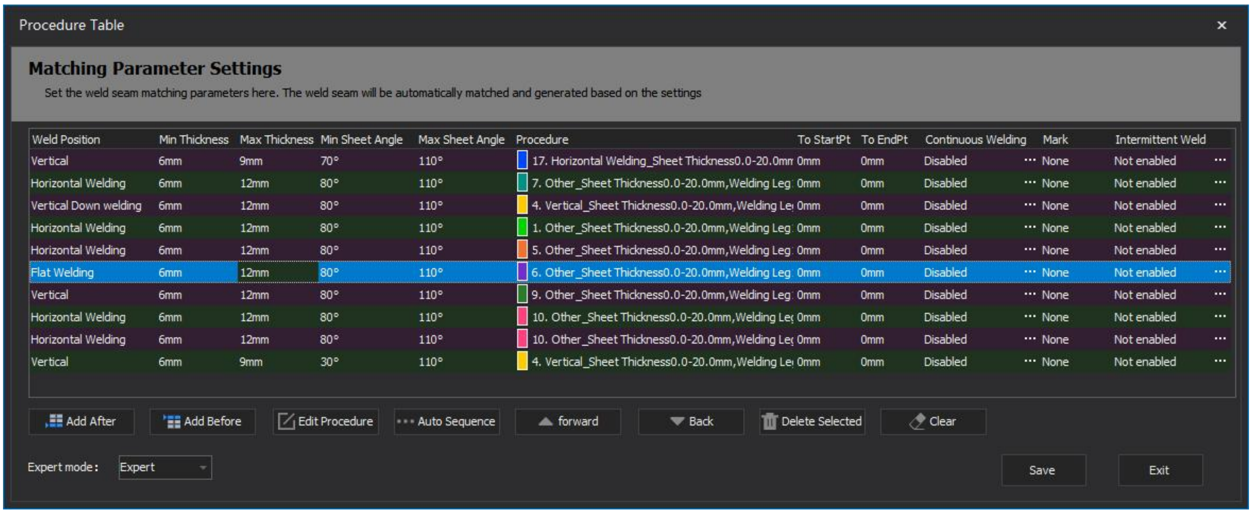

Figure 5-12 Procedure table

The primary filtering rules include weld position (flat welding, horizontal fillet welding, vertical up welding, and vertical down welding), sheet thickness range, and sheet angle range. For each matching rule, the corresponding procedure layer can be set, and the start and end distances of welds under this layer can also be specified.

Enabling ***Continuous Welding*** opens a secondary interface where vertical up wrap welding and vertical down wrap welding can be configured. The front and rear welds of a wrap welding can have separate procedure parameters and optimal push-pull angles.

⚠ Notice: Because the start and end points of welds are often blocked by other sheets, which may interfere with the robotic arm movement, the torch posture at these points can be at its mechanical limit. By setting optimal push-pull angles, the software automatically transitions the welding push-pull angle from the extreme posture at the start and end points to the optimal angle during welding.

5.3 Global Parameter Settings

5.3.1 Axis Motion Speed and Rigidity Settings

Caution: Make sure that the maximum speed and acceleration in the Platform Configuration Tool are filled in strictly according to the robot manufacturer's recommended factory parameters. OEM should obtain these parameters from the robot supplier. The corresponding parameter configuration files can also be downloaded from the robot manufacturer's official website.

Open the ***Global Parameter Settings*** interface, enable ***Expert mode***, and in ***Robotic Arm***, you can select a preset rigidity level template to automatically populate the trajectory speed and acceleration for each axis. It is recommended to use the default setting ***Rigidity level 2***. External axis motion speed/acceleration does not provide templates and must be configured manually according to the manufacturer's factory parameters.

Velocity Mode provides two options: ***Safe Mode*** and ***Rapid Mode***.

- Safe Mode:
  - The system automatically switches between high-speed and low-speed travel.
  - When the robot arm is close to the workpiece, worktable, or other objects, it switches to ***Linear low speed***. ***Linear high speed*** is used for long-distance travel.
- Rapid Mode: Only ***Linear high speed*** is applied.

The input boxes and sliders below allow you to configure low-speed and high-speed separately.

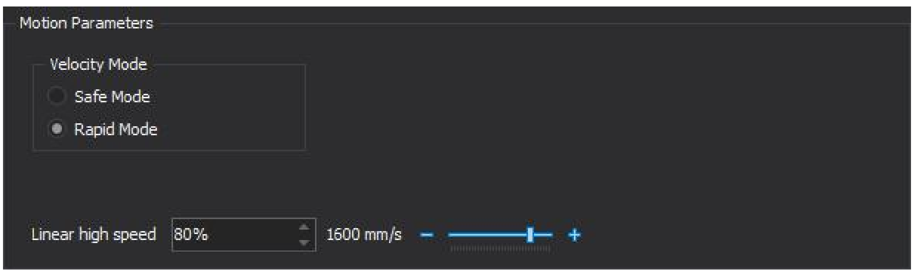

Figure 5-13 Velocity mode

5.3.2 System Parameter Setting

Some parameters require enabling ***Expert mode*** before they can be set.

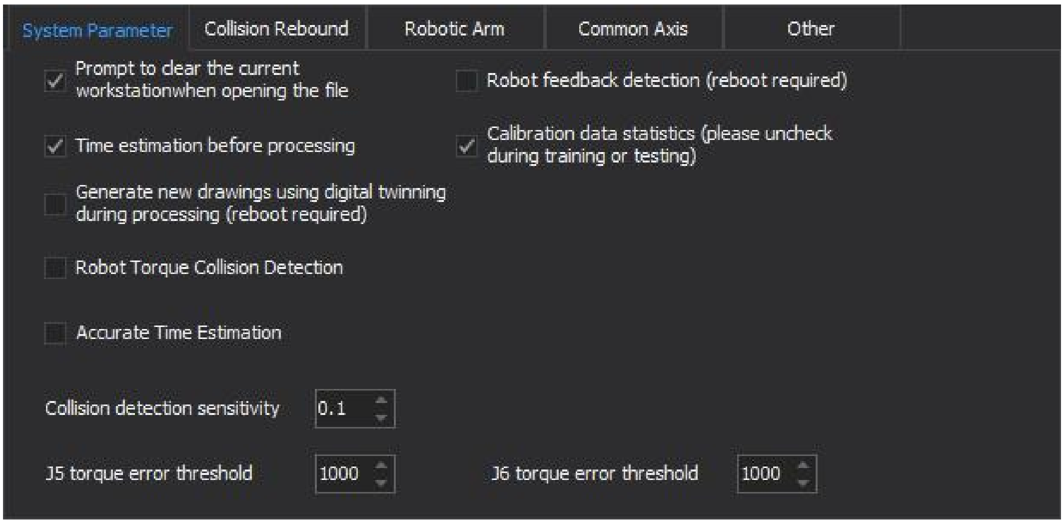

Figure 5-14 System parameter setting

Descriptions of system parameter settings are as follows:

Table 5-1 System Parameters Decriptions

Parameter	Description
Prompt to clear the current workstation when opening the file	By default, when importing drawings via ***Open***, all drawings already imported to the current station will be cleared automatically. If this option is selected, the system will display a prompt before clearing. See Fig. 5-15.
Time estimation before processing	After clicking ***Start***, the estimated machining time will be displayed in the log. A deviation of up to 20% may occur. See Fig. 5-16.
Generate new drawings using digital twinning during processing (reboot required)	Allows creating a new digital twin preset weld seam while processing is in progress.
Robot Torque Collision Detection/J5 torque error threshold/J6 torque error threshold	When enabled, the system activates torque collision detection to protect cables by monitoring J5 and J6 torques. The torque error thresholds define the monitoring limits, in N·m. Recommended value: 1000.
Accurate Time Estimation	Provides a more precise estimation algorithm but requires longer computation time and higher resource usage from the CNC host.

Parameter	Description
Robot feedback detection (reboot required)/Collision detection sensitivity	● When enabled, the system determines collisions by comparing the calculated torque and feedback torque against the collision detection threshold. ● Sensitivity threshold range: 0.1 to 1. ■ 0.1: Sensitive (default recommended). ■ 1: Less sensitive.

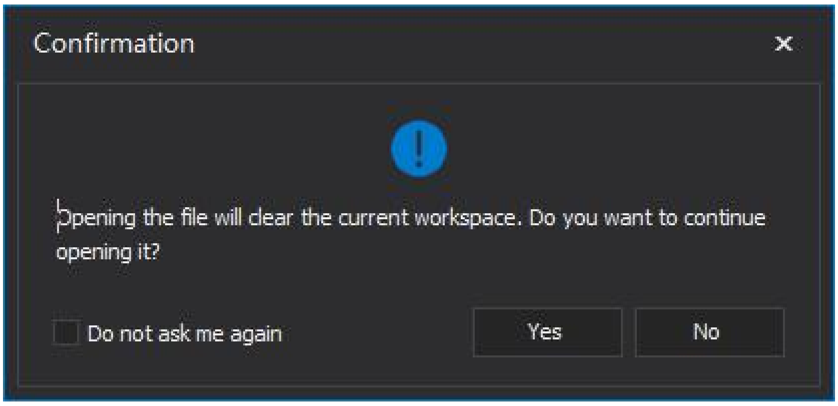

Figure 5-15 Open file popup prompt

Figure 5-16 Estimated processing time

Chapter 6 Weld Editing

6.1 Manual Editing of Single Weld / Continuous Weld / Continuous Curve

6.1.1 Single Weld

Right-click the workpiece model → click ***Select welding edges*** to select the weld edge to be edited. When the mouse pointer approaches a weld, it will automatically snap to the edge. If two welds are close to each other, a pop-up dialog will appear, asking to choose the target weld.

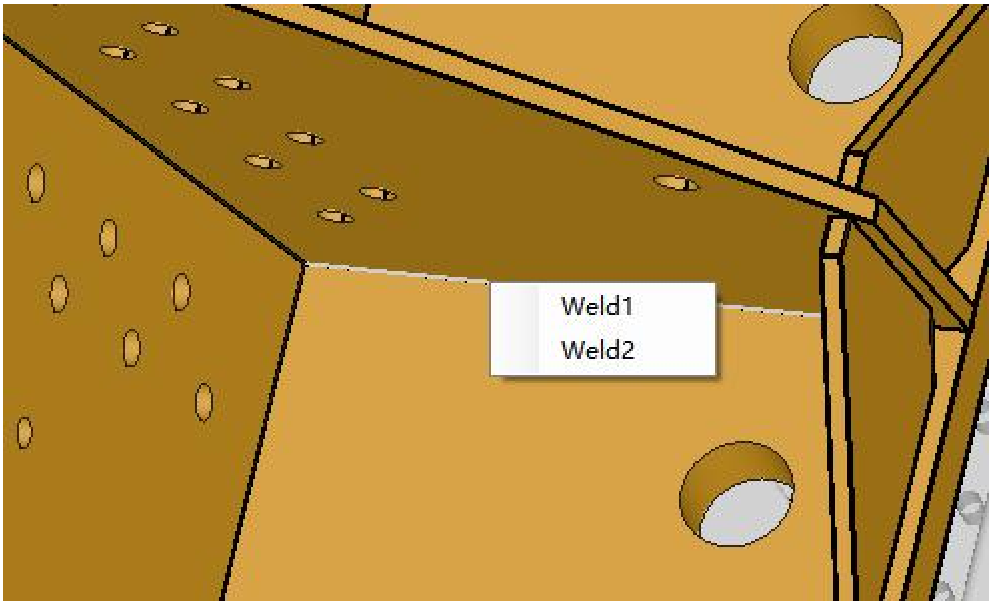

Figure 6-1 Adjacent weld selection

Once a weld is selected, the system automatically enters the ***Edit Weld*** interface. The weld is displayed on the model with the red endpoint marking the start point. Click ***Reverse*** to swap the start and end point.

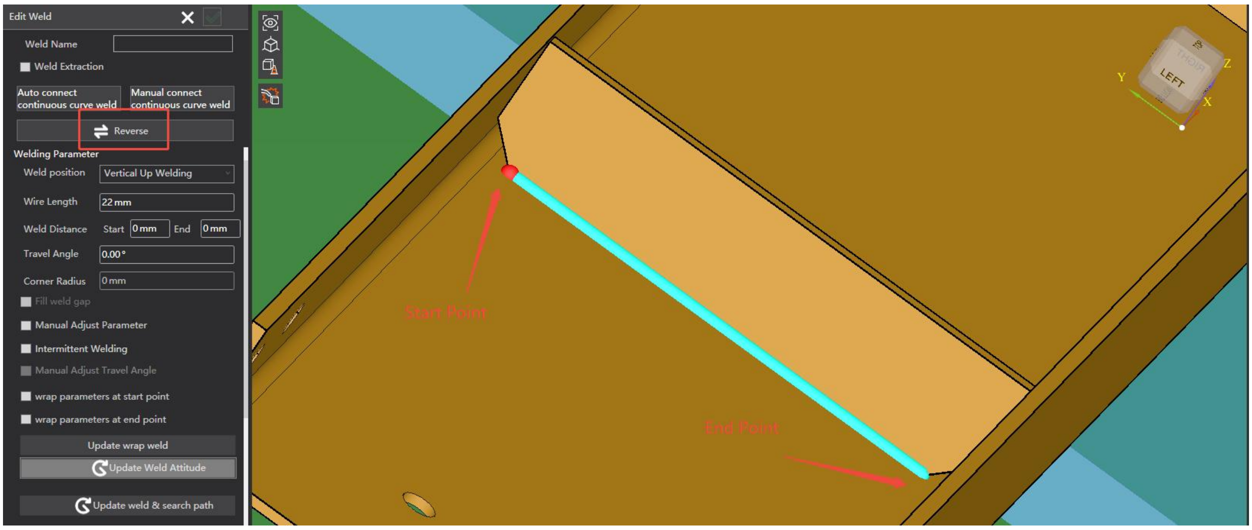

Figure 6-2 Edit weld

The welding system currently supports the following parameters:

- Weld Position: Flat welding, horizontal fillet welding, vertical up welding, and vertical down welding.
- Weld Length: Fillet joint, lap joint, and butt joint.
- Weld Procedures: Curved weld, continuous welding, intermittent welding, etc.

The system automatically determines the applicable welding position and weld type based on the model and seam location. For detailed definitions of joint boundaries, refer to the latest version of the *Technical Boundary Specification*.

6.1.2 Continuous Welding

If the current weld endpoint connects with another weld edge, you can select that seam again to enable continuous weld. As long as the welds are connected end-to-end, the continuous weld procedure can be applied repeatedly without any limit on the number of seams.

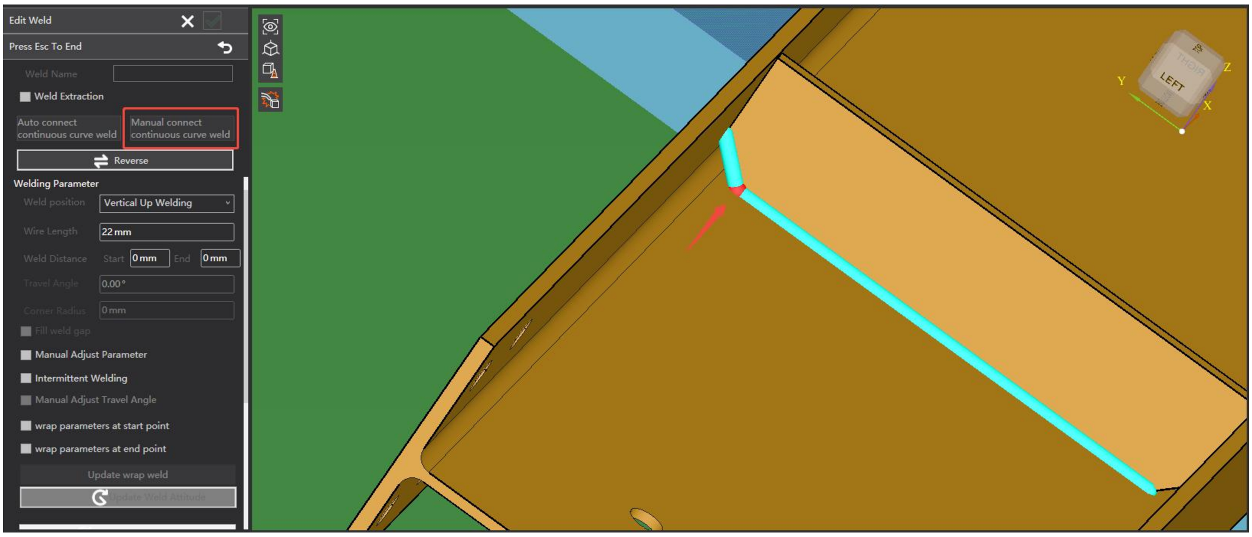

Figure 6-3 Continuous weld editing

⚠ Caution:Once continuous weld is enabled, the system will automatically apply corner procedure. In this case, the reverse trajectory function is disabled, and the weld start point cannot be reset.

6.1.3 Auto Connect Continuous Curve Weld

For smooth continuous curves, use ***Auto connect continuous curve weld*** to set up the curved weld.

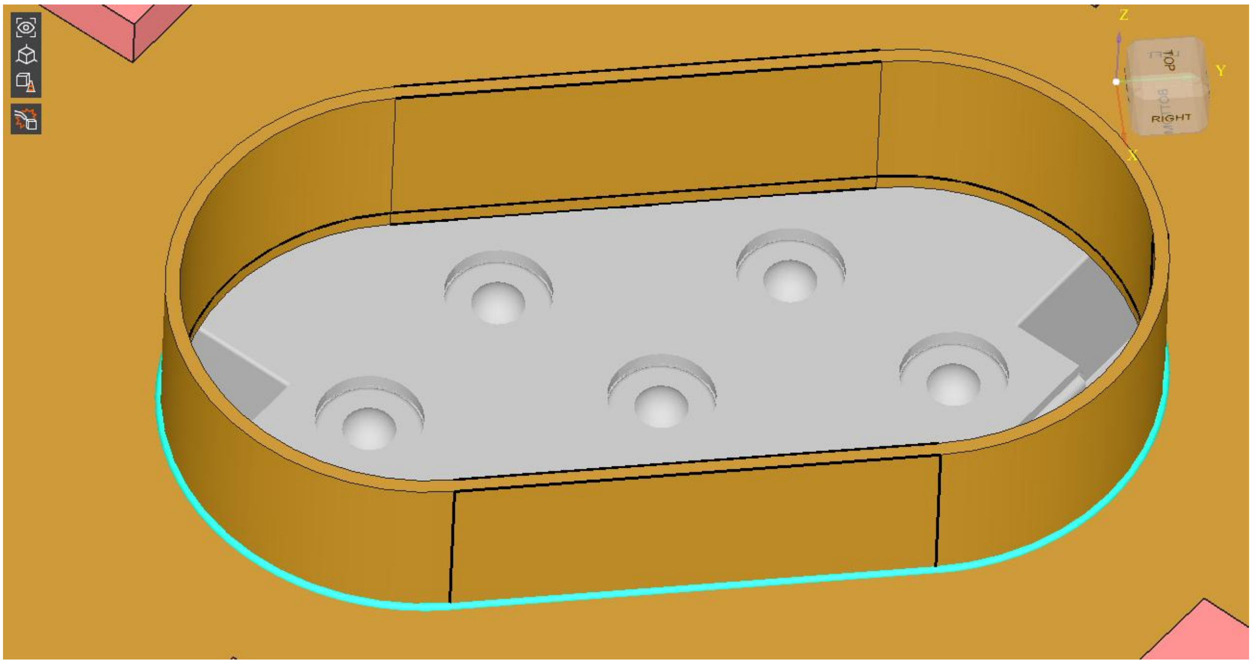

Figure 6-4 Continuous curve weld illustration

Caution:

1. If the curve is closed, the weld start point will be automatically adjusted based on the robot arm's travel range.

2. Continuous curve and continuous weld cannot be used simultaneously.

3. The default search mode for continuous curve welds is ***Scan***.

6.1.4 Manual Connect Continuous Curve Weld

If external issues with the model cause gaps in a continuous curve, use ***Manual connect continuous curve weld*** to repair it. The gap must be less than 50 mm. The missing segment will not rely on model data; instead, the welding path will be automatically generated after scanning and tracking. By default, multiple segments of a continuous curve weld use the same procedure layer.

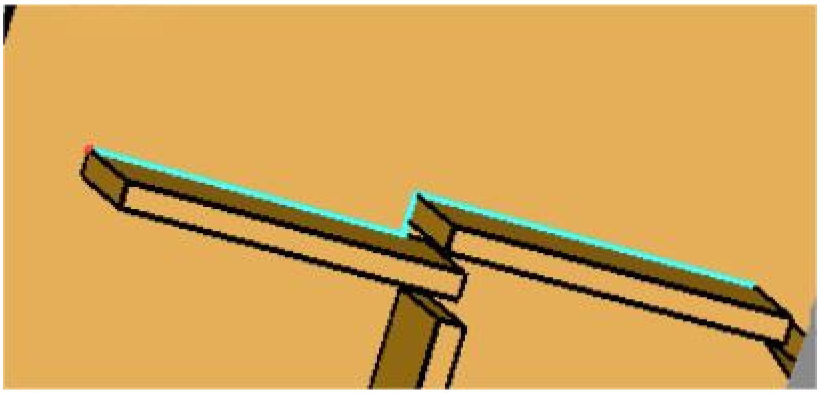

Figure 6-5 Manual connect continuous curve weld

6.1.5 Welding Parameter Settings

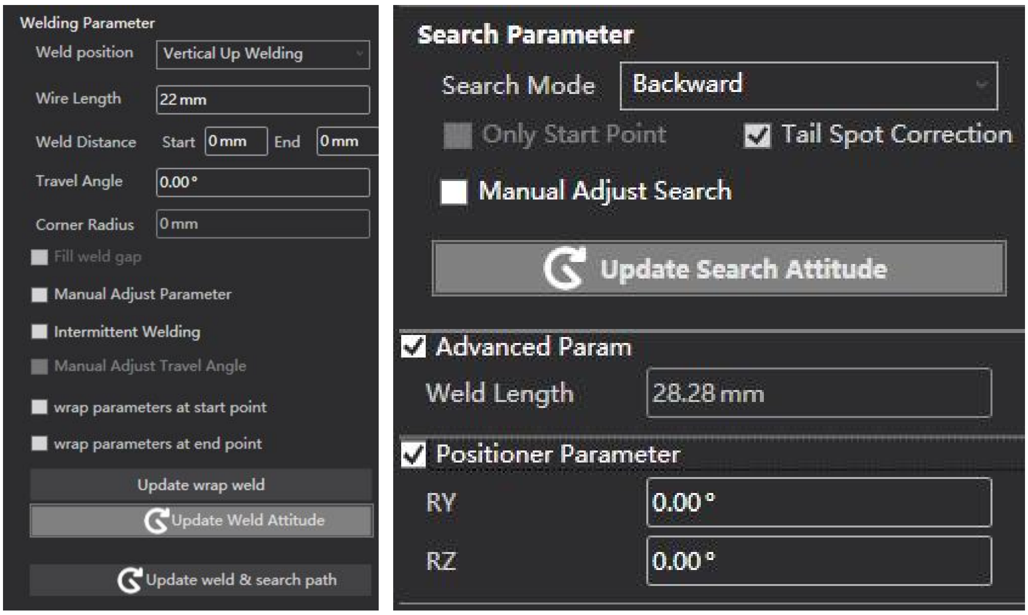

Figure 6-6 Parameter settings

Detailed parameter descriptions are as follows:

Table 6-1 Welding Parameters, Search Parameters, and Positioner Parameters

Parameter	Description
Weld Position	Includes flat welding, horizontal fillet welding, vertical up welding, and vertical down. Automatically determined by the system. For positioner layouts, manual adjustment is required.
Wire Length	Refers to the stick-out length, i.e., the distance from the contact tip at the wire exit to the molten pool. Accuracy depends on TCP calibration and the standard stick-out value input.
Weld Distance	Equivalent to weld length; defaults to the model edge length. Start/end distances can be adjusted manually.
Travel Angle	The angle between the welding wire and the weld normal vector. A travel angle of 0° means the wire is perpendicular to the weld.
Depart/Approach Angle	Travel angles at the weld start/end points. The intermediate travel angle gradually transitions to the optimal value set.
Intermittent Welding	Supports custom single-pass length and weld interval. The system automatically adapts the intermittent welding weld to the total weld length. For curves or continuous welds, the software automatically calculates and connects full welds across corners.
Wrap Parameters	Supports setting wrap parameters. Even if the model does not contain explicit corner edges, the system can execute wrap welding. Wrap welding follows straight-line procedure and do not use arc tracking.
Search Parameter	By default, fillet welds use ***Fly*** for search, some weld types allow manual adjustment of positioning methods. Specific seam searching types and
Positioner Parameter	In positioner layouts, manual input of rotation angles for each axis is supported to constrain weld position. If not selected, the software calculates automatically.

6.1.6 Update Seam Parameters

Supports updating welding and positioning postures either independently or simultaneously. When the weld location or robot travel is restricted, synchronous updating may take longer.

After updating weld parameters, the digital twin interface automatically refreshes the welding torch posture and positioning laser scan range (green line). Only when both update buttons in the weld editing interface turn green can you confirm and save the operation via the confirm button in the upper-right corner.

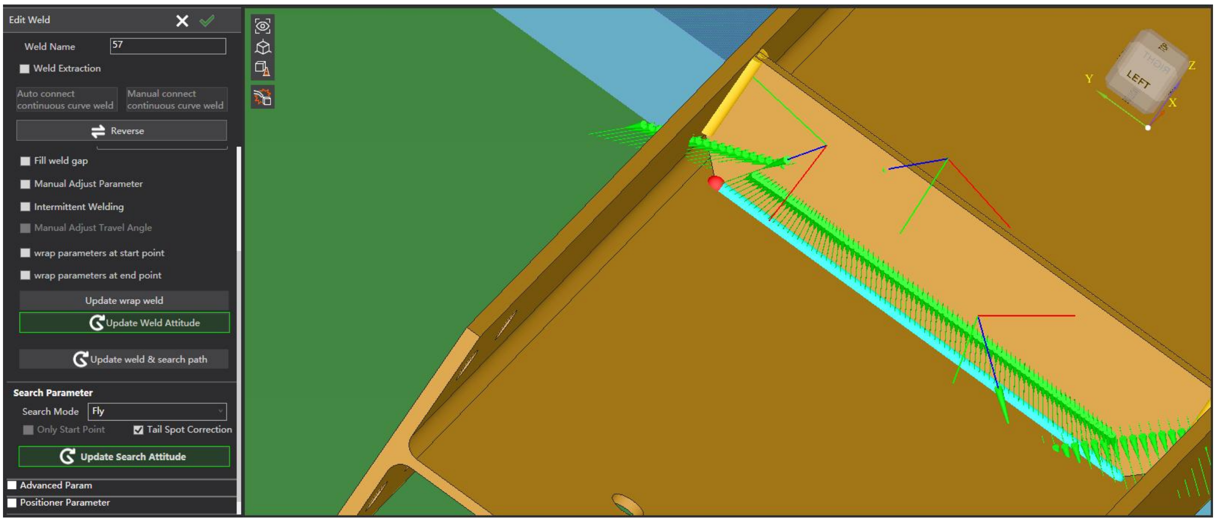

Figure 6-7 Updated seam parameters

6.2 Multi-layer Multi-pass Welding Manual Editing

Right-click the workpiece and select ***Add Multi-layer Multi-pass Weld*** to enter the editing interface.

6.2.1 Import from the Procedure Table

Supports automatic parameter configuration for multi-layer multi-pass welds. All you need is to preset multi-layer multi-pass welding procedures in the procedure table. After selecting the corresponding procedure layer and updating parameter matching, the system will automatically write in information such as groove geometry, weld pass quantity, filter pass offset, and procedure parameters of each pass.

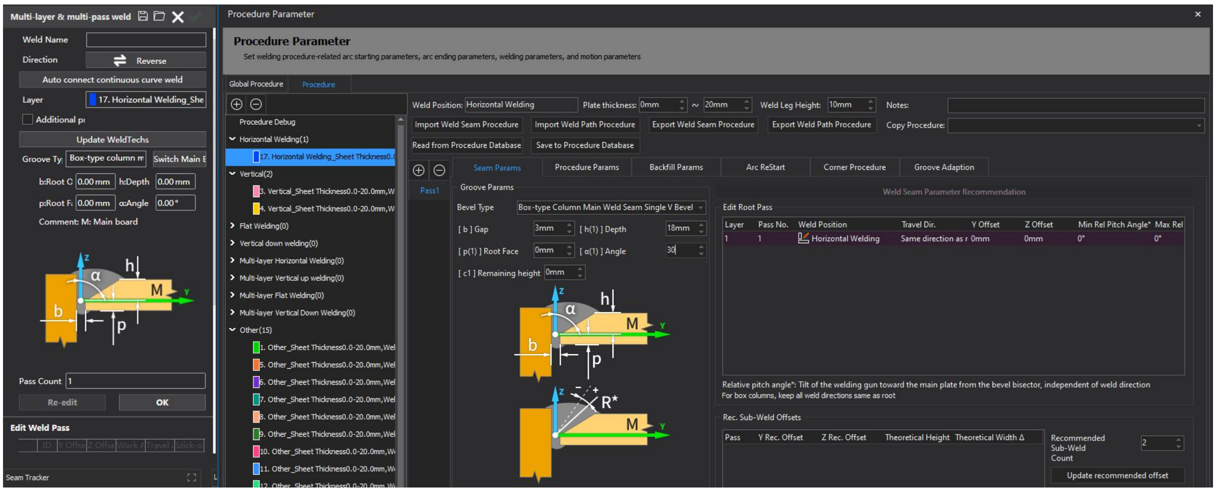

Figure 6-8 Example of importing multi-layer multi-pass welding parameters from the procedure table

6.2.2 Multi-layer Multi-pass Welding Parameter Manual Setting

The operation steps are as follows:

Step 1 Set groove type. Select the groove type based on the actual geometry. Currently supported types include: natural bevel, box-type column main weld seam single V bevel, I-shaped groove, asymmetric double V bevel, V groove, etc.

Step 2 Switch main board. The main board surface is used to determine the offset direction when setting filter pass offsets. The software will automatically select the two adjacent sides near the welding position as the main board surfaces.

Step 3 Set groove geometry parameters. Illustrated diagrams are provided to explain the meaning of each parameter.

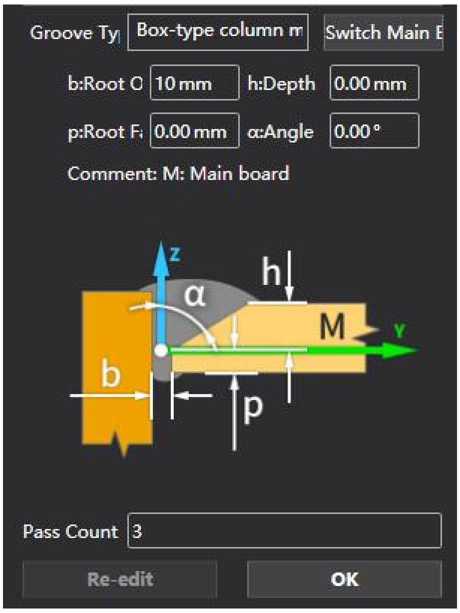

Figure 6-9 Set groove geometry parameters

Step 4 Edit pass count.

Step 5 Edit Root Pass. Enter the root pass editing interface to configure welding position, push/pull angle, and searching parameters. The parameter settings are consistent with those in the single weld editing interface. Additional parameters such as root pass offset can also be set in the main interface of multi-layer multi-pass settings.

Step 6 Edit filter pass. Select the target filter pass from the weld list, set offset parameters, and the system will automatically perform offset calculation.

⚠ Notice: During weld procedure debugging, completed multi-layer multi-pass welding procedures can be imported into the procedure table.

6.3 Select Surface and Add Weld

When adjacent welds are hard to distinguish, or when positioning errors occur due to model deviation, you can directly select the intersection of two adjacent faces to determine the weld position.

Right-click the workpiece, choose ***Select Surface and Add Weld***, then select two adjacent angled surfaces. The software will automatically calculate their intersection line as the weld. The two surfaces do not need to be physically connected; the software will perform projection automatically.

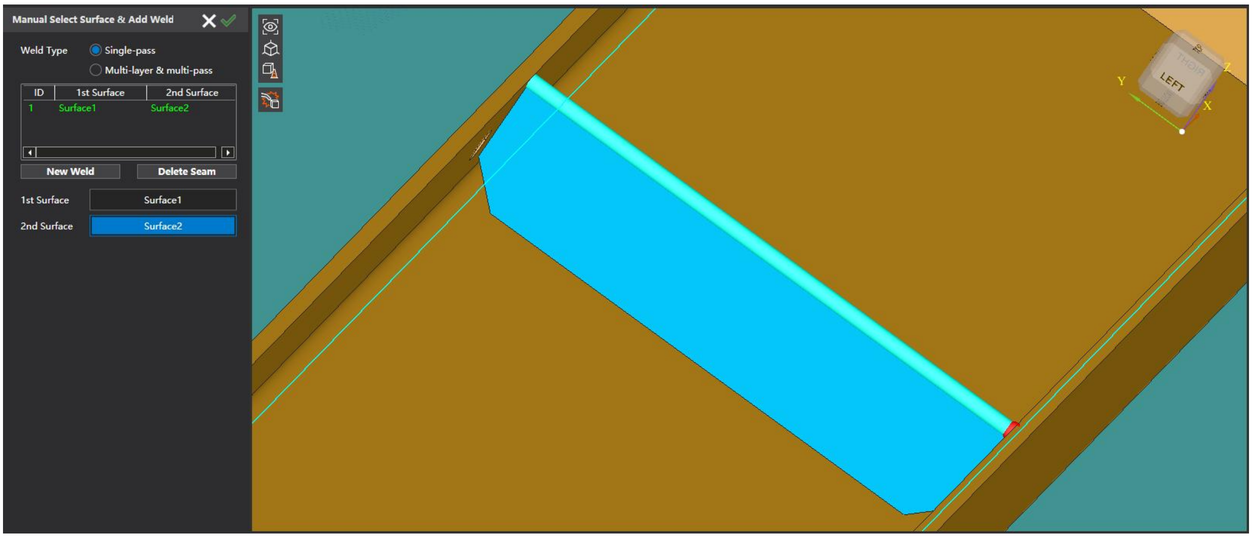

Figure 6-10 Select surface and add weld

6.4 Auto Generate Toolpath

Auto Generate Toolpath refers to intelligent planning of all welds within the robot's travel range.

Right-click the workpiece, select *Auto Generate Toolpath*, and enter the *Auto Generate Drawing* interface. Select *H-beam*, *Feul tank* or *Fillet Weld* template based on the weld type. When selecting the *Fillet Weld* template, you need to specify the minimum weld length and, if required, check *Auto connect continuous welds*.

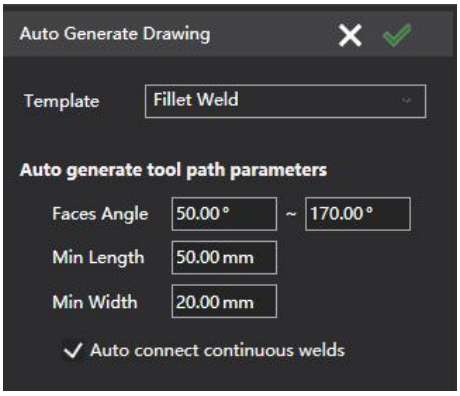

Figure 6-11 Auto generate drawing interface

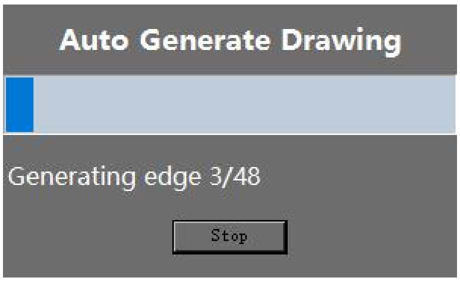

Figure 6-12 Wait for the software to automatically generate welds

6.5 Select Rib and Create Weld

By manually selecting a rib, the software intelligently plans all welds that can be welded.

Step 1 Right-click the workpiece, choose ***Select Rib and Create Weld***, and enter the operation interface.

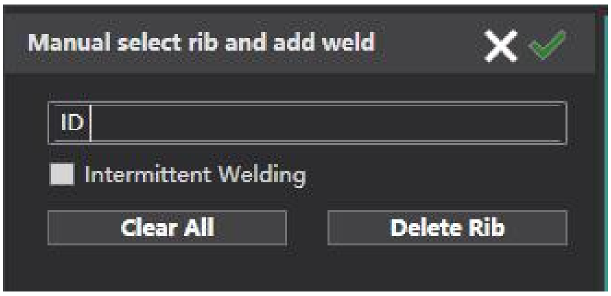

Figure 6-13 Manual select rib and add weld interface

Step 2 When moving the mouse pointer over the workpiece, the part boundary will be highlighted in blue. Click on the rib to record the selection. Multiple ribs can be selected by consecutive clicking.

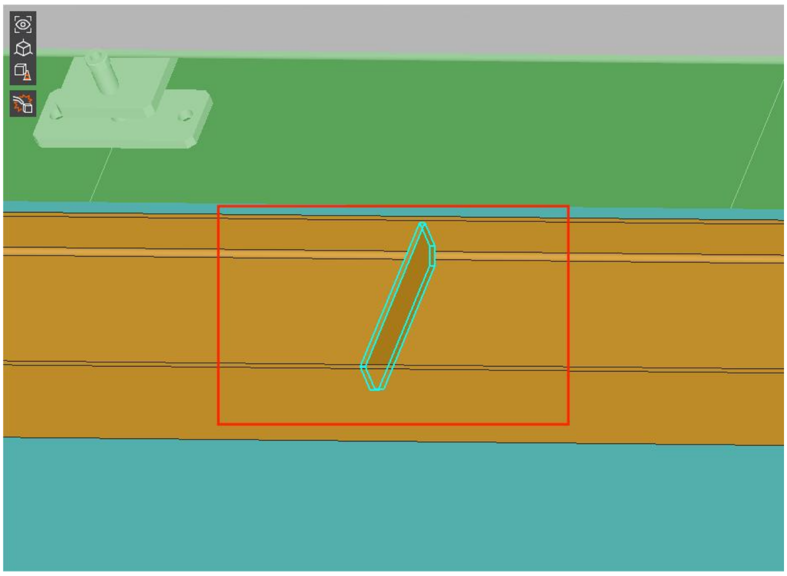

Figure 6-14 Select ribs

Step 3 After selection, click the confirm button at the top-right corner, and the system will automatically generate welds.

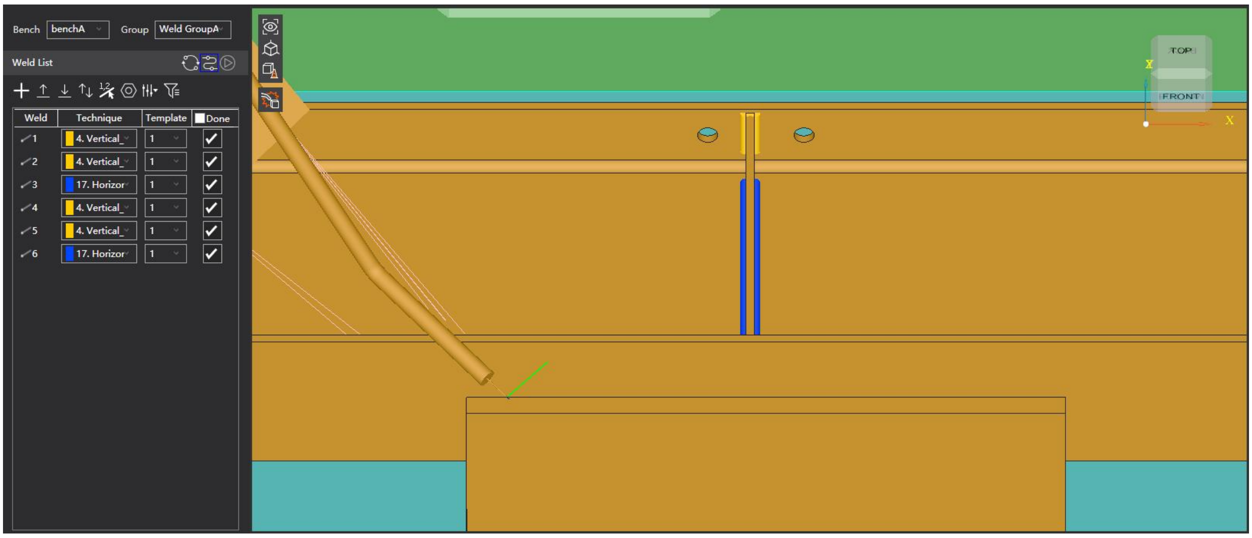

Figure 6-15 Select rib and auto generate toolpath

Chapter 7 Processing Planning

7.1 **Weld Sequence**

After welds are generated, weld sequencing must be performed. By optimizing welding order and planning torch travel paths, both welding efficiency and quality can be improved. Three sequencing methods are available.

7.1.1 Manual Sequence

Select the weld to be adjusted, then click the ***Weld Up/Weld Down*** buttons to manually rearrange the weld order.

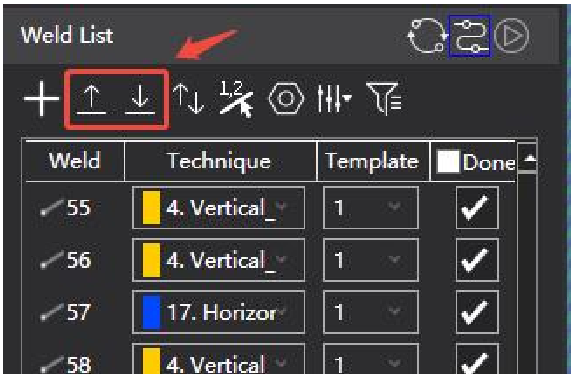

Figure 7-1 Manual sequence

7.1.2 Auto Sequence

With automatic sequencing, the software calculates the optimal weld order based on the model and weld data.

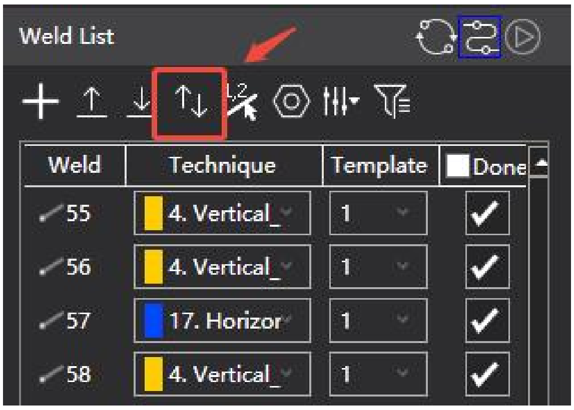

Figure 7-2 Auto sequence icon

Step 1 Click ***Auto Sequence*** to open the interface and select the appropriate method according to the workstation type:

- Shortest path of joint travel: Based on minimizing joint rotation angles.
- Position sort Movepath: Based on minimizing positioner rotation.
- Along ground rail direction: Sorts along the positive ground rail direction, with optional reverse direction.

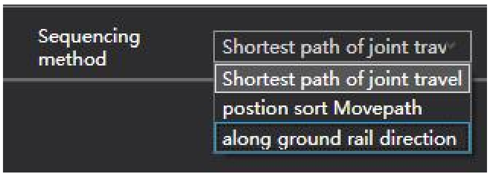

Figure 7-3 Sequencing method

Step 2 When ***Along ground rail direction*** is selected, you can check ***against ground rail direction*** or ***interleaved sequencing of multi-layer multi-pass welds***.

- Against ground rail direction: Used in multi-robot welding on the same rail. To avoid collisions caused by opposing weld directions, sequencing is adjusted so that all robots weld in the same direction.
- Interleaved sequencing of multi-layer multi-pass welds: To prevent heat distortion from welding multi-layer multi-pass on one side only, alternating sequencing is applied. Root passes are alternately welded on both sides, followed by sequential filter passes welding by layer on one side.

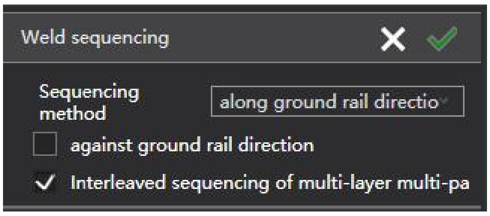

Figure 7-4 Interleaved sequencing of multi-layer multi-pass welds

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⚠ Notice: Conditions for interleaved sequencing of multi-layer multi-pass welds: Plate thickness < 30 mm; supports horizontal fillet welding and but joint flat welding; not applicable to vertical welds; closed geometries (e.g., rings, hatch covers) with inner and external layers may be affected.

Step 3 Click confirm (top right) to apply sequencing.

7.1.3 Sort on the model

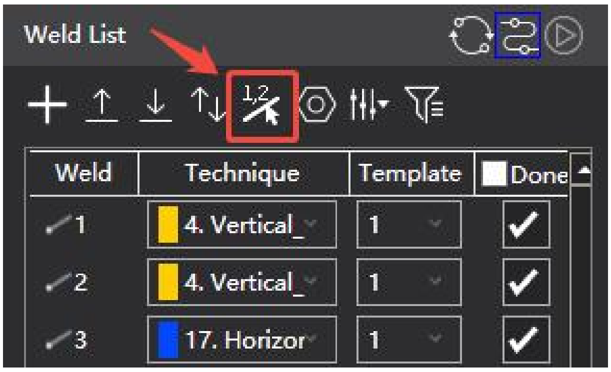

Figure 7-5 Sort on the model icon

Supports sequencing by clicking welds directly in the digital twin model.

Step 1 Two sequencing modes are available:

- From Start: Click to sequence all welds.
- Start from current weld: Sequence only the remaining unsequenced welds.

Step 2 Welds are shown in gray after the mode is selected. By clicking welds in sequence, they are highlighted with layer colors and numbered for clear visualization.

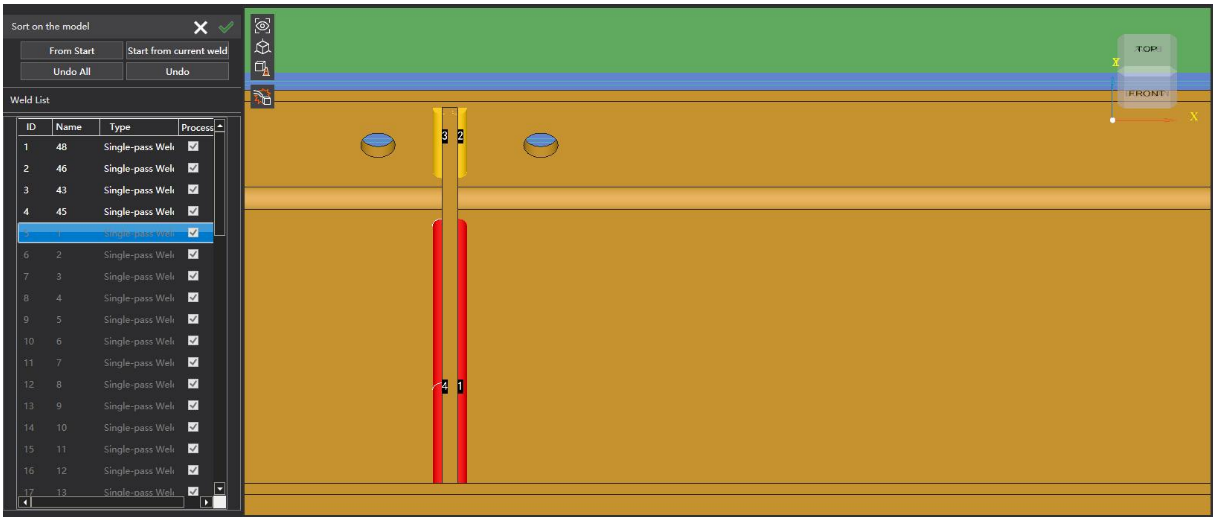

Figure 7-6 Select weld to sort on the model

Step 3 Click confirm (top right) to apply.

7.2 Edit Weld

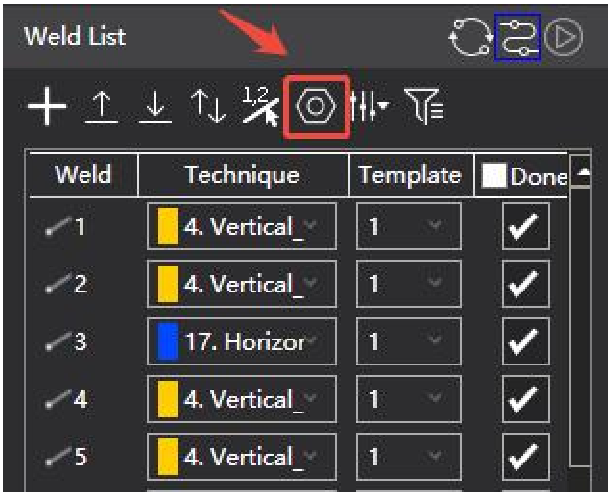

Figure 7-7 Edit weld icon

Select a weld and click the icon to enter weld editing mode. For parameter details, see 6.1.5 Welding Parameter Settings.

7.3 Filter and Modify

Filter welds by length.

Step 1 Set filter conditions:

1. Manually select weld positions.
2. Measure weld length in the layout and input the length range.

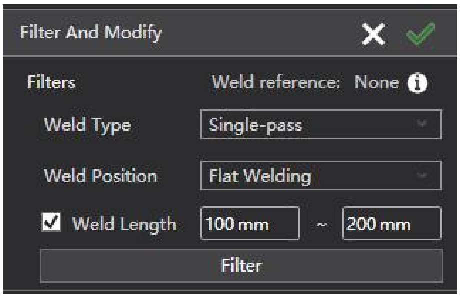

Figure 7-8 Set filter conditions

Step 2 Click ***Filter***. The software automatically filters welds.

Step 3 Select the filtered welds and perform batch modification in ***Welding Parameter***.

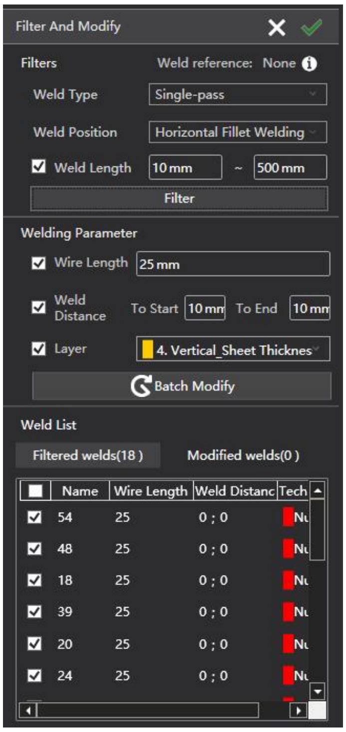

Figure 7-9 Batch modify

Step 4 Click confirm (top right) to apply changes.

7.4 Remapping

If layout parameters change (e.g., TCP recalibration, seam tracker recalibration) or workpiece position changes (e.g., re-fixturing, pose adjustment), click ***Remapping*** to automatically adapt existing toolpaths.

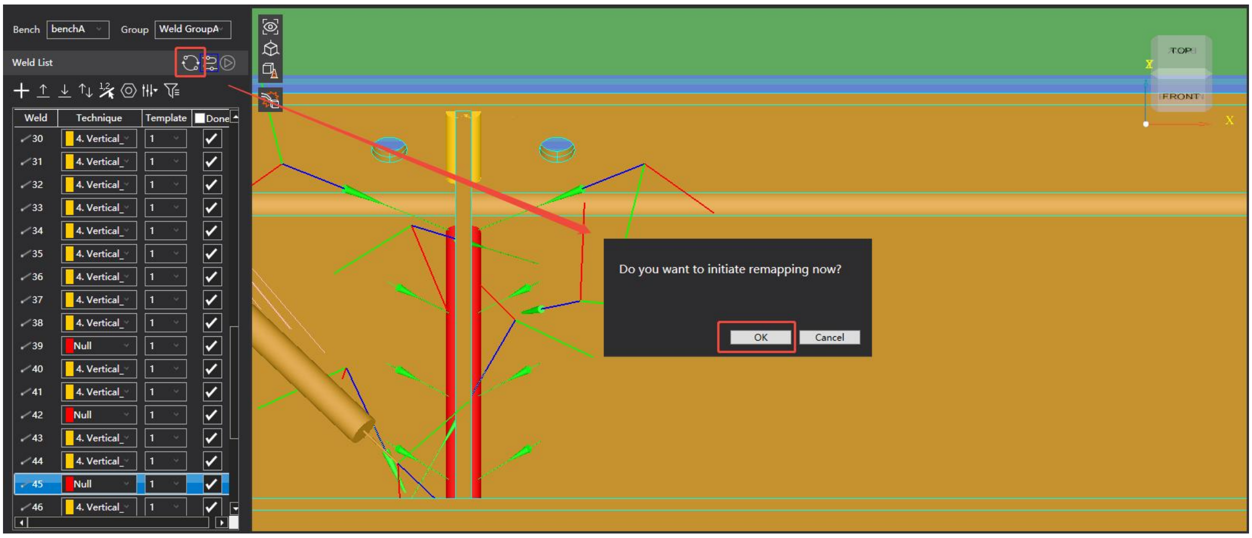

Figure 7-10 Remapping

7.5 Path Planning

After welding posture, search posture, and procedure parameters are set, use *Path Planning* to automatically optimize robot travel between welds and between welding and searching motions.

Path planning steps:

Step 1 Start Planning: Click *Path Planning* in the weld list. The system calculates the optimal travel path.

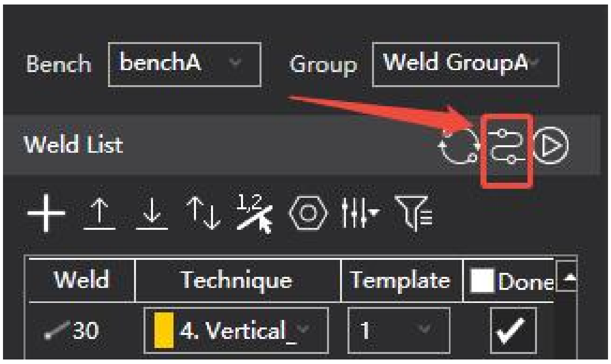

Figure 7-11 Path planning icon

Step 2 Progress Monitoring: A progress window in the digital twin displays real-time status.

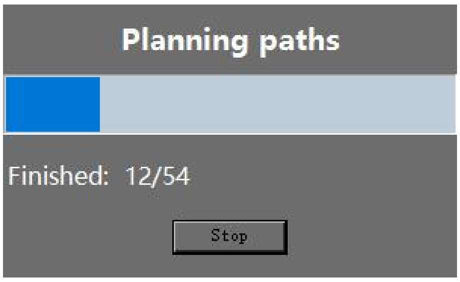

Figure 7-12 Progress monitoring

Step 3 Completion: When progress reaches 100%, the log displays *Path Planning OK*.

Step 4 Ready state: The complete path data is generated.

7.6 Simulation

After path planning, ***Simulation*** visualizes the full robot (and positioner) motion in the digital twin, including: TCP travel paths, welding paths, and searching paths. This allows users to verify machining feasibility before execution.

The execution steps are as follows:

Step 1 Complete path planning.

Step 2 Click ***Simulation*** (top right) in the weld list.

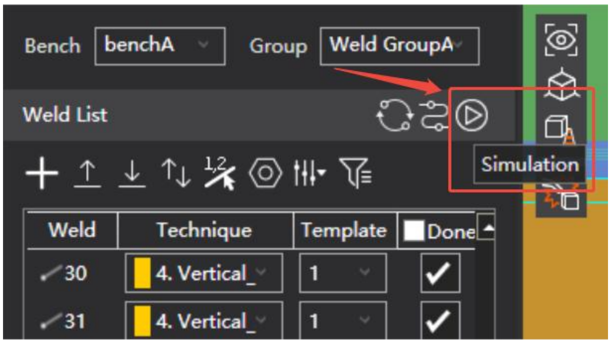

Figure 7-13 Simulation icon

Step 3 Observe robot motion in the digital twin.

- Simulation Speed: Enter 1 to 50 to control playback speed.
- Step Speed: Enter 1 to 50 to control incremental step distance.

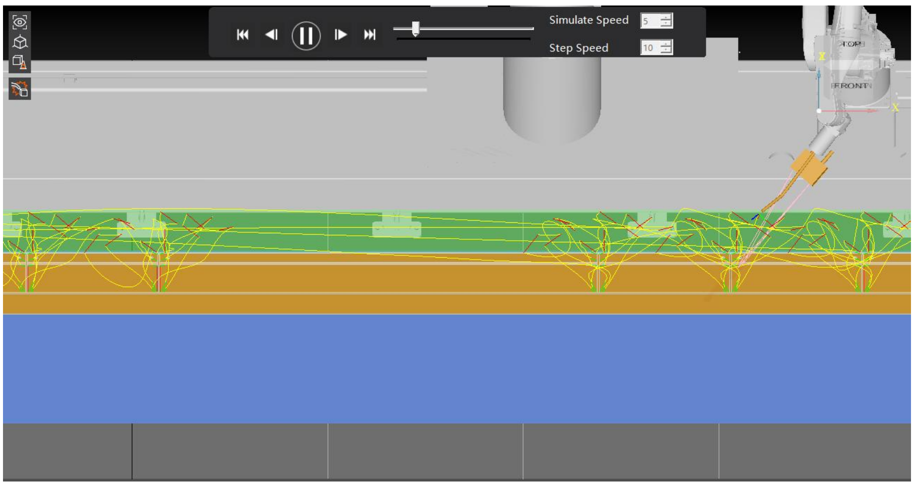

Figure 7-14 Simulation interface

7.7 Bench and Group Switching

When multiple benches or weld groups exist, they can be switched in the designated area of the interface.

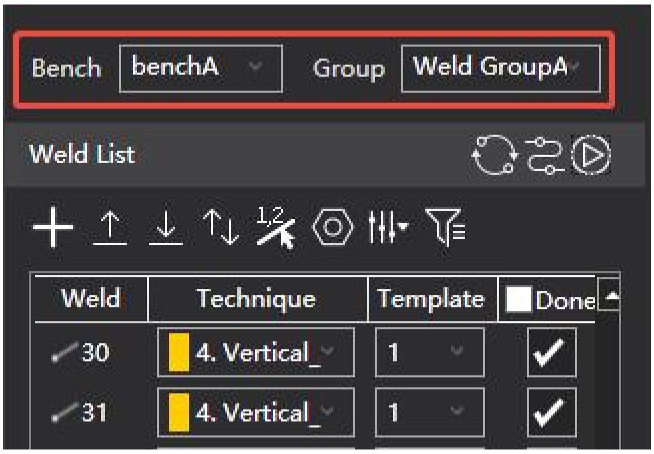

Figure 7-15 Bench and group switching

Chapter 8 Digital Twin Interface

8.1 Initial Positioning Point Cloud

The initial positioning point cloud is used to evaluate the alignment between the scanned point cloud data and the workpiece model, serving as a reference baseline for machining.

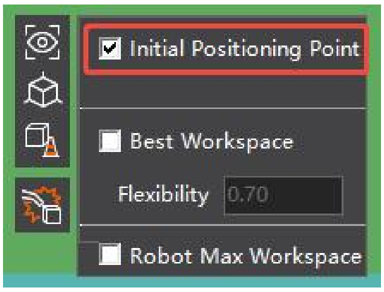

Figure 8-1 Initial positioning point cloud

8.2 Best/Max Workspace

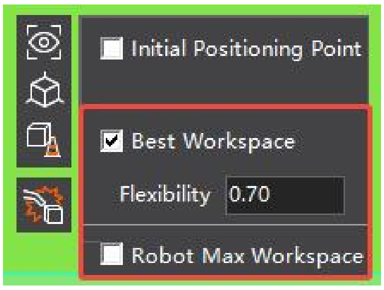

Figure 8-2 Best/Max workspace

- Best workspace: The green rectangular area in the illustration represents the robot's optimal working range.

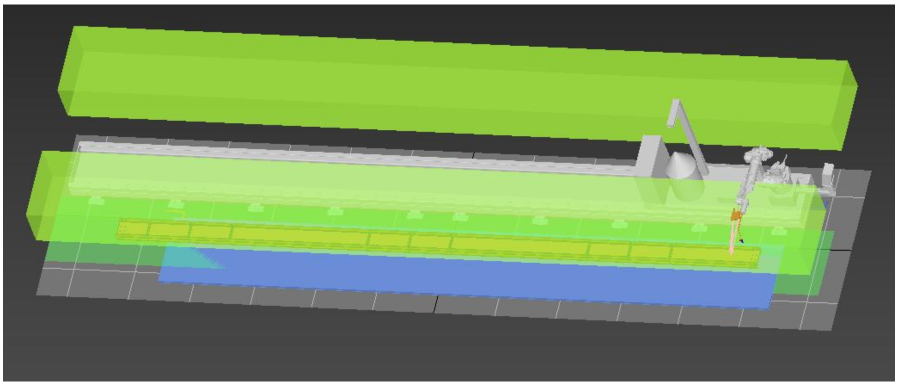

Figure 8-3 Best workspace diagram

- Max workspace: The red spherical area in the illustration represents the robot's maximum working range.

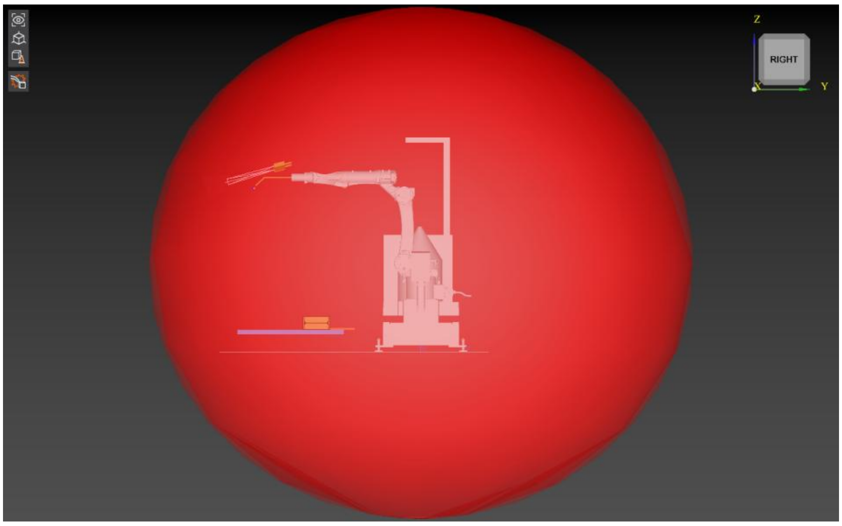

Figure 8-4 Max workspace diagram

8.3 View Switching

You can directly select a view from the list to switch to the corresponding perspective. The default view of the software can also be set here.

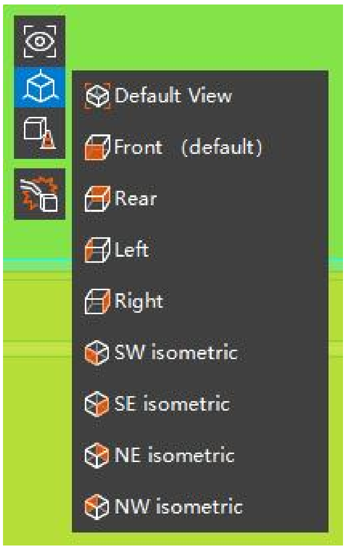

Figure 8-5 View switching

8.4 Obstacle Manager

Since various types of obstacles (such as anti-collision devices) may exist in the actual working environment but are not automatically displayed in the digital twin interface, you need to manually add these obstacle models. This ensures that path planning can effectively avoid potential collisions.

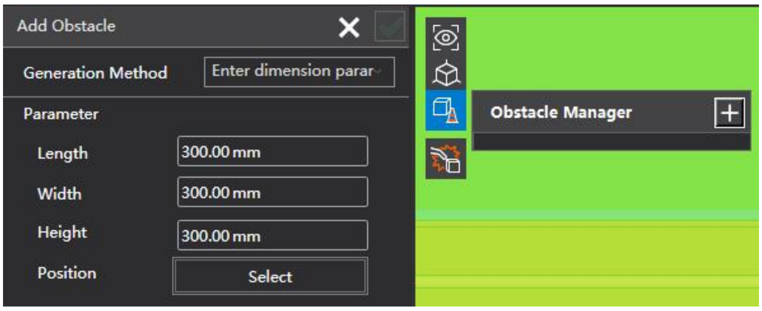

Figure 8-6 Obstacle manager

Chapter 9 Highlight Features

9.1 Co-Rail Multi-Robot Communication

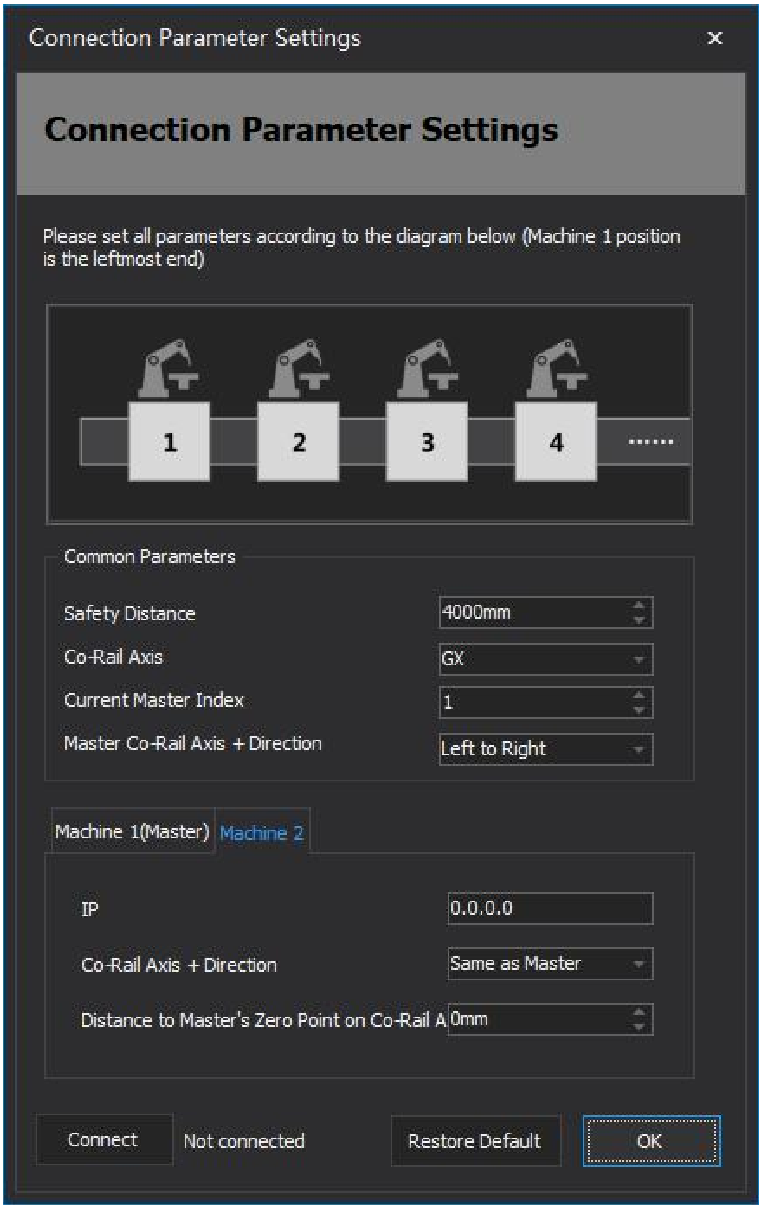

Figure 9-1 Co-rail multi-robot setting

The co-rail communication function supports linear track and 7-axis gantry systems. The setup procedure is as follows:

Step 1 Connect multiple CNC hosts in series with network cables. Go to ***Platform Config Tool*** → ***Layout Config*** → ***Base Config***, check ***Co-Rail Multi-Robot*** and fill in the ***Corail Robot Quantity***, then save and exit.

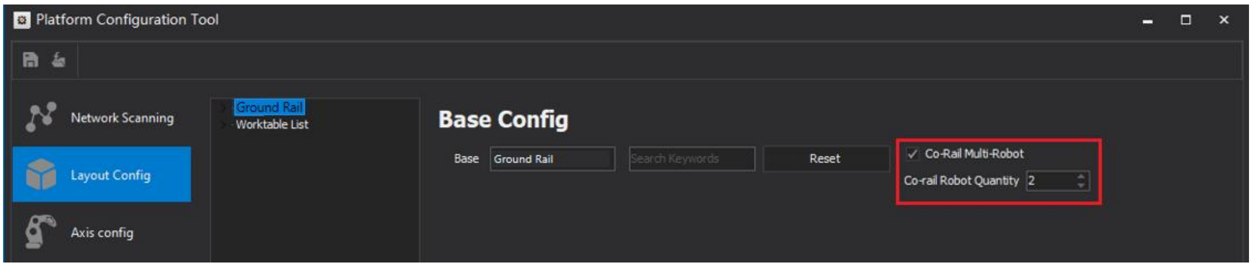

Figure 9-2 Co-rail multi-robot config

Step 2 Designate the leftmost robot as Machine 1 (Master). On Machine 1, open CypWeld and go to ***Connection Status*** → ***Settings*** to open the ***Connection Parameter Settings*** interface.

Step 3 Configure the following:

- Safety Distance: Set according to on-site conditions.
- Co-Rail Axis: Default GX axis for 7-axis systems, and GY for 8/9-axis systems.
- Current Master Index: Set according to on-site conditions.
- Master Co-Rail Axis + Direction: Set according to on-site conditions.

Step 4 Configure the Machine1 (Master) IP address.

⚠ Notice: Find the IP via ***Win + R*** → enter ***cmd*** and press ***Enter*** → enter ***ipconfig*** and press ***Enter*** → ***IPv4 Address***.

Step 5 Configure the IP addresses of the remaining robots according to the total robot number. Set the rail axis positive direction and the zero-point distance between robots.

- Zero-point distance: The actual spacing between robot bases when aligned at GX/GY zero position.

Step 6 Click ***OK*** to complete.

⚠ Notice:

1. The *Co-Rail Multi-Robot* option must be enabled in each machine's platform configuration tool.

2. When configuring Machine 1 (Master), ensure CypWeld is open on all other machines.

9.2 CleanTorch & CutWire Setting

Follow the steps below to configure the torch cleaning and wire cutting station:

Step 1 According to the actual wiring position on HPL2720E, open *CypConfig* → *General Output*, and configure the output port. After configuration, save and close the tool.

Step 2 Open CypWeld, click *Tool* → *Parameter Settings* → *CleanTorch_CutWire Setting* to enter the *CleanTorch & CutWire Setting* interface.

Step 3 Activate *Enable Auto CleanCut*, and sequentially teach and record coordinates of clean torch safe point, clean torch position, cut silk position, and jet oil position.

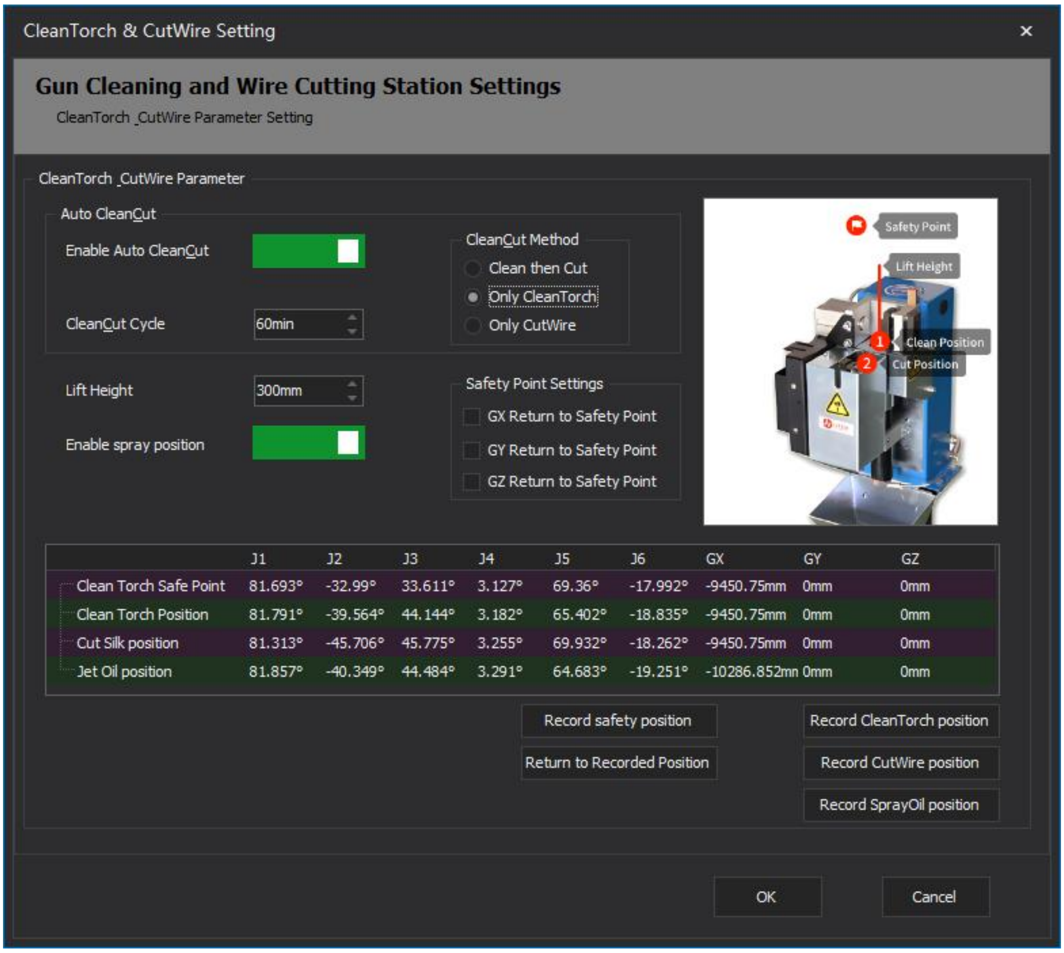

Figure 9-3 CleanTorch & CutWire Setting interface

Step 4 Navigate to ***PLC Process*** → ***Execute Custom PLC*** → ***Clean Torch Cut WeldingWire*** to enter the PLC interface. Use the default process, then click ***Import from Preset Process*** → ***Save***. (PLC Process password: 61259023)

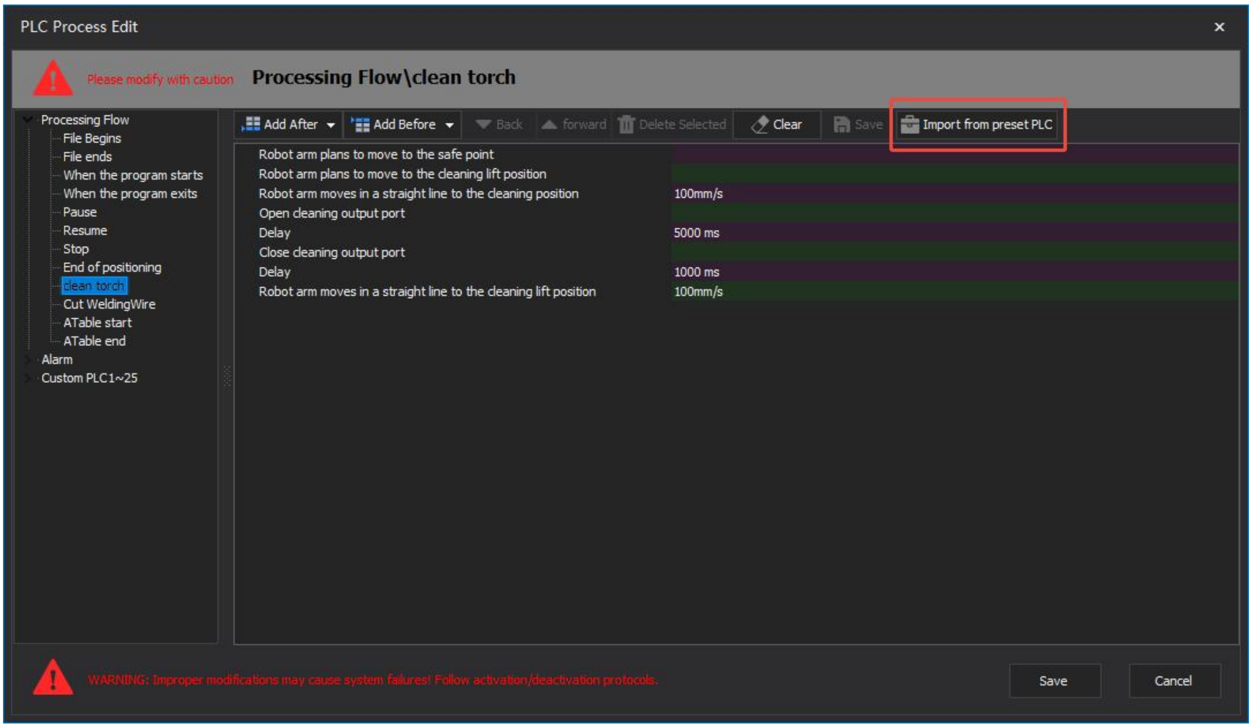

Figure 9-4 Clean torch PLC

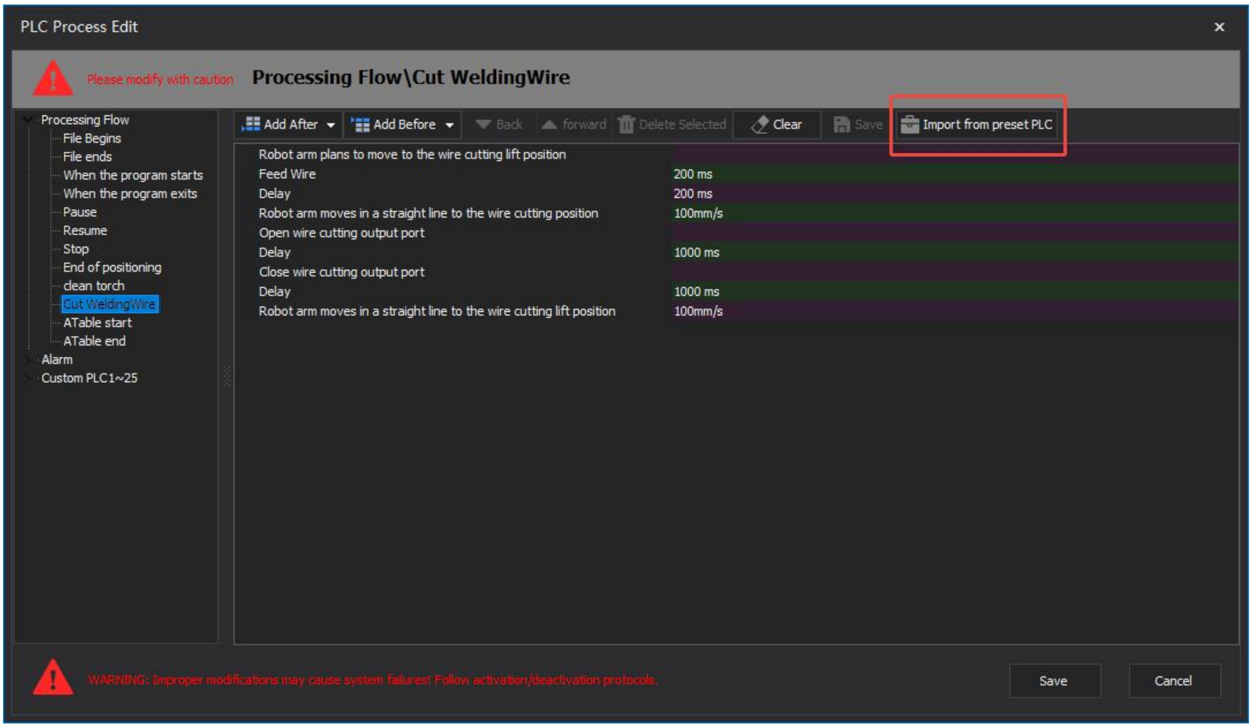

Figure 9-5 Cut WeldingWire PLC

Step 5 Use the ***CleanCut Cycle*** setting to enable automatic operation, or manually trigger the process via PLC.

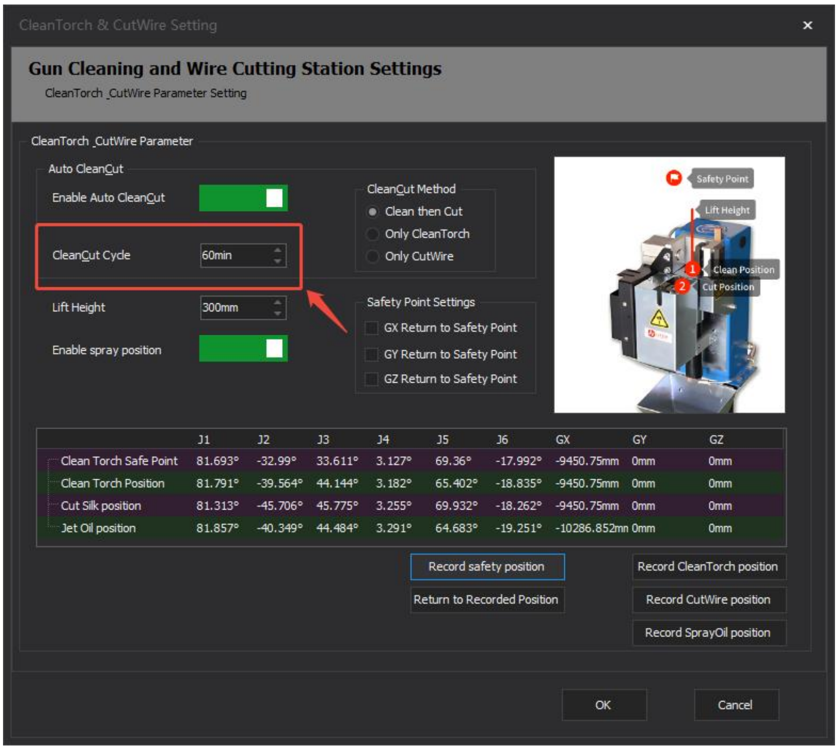

Figure 9-6 CleanCut Cycle setting

9.3 Mark Settings & Set Docking

Mark setting steps:

Step 1 Go to ***Tool*** → ***Parameter Settings*** → ***Mark Settings***.

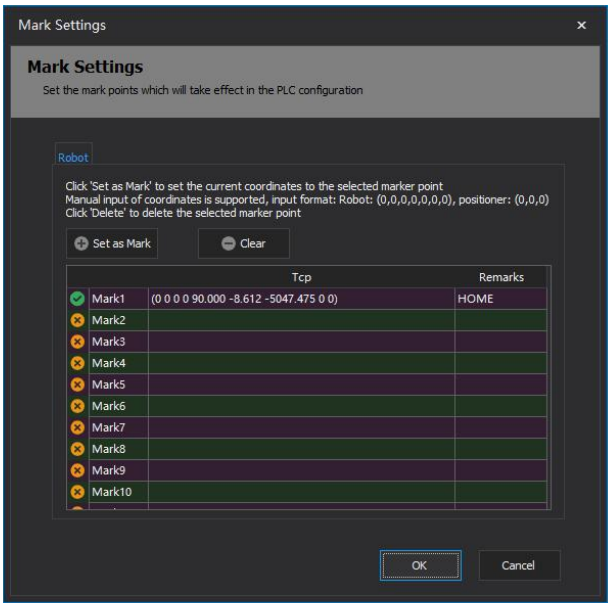

Figure 9-7 Mark settings

Step 2 Move the robot to the target posture and click ***Set as Mark***.

Step 3 Click ***OK*** to activate the mark point in PLC configuration.

Dock setting steps:

Step 1 Go to ***Tool*** → ***Parameter Settings*** → ***Set Docking***.

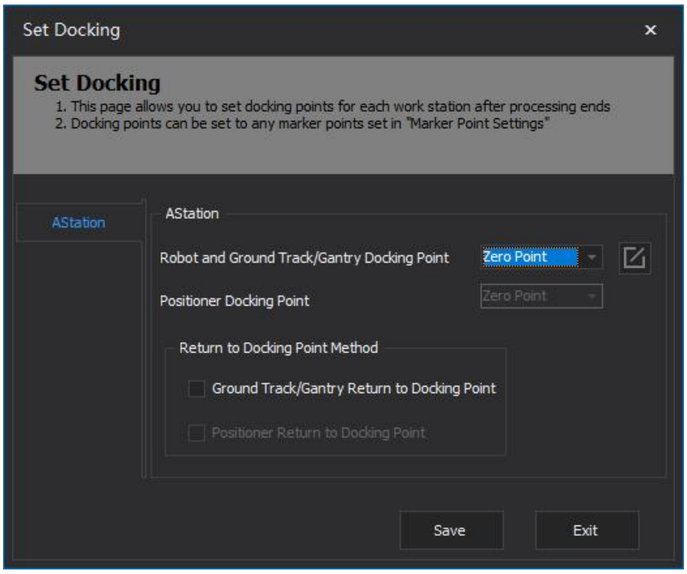

Figure 9-8 Set docking

Step 2 Set docking points for each bench. Docking points can be any predefined mark point.

9.4 Groove Self-adaptive of Box Column

Groove self-adaptive of box column is set as follows:

Step 1 Go to ***Generate workpiece model*** to enter the corresponding interface.

Step 2 Teach three edge points of the workpiece and record coordinates. The system performs parametric modeling and initial positioning automatically.

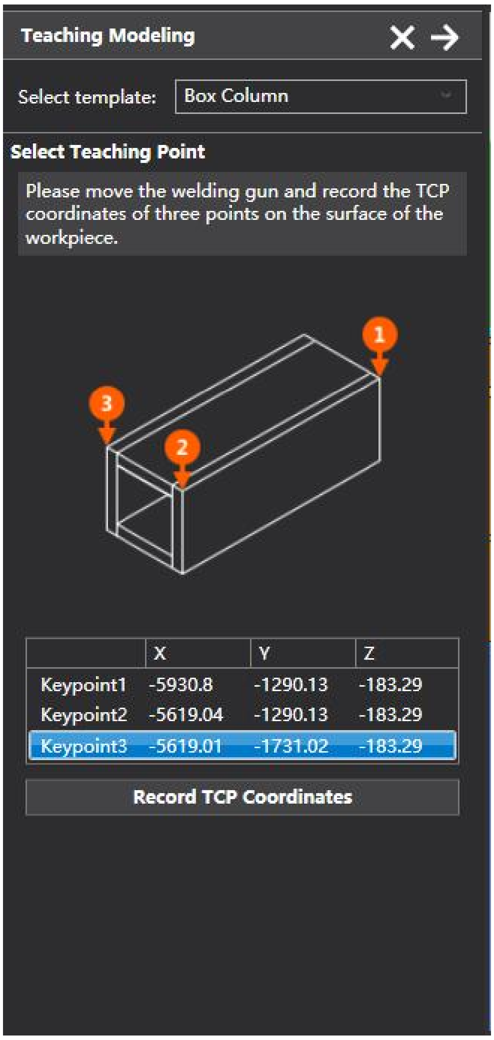

Figure 9-9 Teaching modeling

Step 3 Input ***Cover Thickness*** and ***Side Plate Thick*** to adjust plate dimensions. Confirm in the top right, and the box column will be parametric modeled in the digital twin layout.

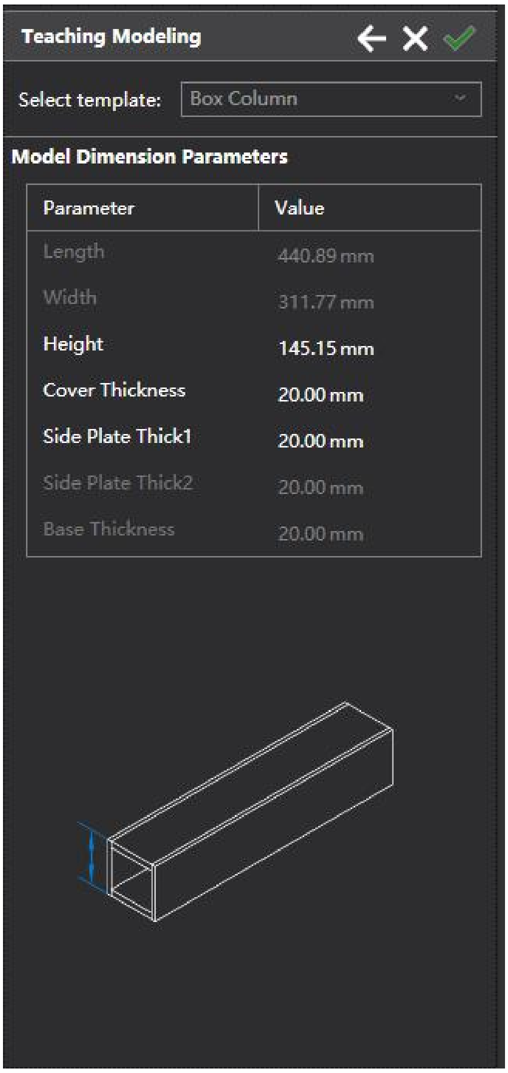

Figure 9-10 Adjust plate dimensions

Step 4 Right-click the model → ***Add Multi-Layer Multi-Pass Weld*** to set groove geometry and welding parameters, or load presets from the procedure table.

Step 5 For Boss Interruption: Right-click workpiece → ***Box column toolpath generation***. Configure during initial weld editing or after multi-layer multi-pass parameters are set.

1. Auto scan boss: Select weld edges to truncate, set groove parameters, then click ***Start scan***.

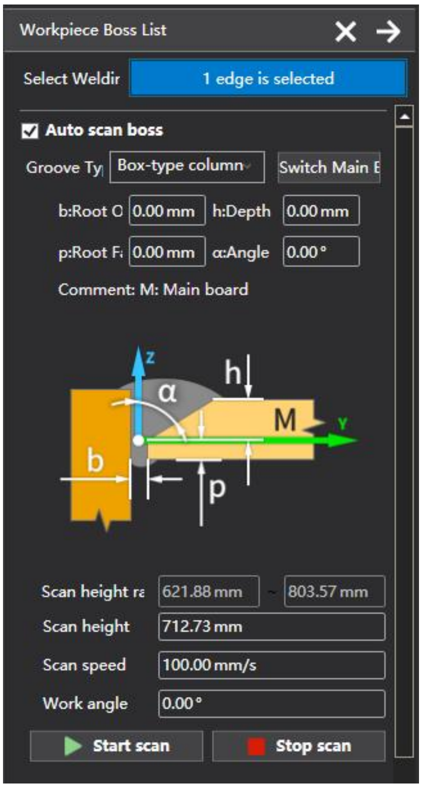

Figure 9-11 Auto scan boss settings

2. Manual Boss Teaching:

   a. Check ***Manually add boss face*** to open the manual teaching interface.

   b. Jog the robot to the boss location, and record coordinates.

   c. The boss appears as a white rectangle in the model (recommended slightly higher than actual boss for safer path planning).

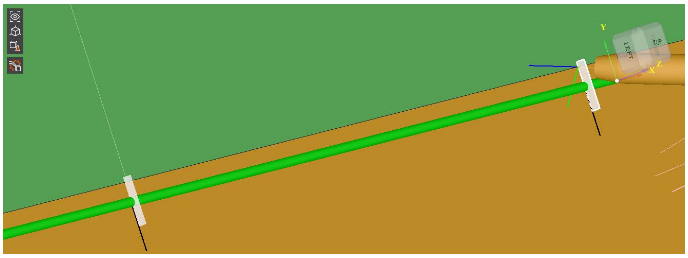

Figure 9-12 Boss setting succeed

9.5 Seam Tracker Protective Lens Check

Contamination on the seam tracker protective window/lens may cause recognition errors or scanning failure. Regular inspection is recommended. Lens checking steps:

Step 1 Go to *Tool* → *Seam Tracker Protective Lens Check*.

Step 2 Select the marker type.

Step 3 Jog the robotic arm so that the end of the torch reaches the marked point position, with the bottom face of the seam tracker as parallel as possible to the horizontal plane. Then click *Record Coordinates*.

1. Triangular (Pyramid) Marker: Tip of the prism.

2. Disc Marker: Center of the disc.

Step 4 Click *Start* to begin the automatic protective lens check.

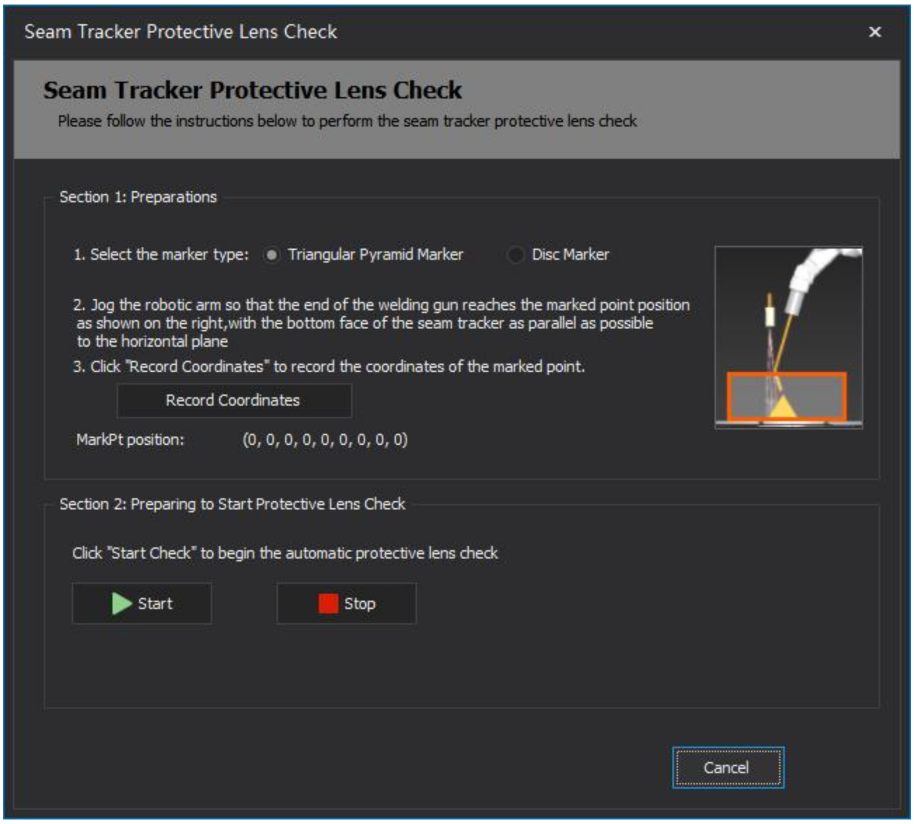

Figure 9-13 Seam tracker protective lens check

9.6 Machining Information

Step 1 In *Global Parameters*, enable *Time estimation before processing*.

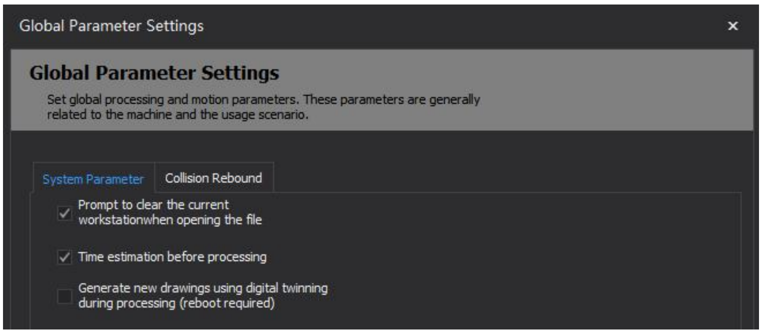

Figure 9-14 Global parameter settings

Step 2 In the *View* menu, click *Statistics* to open the processing statistical information for real-time monitoring.

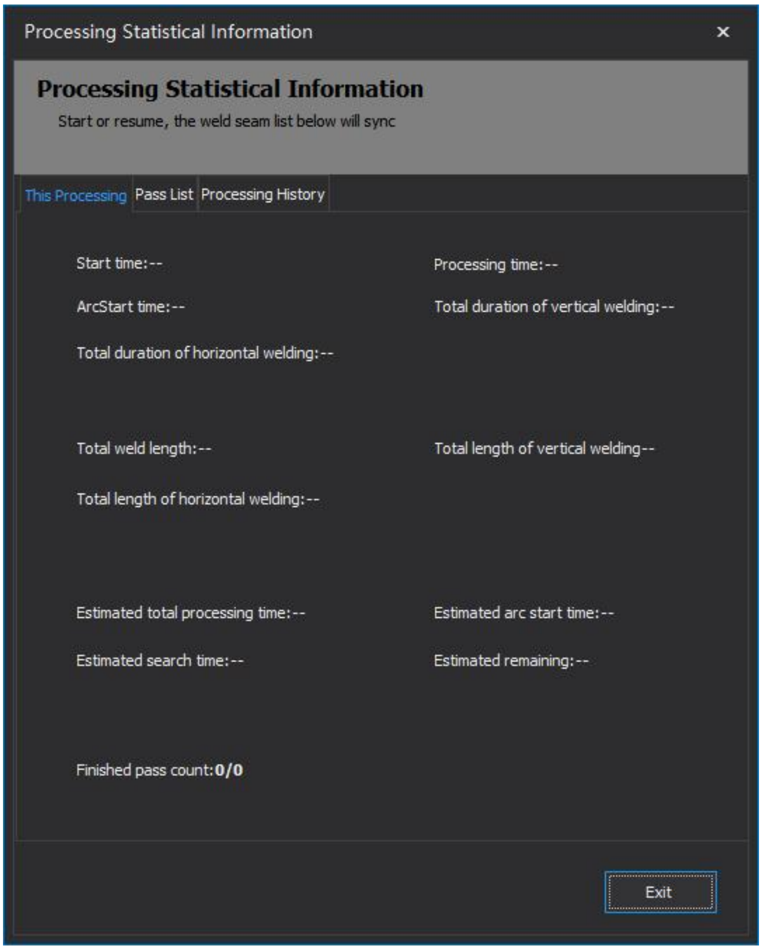

Figure 9-15 Processing statistical information

Chapter 10 Auxiliary Tools

10.1 Measure

Right-click and select ***Measure*** to measure the distance between two points, or directly select a line to measure.

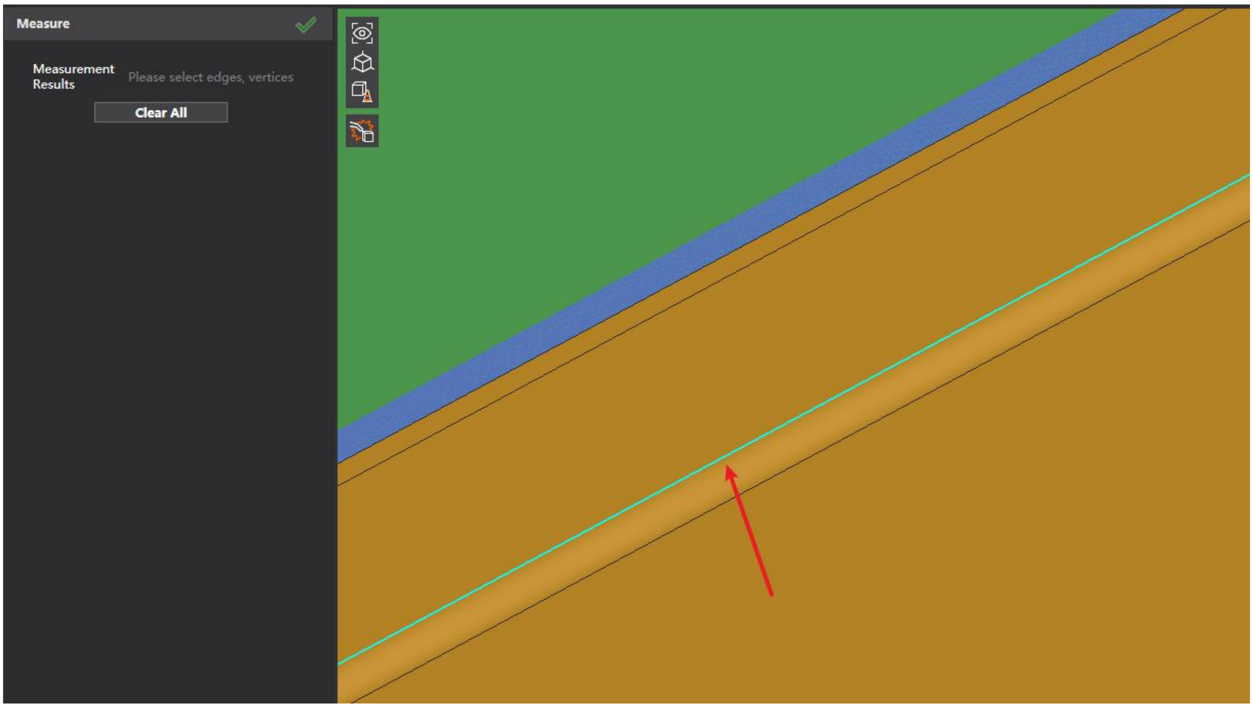

Figure 10-1 Measure

10.2 Select Point

Right-click and select ***Select Point*** to choose a specific point. A system dialog will display the coordinates of the selected point and prompt whether to move to that point. Click ***OK*** to move the robot tip to the selected location. This function is generally used during initial positioning error measurement.

10.3 Arc Start Debugging

Arc start debugging is used to adjust welding parameters. The operation steps are as follows:

Step 1 Confirm that the software is ready and the robotic arm TCP has moved to the starting position for welding.

Step 2 Select the welding movement direction as required.

Step 3 Enter weld path length, set teaching end, and define in-place welding direction.

Step 4 Set the welding procedure parameters and determine if the actual arc start is required.

Step 5 Click ***Start*** to begin arc start debugging.

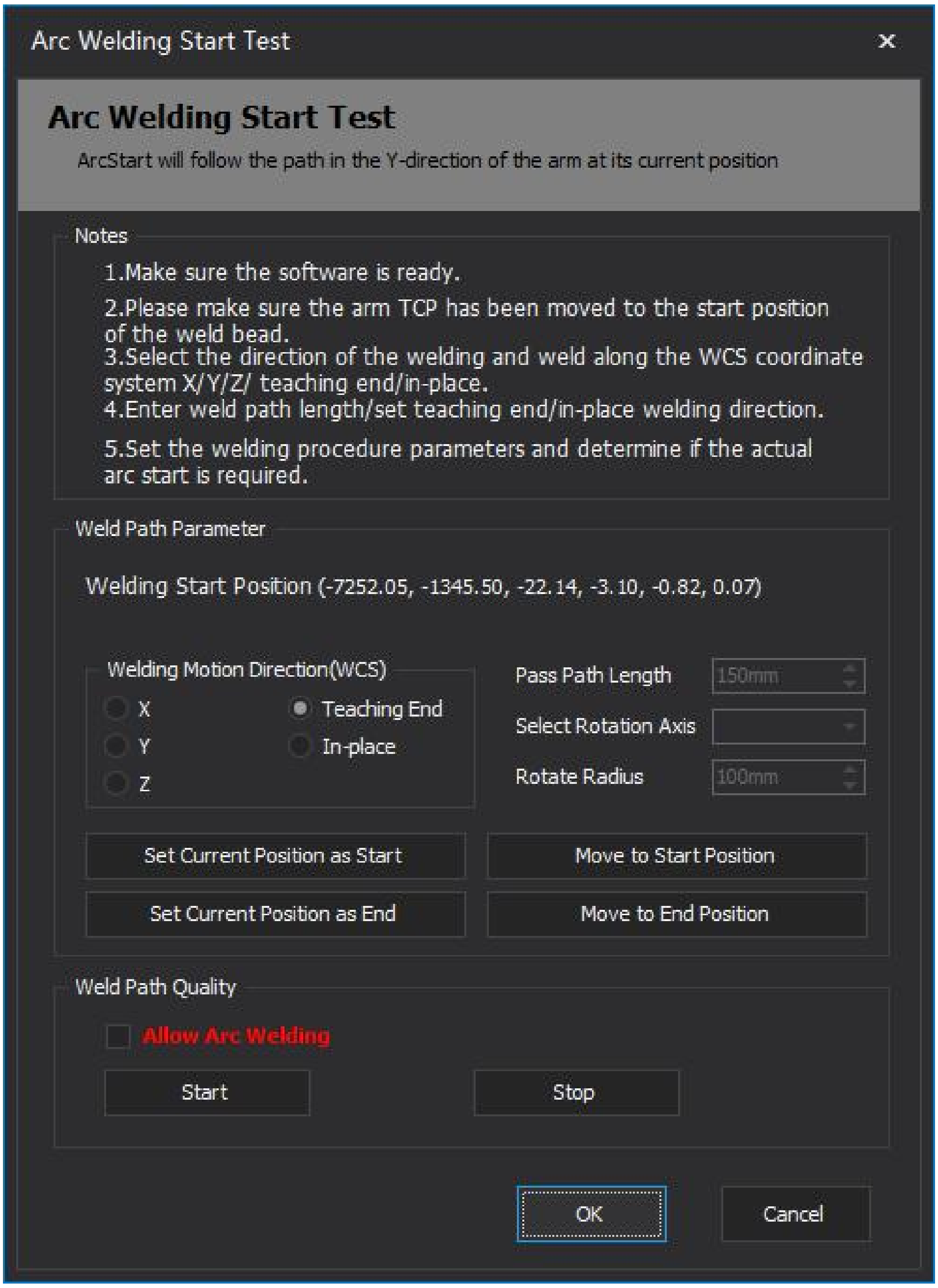

Figure 10-2 Arc start debugging

10.4 Sectional Continuous Welding Debugging

For welds that cannot be automatically recognized by the software, a manual teaching method can be used to set the welding path and perform welding operations. The operation steps are as follows:

Step 1 Make sure the software is ready, and the robotic arm is in a safe position, ensuring no interference during motion.

Step 2 Make sure you have recorded at least two teaching points.

Step 3 Set the welding procedure parameters and determine if the actual arc of the welder is required.

Step 4 Click ***Start*** to begin the sectional continuous welding debugging.

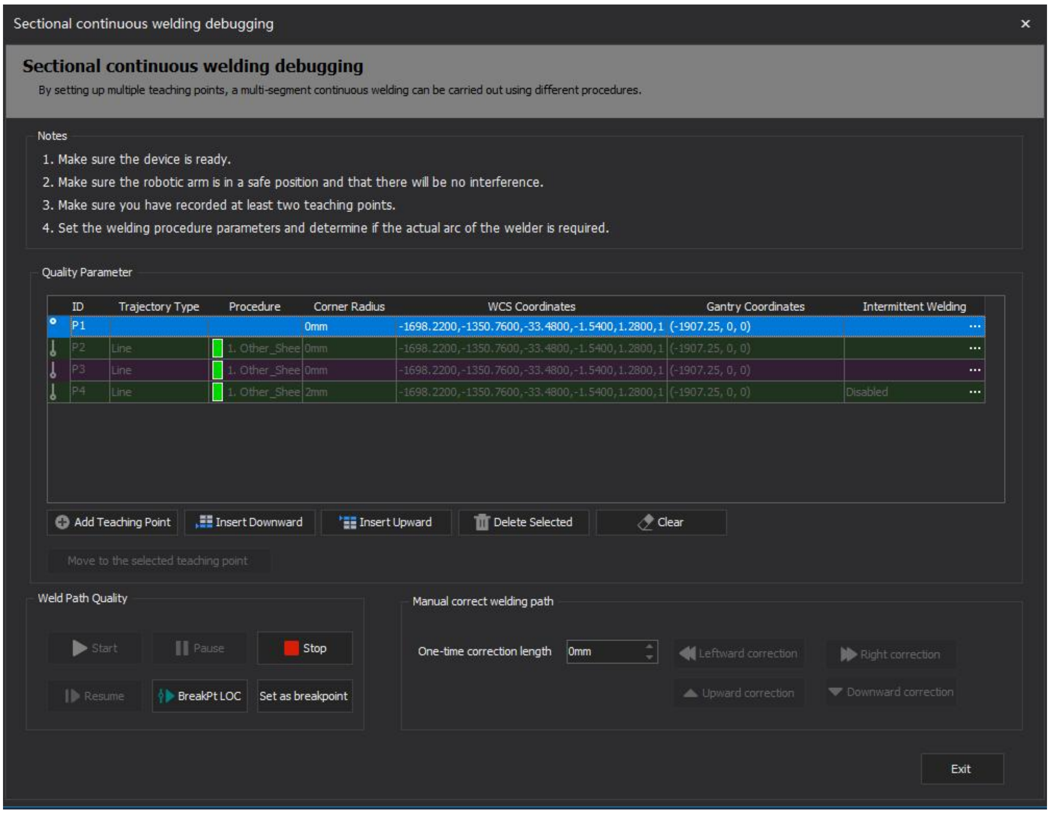

Figure 10-3 Sectional continuous welding debugging

10.5 System Delay Measurement

Step 1 Navigate to ***Tool*** → ***Parameter Settings*** → ***System Delay Measurement*** and ensure all axes have returned to zero position.

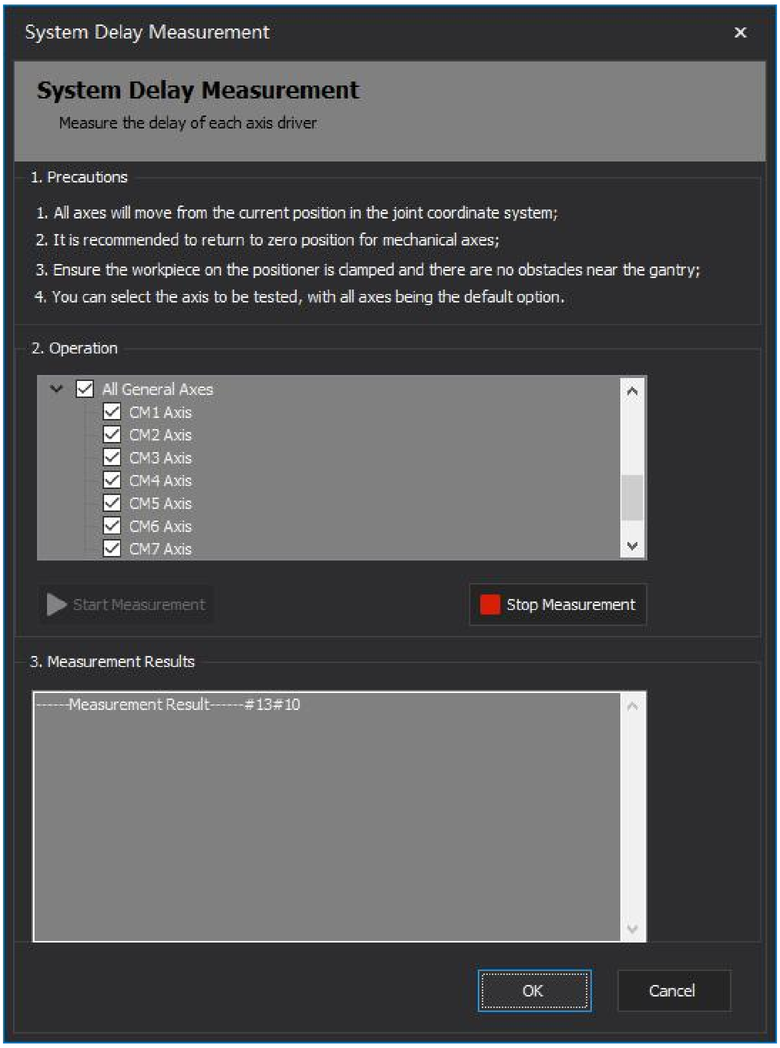

Figure 10-4 System delay measurement

Step 2 Ensure there are no obstacles near the gantry. You can select the axis to be tested, with all axes being the default option. Then, click ***Start Measurement***.

Step 3 The ***Measurement Results*** box will display the calibrated delay for each axis. If "Calculation Result Available" is shown, the measurement is successful.

Step 4 Compensate. Go to ***Procedure Parameter → Global Procedure → Arc Tracking***, enter the system delay measured in Step 3 into ***Phase delay in sampling***.

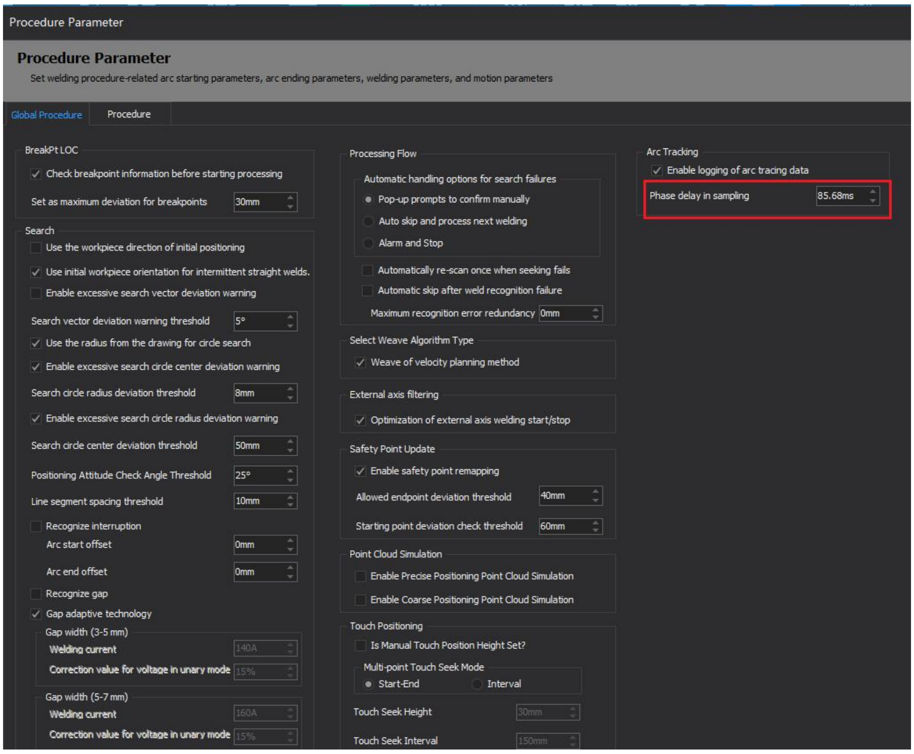

Figure 10-5 Phase delay sampling

⚠ Notice: System delay measurement may result in the following situations:

1. No result: Caused by inconsistent speed units between the drive and software. Change the drive encoder type to match the speed units.

2. Result unusable: Axis delays are inconsistent. Adjust drive delays (consult the drive manufacturer). Axial errors must be within 5 ms.

3. Usable result: Enter the final measured value into ***Phase delay in sampling***. For Aotai welders, add 40 ms to the final value before entering.

10.6 Robot Identification

Robot identification currently supports upright mounting only. The operation steps are described as follows:

Step 1 Open ***Platform Configuration Tool*** → ***Layout Config*** → ***Robot Configuration***. Select the correct robot model for ***Dynamic Model***.

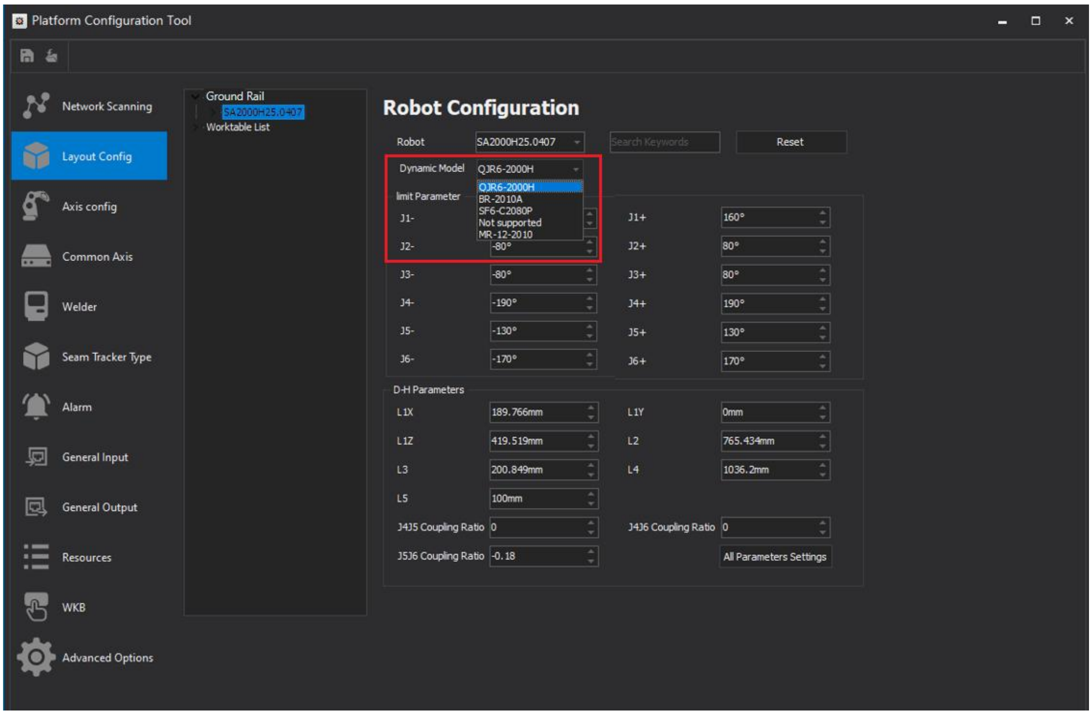

Figure 10-6 Dynamic model setting

Step 2 Move the robot to a clear space and rotate the J1 axis to ensure no obstacles in front or behind the robot.

Step 3 In the settings panel, click ***Global Parameter*** to open the ***Global Parameter Settings*** interface, and enable ***Expert mode***. Click ***Robot Arm***, and set ***Trajectory motion speed limit*** to 10 RPM for all axes. Restore previous values after identification.

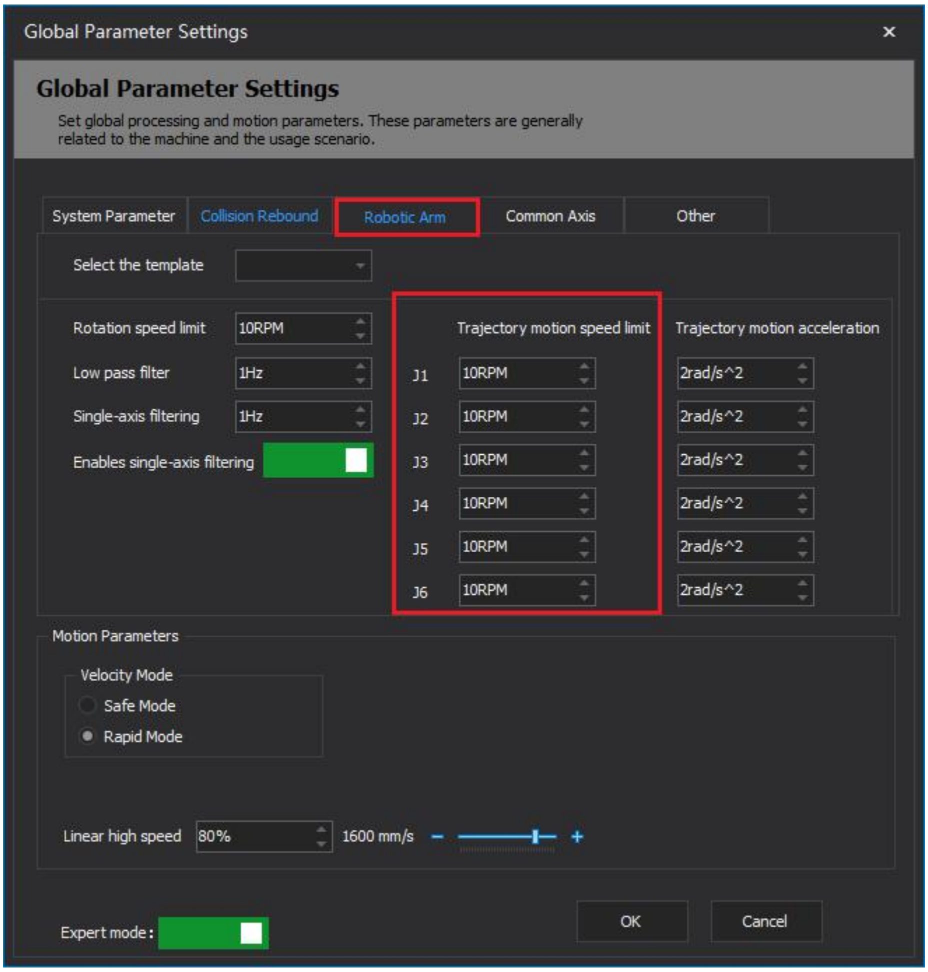

Figure 10-7 Set trajectory motion speed limit

Step 4 Navigate to ***Tool*** → ***Parameters Settings*** → ***Robot Identification***, and click ***Record Home Position and Start Auto-Selection***.

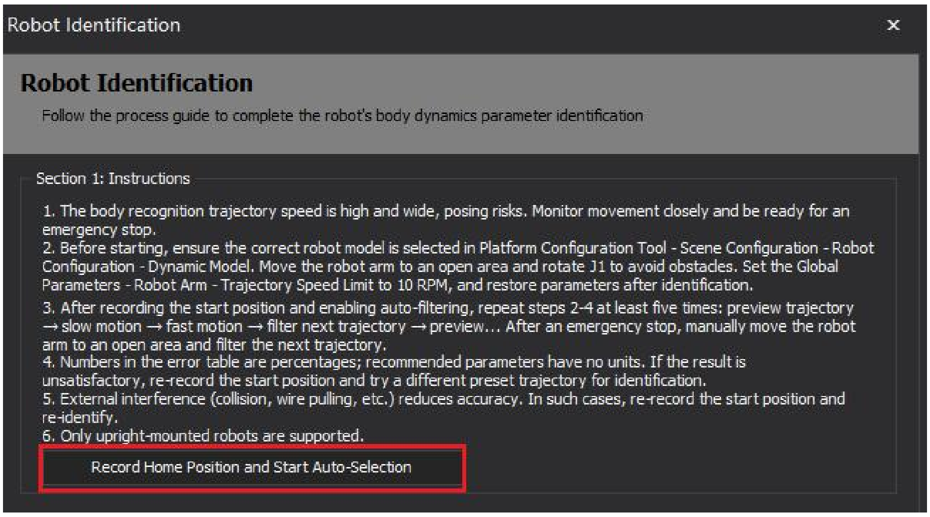

Figure 10-8 Record home position and start auto-selection

Step 5 Click ***Preview trajectory*** to generate a yellow trajectory on the model.

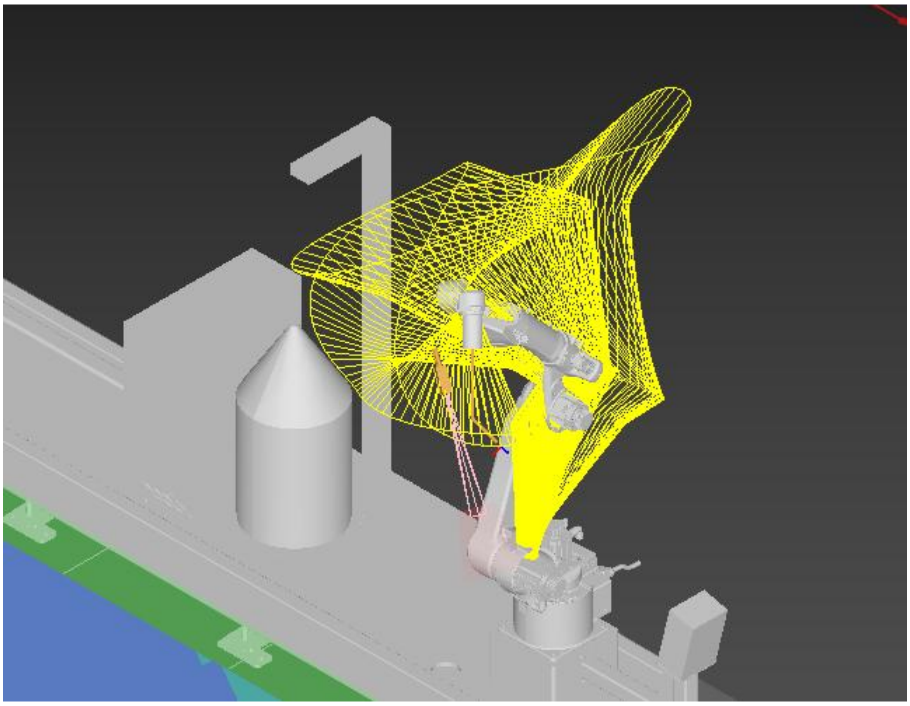

Figure 10-9 Preview trajectory

Step 6 Click ***Start Slow Motion***. After completion, click ***Start Fast Motion***.

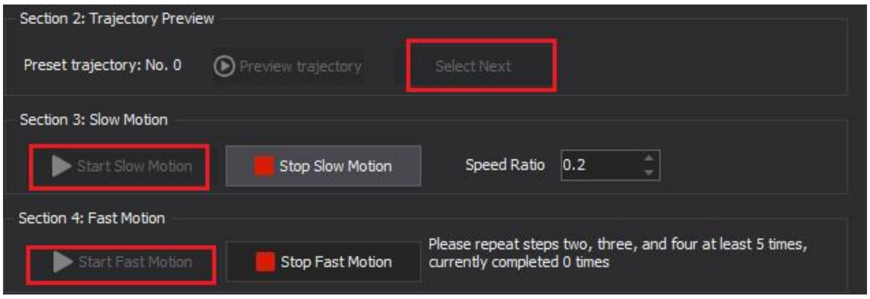

Figure 10-10 Slow/Fast motion

Step 7 After fast motion, click ***Select Next*** and repeat steps 5 to 6 at least five times.

Step 8 Click ***Calculate Errors*** and then perform ***Apply dynamic parameters*** to complete body identification.

⚠ Caution:

1. Due to high speed and large coverage of the identification trajectory, there is a potential safety risk. Closely monitor the robot's motion and be prepared to use the emergency stop.

2. Units in the error analysis table are percentages; recommended parameters are unitless.

3. If results are unsatisfactory, re-record the start position or try a different preset trajectory.

4. External interference (collision, cable pull, etc.) may reduce identification accuracy. In such cases, re-record the start position and perform a second identification.

10.7 Friction Identification

The operation steps for robot friction identification are described as follows:

Step 1 Navigate to ***Tool*** → ***Parameters Settings*** → ***Friction Identification***, and click ***Return Zero***.

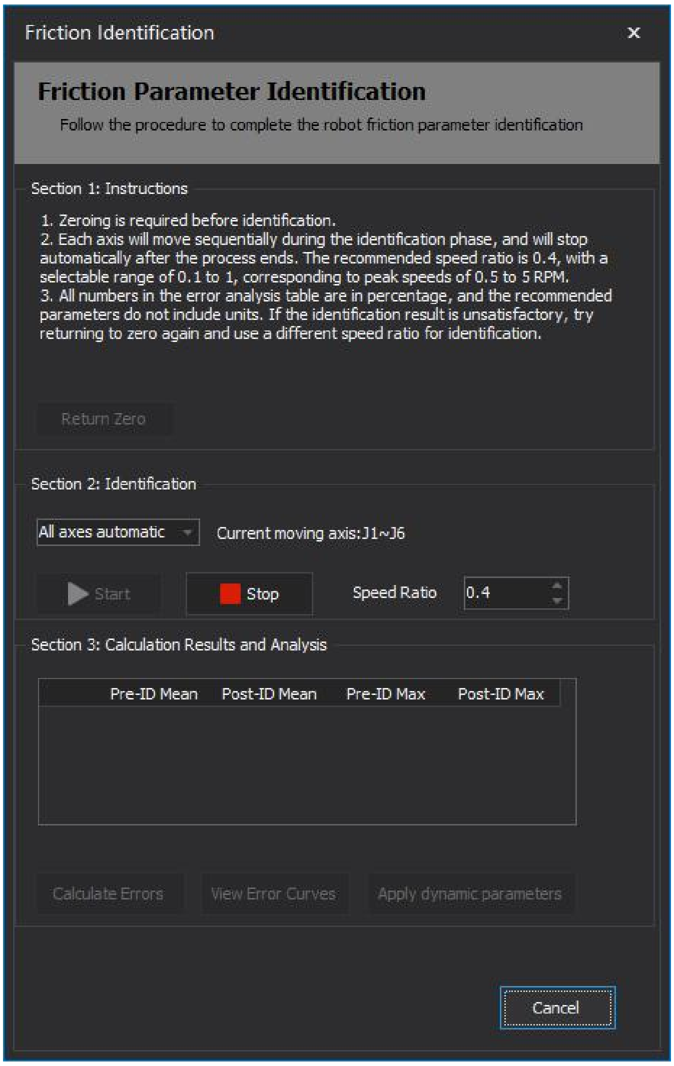

Figure 10-11 Friction identification

Step 2 Click ***Start***. During identification, all axes move sequentially. The process stops automatically after completion.

Step 3 Click ***Calculate Errors***. If satisfactory, perform ***Apply dynamic parameters*** to complete friction identification. If not, reperform ***Return Zero*** and try different ***Speed Ratio*** values.

10.8 Nozzle/Collision Box Parametric Modeling

CypWeld supports parametric modeling of the welding nozzle. After modeling, the software automatically generates model redundancy, facilitating physical collision calculations and smoothness levels in welding procedure parameters.

The steps for the nozzle parametric modeling are described as follows:

Step 1 Go to ***Offline Programming Parameter*** → ***Nozzle Parametric Modeling***.

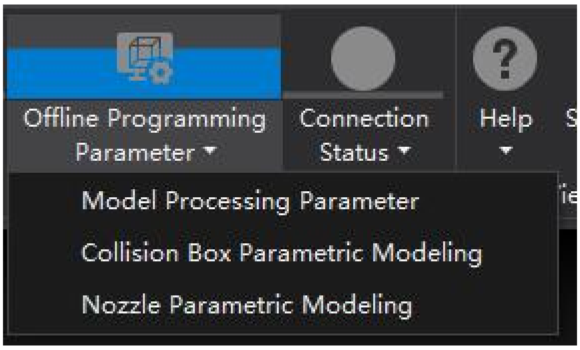

Figure 10-12 Nozzle parametric modeling entrance

Step 2 Fill in the nozzle model parameters on the left according to the diagram on the right of the function page.

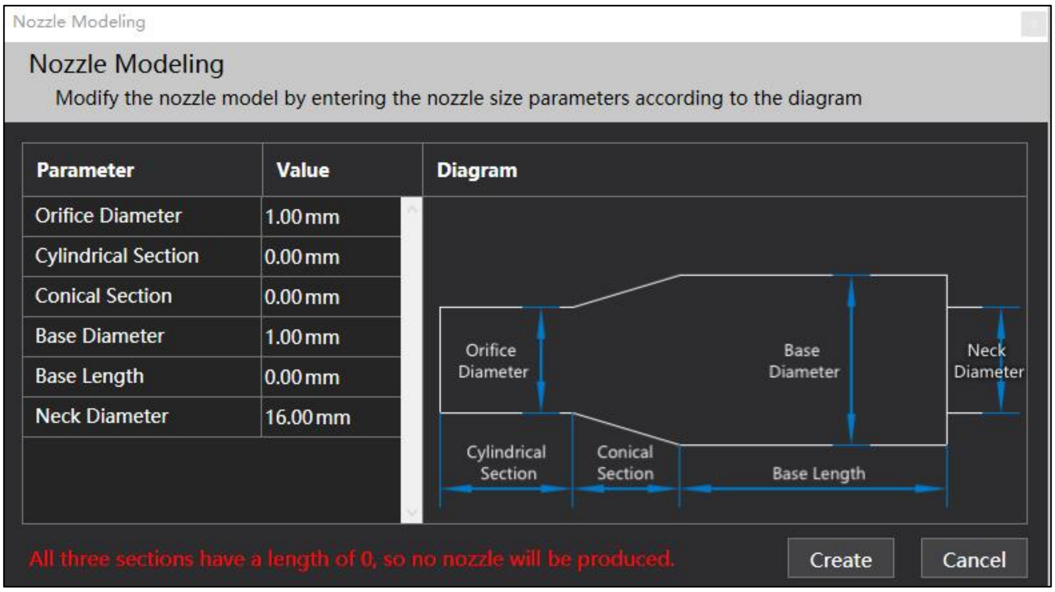

Figure 10-13 Nozzle parametric modeling interface

Step 3 Click ***Create*** to automatically include the nozzle model parameters in calculations.

The steps for the collision box parametric modeling are described as follows:

Step 1 Go to *Offline Programming Parameter→ Collision Box Parametric Modeling*.

Step 2 Set the collision box dimensions in a stepwise manner. By default, each layer is a cylinder defined by height and base diameter. Each layer is configured left to right, corresponding to the dimension table from top to bottom.

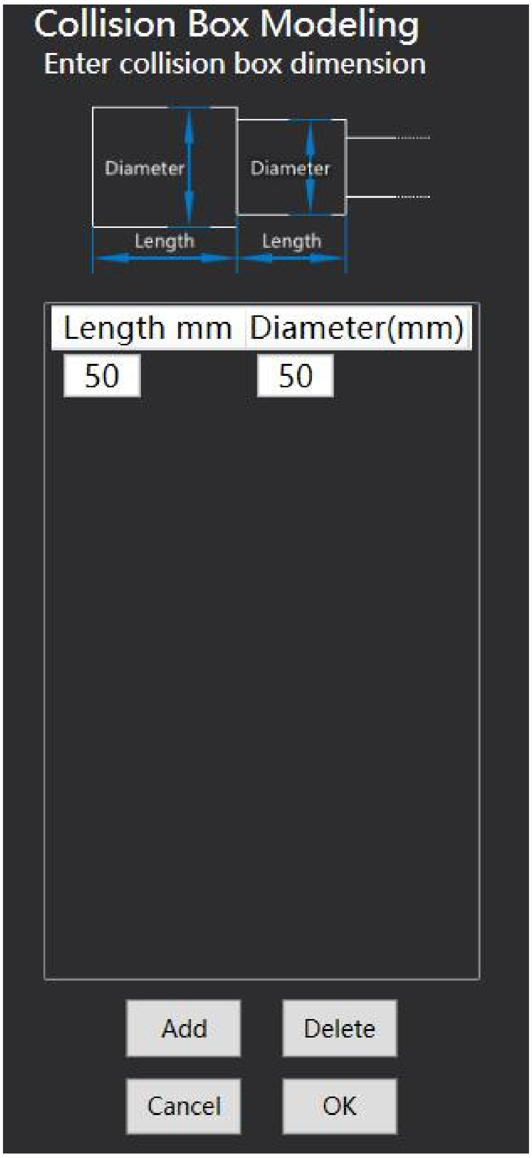

Figure 10-14 Collision box parametric modeling

Step 3 At the bottom of the ***Collision Box Modeling*** page, ***Add*** is used to add a cylinder layer; ***Delete*** is used to remove the selected layer and its dimension data. After completing parameter setup, click *OK* to finalize collision box modeling.

10.9 Monitoring Tool

10.9.1 Extension Board Monitoring

Used to monitor all I/O signals and provide test functionality for each axis. Navigate to *Tool→ Monitoring Tools→ Extension Board Monitoring*.

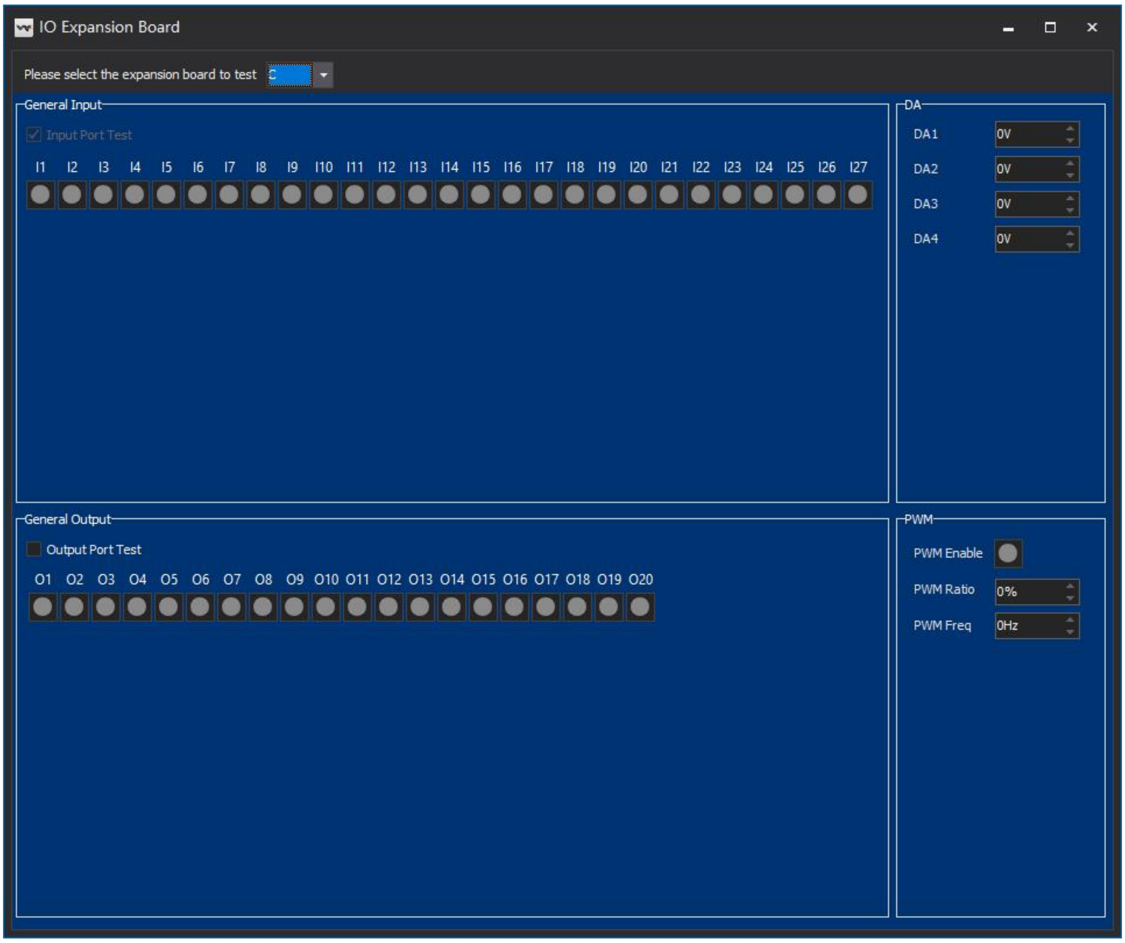

Figure 10-15 Extension board monitoring

10.9.2 Real-time Curve Monitoring

Used to monitor parameter feedback during the welding process, such as arc tracking cycles and real-time welding current. Navigate to ***Tool → Monitoring Tool → Real-time Curve Monitoring***.

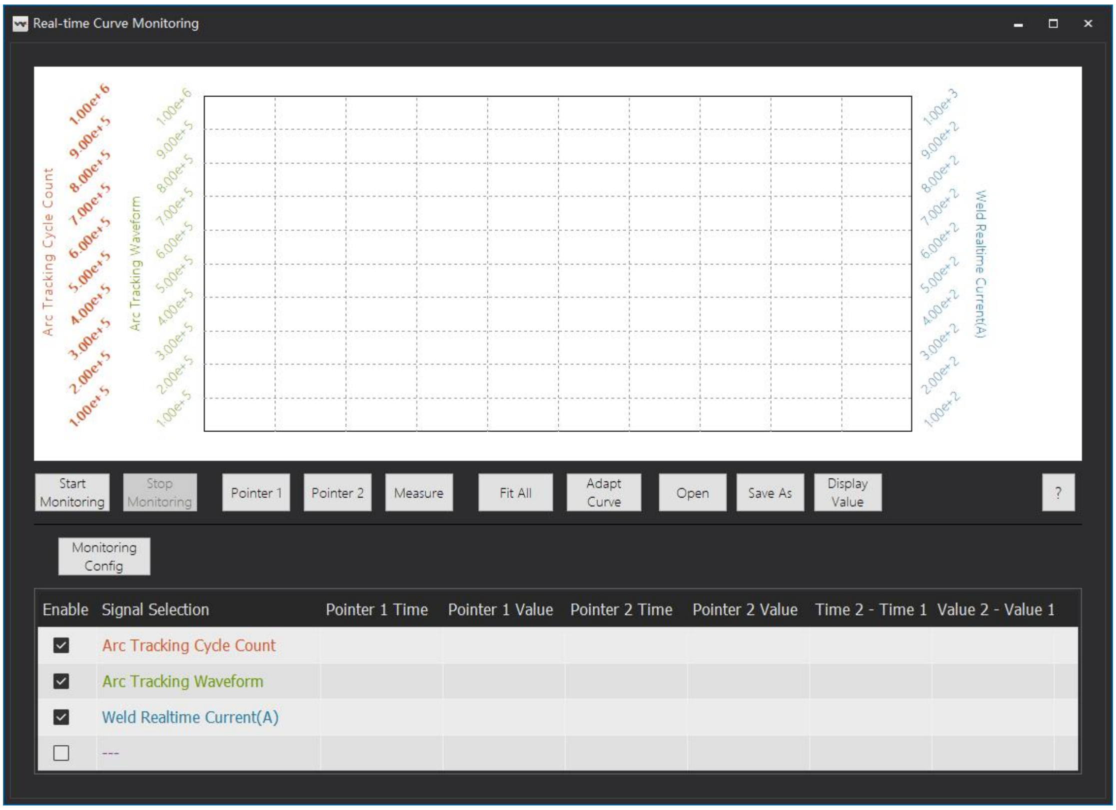

Figure 10-16 Real-time curve monitoring

10.9.3 Motion Control Monitoring

Used to monitor real-time motion status and servo information of the robot's six axes and external axes. This tool also allows setting the zero point of the external axis or the robot body's six axes. Navigate to *Tool* → *Monitoring Tool* → *Motion Control Monitoring*.

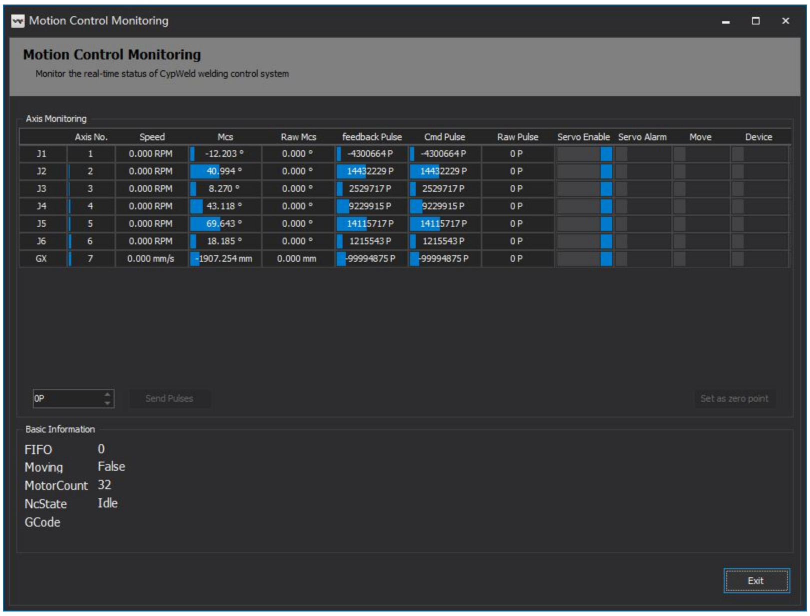

Figure 10-17 Motion control monitoring

10.9.4 Servo Alarm Information

Used to view detailed servo alarm information. Navigate to *Tool* → *Monitoring Tool* → *Servo Alarm Info*.

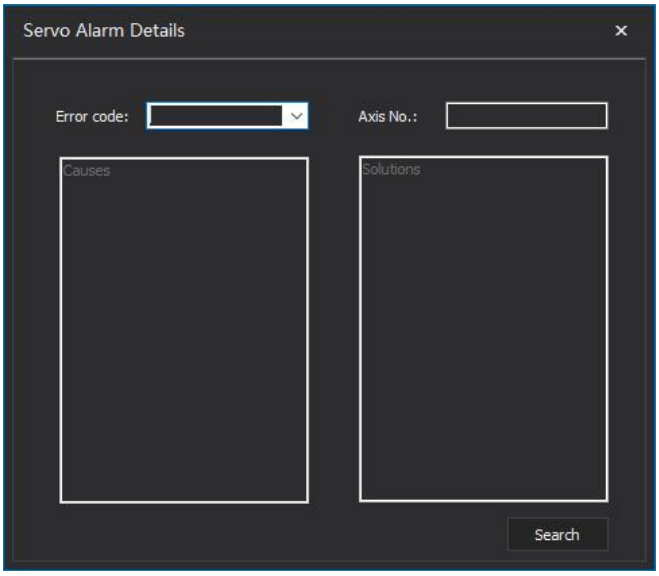

Figure 10-18 Servo alarm information

10.9.5 Welding Monitoring

Used to monitor welding track abnormalities and welding current status. Navigate to ***Tool → Monitoring Tool → Welding Monitoring***.

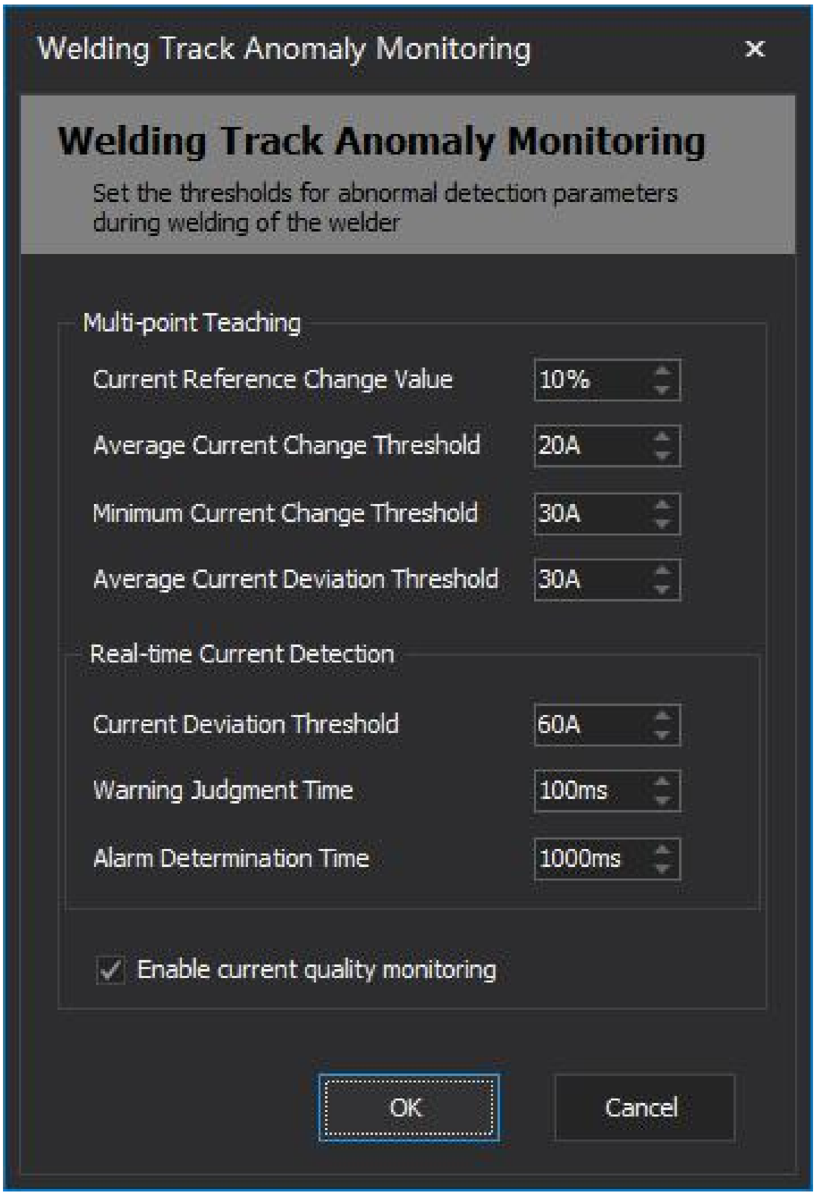

Figure 10-19 Welding monitoring

Chapter 11 Parameter Description

11.1 Offline Programming Parameter

11.1.1 Refer Search

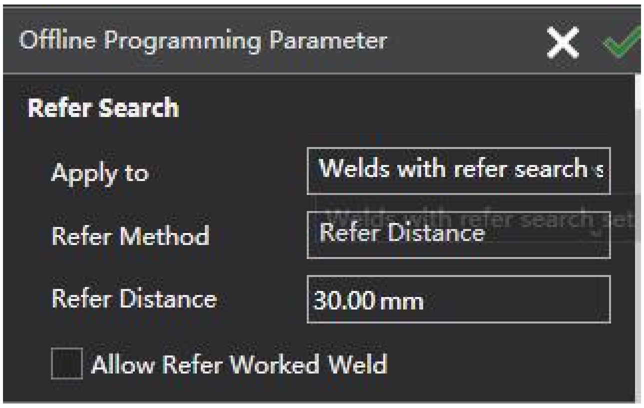

Figure 11-1 Refer search

The parameters are described in the following table:

Table 11-1 Refer Search Parameter Description

Parameter	Description
Apply to	● All Welds: Applies globally to all welds. ● Welds with refer search set: Applies only to welds where ***Weld Editing*** → ***Search Method*** is set to ***Refer Search***.
Refer Method	● Direct Reference: Multiple weld seams with the same start point require scanning only once. ● Distance Reference: Other weld seams within the configured reference distance can share the reference.
Refer Distance	Defines the allowable distance range for reference. Other weld seams within this distance can use the reference.

11.1.2 Collision Detection

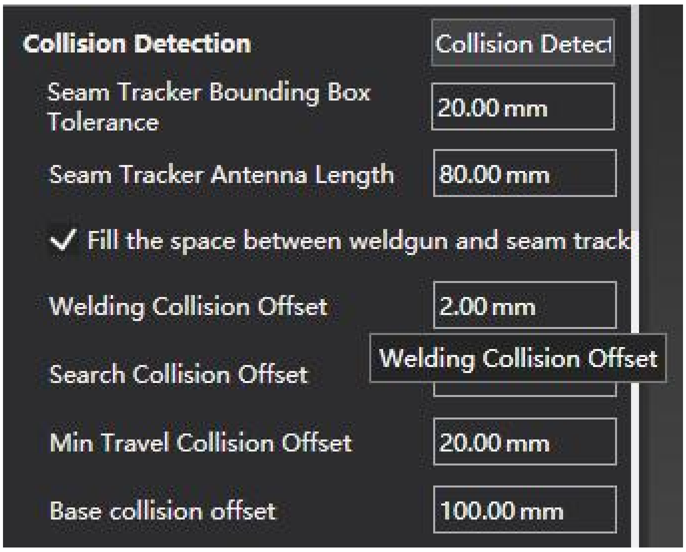

Figure 11-2 Collision detection

The parameters are described in the following table:

Table 11-2 Collision Detection Parameter Description

Parameter	Description
Seam Tracker Bounding Box Tolerance	Defines the bounding box size of the seam tracker, used for collision detection of the seam tracker model.
Seam Tracker Antenna Length	Sets the antenna length of the seam tracker. This simulates the tracker's signal cable for obstacle avoidance calculations during welding in narrow areas. See Figure 11-3 for reference.
Fill the space between torch and seam tracker	By default, the gap between the seam tracker and the torch does not allow other models to pass through.
Welding Collision Offset	Defines the offset threshold for collision planning during welding.
Search Collision Offset	Defines the offset threshold for collision planning during searching.
Min Travel Collision Offset	Defines the offset threshold for collision planning during travel.
Base collision offset	When auxiliary equipment such as welders, wire feeders, or electrical cabinets is mounted on the robot base and represented as a single unified model in the digital twin environment, this parameter sets the offset threshold for collision planning.

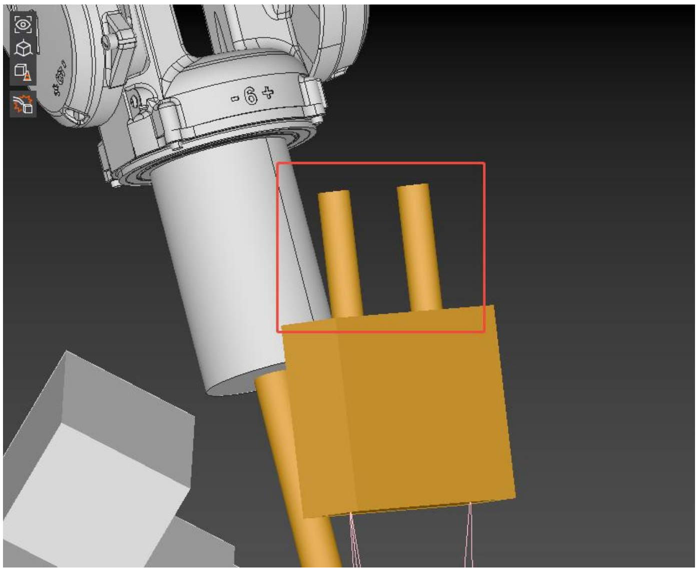

Figure 11-3 Seam tracker antenna length

11.1.3 Seam Tracker Initial Positioning

Figure 11-4 Seam tracker initial positioning

The parameters are described in the following table:

Table 11-3 Seam Tracker Initial Positioning Parameter Description

Parameter	Description
Z-Plane Collision Detection Offset	During initial positioning, the scanning height of the seam tracker is determined by the imported model. Since deviations may exist between the digital model and the actual workpiece, this parameter defines the collision detection offset .
Max feature point error for initial positioning	In the three-point initial positioning function, this sets the error threshold between the teaching points and the model points. If the deviation exceeds this threshold, the calibration will be considered as failed.

11.1.4 Algorithm Branching

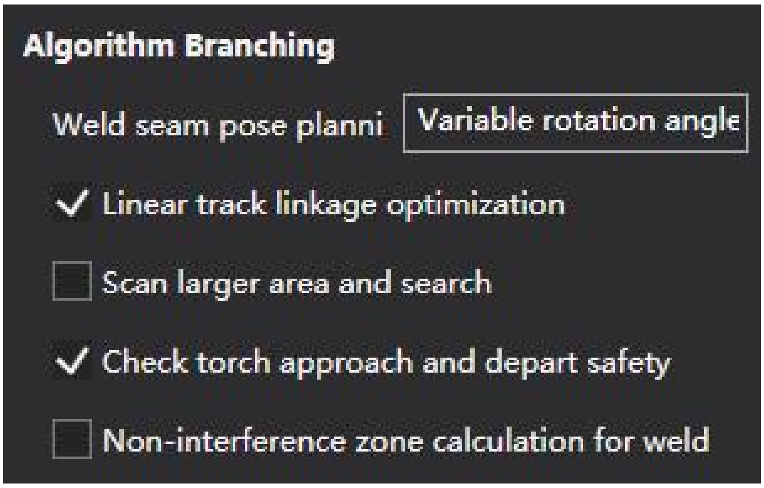

Figure 11-5 Algorithm branching

The parameters are described in the following table:

Table 11-4 Algorithm Branching Parameter Description

Parameter	Description
Weld seam pose planning algorithm	Defines whether the rotation angle is automatically optimized during weld seam editing. This improves planning success rate but may affect weld formation quality.
Linear track linkage optimization	When enabled, the external axis will automatically coordinate during searching if the robot arm's travel is insufficient.
Linear track linkage optimization	When enabled, if the robot arm travel is insufficient during seam tracking, the external axis will automatically be linked for coordinated motion.
Scan larger area and search	When enabled, if the software detects insufficient point cloud data while scanning weld seams on small step surfaces, it will automatically perform an additional scan of the adjacent large surface area to assist recognition.
Non-interference zone calculation for weld	When enabled, the system will automatically generate non-interference toolpaths for partition plate units passing through manholes.

11.1.5 Butt Weld Parameter

Figure 11-6 Butt weld parameter

The parameters are described in the following table:

Table 11-5 Butt Weld Parameter Description

Parameter	Description
Gap Between Two Surfaces	Sets the default gap for butt weld seams.
Height Diff	Sets the default height difference between the two plates on either side of the butt weld.

11.1.6 Search Parameter

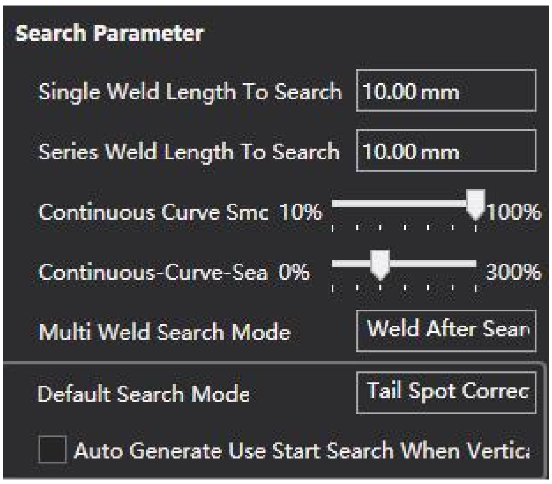

Figure 11-7 Search parameter

The search (precision positioning) parameters are described in the following table:

Table 11-6 Search Parameter Description

Parameter	Description
Single Weld Length To Search	If the single weld length is shorter than this value, ***Refer Search*** will be used by default.

Parameter	Description
Series Weld Length To Search	If the series weld length is shorter than this value, ***Refer Search*** will be used by default.
Continuous Curve Smc	Adjusts the toolpath transition distance before and after corners in continuous curves. A smaller ratio results in sharper tool transitions.
Continuous-Curve-Search Smooth Rate	Optimizes the scanning posture at corners during seam tracking. By adjusting the motion trajectory in advance, it reduces self-occlusion of the workpiece. Increasing this ratio appropriately can help mitigate occlusion issues caused by initial positioning errors or delayed posture adjustment during searching. Default value: 100%.
Multi Weld Search Mode	Defines the seam searching mode for sub-passes in multi-layer multi-pass welding.
Default Search Mode	● Sets the default seam searching method for automatically generated weld seams and manually edited weld seams. Options include ***Start Spot Search***, ***Tail Spot Correction***, and ***Scan Search***. ● When using ***Start Spot Search*** or ***Scan Search***, enabling ***Auto Generate Use Start Search When Vertical Up Wrapping*** allows the system to use start-spot searching for vertical upward corner seams by default, without searching the corners.

11.1.7 Dual-bench Parameter

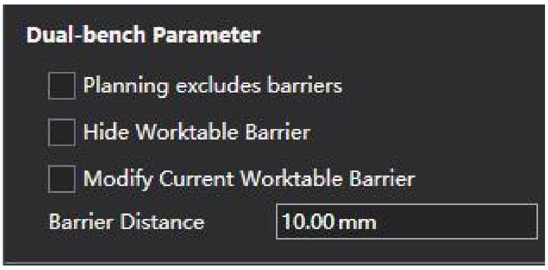

Figure 11-8 Dual-bench parameter

Only to positioners equipped with dual-bench. Details are shown in the following table:

Table 11-7 Dual-Bench Parameter Description

Parameter	Description
Planning excludes barriers	Allows the robot arm to move beyond the workable barriers during path planning.
Hide Workable Barrier	Hides the display of the workable barrier. Collision planning, however, remains active.
Modify Current Worktable Barrier	Adjusts the position of the worktable barrier.

11.1.8 Auto-generated Drawing Parameters

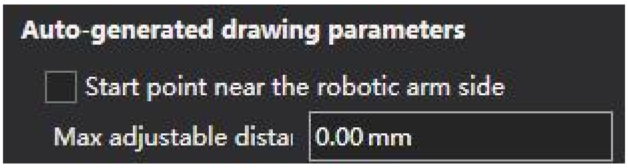

Figure 11-9 Auto-generated drawing parameters

The parameters are described in the following table:

Table 11-8 Auto-Generated Drawing Parameters Description

Parameter	Description
Start point near the robotic arm side	In the auto-generated weld seam function, the weld seam start point is placed on the side closer to the robot by default.
Max adjustable distance	Sets the maximum allowable adjustment distance between the start and end points in the *Procedure Table*.

11.1.9 Box Column Parameters

Figure 11-10 Box column parameters

➢ Minimum weld length: When generating weld seams on box column workpieces, this parameter defines the shortest allowable weld seam length.

11.1.10 Scallop Parameters

Figure 11-11 Scallop parameters

➢ Auto scallop joint: When enabled, seams interrupted by scallops will be automatically joint. During manual seam generation or automatic drawing (excluding tower-foot automatic drawing and batch mode), the system sets the three-plane start/end points according to the seam interruption length caused by partitions. This option is disabled by default. When enabled, the default value is 25 mm.

11.2 **Global Procedure Parameter**

11.2.1 BreakPtLOC

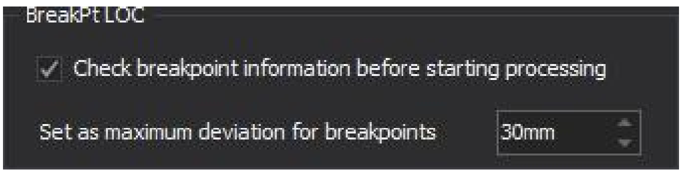

Figure 11-12 Breakpoint location

The parameters are described in the following table:

Table 11-9 BreakPtLOC Parameter Description

Parameter	Description
Check breakpoint information before starting processing	When enabled, the software will prompt a pop-up before each processing cycle if breakpoint information exists, asking whether to continue from the current position.

Parameter	Description
Set as maximum deviation for breakpoints	Defines the maximum allowable TCP relocation distance when setting a new breakpoint for reprocessing. This value must remain within a strict safety range. Exceeding this distance may cause significant deviation from the original weld seam position, resulting in collision risks.

11.2.2 Arc Tracking

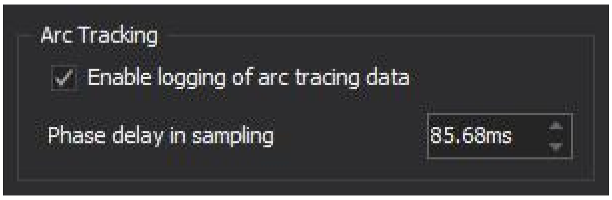

Figure 11-13 Arc tracking

The parameters are described in the following table:

Table 11-10 Arc Tracking Parameter Description

Parameter	Description
Enable logging for arc tracing data	When enabled, the software automatically records arc tracking data during the welding process (recommended).
Phrase delay in sampling	After performing System Delay Measurement, the delay data is entered here to compensate for the arc tracking sampling delay.

11.2.3 Search

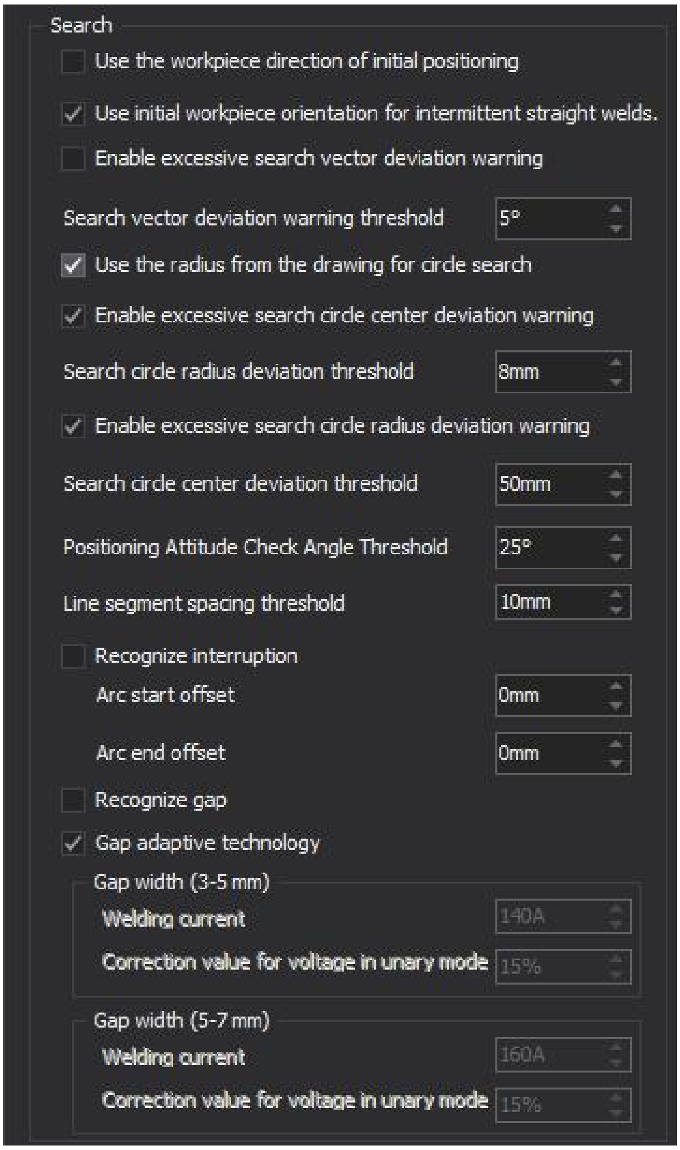

Figure 11-14 Search parameters

The parameters are described in the following table:

Table 11-11 Search Parameter Description

Parameter	Description
Use the workpiece direction of initial positioning	When enabled, ***Search*** (precision positioning)will only be applied at the weld start point. The welding direction will be determined by 3D model data and initial positioning results.
Use initial workpiece orientation for intermittent straight welds	When enabled, during intermittent straight welds, the welding direction will not follow ***Search*** (precision positioning) results, but instead use 3D model data and initial positioning results.

Parameter	Description
Enable excessive search vector deviation warning/Search vector deviation warning threshold	When enabled, if the detected welding direction vector from the precision positioning scan deviates from the model beyond the set threshold, the software will trigger an alarm.
Use the radius from the drawing for circle search	When enabled, circular weld paths (arc radius) will not be fitted based on scan results but will follow model data. CAD/model data consistency must be ensured.
Enable excessive search circle radius deviation warning/Search circle radius deviation threshold	When enabled, if the fitted circular radius from vision scanning deviates from model data beyond the threshold, the software will trigger an alarm.
Enable excessive search circle center deviation warning/Search circle center deviation threshold	When enabled, if the fitted circular center position from vision scanning deviates from model data beyond the threshold, the software will trigger an alarm.
Line segment spacing threshold	In continuous welding with corner-seam positioning enabled, if the detected corner position deviates from model data beyond the threshold, the syoftware will trigger an alarm.
Recognize interruption	When enabled, for discontinuous welds, the software will automatically end/restart the arc before and after each gap, skipping the interval to enable a continuous welding workflow.
Arc start offset	Offset distance for starting the arc after an interruption in discontinuous welds.
Arc end offset	Offset distance for ending the arc before an interruption in discontinuous welds.
Recognize gap	● When enabled, the software can automatically detect gaps between horizontal and vertical plates in fillet welds and apply adaptive filling. ● On the weld seam editor page, when ***Fill Weld Gap*** is enabled, the software will enforce scanning-based seam tracking for gap recognition and filling during welding.

11.2.4 Processing Flow

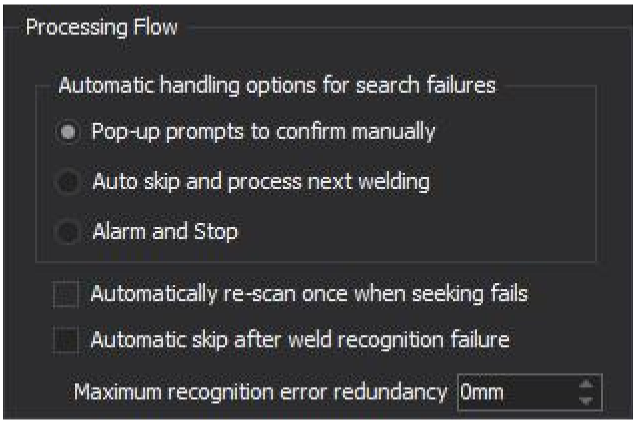

Figure 11-15 Processing flow

The parameters are described in the following table:

Table 11-12 Processing Flow Parameter Description

Parameter	Description
Automatic handling options for search failures	Defines the handling mode when fine positioning fails. The software provides three options: ● Pop-up prompts to confirm manually: The operator manually selects the next action (manual positioning/point-cloud selection/skip seam/stop processing). ● Auto skip and process next welding: The software automatically skips the current seam and proceeds to the next weld task. ● Alarm and Stop: The software immediately triggers an alarm and halts processing.
Automatically re-scan once when seeking fails	When enabled, if precise positioning fails on the first attempt, the software will re-scan the same seam using the same method.
Automatic skip after weld recognition failure	When enabled, if the precise positioning result is too close to the worktable (below a defined threshold), the software will treat it as a failure and display a prompt. This is applicable when the workpiece is directly placed on the table surface.
Maximum recognition error redundancy	Defines the maximum allowable distance between the precise positioning result and the worktable.

11.2.5 Select Weave Algorithm Type

Figure 11-16 Select weave algorithm type

- Weave of velocity planning method: When enabled, activates an optimized weaving motion. By applying filtering, the weaving movement is stabilized and smoothed (recommended to enable).

11.2.6 External Axis Filtering

Figure 11-17 External axis filtering

- Optimization of external axis welding start/stop: When enabled, improves external axis filtering. In scenarios with frequent start-stop movements, this reduces vibration caused by insufficient rigidity of the external axis (recommended to enable).

11.2.7 Safety Point Update

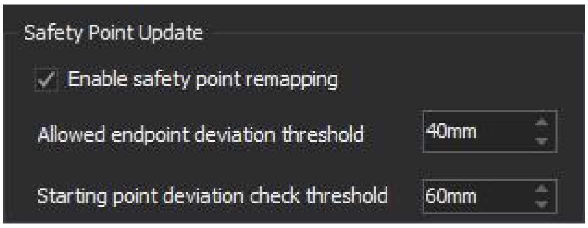

Figure 11-18 Safety point update

The parameters are described in the following table:

Table 11-13 Safety Point Update Parameter Description

Parameter	Description
Enable safety point remapping	During arc-tracking correction, if the actual seam end position deviates from the model beyond the set threshold, the software will automatically offset the torch lift safety point to the calculated position adjusted by arc-tracking results.
Allowed endpoint deviation threshold	If the actual seam end deviates from the model end beyond this threshold, the software will trigger an alarm notification.

11.2.8 Point Cloud Simulation

Figure 11-19 Point cloud simulation

The parameters are described in the following table:

Table 11-14 Point Cloud Simulation Parameter Description

Parameter	Description
Enable Precise Positioning Point Cloud Simulation	In Demo mode, external point cloud data can be imported for simulation (for BOCHU R&D use only).
Enable Coarse Positioning Point Cloud Simulation	In Demo mode, external point cloud data can be imported for simulation (for BOCHU R&D use only).

11.2.9 Touch Positioning

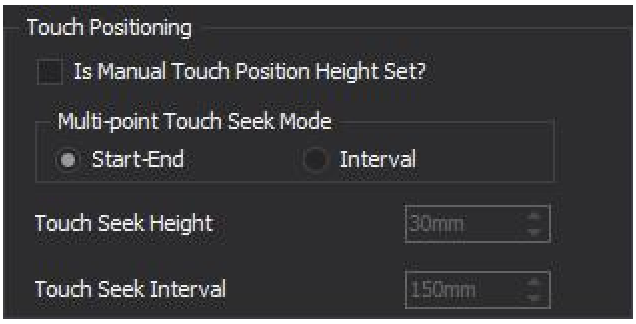

Figure 11-20 Touch positioning

Refers specifically to wire-based bevel touch sensing, not nozzle sensing. Before each use, please perform ***Clean Torch_CutWire***. The parameters are described in the following table:

Table 11-15 Touch Positioning Parameter Description

Parameter	Description
Is Manual Touch Position Height Set?	When enabled, the operator can manually set the touch sensing height, i.e., the linear distance between the touch point and the root of the bevel seam.
Multi-point Touch Seek Mode	Provides two seam calibration methods along the weld direction: ● Start-End: Calibration is performed using only the seam start and end points. ● Interval: Enables the ***Touch Seek Interval*** parameter, allowing calibration at multiple points along the weld at defined intervals.
Touch Seek Height	When manual mode is enabled, defines the linear distance between the wire touch point and the root of the bevel seam.
Touch Seek Interval	Defines the spacing distance between multiple touch sensing operations along the weld direction.

11.3 Point Cloud Reconstruction Parameter

For details, please refer to *CypWeld Intelligent Welding Control Software User Manual - System 3800 Edition*.

11.4 Seam Tracker Debugging Parameter

11.4.1 Roughlocate Parameter Setting

1. GlobalParams

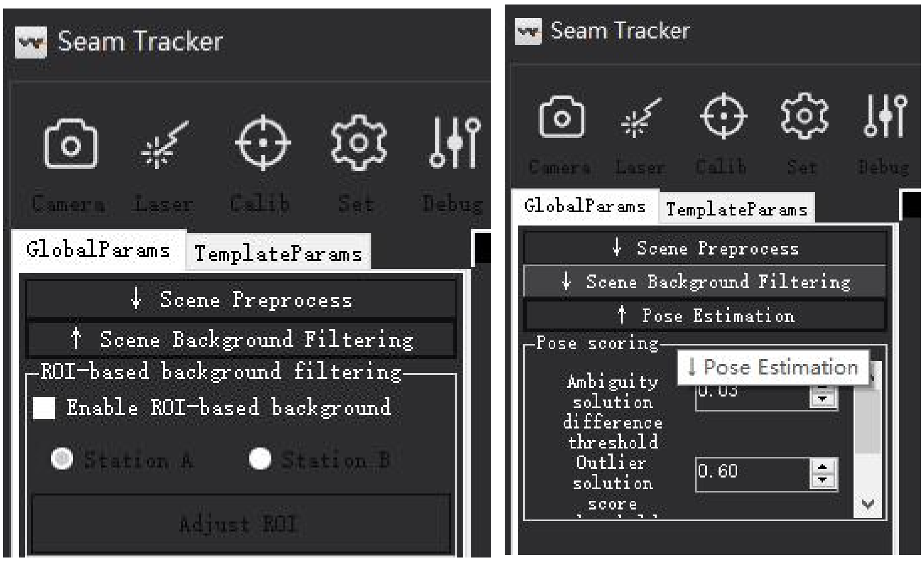

Figure 11-21 Partial global parameters

The parameters are described in the following table:

Table 11-16 Partial Global Parameter Description

Parameter	Description
Enable ROI-based background filtering	Disabled by default. Enable when background point clouds cannot be automatically filtered (e.g., excessive noise, high background points captured, or the workpiece base plate is close to the worktable).
Station A/B Switching	If enabled, the ROI must be assigned to the corresponding station.
Adjust ROI	Before adjustment, an initial positioning scan must be performed. The ROI is then selected based on the scanned point cloud.
Pose scoring: Ambiguity solution difference threshold	If multiple registration results exceed the valid score threshold and their score difference is below this ambiguity threshold, they are treated as ambiguous results. The software will prompt the user to select manually. Default: 0.03 (no change required).

Parameter	Description
Pose scoring: Outlier solution score threshold	If registration scores fall between the valid threshold and outlier threshold, the results are treated as outlier solution score, and a prompt will appear. Default: 0.6. Usually no adjustment is required; lower if initial positioning repeatedly fails.
Pose scoring: Valid solution score threshold	Registration scores above this threshold are treated as valid, and initial positioning succeeds directly. Default: 0.95 (no change required).

2. TemplateParams

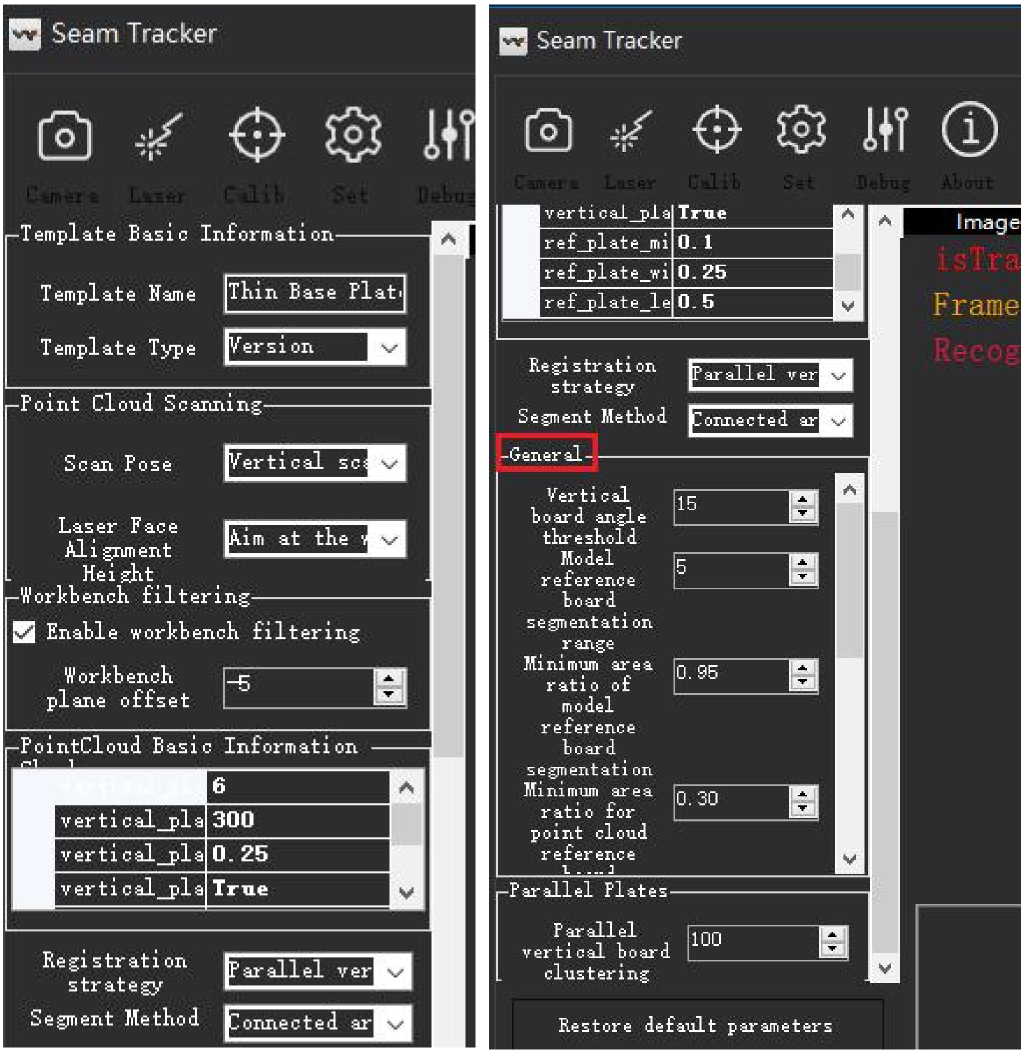

Figure 11-22 Template parameters

The parameters are described in the following table:

Table 11-17 Template Parameter Description

Parameter	Description
Template Type	● Version (General): Templates provided with software installation. Not included in parameter backups. Restored after each installation. ● Site (Dedicated): Templates created per machine. Included in parameter backups and retained after software upgrades.
Scan Pose	● Tilt scan: 45° scanning. Provides wider coverage and less reflection sensitivity, but more occlusion. Suitable for narrow and shallow workpieces. ● Vertical scan: Nearly perpendicular scanning. Less occlusion but narrower coverage, more reflection-sensitive. Suitable for wide and deep workpieces.
Laser Face Alignment Height	Used for path planning to define the optimal viewing distance of the laser plane. ● Align the center: Suitable for H-beams with central features. ● Align the top: Suitable for pipe assemblies, fuel tanks with features located on the top surface. ● Aim at the workbench: Suitable for T-joints and assemblies with bottom features.
Workbench plane offset	Sets an upward offset relative to the CAD worktable height to filter out background point clouds. ● No modification required if reference plate (e.g., H-beam web) is not in contact with the workbench. ● Reduce offset if the reference plate is in direct contact with the workbench (e.g., ship assembly).
Registration strategy	Defines the method of generating feature points for registration. If the reference plate includes a vertical plate, no modification is required. ● Automatic judgment/Non-parallel version/Parallel version: Uses vertical plate point clouds. ● Vertical board + Reference Plate Contour: Uses both vertical plate point clouds and horizontal plate contour point clouds.

Parameter	Description
Vertical board angle threshold	Defines the allowable angular deviation (relative to Z-up axis) for vertical plate recognition. Default: 15°. Increase for highly tilted plates.
Model reference board segmentation range	Height difference range within which surfaces are considered coplanar. Default: 5 (no modification required).
Minimum area ratio for model reference board	Surfaces with an area ≥ given ratio of the largest extracted model board are treated as a candidate reference board. Default: 0.95.
Minimum area ratio for point cloud reference board	Surfaces with an area ≥ given ratio of the largest extracted point cloud plate are treated as a candidate reference plates. Default: 0.3.
Reference board inflection point filtering range	Point clouds above this threshold relative to the reference board are treated as vertical board corner points. Default: 30. Reduce when thin lap plates exist above the reference board.
Reference board extraction algorithm	Algorithm for extracting reference board. Default: RANSAC.
Random sample consensus threshold	Used when RANSAC is selected. Defines allowable vertical fluctuation of the computed plane. Default: 10.
3D Pose Refinement	When enabled, a secondary registration is performed after initial alignment to correct minor pose deviations.
Bottom Surface Strictly Aligned	If the digital twin model is already confirmed to match the actual workpiece orientation, enable this option to reduce computation time and improve accuracy.
Simulation PointCloud RefPlate	During model-based reference plate search, the system uses a discretized simulated point cloud form for reference plate detection.

11.4.2 Weld Recognition Parameter

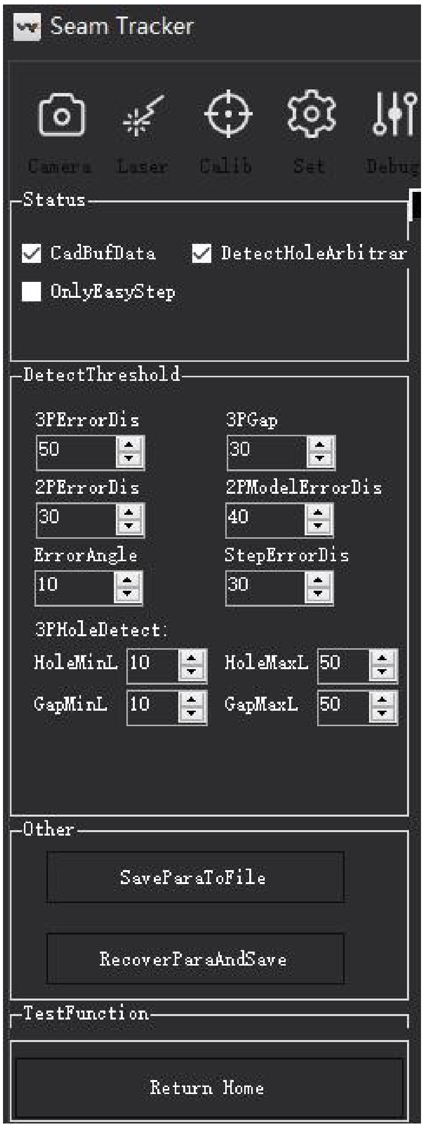

Figure 11-23 Weld recognition parameter

The parameters are described in the following table:

Table 11-18 Weld Recognition Parameter Description

Parameter	Description
CadBufData	Enable *CadBufData*, to generate a buf model file for the vision system to acquire model information.
DetectHoleArbitrary	Enable scan-based search to detect previously welded holes.
OnlyEasyStep	Enable recognition only for right-angle overlaps of single thin sheets.
3PErrorDis	Threshold for the deviation between the start point recognized on three planes and the model's initial start point. Exceeding this threshold results in recognition failure.

Parameter	Description
3PGap	Maximum distance allowed between point clouds of three planes. (See Figure 11-23: yellow and blue distances belong to 3-plane gap.)
2PErrorDis	Threshold for the deviation between the start point recognized on two planes and the model's initial start point. Exceeding this threshold results in recognition failure.
2PModelErrorDis	Threshold for deviation when using the new 2-plane screening algorithm. When enabled, this distance is used as the reference for initial positioning.
ErrorAngle	Threshold for the angular deviation between the recognized point cloud plane and the corresponding model plane. Exceeding this threshold results in recognition failure.
StepErrorDis	Threshold for the deviation between the recognized overlap start point and the model's initial start point. Exceeding this value results in recognition failure.
HoleMinL	Minimum length for passing weld holes. (See Figure 11-24)
HoleMaxL	Maximum length for passing weld holes.
GapMinL	Minimum distance between non-weld seam plates.
GapMaxL	Maximum distance between non-weld seam plates.
SaveParaToFile	After adjusting any parameter, click ***SaveParaToFile*** to store the settings in the parameter file.
RecoverParaAndSave	Restore all parameters to default and save to the parameter file (overwrite existing file).

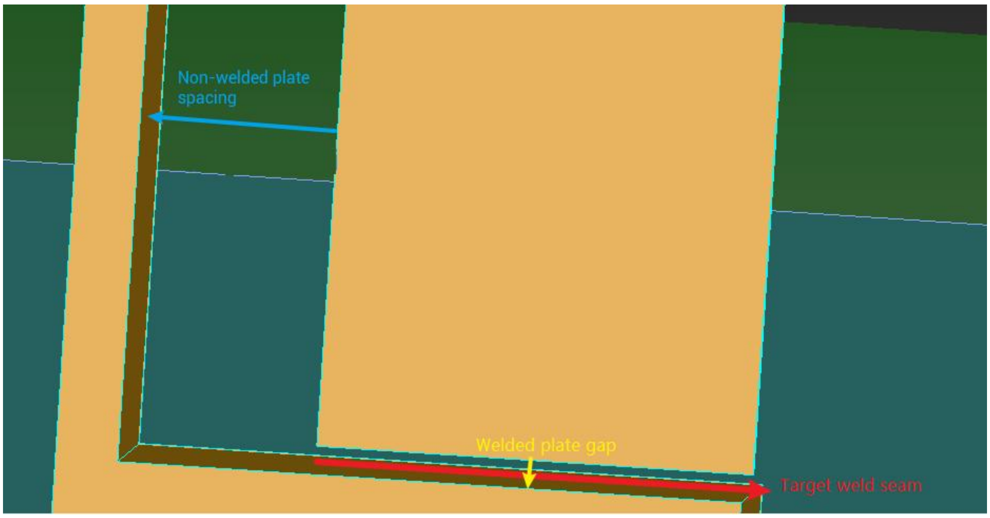

Figure 11-24 Illustration of 3-plane gap

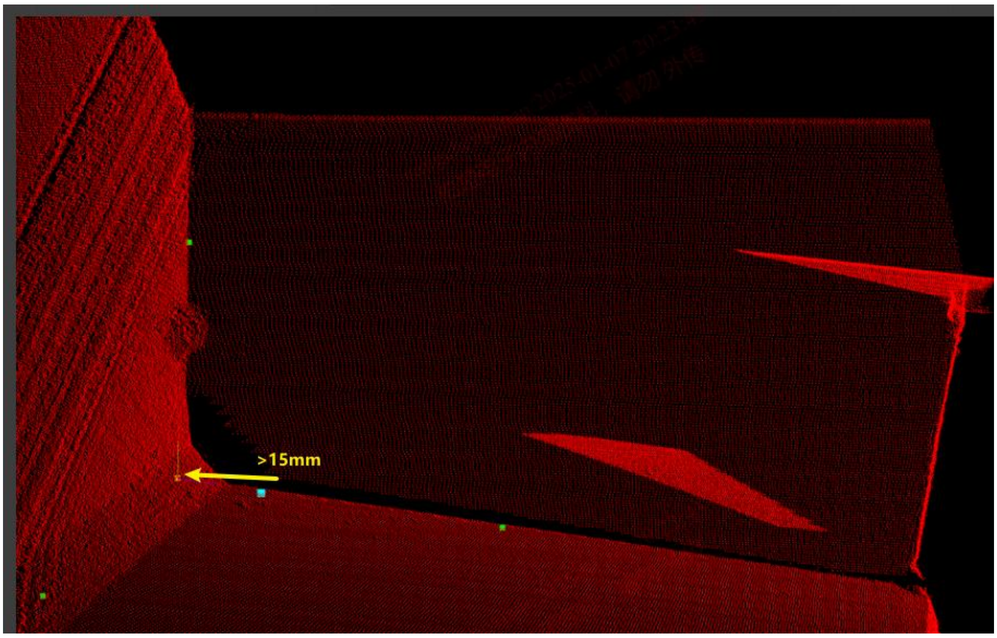

Figure 11-25 Minimum length of scallop

11.4.3 Butt Welding Search Parameter

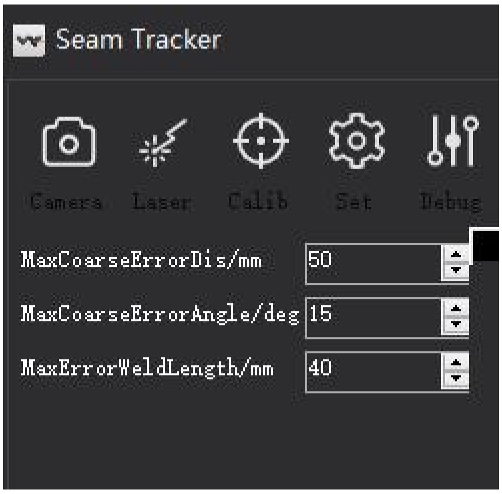

Figure 11-26 Butt welding search parameter

The parameters are described in the following table:

Table 11-19 Butt Welding Search Parameter Description

Parameter	Description
MaxCoarseErrorDis/mm	Threshold for the deviation between the recognized overlap start point and the model's initial start point. Exceeding this value results in recognition failure.
MaxCoarseErrorAngle/deg	Threshold for the angular deviation between the recognized seam and the model seam direction. Default value is recommended.

Parameter	Description
MaxCoarseErrorLength/mm	Threshold for the length deviation between the recognized seam and the model seam. Default value is recommended.

11.4.4 Groove Debug

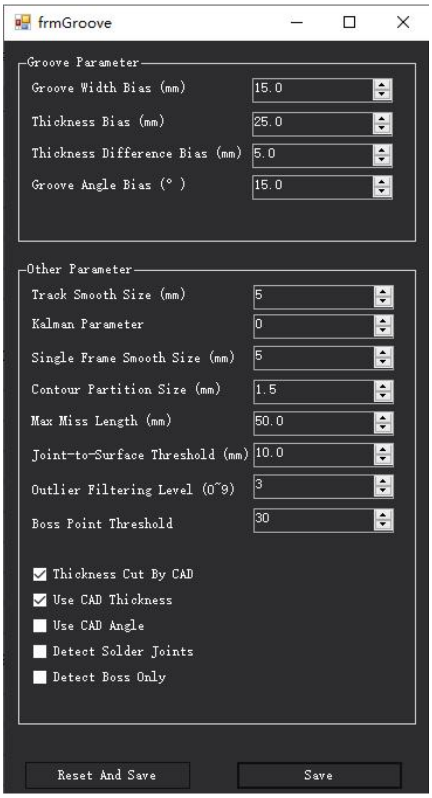

Figure 11-27 Grove debugging parameters

The parameters are described in the following table:

Table 11-20 Groove Debugging Parameter Description

Parameter	Description
Groove Width Bias (mm)	When recognizing a single-frame groove, the allowable groove width is within the range (Width - Z, Width + Z), where Z is this tolerance value. Default recommended.
Thickness Bias (mm)	Maximum deviation allowed between the recognized plate thickness and the standard value. Default recommended.
Thickness Difference Bias (mm)	Maximum allowable misalignment; exceeding this is considered an abnormal groove. Default recommended.
Groove Angle Bias (°)	Tolerance range for groove angle recognition to determine if it matches the expected groove. Default recommended.

Parameter	Description
Track Smooth Size (mm)	Smooths the final weld trajectory to remove jitter; higher values produce smoother curves.
Kalman Parameter	Gain parameter for the Kalman filter applied to the recognition results.
Single Frame Smooth Size (mm)	Applies local smoothing to weld features in each point cloud frame.
Contour Partition Size (mm)	Used to segment contours in the point cloud for subsequent feature extraction.
Max Miss Length (mm)	If a weld feature segment is missing less than this distance, interpolation is attempted; otherwise, it is treated as a break.
Joint-to-Surface Threshold (mm)	Determines whether a point is considered a weld point. Points closer to the top surface of the box-type column than this distance are considered obstacles requiring interruption.
Outlier Filtering Level (0 to 9)	Controls the filtering strength for outlier points in the point cloud; higher levels remove more points.
Boss Point Threshold	If the ratio of boss points in an area exceeds this value, the area is judged as non-weld.
Thickness Cut By CAD	The system automatically recognize all plates. The plates exceeding the preset recognition thickness will be ignored.
Use CAD Thickness	Uses the pre-set drawing plate thickness as a reference for recognition.
Use CAD Angle	Uses the drawing groove angle for matching and recognition.
Detect Solder Joints	Enable when recognizing weld points; default is disabled.
Detect Boss Only	Only recognizes boss features, not weld seams; default is disabled.

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