wenglor
the innovative family

Optical Seam Tracking Solutions
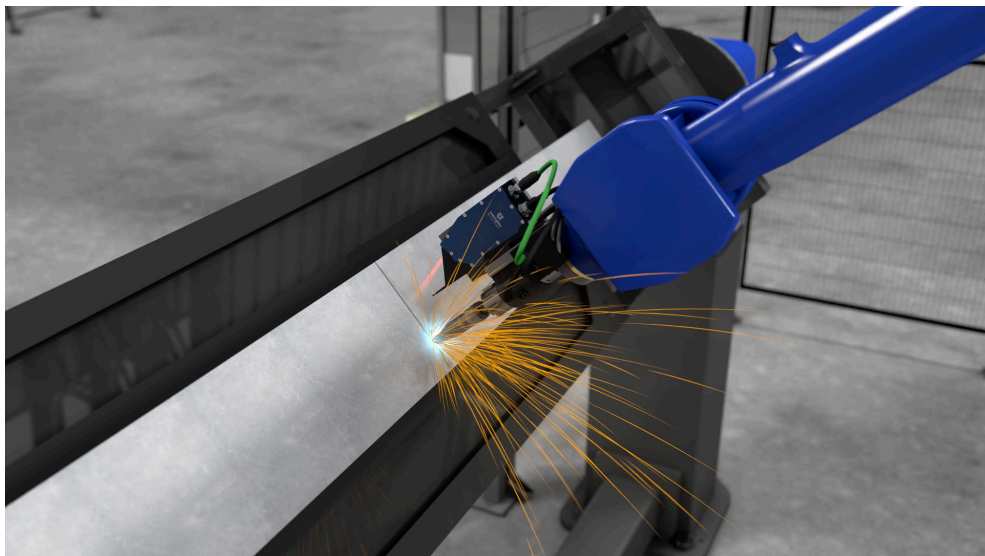
Operating Instructions

Table of Contents

1. Change Index of Operating Instructions

Version	Date	Description/Change
1.0.0	23.03.2022	Initial version of the operating instructions
1.0.1	31.03.2022	Indication of protective foil ZLSE010
1.0.2	13.04.2022	Adaption section 7.9.1 "String Count"
1.0.3	11.07.2022	Update of FANUC system requirements
1.0.4	25.05.2023	Update of changelog for robot weld seam tracking interfaces
1.1.0	13.12.2023	Update with generic robot weld seam tracking interface

2. General

2.1 Information Concerning these Instructions

The operating instructions describe how to setup an automated welding application using optical seam tracking in combination with the optional uniVision image processing software and the optional wenglor robot interfaces.

> **NOTE!**
> Separate extended instructions for each product are available on www.wenglor.com in the download section of each product.

2.2 Explanations of Symbols

• Safety precautions and warnings are emphasized by means of symbols and attention-getting words.

• Safe use of the product is only possible if these safety precautions and warnings are adhered to.

The safety precautions and warnings are laid out in accordance with the following principle:

> **ATTENTION-GETTING WORD**
> **Type and Source of Danger!**
> Possible consequences in the event that the hazard is disregarded.
> • Measures for averting the hazard.

The meanings of the attention-getting words, as well as the scope of the associated hazards, are listed below.

> **DANGER!**
> This word indicates a hazard with a high degree of risk which, if not avoided, results in death or severe injury.

> **WARNING!**
> This word indicates a hazard with a medium degree of risk which, if not avoided, may result in death or severe injury.

> **CAUTION!**
> This word indicates a hazard with a low degree of risk which, if not avoided, may result in minor or moderate injury.

> **ATTENTION:**
> This word draws attention to a potentially hazardous situation which, if not avoided, may result in property damage.

> **NOTE!**
> A note draws attention to useful tips and suggestions, as well as information regarding efficient, error-free use.

2.3 Limitation of Liability

- The product has been developed taking into account the state of the art as well as the applicable standards and guidelines.
- We reserve the right to make technical changes.
- A valid declaration of conformity can be found at www.wenglor.com in the download area of the product.
- wenglor sensoric elektronische Geräte GmbH (hereinafter "wenglor") accepts no liability for:
    - » Failure to observe the operating manual,
    - » Unsuitable or improper use of the product,
    - » Excessive use, incorrect or negligent treatment of the product,
    - » Incorrect installation or commissioning,
    - » Use of untrained personnel,
    - » Use of unauthorized spare parts or
    - » Improper or unauthorized changes, modifications or repair work to the products.
- This operating manual does not contain any guarantees/warrantees from wenglor with regard to the processes described or certain product properties.
- wenglor assumes no liability with regard to printing errors or other inaccuracies contained in this operating manual, unless it can be proven that wenglor was aware of the errors at the time the operating manual was created.

2.4 Copyrights

- The contents of these instructions are protected by copyright law.
- All rights are reserved by wenglor.
- Commercial reproduction or any other commercial use of the provided content and information, in particular graphics and images, is not permitted without previous written consent from wenglor.

3. For your Safety

3.1 General Safety Precautions

NOTE!
- In the event of possible changes, the respectively current version of the operating instructions can be accessed at www.wenglor.com in the product's separate download area.
- Read the individual operating instructions carefully before using the product.
- The sensor must be protected against contamination and mechanical influences.

3.2 Laser/LED Warnings

⚠️ **ATTENTION:**
For detailed explanation concerning laser safety, please see sensor operating instructions provided on wenglor.com.

Warning labels are included with the products depending on laser class and type of light. The respective warning labels must be attached to the system in a plainly visible fashion.

| Laser Class	IEC EN 60825-1	FDA/CFR
Laser Class 1M (EN 60825-1) Applicable standards and safety regulations must be observed.	⚠ CAUTION LASER 1M EN60825-1: 2014 λ= 620-690 nm	Not applicable
Laser Class 2M red (EN 60825-1) Applicable standards and safety regulations must be observed.	⚠CAUTION LASER 2M EN60825-1: 2014 P_o< 1 mW , λ= 620-690 nm	**CAUTION** LASER RADIATION DO NOT STARE INTO BEAM Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, June 24, 2007 CLASS 2 LASER PRODUCT
Laser Class 2M blue (EN 60825-1) Applicable standards and safety regulations must be observed.	LASER 2M EN60825-1: 2014 λ= 400-460 nm	**CAUTION** LASER RADIATION DO NOT STARE INTO BEAM Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, June 24, 2007 CLASS 2 LASER PRODUCT
Laser Class 3R red (EN 60825-1) Applicable standards and safety regulations must be observed. The laser outlet is identified on the device.	⚠CAUTION LASER 3R EN60825-1: 2014 λ= 620-690 nm	**DANGER** LASER RADIATION - AVOID DIRECT EYE EXPOSURE Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, June 24, 2007 620-690 nm < 5 mW CLASS IIIa LASER PRODUCT
Laser Class 3R blue (EN 60825-1) Applicable standards and safety regulations must be observed. The laser outlet is identified on the device.	⚠CAUTION LASER 3R EN60825-1: 2014 λ= 400-460 nm	**DANGER** LASER RADIATION - AVOID DIRECT EYE EXPOSURE Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, June 24, 2007 400-460 nm < 5 mW CLASS IIIa LASER PRODUCT
Laser Class 3B blue (EN 60825-1) Applicable standards and safety regulations must be observed. The laser outlet is identified on the device.	⚠WARNING LASER 3B EN60825-1: 2014 λ= 400-460 nm Avoid Exposure to the Beam	**DANGER** LASER RADIATION - AVOID DIRECT EXPOSURE TO THE BEAM Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, June 24, 2007 400-460 nm < 500 mW CLASS IIIb LASER PRODUCT

4.   System Overview

The system consists of

- one 2D/3D Profile Sensor of the weCat3D series
- the optional wenglor software application to find the tracking point, running on Smart 2D/3D Profile Sensors or on separate Control Units
- the optional wenglor robot interface (only running on Control Units)

4.1   System with wenglor Software Application

The following options are possible if using the wenglor software application to find the tracking point.

4.1.1   Robot-guided Seam Tracking with Control Unit

System overview with 2D/3D Profile Sensor and Control Unit (with wenglor software application and robot interface).
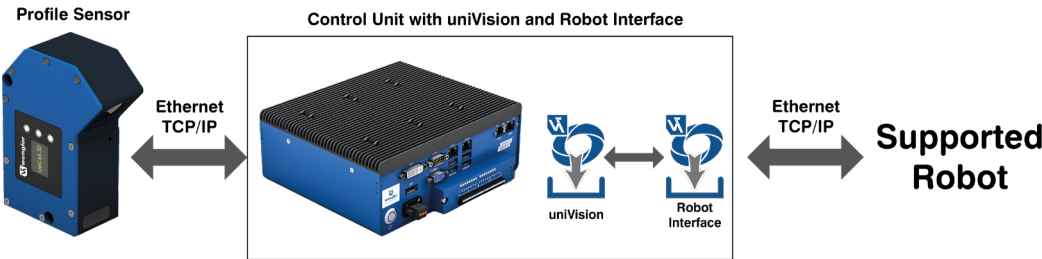
### 4.1.2   Not Robot-guided Seam Tracking with Contol Unit

System overview with 2D/3D Profile Sensor and Control Unit (with wenglor software application). The robot interfaces are not used. The communication to any PLC or robot PLC is possible via standard interfaces like Profinet, EtherNet/IP, TCP/IP or UDP.

4.1.3 Not Robot-guided Seam Tracking with Smart 2D/3D Profile Sensor

System overview with Smart 2D/3D Profile Sensor (with wenglor software application). The robot interfaces are not used and the communication to any PLC is possible via standard interfaces like TCP/IP or UDP. The performance of the Smart 2D/3D Profile Sensor is limited. In case of higher performance requirements, it is possible to use the external Control Unit.

Profile Sensor

**TCP/IP
UDP**

⟷
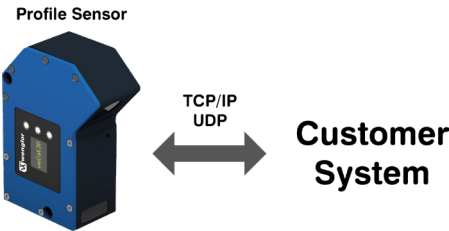
Customer
System

4.2 Sensor without wenglor Software Application

In the case of using only the 2D/3D Profile Sensor hardware without wenglor software application, any customer or third-party software usage is possible. Then the sensor only sends the height profiles (pointclouds) to the customer or third-party software.

Profile Sensor

**TCP/IP
UDP
GigE Vision**

⟷

Customer or
third-party Software
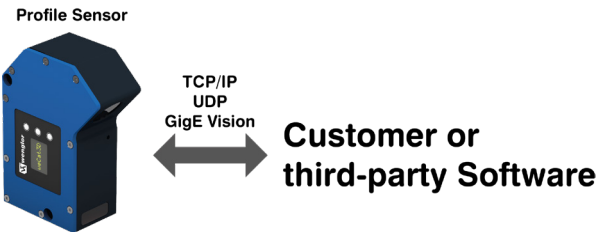
NOTE!
Please refer to the sensor operating instructions how to integrate the sensor using the provided SDK, GigE Vision or TCP/IP interface:
https://www.wenglor.com/en/Interfaces-of-2D-3D-Profile-Sensors/s/Themenwelt+weCat-3D+Schnittstellen

5. Product Overview

The operating instructions cover several products.

5.1 wenglor weCat3D Sensors

The weCat3D sensors are the 2D/3D Profile Sensors of wenglor. Depending on the application and requirements different sensor series are available:

weCat3D sensors	Properties
MLZLxxx	Optimized sensor for welding applications with integrated cooling and purging different laser classes are available. 10 protective screens (plastic) for replacement included in delivery.
MLSLxxx	Compact housing, different laser classes and measurement ranges are available.
MLWLxxx	High performance sensor with high resolution, different laser classes and measurement ranges are available.

For details and the complete list of accessories see the sensor operating instructions on
www.wenglor.com/weCat3D-Manual.

NOTE!
If using the wenglor software application directly on the Smart 2D/3D Profile Sensor without a separate Control Unit (see section 4.1.3), it is necessary to order the following additional licenses:

- DNNL017: License Upgrade weCat3D Seam Tracking (Module Pointcloud Seam Tracking)
- DNNL015 (optional): License Upgrade weCat3D Profile Analysis (Module Pointcloud Calculus, Module Pointcloud Measure, Module Pointcloud Coordinate System, Module Pointcloud Region, Module Pointcloud Pattern Match, Module Pointcloud Filter)

How to generate and activate uniVision licenses is described in the operating instructions of the uniVision software.

5.1.1 Accessories for weCat3D Sensors

Please find the complete list of all available accessories in the sensor operating instructions on www.wenglor.com/weCat3D-Manual.

Following accessories improve the performance of the sensor at welding applications:

Sensor	Accessories	Comment
MLZLxxx*	• ZLSE010 protective screen (plastic) • ZLSE011 protective screen (glass) • ZLSE012 protective screen retainer • ZLSE013 guard plate	Protects the optical window of the sensor.
MLSL1xx	ZLSS003 protective housing	Combines cooling, protection and purging of the optical window.
MLSLxxx MLWLxxx	Protective screen retainers with ex-changeable screens of glass or plastic	Protects the optical window of the sensor.
MLSLxxx MLWLxxx	Cooling units	Allows to use the sensor at higher environmental tempertures.

* The MLZLxxx is equipped with connections for cooling and purging (see section 6.3).

If the sensor is used with a robot there are special torsion resistant cables available:

Ethernet cable:		
ZC1V020	M12x1, 8-pin X-coded, RJ45	5 m
ZC1V021	M12x1, 8-pin X-coded, RJ45	10 m

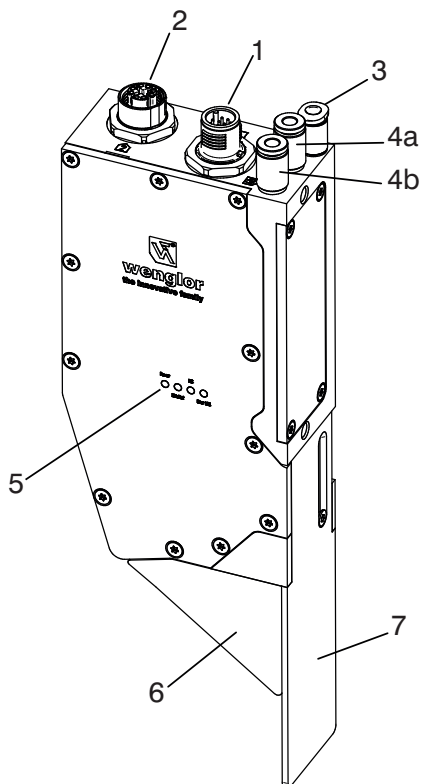| Power supply cable:		
ZDCL001	M12x1, 12-pin to open end	2 m
ZDCL002	M12x1, 12-pin to open end	5 m
ZDCL003	M12x1, 12-pin to open end	10 m
ZDCL007	M12x1, 12-pin to open end	30 m

5.2 MLZLxxx

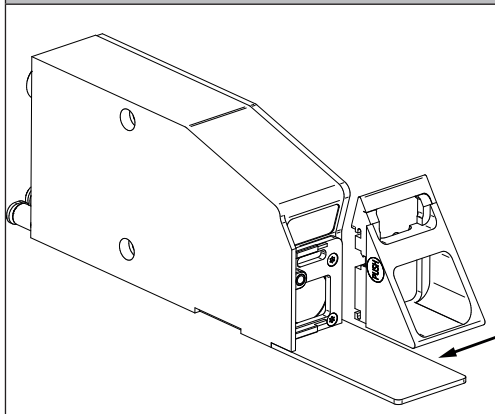### 5.2.1 Measuring Field X, Z

MLZL1x1
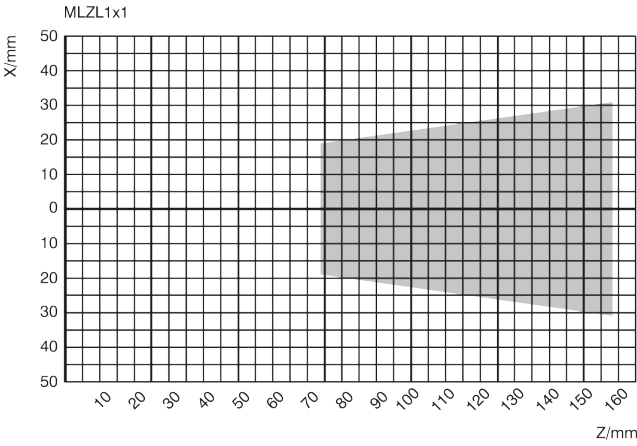
5.2.2 Dimensional Drawings
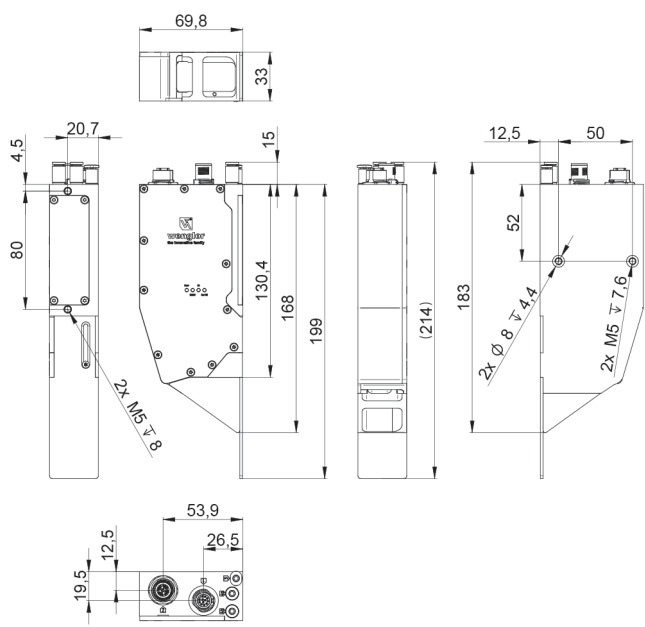
5.2.3 Sensor Construction

1 = Power supply plug connector, digital I/O
2 = Connection socket Ethernet
3 = Air purging
4a = Air/water cooling IN
4b = Air/water cooling OUT
5 = LED display
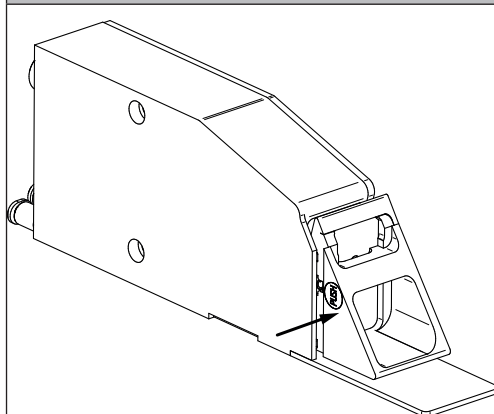6 = Screening grid retainer with screening grid
7 = Guard plate

5.2.4 Installation of Screening Grid Retainer and Screening Grid

Assembly of the screening grid retainer:	Disassembly of the screening grid retainer:
Insert the screenig grid retainer into the guide bar of the sensor (see picture above) and slide it to the left until it snaps in.	By pressing the push button, the screening grid retainer is removed from the fixation and can be slided out to the right (see picture above).

Inserting the screening grid:	Removing the screening grid:
Slide the screening grid into the relevant slot, bevelled edges first (see picture above).	Place a pointed object (e. g. fingernail) on the upper edge of the screening grid and slide it out of the screening grid retainer (see picture above).
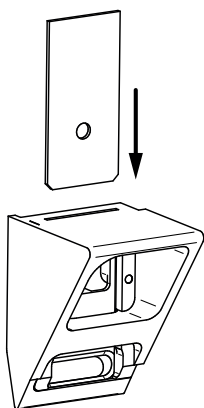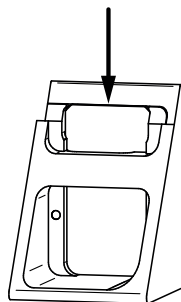
NOTE!
Before inserting the plastic screening grid (ZLSE010) please remove the protective foils on both sides of the screening grid.

5.3 Control Unit

- BB1C009 and BB1C509: Control Unit with uniVision seam tracking

NOTE!

- BB1C009 and BB1C509 are IPCs with i7 processor which contain the licenses for standard profile analysis modules and the license for module Pointcloud Seam Tracking.
- When using another Control Unit (e.g. BB1C008) you can order the following additional licenses separately:
  - » DNNL016: License upgrade Control Unit, seam tracking (Module Pointcloud Seam Tracking)
  - » DNNL009 (optional): License upgrade Control Unit, profile analysis (Module Pointcloud Calculus, Module Pointcloud Measure, Module Pointcloud Coordinate System, Module Pointcloud Region, Module Pointcloud Pattern Match, Module Pointcloud Filter).
- It is recommended to use only Control Units with i7 processor especially if using the wenglor robot interfaces.
- How to generate and activate uniVision licenses is described in the operating instructions of the uniVision software.

5.3.1 Accessories for Control Unit

- ZNNG026: Monitor
- Z0044: Keyboard

5.4   Robot Interface

• DNNP012: Generic robot weld seam tracking interface

5.4.1   System Requirements for Robot Interface

The robot weld seam tracking interface is tested with the following hardware and software versions of the robot:

Robot manufacturer	System requirements
ABB	Controller: IRC5 Software RobotWare 6.0 Sensor Interface: Optical Tracking Arc
FANUC	Controller: R-30iB or R-30iA Software ArcTool SW V8.30P/36 Software options: R691 and R648 or Controller: R-30iBPlus or R-30iA Software ArcTool SW V9.40P/27 Software options: R901
KUKA	Controller: KR C5 Operating system: KSS 8.7 Software: KUKA SeamTech Tracking 4.0
Yaskawa	Controller: DX200, YRC 1000 Software: MotoEyeLT
Kawasaki	Controller: E series Software: Option Laser Tracking

6. Installation

6.1 General Installation Instructions

The installation starts with the mounting of the 2D/3D Profile Sensor. The installation depends on the sensor type.
It is very important that the camera of the sensor does not look directly into the welding spot, because this introduces a lot of noise due to the light of the welding process. This requires to mount the sensor tilted for the MLSLxxx and MLWLxxx series with an angle α to obtain a small or a large forerun.

Mounting of sensor with small forerun:
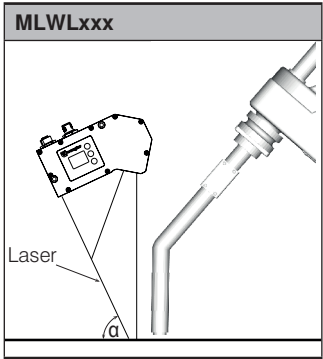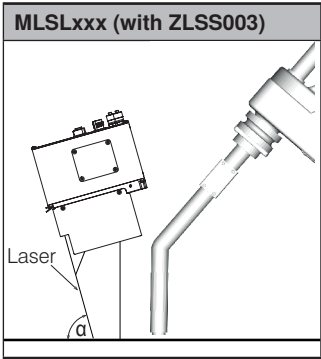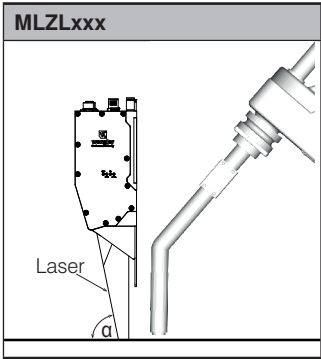
Mounting of sensor with large forerun:
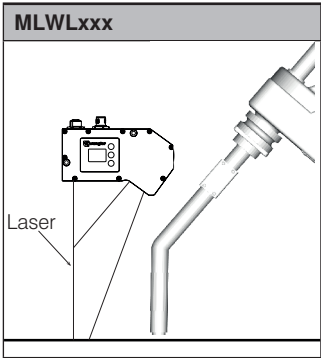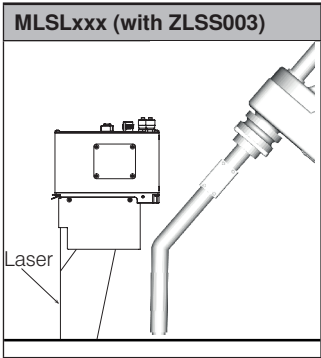
Angle α for different sensor types: :

2D/3D Profile Sensor	Minimum α in °
MLZL1x1*	73.5
MLWL2x5	75.6
MLWL2x4	76.2
MLWL2x3	76.3
MLWL2x2	74.9
MLWL2x1	72.0
MLWL1x5	56.9
MLWL1x4	56.9
MLWL1x3	56.2
MLWL1x2	67.2
MLWL1x1	58.5
MLSL2x6	83.1
MLSL2x5	82.6
MLSL1x4	81.6
MLSL1x3	75.2
MLSL1x2	60.9
MLSL1x1	58.1

* corresponds to vertical mounting of the sensor

6.2 Sensor Mounting

Depending on the configuration, the sensor / protective housing can be mounted in different ways:

Sensor / protective housing	Mounting possibility	Comment
MLSL1xx MLSL2xx	Two mounting points with drilling pattern 80 mm x 35 mm	Two screws M4 (6 mm depth)
MLWL1x1 MLWL1x2 MLWL2x1 MLWL2x2 MLWL2x3	Two mounting points on two sides with drilling pattern 80 mm x 35 mm	Two screws M5 (12 mm depth)
MLWL1x3 MLWL1x4 MLWL1x5 MLWL2x4 MLWL2x5	Mounting with clamp ZLWE011 drilling pattern 83 mm x 54 mm (discontinued) ZLWE012 drilling pattern 80 mm x 54 mm	Four screws M7
Protective housing ZLSS003	Short side drilling distance 59 mm	Two screws M5 (16 mm depth)

NOTE!
For details see the technical drawing in the sensor operating instructions on
www.wenglor.com/weCat3D-Manual

6.3   Connection of Cooling and Purging

Sensor / Accessories	Medium		Tube dimensions
Cooling unit	Water:	max. 2 bar	Tube with 6 mm outer diameter and 4 mm inner diameter
	Oil free air:	max. 2 bar	
Protective housing ZLSS003	Cooling:		Tube with 6 mm outer diameter and 4 mm inner diameter
	Water:	max. 2 bar	
	Oil free air:	max. 2 bar	
	Purging:		
	Oil free air:	max. 2 bar	
MLZLxxx	Cooling:		Tube with 4 mm outer diameter
	Water:	max. 2 bar	
	Oil free air:	max. 2 bar	
	Purging:		
	Oil free air:	max. 2 bar	

6.4   Connection

This section contains information about electrical and network connections.

6.4.1   Cabling of System Components

weCat3D - Control Unit - PLC:

weCat3D Sensor   Control Unit with uniVision   Robot controller or customer PLC

Smart weCat3D - PLC:

Power cable weCat3D

+24 V DC
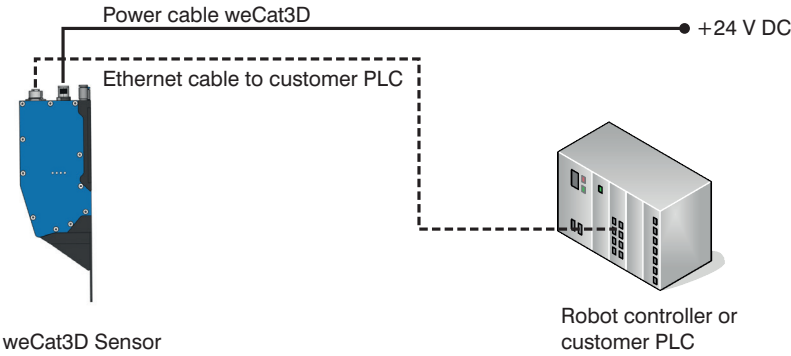
Ethernet cable to customer PLC

weCat3D Sensor
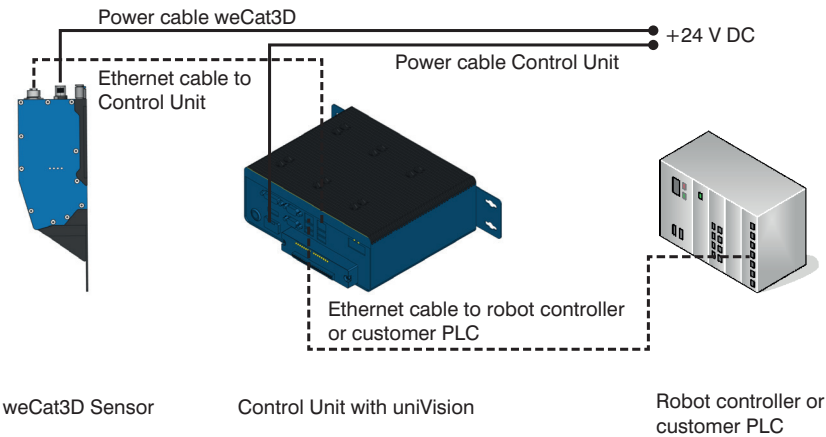
Robot controller or
customer PLC

6.4.2 Electrical Connection

6.4.2.1 Electrical Connection of 2D/3D Profile Sensor

The connection is made via a 12x1 12-pin connector.

Pin	Description
1	+ 24 V DC (18-30 V DC)
2	Ground
3	Digital In/Out 1
4	Digital In/Out 2
5	Digital In/Out 3
6	Digital In/Out 4
7	Encoder Input A
8	Encoder Input $\bar{\text{A}}$
9	Encoder Input B
10	Encoder Input $\bar{\text{B}}$
11	Encoder Input O
12	Encoder Input $\bar{\text{O}}$
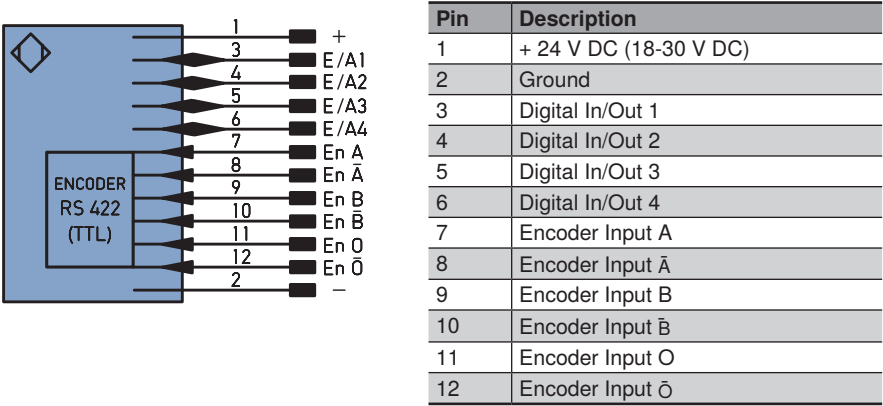
6.4.2.2 Electrical connection of Control Unit

The Control Unit is equipped with a 3-pin feed-through header for the power connection

6.4.3   Network Connection

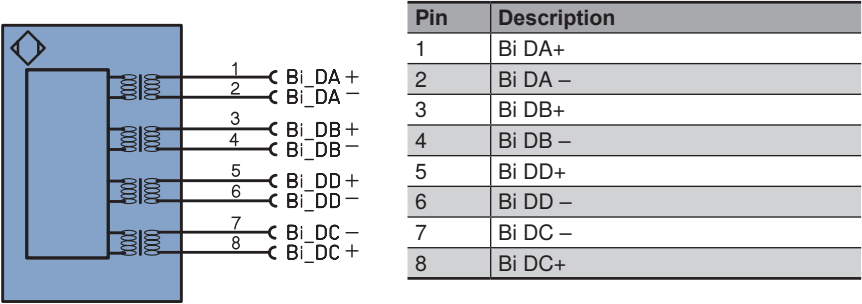The communication between the 2D/3D Profile Sensor, the optional Control Unit and the robot controller or PLC works via a TCP/IP Ethernet connection.

#### 6.4.3.1 Ethernet Connection of 2D/3D Profile Sensor

The Ethernet connection is made via a 12x1 8-pin x-coded connector.

Pin	Description
1	Bi DA+
2	Bi DA –
3	Bi DB+
4	Bi DB –
5	Bi DD+
6	Bi DD –
7	Bi DC –
8	Bi DC+

NOTE!
The network settings of the 2D/3D Profile Sensor can be adjusted via the OLED display (MLSL and MLWL only) or the sensor website if using no wenglor software application (see section 4.2).

6.4.3.2 Ethernet Connection of Control Unit

The Control Unit is equipped with two LAN ports.
Connect LAN2 to the 2D/3D Profile Sensor and LAN1 to the robot controller or PLC.
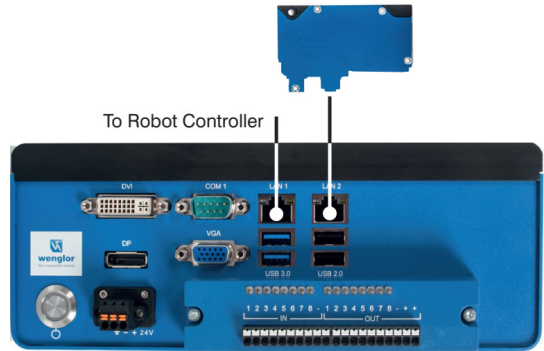
NOTE!
By default, LAN1 and LAN2 of the Control Unit are bridged. Do not change the settings in order to work without an external switch.

7. Settings in wenglor Software Application

> **NOTE!**
> This section describes the configuration of the system with wenglor software application (see section 4.1). In the case the sensor is not used with wenglor software application please refer to the documentation of the sensor interfaces (see section 4.2).

If using the wenglor software application (uniVision application) for finding the tracking point, it is necessary to configure the project via the software uniVision.

Software uniVision for Linux is available directly on the Control Unit if connecting a monitor, a keyboard and a mouse.

Software uniVision for Windows is available for any 64 bit Windows 7 or 10 PC (download from https://www.wenglor.com/product/DNNF020)

> **NOTE!**
> All devices (2D/3D Profile Sensor, optional Control Unit, robot controller or PLC and PC with software uniVision) must be in the same network.

7.1 Network Configuration

7.1.1 Optical Seam Tracking with Control Unit

Example configuration:

- 2D/3D Profile Sensor (gets network configuration from Control Unit)

- Control Unit:
  - » IP address range: 192.168.100.250 – 192.168.100.252 (Bridge set to "LAN1 and LAN2")
  - » Subnet mask: 255.255.255.0

- PC with software uniVision for Windows:
  - » IP address: 192.168.100.200
  - » Subnet mask: 255.255.255.0

- Robot Controller or PLC:
  - » IP address: 192.168.100.100
  - » Subnet mask: 255.255.255.0

7.1.2 Optical Seam Tracking with Smart 2D/3D Profile Sensor

Example configuration:

• Smart 2D/3D Profile Sensor:
  » IP address: 192.168.100.1
  » Subnet mask: 255.255.255.0

• PC with software uniVision for Windows:
  » IP address: 192.168.100.200
  » Subnet mask: 255.255.255.0

• PLC:
  » IP address: 192.168.100.100
  » Subnet mask: 255.255.255.0

7.2 Starting the Software uniVision

NOTE!
The software uniVision can be downloaded from the website
www.wenglor.com/product/DNNF020
The Control Units BB1C5xx are supported starting with uniVision 2.6.1.

Open the software uniVision and click on "Connect to Device".

7.3 Setup Control Unit with 2D/3D Profile Sensor

If the device list is empty (default), the network search is started automatically. Select the Control Unit and click on "Add to Device List". If needed, it is possible to change the network settings of the Control Unit via clicking on "Edit Network Settings".
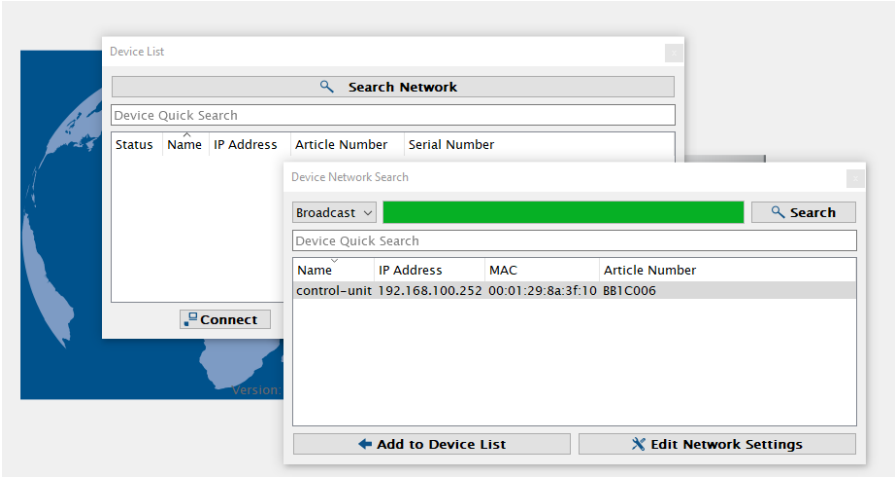
Select the Control Unit in the device list and click on "Connect" to find the connected devices.
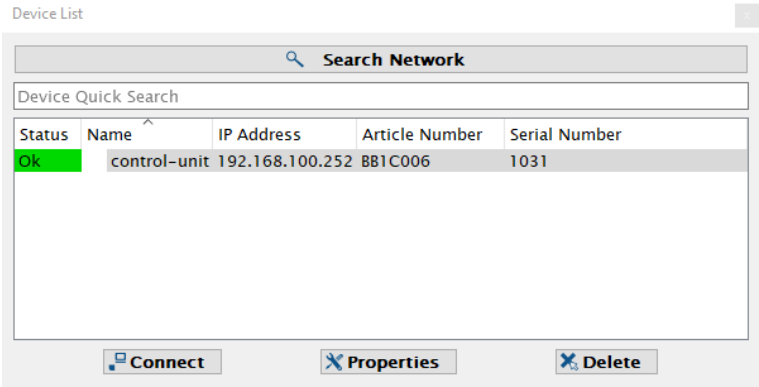
Click on "Managed by Control Unit" at the relevant 2D/3D Profile Sensor in order to add it to the Contol Unit and then click on "Close".

Double click on the 2D/3D Profile Sensor in the device list in order to create a uniVision application that evaluates the data of the sensor.

7.4 Setup Smart 2D/3D Profile Sensor

In order to find the Smart 2D/3D Profile Sensor in the network search it is necessary that the operating mode is set to "Smart".
Changing the default "Profile" operating mode" to "Smart" operating mode is possible via

• OLED display on 2D/3D Profile Sensor (MLSL and MLWL only) or
• Sensor website (default: 192.168.100.1 → Device settings)

Adjust the network settings of the 2D/3D Profile Sensor via the OLED display (MLSL and MLWL only) or the website (default:192.168.100.1 → Device settings)

If the device list is empty (default), the network search is started automatically. Select the Smart 2D/3D Profile Sensor and click on "Add to device list"

Double click on the Smart 2D/3D Profile Sensor in the device list in order to establish the connection to the sensor.

7.5 Templates for Welding Applications

Select "Templates" and click on "Next" to select a pre-configured uniVision project for seam tracking applications.
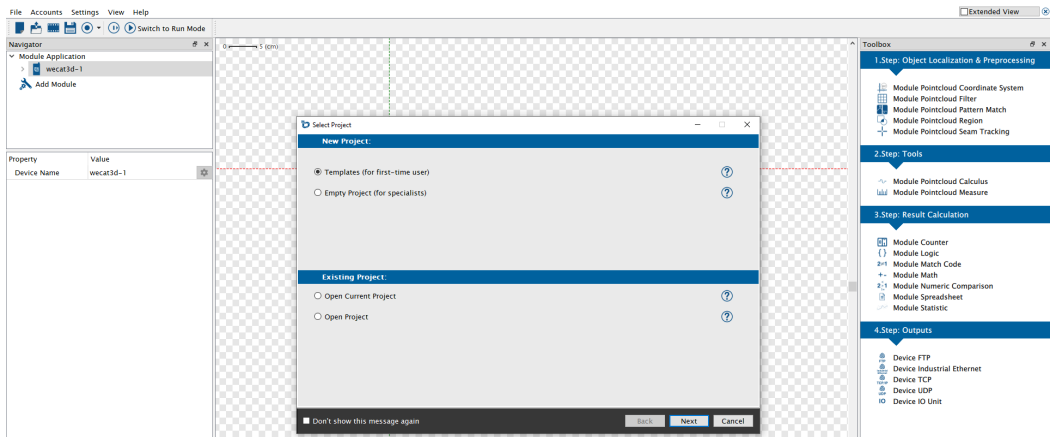
Select the relevant template for the seam tracking application. The following templates for seam tracking application and the calibration with robots are available:

• Find butt joint
• Find lap joint
• Find T joint
• Find dent
• Calibrate robots (edge, see Fig. 1)
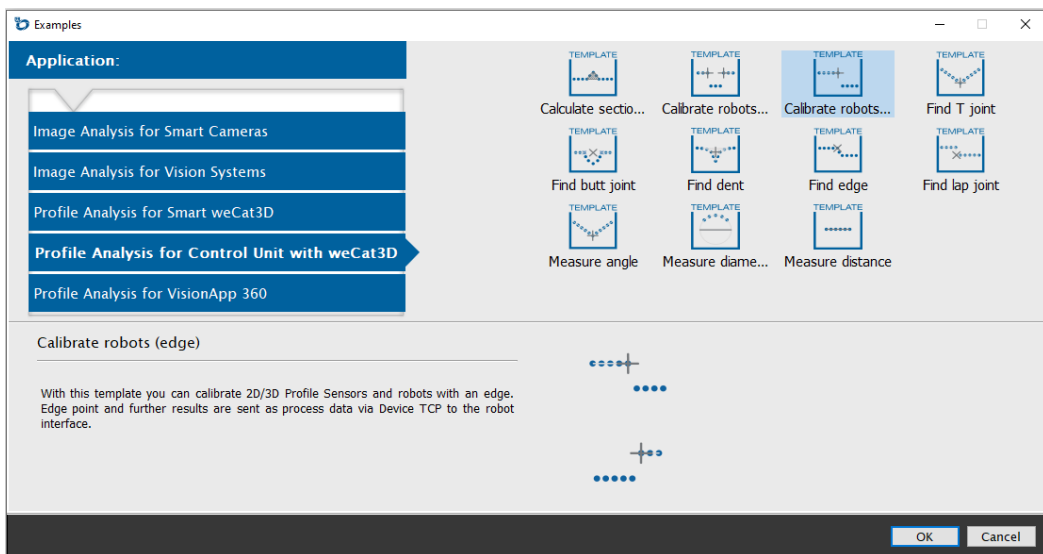• Calibrate robots (calibration plate, see Fig. 2)

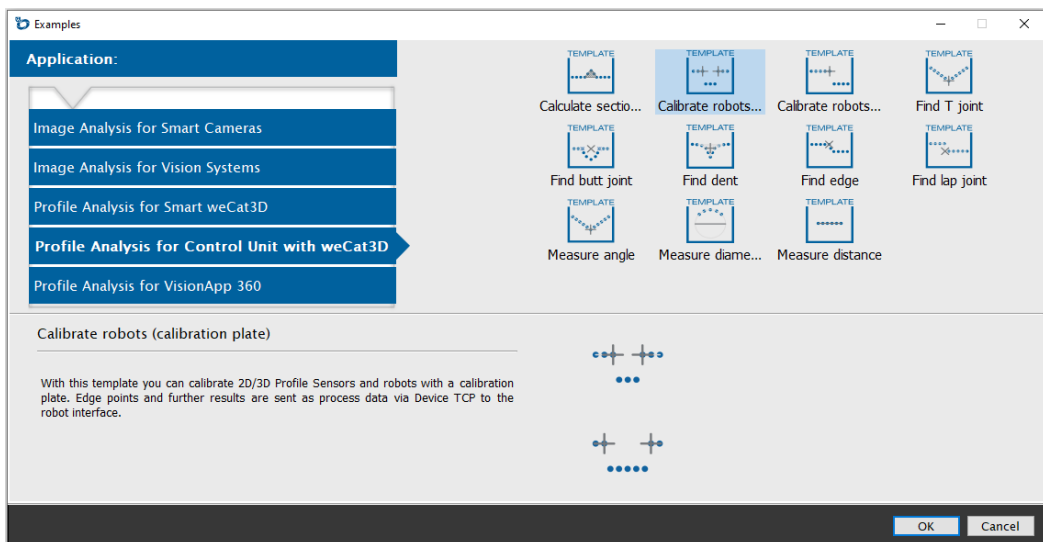Fig. 1: Template for calibrate robots (edge)

Fig. 2: Template for calibrate robots (calibration plate)

NOTE!
Check the description and the pictures of the templates to find the most suitable template. For further information about the different joint types see section 7.7.1.

Click on "OK" to start adjusting the template.
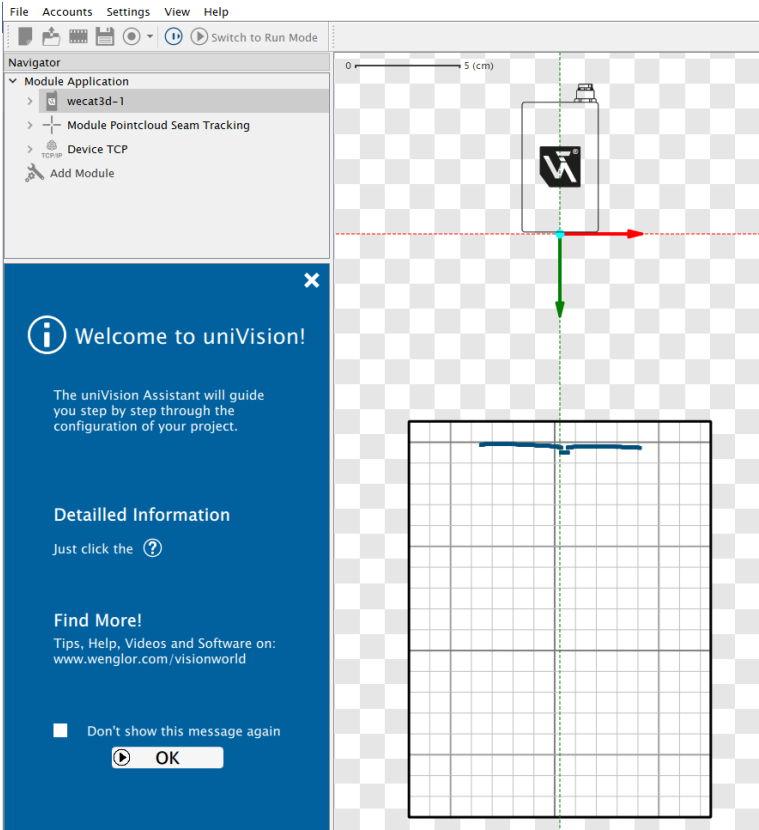
On the left side, the navigator contains the current project configuration with all settings, the center contains the current profile of the sensor and on the right side, the toolbox contains all available modules.

NOTE!
If the licence for Module Pointcloud Seam Tracking is not active on the Smart 2D/3D Profile Sensor or the Control Unit, it is necessary to order the license first. Details about generating and activating uniVision licenses are available in the uniVision software manual.

NOTE!
Activate the "Extended View" on the top right part of the software to see all parameters for complex applications (see marking in Fig. 3).

Fig. 3: Extended view
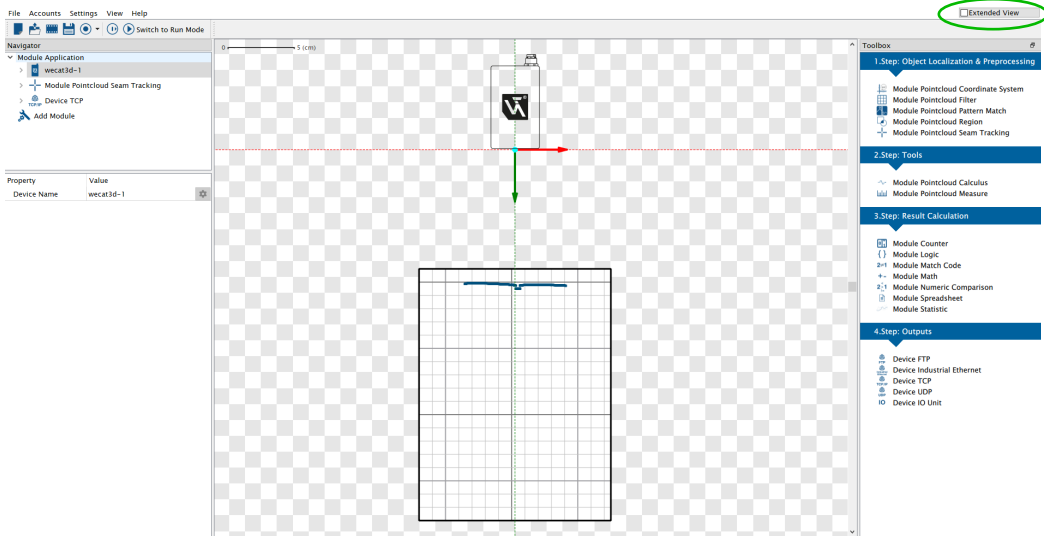
The templates for seam tracking applications contain at least the following modules:

- Device weCat3D
- Module Pointcloud Seam Tracking
- Device TCP

7.6   Setup Device weCat3D

Device weCat3D contains all sensor settings. For seam tracking applications, the settings described in the sections 7.6.1, 7.6.2 and 7.6.3 are important.

NOTE!

All sensor parameters are described in detail in separate manuals of the sensor and the uni-Vision software. The manual for seam tracking applications contains only the most relevant parameters with some welding specific explanations.

7.6.1   Acquisition Control: Exposure Time

Select a suitable value for the exposure time in μs so that the intensity of the measuring points is not too low and not too high. In general, the exposure time should be as short as possible at seam tracking applications to reduce the impact of the welding process on the profile quality as much as possible.

- Move the mouse position on single measuring points to see the intensity value at the bottom right part of the uniVision software. The intensity of the measuring points has a range from 0 to 1024 and should be in the middle for an optimal profile quality.

• Open the website of the sensor via entering the IP of the sensor in a browser for detailed analysis of the intensity (default: http://192.168.100.250 -> "2D/3D profile settings").
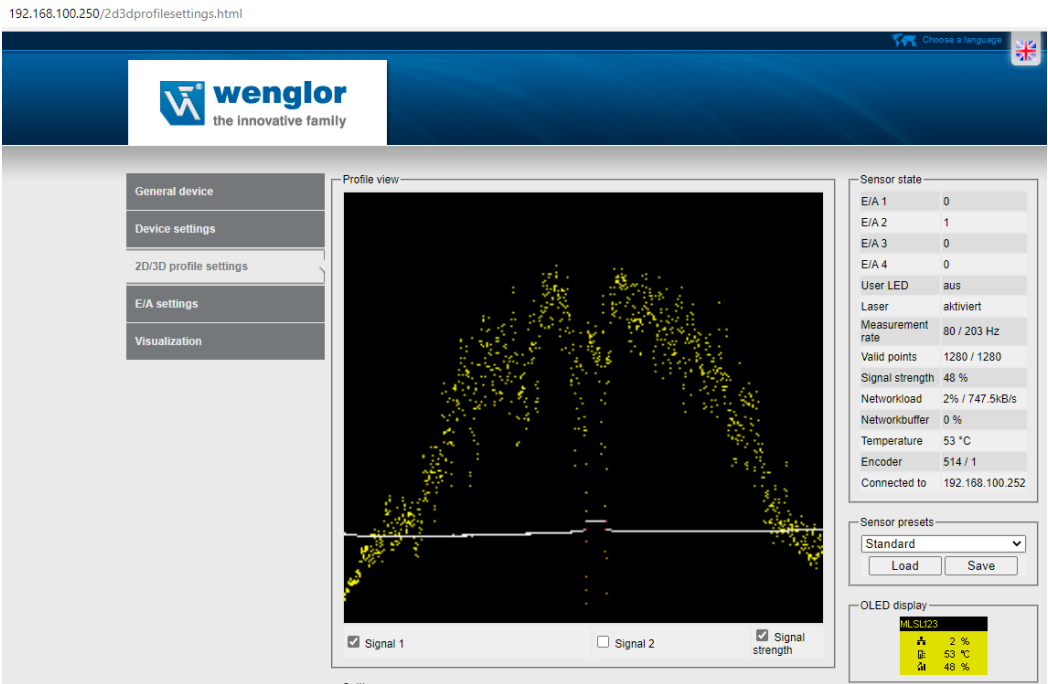
7.6.2 Acquisition Control: Acquisition Line Rate

The acquisition line rate defines the number of captured profiles per second. For slow movements of the welding process, slow acquisition line rates are sufficient. For fast movements of the welding process, select high values of the acquisition line rate.

NOTE!
Typical seam tracking applications require acquisition line rates between 50 and 100 Hz.

7.6.3 Signal Control

Open the "Extended View" to see the "Signal Control", if during the welding process the impact on the profile quality is still too high for a stable joint detection.

"Signal Enable" with the "First" (default) signal is suitable for typical seam tracking applications.
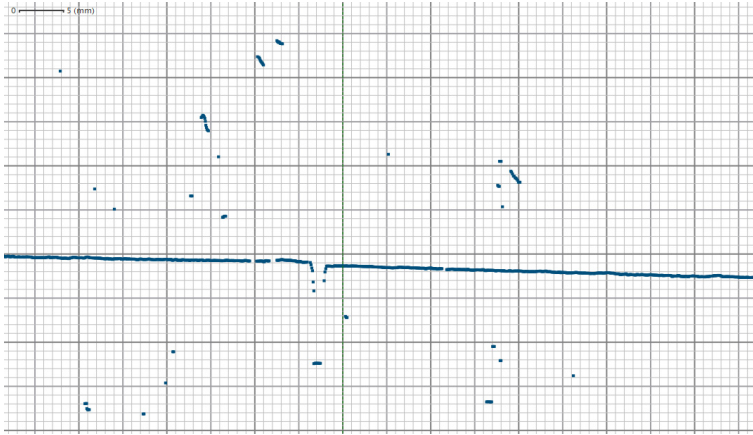
The "Signal Selection" is by default set to "Intensity [Strength]" which is most suitable for most seam tracking applications.

Intensity	Second

7.7 Setup Module Pointcloud Seam Tracking

With Module Pointcloud Seam Tracking it is possible to detect common joint types in height profiles of 2D/3D Profile Sensors. Results of the module are the tracking point and further joint specific results needed for sensor-guided seam tracking applications at robots or linearization tables.

The following step by step procedure shows how to adjust the module.

7.7.1 Basic Parameters

This section gives a description of the parameters which appear in multiple types.
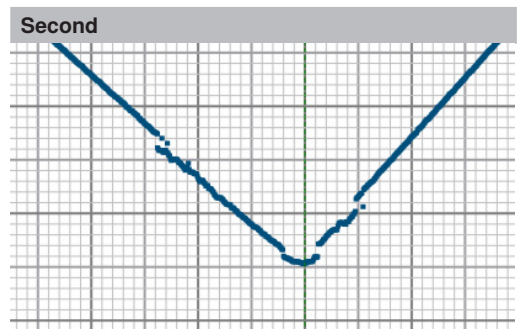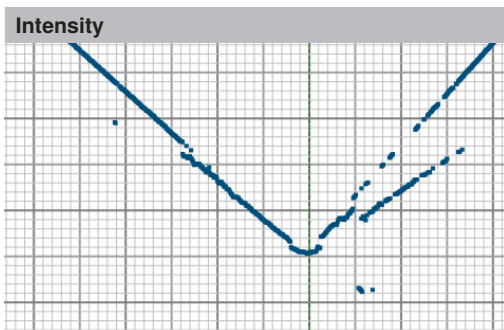
7.7.1.1 Link "Input Pointcloud"

In the templates, the link of the "Input Pointcloud" is preset to the output pointcloud of Device weCat3D.

> **NOTE!**
> If adding Module Pointcloud Seam Tracking from the toolbox to the uniVision project, it is necessary to select the input pointcloud (e.g. output pointcloud of Device weCat3D).

7.7.1.2 Select the "Type" of the joint

In the templates the joint type is preset depending on the selected template.

> **NOTE!**
> If adding Module Pointcloud Seam Tracking from the toolbox to the uniVision project, it is necessary to select the joint type.

Following joint types are available:

- **Butt joint:**
  Two metal sheets are on a similar height with a small gap. A necessary condition for the detection is that an edge is observable to the left and right of the gap. Possible tracking points are the left, the right and the midpoint between these points. This type also fits for the calibration of the robot and the sensor system via the calibration plate.
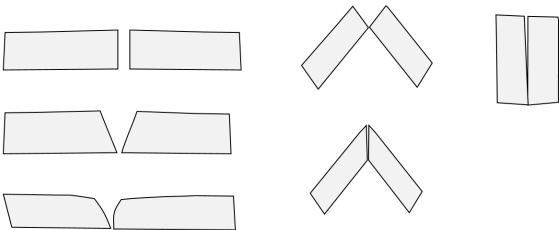
- **Lap joint:**
  One metal sheet is on top of the other with a certain height difference. Possible tracking points are the top, the middle and the bottom point.
  This type also fits for the calibration of the robot and the sensor system via an edge.
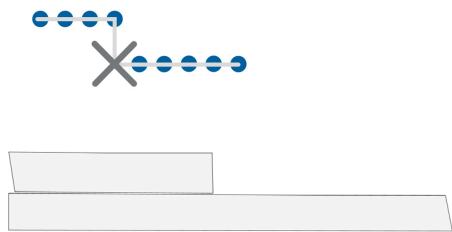
- **T joint:**
  Two metal sheets are in a certain angle (e.g. 90°). Gaps to left and/or right are considered. Tracking point is the intersection point.
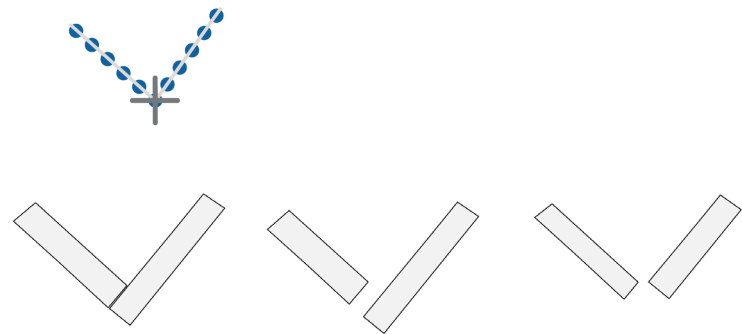
- **Edge:**
  Only one metal sheet on the left or right side has a clear and consistent shape – the other metal sheet not.

- **Dent:**
  Two metal sheets are on the same or similar height level, but in comparison to the butt joint, there is no clear and sharp edge visible - only a dent. This algorithm is most suitable for welding at tanks or barrels for example. Tracking point is the centroid, the left, the right and the bottom point of the found area.
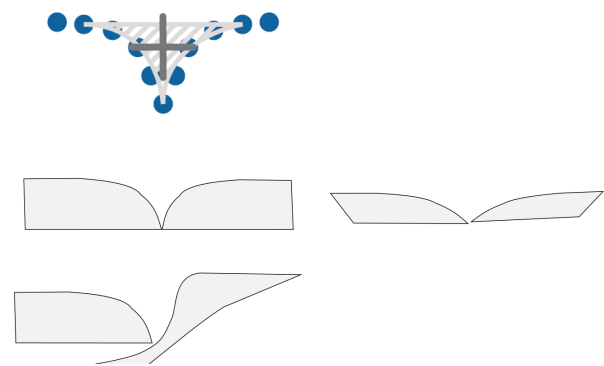
7.7.1.3 Define "Search Box"

Move the Search Box to the relevant area within the field of view of the sensor. The Search Box should cover all possible areas where the joint can appear.

7.7.1.4 Filtering

In order to eliminate noise during the welding process, the algorithm tries to find connected groups in the height profile. Small groups are considered as noise – consequently they are filtered and not used anymore for the next steps.
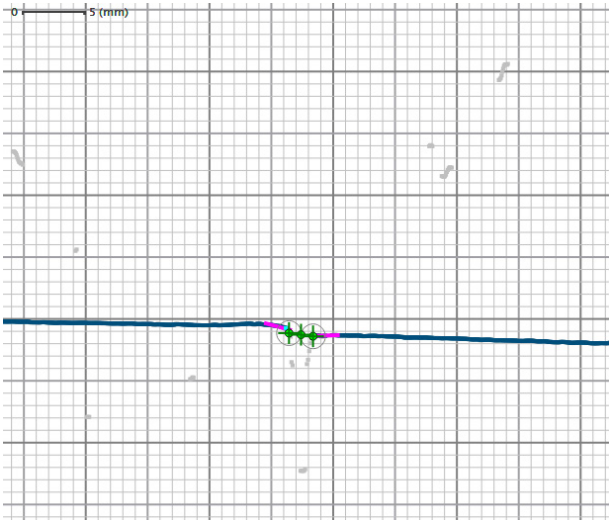
Profile data dismissed, due to filtering, are visualized in grey color. The profile points used for tracking have blue color.

Following parameters are relevant for the filtering:

- **Gap Closure:**
  Defines the maximum distance between measuring points in order to group points together. Noise can also create gaps where actually no gap exists. Optimize the sensor settings to avoid such unwanted gaps (see Setup Device weCat3D).

> **NOTE!**
> It is not possible to detect a joint, if the gap width is smaller than the Gap Closure. On the other hand, if the Gap Closure has a very small value, every gap which is wider than this, creates candidates for tracking points (see section 7.7.1.5) and therefore the risk of false-positives increases.

Example:
Decrease the Gap Closure to find the Points of Interest (cyan points). On the left side no Point of Interest is found because of the too big gap closure value of 0.6 mm. On the right side Points of Interest are found because of the smaller gap closure value of 0.2 mm.

Gap Closure: 0.6 mm	Gap Closure: 0.2 mm
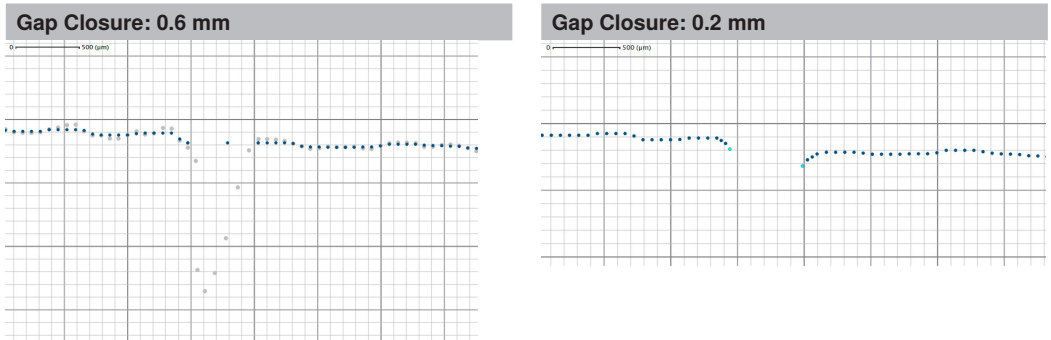
Due to a smoothing step before computing connected components the Gap Closure value needs to be chosen slightly larger than the gaps that are visible in the raw data. For example, the original profile (grey) has a gap that is smaller than 500 μm, but in the smooth profile (blue) it is larger. In order to connect the cluster set a Gap Closure value that is larger than the distance between the Points of Interest (cyan points , see section 7.7.1.5 for details). Compare also following figure:
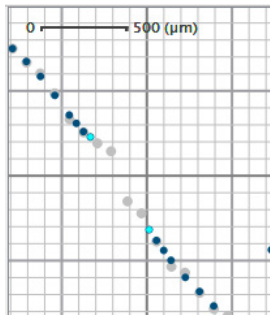
- **Min Cluster Size:**
  Defines the minimum number of measuring points that is necessary to consider the cluster as valid profile. The Min Cluster Size helps to ignore small reflections and to filter them out. This parameter rarely needs adjustment.

7.7.1.5 Points of Interest

For the joint types "Butt joint", "Lap joint", "T joint" and "Edge" the algorithm tries to find Points of Interest. These points are the candidates for tracking points. Joint specific checks apply in the following to determine if these points (or point pairs) are the tracking point(s) we are searching for. On the other hand this means, if the algorithm does not find Points of Interest at a certain position, it cannot find a tracking point there!

Points of Interest (cyan color) are the start and end points of a cluster (profile group) and edges within clusters.
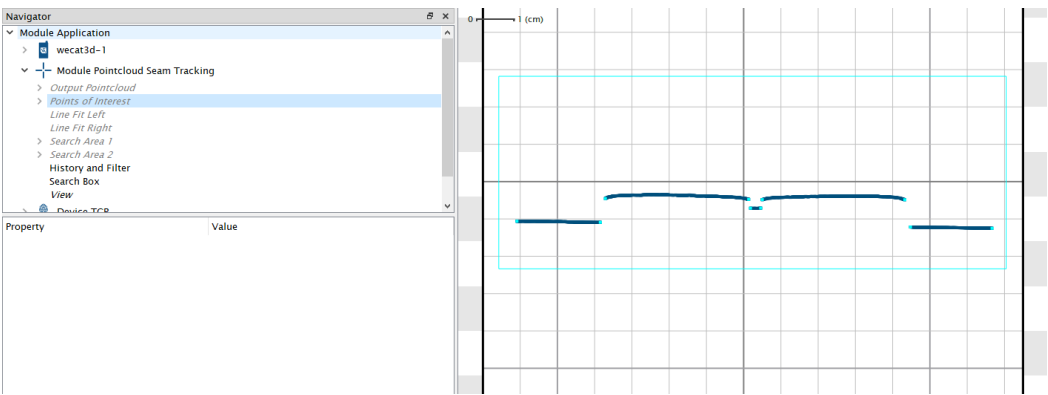
The relevant parameter for finding edges is

- **Edge Detection:**
  The algorithm finds more edges if using a high value for Edge Detection. If edges are not sharp, it might be necessary to increase the value.

> **NOTE!**
> Avoid unnecessary high values, as every edge is a Points of Interest and every Point of Interest is a tracking point candidate. Hence, a high value may increase process time and the risk of false-positives.

Example:
At edges without significant corner point, the algorithm finds no Point of Interest. Increasing the Edge Detection value resolves the problem.

Edge Detection: 50

Edge Detection: 70
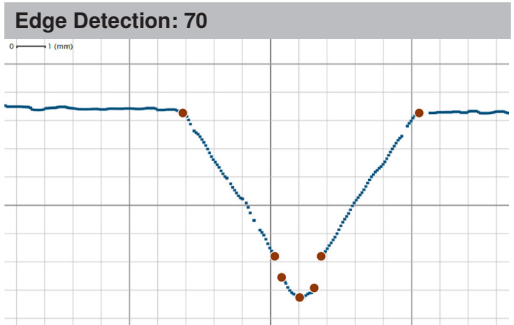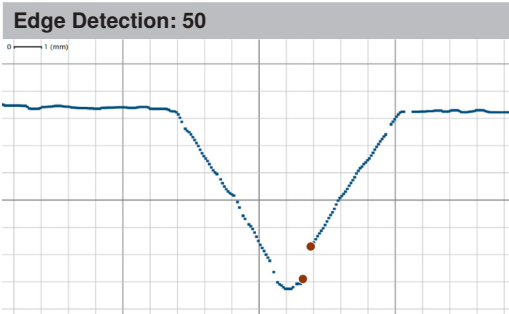
7.7.1.6 Straight Line Left/Right

Defines the length of line segments fitted next to the tracking points. These line segments (magenta color) have the purpose to determine how the profile looks like at the tracking point.
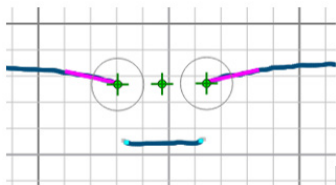
The algorithm uses the line fits for plausibility checks. Make sure that it is possible to fit a straight line at this part of the profile – otherwise adjust the length of the lines.

On rough surfaces, it is often helpful to use long line segments.

At least 75 percent of the line have to be covert with points of the profile – otherwise no line fit is possible and, hence, it is not possible to find a tracking point at this position. Furthermore, a certain amount of points is necessary for a successful fit.

7.7.1.7 Angle Left/Right Min/Max

Defines the tolerated minimum and maximum angles of the left/right straight lines. If the angles of the straight lines are out of the allowed angle range, the algorithm finds no tracking points. Use the results of Angle Left and Angle Right to adjust the angles accordingly.
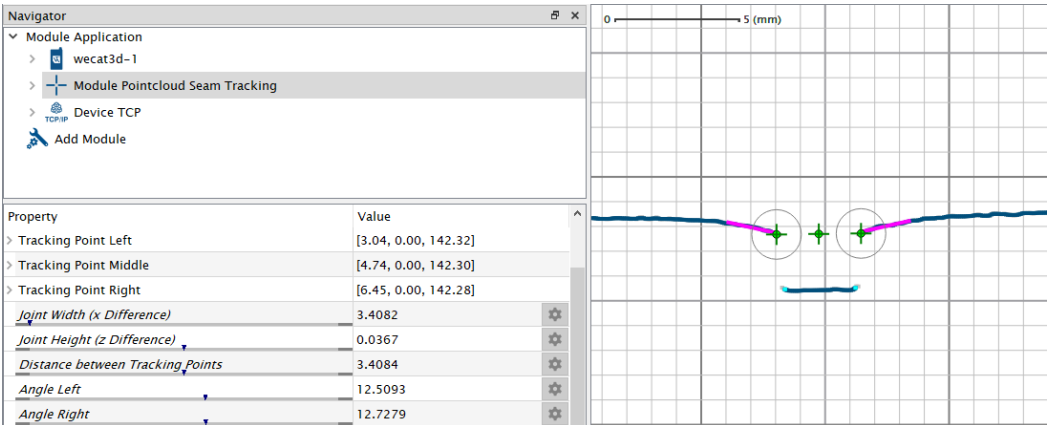
NOTE!

Do not set the allowed range to tight. The algorithm uses Angle Left/Right Min/Max not only to restrict the line results, but also to restrict the search area for the line fit! For example, in the picture below, it is not possible to find a line fit at the left point if the angles are restricted as illustrated with the green area.
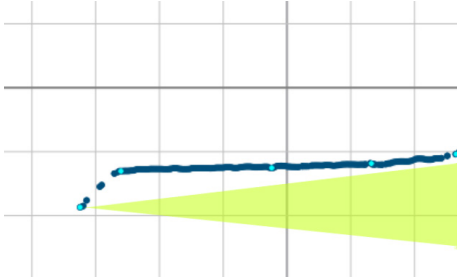
7.7.2 Basic Outputs

The algorithm calculates for most joints types the results described in the following sections.

7.7.2.1 Process Time

Indicates the process time in μs for Module Pointcloud Seam Tracking

7.7.2.2 Module State

Following numbers indicate the module state:

     0: Filtered tracking points found successfully
  1106: No filtered tracking points found

The module state makes no statement about the current tracking points, only about the filtered tracking points! It is possible that the current tracking points are invalid (in this case, entries are in error state), but the module state is 0.

7.7.2.3 Joint Found [%]

Percentage of profile evaluations with successful joint detection. The result provides an information on how good the settings are for the joint detection on a certain part. The history is reset with system start, project loading and acquisition start commands. If the acquisition is started before the joint detection or the acquisition is continued after the joint detection, the percentage will decrease accordingly.

7.7.2.4 Angle Left and Angle Right

Angle of left and right straight lines. Angles are measured with respect to the horizontal axis. Starting from the tracking point, if the line points upwards, the sign is positive and if it points downwards, the sign is negative.
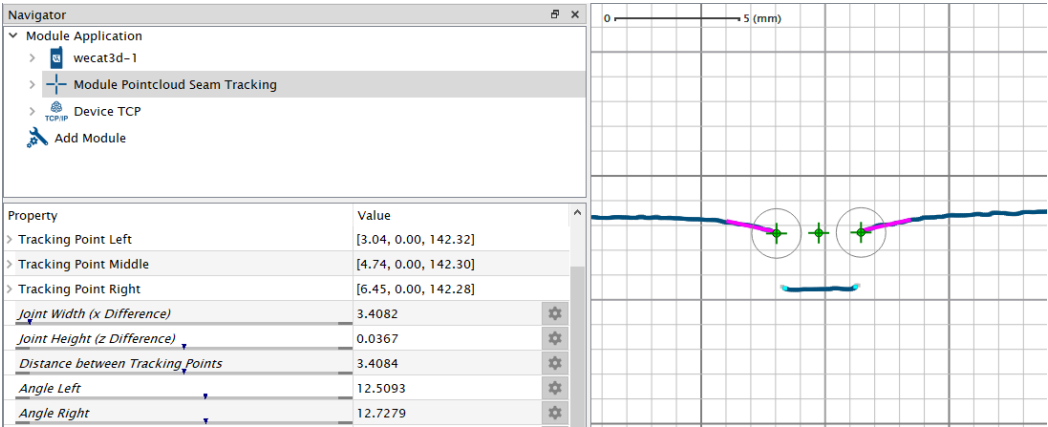
7.7.2.5 Tracking Points Valid

Boolean Flag that indicates if valid tracking points are found.

7.7.2.6 Tracking Points Invalid

Boolean Flag that indicates if valid tracking points are not found.

7.7.3 Butt Joints

7.7.3.1 Parameters

The following parameters are relevant for butt joints:

- **Input Pointcloud:**
  See Basic parameters

- **Joint Width Min:**
  Defines the minimum difference of the x values of the left and right tracking points. If the real butt joint has a smaller width than Joint Width Min, no tracking point is found.

- **Joint Width Expected:**
  Defines the expected difference of the x values of the left and right tracking points. If several potential tracking points are within the limits, the algorithm choses the one with the better Joint Width Expected value.

- **Joint Width Max:**
  Defines the maximum difference of the x values of the left and right tracking point. If the real butt joint has a bigger width than Joint Width Max, no tracking point is found.
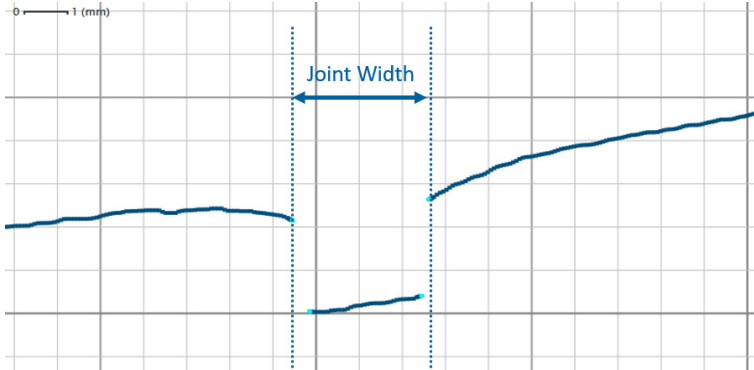
- **Joint Height Expected:**
  Defines the expected difference of the z values of the left and right tracking points. If the left tracking point is lower than the right one (step up), enter positive values for Joint Height Expected. If the left tracking point is higher than the right one (step down), enter negative values for the Joint Height Expected. By default, Joint Height Expected is set to 0 mm.

- **Joint Height Difference Max:**
  Defines the maximum height difference (positive and negative) that is accepted for left and right tracking points around the Joint Height Expected. If the real butt joint is out of the Height Difference Max window, no tracking point is found.
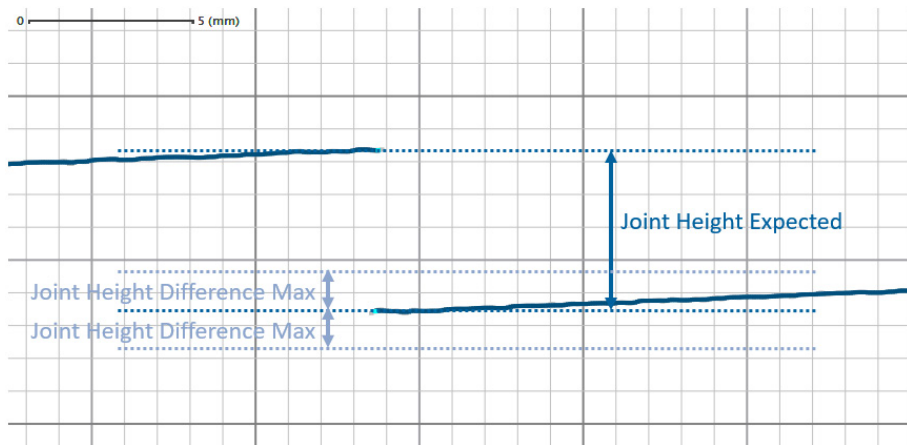
- **Gap Closure:**
  See Basic parameters

- **Cluster Size Min:**
  See Basic parameters

- **Straight Line Left/Right:**
  See Basic parameters

Property	Value	
> Tracking Point Left	[3.04, 0.00, 142.32]	
> Tracking Point Middle	[4.74, 0.00, 142.30]	
> Tracking Point Right	[6.45, 0.00, 142.28]	
Joint Width (x Difference)	3.4082	⚙
Joint Height (z Difference)	0.0367	⚙
Distance between Tracking Points	3.4084	⚙
Angle Left	12.5093	⚙
Angle Right	12.7279	⚙
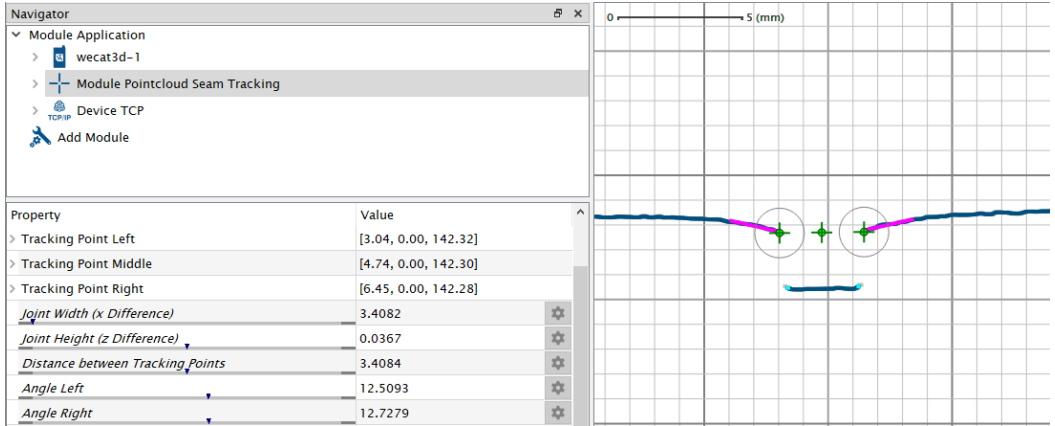
- **Angle Left/Right Min/Max:**
  See Basic parameters

- **Depth Min:**
  Defines the minimum depth between left and right tracking points that should not contain measuring points. The amount of points in the area between left and right tracking point and slightly beneath and above is used as an indicator for welding tacks. Hence, if the number of points in this area is high, no tracking point is found.

Depth Min: 2 mm (tracking points are found)

Depth Min: 5 mm (tracking points are not found)
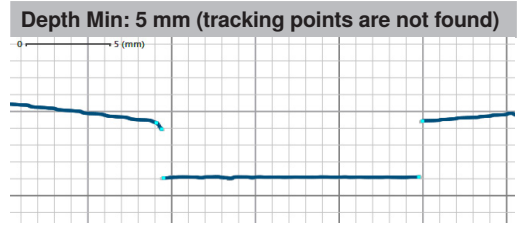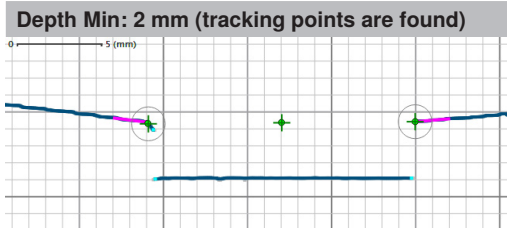
The images show the area to search for welding tacks (cyan) between two Points of Interest (red):

Width 20 mm, depth 3 mm

Width 20 mm, depth 1 mm

Settings in wenglor Software Application
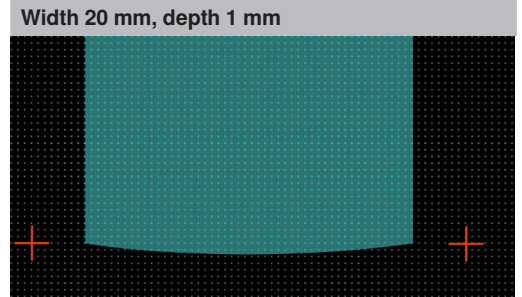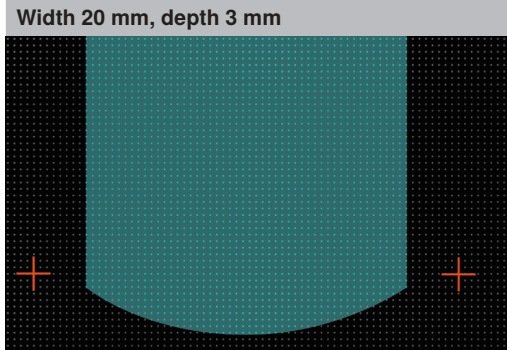
It is even possible to set Depth Min to value zero. In this case, the welding tack detection is disabled completely. A use case for this setup is the tracking of an already welded seam.
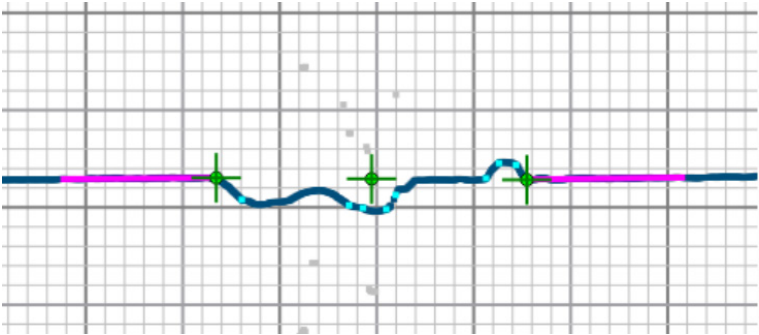
7.7.3.2 Results

The following results are relevant for butt joints:

- **Tracking Point Left/Middle/Right:**
  x and z coordinates of found points

- **Joint Width (x difference):**
  x difference between left and right tracking points

- **Joint Heigth (z difference):**
  z difference between left and right tracking points

- **Distance between Tracking Points:**
  Direct distance between left and right tracking point

- **Angle Left/Right:**
  See Basic outputs

- **Area:**
  Area between tracking points and the points between them. If there are no points between Tracking Point Left and Right, the area is zero.

> **NOTE!**
> The filtered Area in History and Filter is the mean of the last results. How many results are used depends on the smoothing parameter Mean of Last N Results. If the Filtered Tracking Point is the result of the keep valid or extrapolation setup, the value is repeated. If the filtered tracking point is invalid, the area is zero.

- **Joint Found (%):**
  See Basic outputs

- **Tracking Point Valid/Invalid:**
  See Basic outputs

7.7.4 Lap Joints

7.7.4.1 Parameters

The following parameters are relevant for lap joints:

- **Input Pointcloud:**
  See Basic parameters

- **Lap Shape:**
  Defines if the lap joint is step up or step down. The algorithm only finds lap joints with such orientations.

Step down	Step up
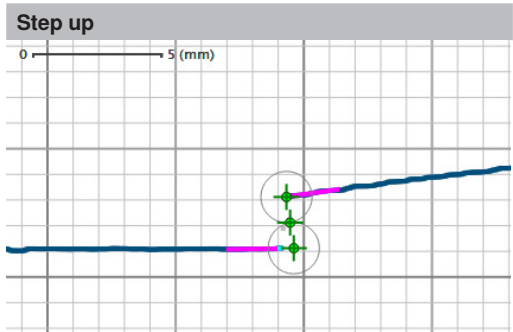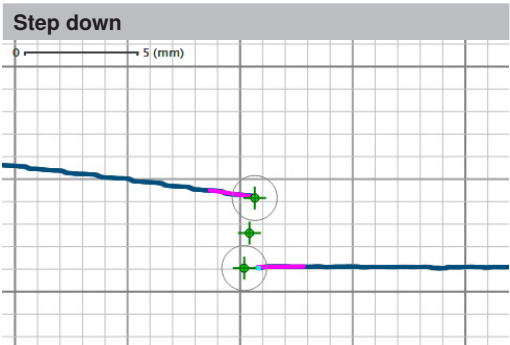
- **Right Angle Correction:**
  Defines the position where the right angle is set. This setup has influence on the position of the bottom tracking point. If it is possible to assume that there is a right angle, the detection of manual welding tacks is supported.
  - » **Right Angle Top:** The Tracking Point Bottom is the intersection point of the projection at the Tracking Point Top with the bottom straight line. The right angle is at the Tracking Point Top.
  - » **Right Angle Bottom:** The Tracking Point Bottom is the intersection point of the projection from the Tracking Point Top with the bottom straight line. The right angle is at the Tracking Point Bottom.

Right Angle Top	Right Angle Bottom
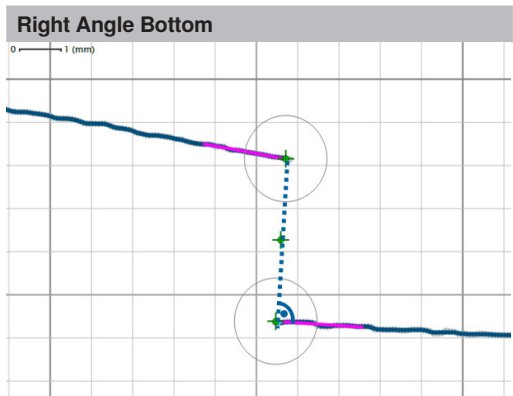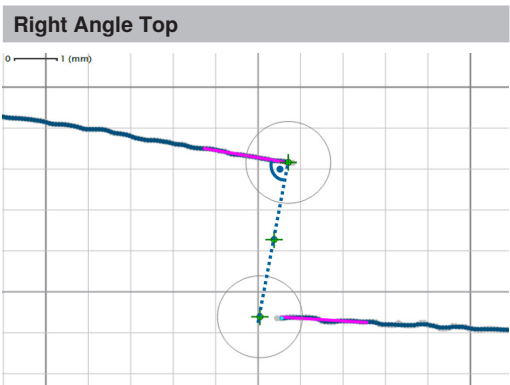
  - » **None (No Right Angle):** The Tracking Point Top and Bottom are equal to the Point of Interest (no alignment). In this case, it is not possible to detect manual welding tags.

Right Angle Top/Bottom: No tracking point is returned at manual welding tags	None (No Right Angle): Tracking Point is returned even at manual welding tags
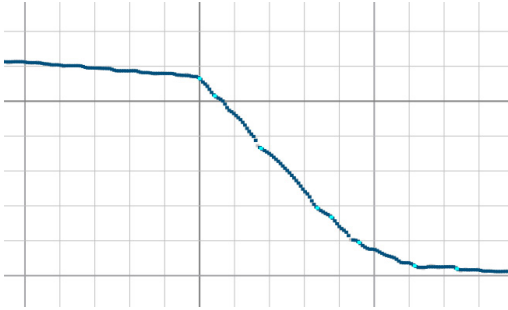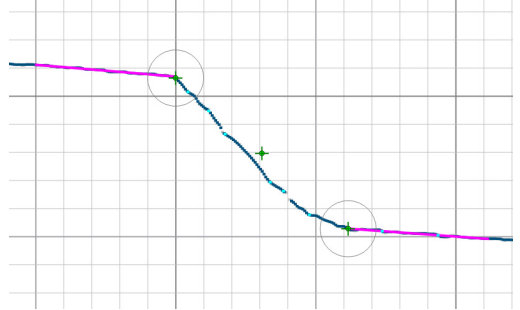
- **Tracking Points Distance Min/Max:**
  Defines the minimum and maximum (direct) distance between top and bottom tracking points. If the real distance of the lap joint exceeds the limits, the algorithm finds no tracking point.
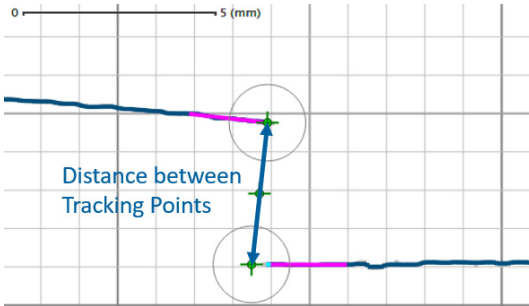
The maximal distance is an important result as it may indicate that the metal parts are not in the proper position. The limits help to stop the welding process when Tracking Point Distance Max is exceeded.

- **Min Tack Width:**
  If the Right Angel Correction value is not set to None, the bottom tracking point is not necessary at the same position as the Point of Interest, which helped finding the tracking point pair. If the distance between Tracking Point Bottom and original Point of Interest is larger than Min Tack Width, a manual welding tag is assumed and no valid result is returned. In other words, a manual welding tack has to have at least a width of Min Tack Width to be recognized.
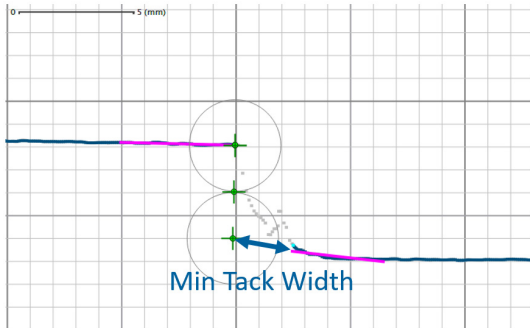
- **Straight Line Left/Right:**
  See Basic parameters

- **Angle Left/Right Min/Max:**
  See Basic parameters

- **Gap Closure:**
  See Basic parameters

- **Edge Detection:**
  See Basic parameters

- **Cluster Size Min:**
  See Basic parameters

7.7.4.2 Results

The following results are relevant for lap joints:

- **Tracking Point Top/Middle/Bottom:**
  x and z coordinates of found points

- **Joint Width (x difference):**
  x difference between top and bottom tracking points

- **Joint Heigth (z difference):**
  z difference between top and bottom tracking points.

- **Distance between Tracking Points:**
  Direct distance between top and bottom tracking points.

- **Angle Left/Right:**
  See Basic outputs

- **Joint Found (%):**
  See Basic outputs

- **Tracking Point Valid/Invalid:**
  See Basic outputs

7.7.5 T Joints

### 7.7.5.1 Parameters

The following parameters are relevant for T joints:

- **Input Pointcloud:**
  See Basic parameters

- **Angle Min:**
  Defines the minimum angle between the left and right straight lines. If the real angle is smaller than Angle Min, no tracking point is found.

- **Angle Expected:**
  Defines the expected angle between the left and right straight lines. If several potential tracking points are within the limits, the algorithm chooses the one with the better Angle Expected value.

- **Angle Max:**
  Defines the maximum angle between the left and right straight lines. If the real angle is bigger than Angle Max, no tracking point is found.

> **i** **NOTE!**
> Use the result Angle to optimize the settings for Angle Min, Angle Expected and Angle Max.
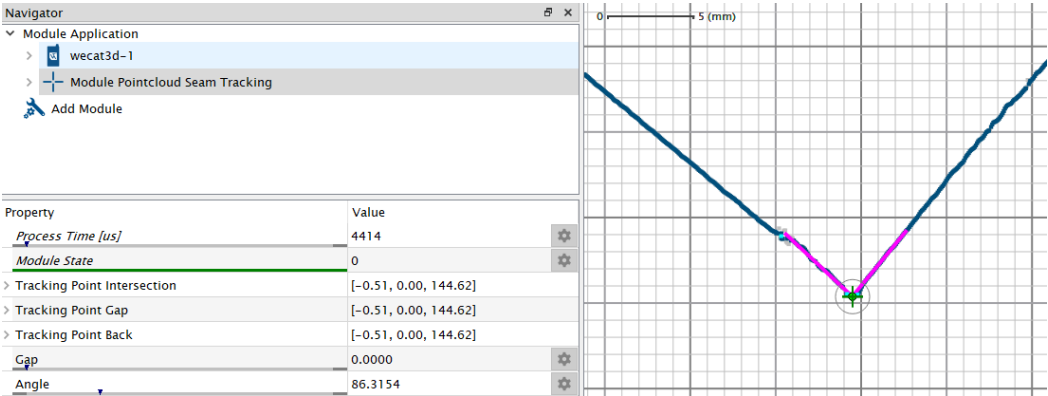
- **Gap Left/Right Max:**
  Defines the maximum gap between the left or right tracking point to the intersection point. If the real gap between the left or right tracking point to the intersection point is bigger than Gap Left Max or Gap Right Max, the algorithm finds no tracking point.

> **NOTE!**
> Use suitable values for Gap Left Max and Gap Right Max to find also T joints with a certain gap. The Gap Left/Right Max values help to stop the welding process when the metal parts are misaligned.

Gap Left/Right Max: 0 mm (No tracking point found)	Gap Left/Right Max: 3 mm (Tracking point found)
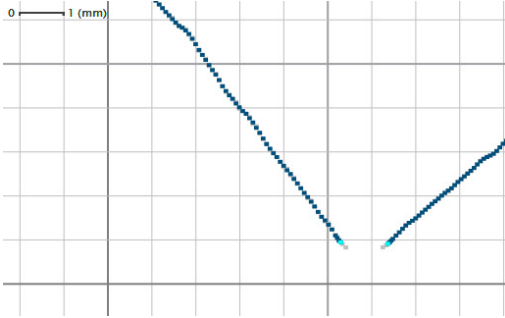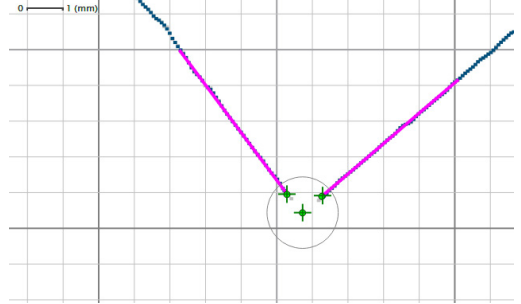
- **Straight Line Left/Right:**
  See Basic parameters

- **Angle Left/Right Min/Max:**
  See Basic parameters

- **Gap Closure:**
  See Basic parameters

- **Edge Detection:**
  See Basic parameters

- **Cluster Size Min:**
  See Basic parameters

7.7.5.2 Results

The following results are relevant for T joints:

- **Tracking Point Intersection:**
  x and z coordinates of intersection point between left and right straight line fits. This is the only point that is used for plausibility check of future results to prevent jumping results.

- **Tracking Point Gap:**
  x and z coordinates of end point of "higher" straight line. In case of no gap, Tracking Point Gap has the same coordinates as Tracking Point Intersection.

- **Tracking Point Back:**
  x and z coordinates of end point of "lower" straight line. In case of no gap, Tracking Point Back has the same coordinates as Tracking Point Intersection.
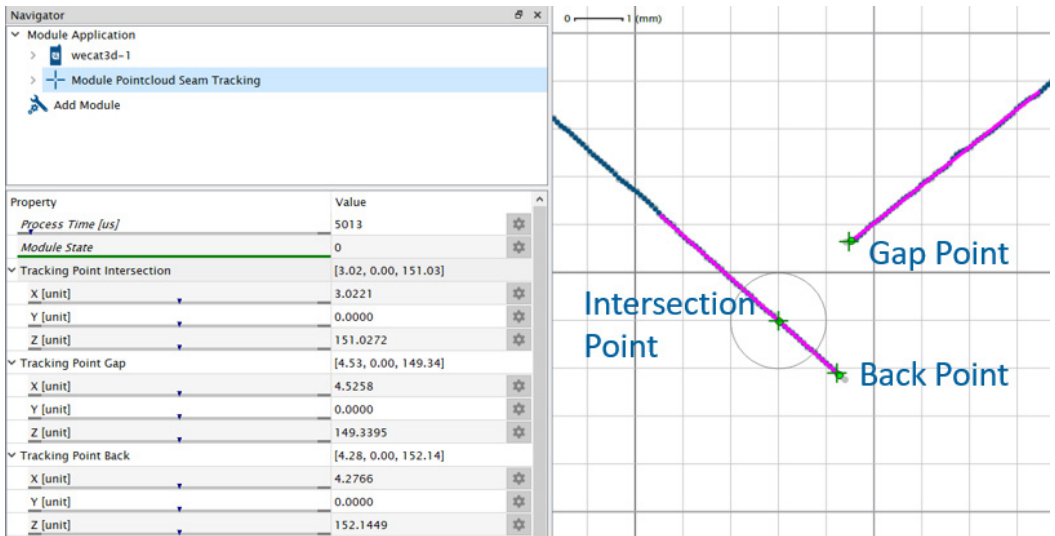
- **Gap:**
  Distance from Gap Point to Intersection Point.

- **Angle:**
  Angle between left and right straight line fits.

- **Angle Left/Right:**
  See Basic outputs

- **Area:**
  Area between Intersection, Back and Gap Point.

> **NOTE!**
> The filtered Area in History and Filter is the area between the filtered Intersection, Back and Gap Points.

- **Joint Found (%):**
  See Basic outputs

- **Tracking Point Valid/Invalid:**
  See Basic outputs

7.7.6 Edge

7.7.6.1 Parameters

The following parameters are relevant for edges:

- **Input Pointcloud:**
  See Basic parameters

- **Edge Type:**
  Defines if looking for edges on the left or on the right side.

- **X Coordinate Expected:**
  Defines the expected x coordinate of the edge point. If several potential tracking points are within the limits, the algorithm chooses the one with the better X Coordinate Expected.
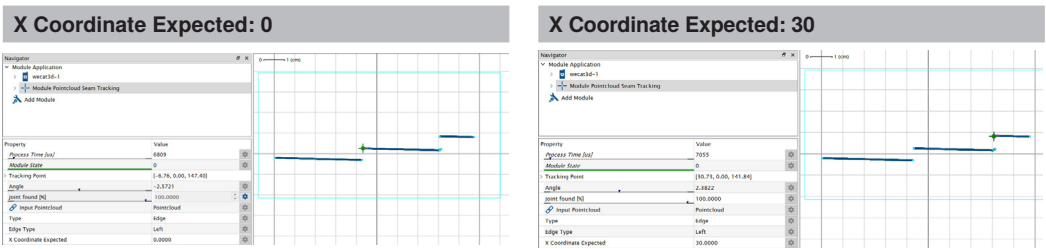
X Coordinate Expected: 0	X Coordinate Expected: 30

- **Straight Line Left/Right:**
  See Basic parameters

- **Angle Left/Right Min/Max:**
  See Basic parameters

- **Gap Closure:**
  See Basic parameters

- **Edge Detection:**
  See Basic parameters

- **Cluster Size Min:**
  See Basic parameters

7.7.6.2 Results

The following results are relevant for edges:

- **Tracking Point:**
  x and z coordinate of the edge point.

- **Angle:**
  See Basic outputs.

- **Joint Found (%):**
  See Basic outputs

- **Tracking Point Valid/Invalid:**
  See Basic outputs

7.7.7 Dent

7.7.7.1 Parameters

The following parameters are relevant for dents:

- **Input Pointcloud:**
  See Basic parameters

- **Filter Width:**
  Dents are detected by comparing the profile with a strongly smoothed version of it. Depending on the intensity of the smoothing, dents are almost gone in the smooth version. The difference to the original profile is used to detect dents. The intensity of the smoothing is adjusted with the parameter Filter Width.
  As smoothing destroys information, the area near the boundary of the search box is not usable for dent detection. The larger the filter width, the more profile is lost. This is visible in the UI by the greyed out profile. Cyan points visualize the boundary of the dent approximation. The dent area is marked with yellow color.
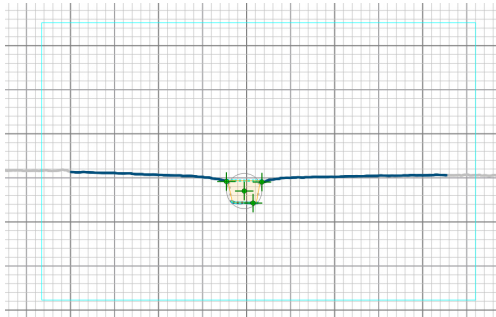
- **Area Min/Max:**
  Defines the range of the allowed area which the found dent is allowed to have.

- **Compactness Min:**
  Compactness is defined as the ratio of the area of an object to the area of a circle with the same perimeter. The maximal compactness value (for a perfect circle) is 1 and the minimal value is 0. The Compactness Min parameter helps to exclude false-positives with long and thin shape.

$$\text{compactness} = (4\pi \times \text{area}) / (\text{perimeter})^2$$

- **Compactness Max:**
  Defines the maximal compactness value.

- **Gap Closure:**
  See Basic parameters

- **Cluster Size Min:**
  See Basic parameters

7.7.7.2 Results

The following results are relevant for dents:

- **Tracking Point Centroid:**
  x and z coordinate of the centroid of the dent area.

- **Tracking Point Left/Right:**
  x and z coordinate of the leftmost/rightmost point in the dent area.

- **Tracking Point Bottom:**
  x and z coordinate of the lowest point in the dent area

- **Area:**
  Area covered by the dent approximation.

> **NOTE!**
> The filtered Area in History and Filter is the man area of the last results. How many results are used depends on the smoothing parameter Mean of Last N Results. If the Filtered Tracking Point is the result of the keep valid or extrapolation setup, the value is repeated. If the filtered Tracking Point is invalid, the area is zero.

- **Compactness:**
  Compactness of the dent approximation.

- **Joint Found (%):**
  See Basic outputs

- **Tracking Point Valid/Invalid:**
  See Basic outputs

7.7.8 History and Filter

For safe and smooth tracking, the last results are stored and used to generate an artificial tracking point, the Filtered Tracking Point. This point is supposed to be more reliable, stable and less affected by noise.

> **NOTE!**
> It is not possible to use the filtering in case of too fast acquisition frequencies for the input device. In case of overflowing data buffers, also the Filtered Tracking Points go in error state.

7.7.8.1 Parameters

The following parameters are relevant for History and Filter:

- **History Reset:**
  Manual reset of the history. In offline mode, when working with teach-plus files, it is sometimes necessary to reset the history manually. Whenever parameters change, the history is reset, too. When working online, with real sensor data, the following actions trigger a history reset automatically:
  - » Booting the system
  - » Loading a project
  - » Starting the acquisition via software Acquisition Start command
  - » Stopping the acquisition via software Acquisition Stop command

- **Prevent Jumping Results:**
  New results of the filtered tracking points are only allowed in a specific search area around the last filtered tracking points.
  - » **Applied Max Distance to Last Tracking Points:** This output shows the applied maximal distance around the last found tracking points. If "Search Area" is activated in "View", the search areas around the last valid tracking points are also visualized in the UI. It is not possible to set this value, as it is computed from the following parameters.
  - » **Initial Max Distance to Last Filtered Tracking Points:** Defines the initial radius of the search area, centered at the last Filtered Tracking Points.
  - » **Increment Max Distance to Last Filtered Tracking Points:** Defines the increment that is added to the radius each time no tracking point is found in order to take into account the movement of the joint position.
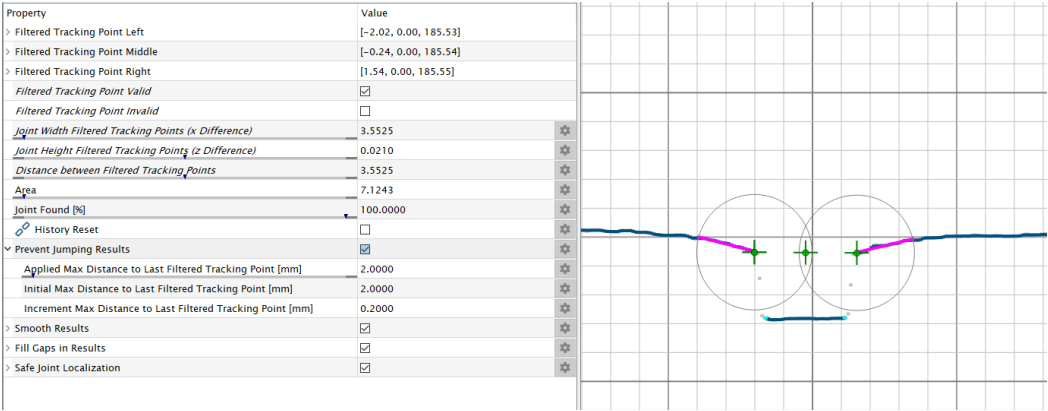
- **Smooth Results:**
  For stable and smooth results, the last valid tracking points can be filtered. If this option is activated, the Filtered Tracking Points are the smoothed version of previous results.
  - » **Mean of Last N Results:** Defines how many previous tracking points are considered to compute the mean. Only valid tracking points of the last N results are used.

- **Fill Gaps in Results:**
It is possible to fill gaps if not every tracking point is found and no errors should be sent to the communication partner. Consequently, Filtered Tracking Points can become valid, even if no current Tracking Points are found.

  » **Runs Without Tracking Point:** Shows the number of evaluations without a valid Tracking Points. This result is reset whenever a valid result is found.

  » **Keep Valid for N Runs:** If no current Tracking Point is found, the last valid Filtered Tracking Points are reused for N runs. Once, no Tracking Point is found for N+1 runs, the Filtered Tracking Points become invalid.

  » **Trend Using Last N Results:** Defines how many steps between consecutive previous Filtered Tracking Points are considered to extrapolate, in case of a missing result. Only the valid Filtered Tracking Points of the last N +1 results are used for this calculation. The target is to preserve the movement of Tracking Points even if there are gaps in the results. By default, the value is set to 1, which means that no trend is applied (only the last result is considered, and therefore there is no movement in these data).

- **Safe Joint Localization:**
This option reduces the risk of false-positive results when localizing joints. Problems arise for example, if the sensor moves towards the joint and detects structures in the surface, which look similar to the joint. In general, there is a risk, that false-positive Filtered Tracking Points set the Search Area at an unsuitable position. This risk is reduced by comparing the current result with previous ones and by only accepting the Filtered Tracking Points, if there is a certain amount of previous results at a similar location. For this purpose, the distances between the current result and the previous ones are measured. Every previous result that has a distance smaller than the search radius S is considered as a match. Search radius S is computed as the search radius at the Filtered Tracking Point. It starts with the value set for Initial Max Distance to Last Filtered Tracking Point and increases when going back in time with the value of Increment Max Distance to Last Filtered Tracking Point.

  » **Relocate Matches:** This output shows the current number of similar results in history.

  » **Relocate Buffer Size:** Defines the number of results stored for comparison.

  » **Relocate Matches Min:** Defines the minimal number of matches within the Relocate Buffer that have to be found in order to consider the Filtered Tracking Points as valid.

7.7.8.2 Results

Depending on the joint type, further results appear.

7.7.9 View

Activate /deactivate or adjust one of the following overlays within the profile:

- **Current Tracking Points:**
  Show the tracking points for the current profile.

- **Filtered Tracking Points:**
  Show the filtered tracking points.

- **Input Pointcloud:**
  Show the original and not filtered input pointcloud with grey points.

- **Points of Interest:**
  Show the Points of Interest with cyan color.

- **Line Fits:**
  Show the line fits for the tracking points.

- **Search Area:**
  Show the search area for the filtered tracking points. The next filtered tracking point is only allowed within the search area, otherwise no tracking point is found in order to avoid jumping tracking points (see section 7.7.8).

- **Area:**
  Show the area of found joints (only supported at some of the joint types).

- **Filtered Tracking Point Cross Size:**
  Defines the size of the cross for the filtered tracking points.

7.8 Setup Device for Outputs

The relevant device for outputs within the uniVision project depends on the use case:

- wenglor robot interface (only on Control Unit): Device TCP
- No wenglor robot interface (on Control Unit or Smart 2D/3D Profile Sensor): Any available interface of the device is possible
    - » Control Unit: PROFINET, EtherNet/IP, TCP/IP, UDP
    - » Smart 2D/3D Profile Sensor: TCP/IP, UDP

> **NOTE!**
> This manual contains all info about Device TCP for the communication to the wenglor robot interface. Check the product page of the relevant device for further info about all other interfaces like PROFINET, EtherNet/IP, TCP/IP, UDP or LIMA.

7.9 Setup Device TCP (for Robot Interface)

In the templates, Device TCP is already part of the project and preset with the relevant defaults for the robot interfaces.

> **NOTE!**
> If creating an empty project, it is necessary to add Device TCP from the toolbox to the project to work with the wenglor robot interface. If not using the robot interface, Device TCP or any other interface (e.g. PROFINET, EtherNet/IP) can be used to send the data to the communication partner (e.g. PLC).

Device TCP needs the following configuration:
- Preamble: (empty)
- Postamble: ; (semicolon)
- Delimiter: , (comma)
- String Count: 9
- Output mode: Formatted
- Error Handling: Value Substitution
- Connections: 5
- TCP Port: 32002
- Blocking Mode: Off (deactivated)

7.9.1 String Count

Character string number	Liked Value
Character string #1	Link with a value which provides information concerning the validity of the measured value (e.g. Filtered Tracking Point Invalid) **NOTE!** The linked value is interpreted as follows: • Int 0 or boolean false: The ascertained value is valid. • Int not equal to 0 or boolean not equal to false: The ascertained value is invalid. The robot ignores the measured value.
Character string #2	Link to the x coordinate of the tracking point.
Character string #3	Link to the z coordinate of the tracking point.
Character string #4	Link to the width difference (e.g. the x value difference at a butt joint).
Character string #5	Link to a height difference (e.g. the z value difference at a lap joint).
Character string #6	Link to an area (e.g. the area from joint type "Dent").
Character string #7	Link to inclination angle of calibration plate to the x-axis of the sensor (only necessary for calibration template via calibration plate at ABB robots).
Character string #8	Link to x-coordinate of second (right) tracking point (only necessary for calibration template via calibration plate at ABB).
Character string #9	Link to z-coordinate of second (right) tracking point (only necessary for calibration template via calibration plate at ABB).

NOTE!
If string 1 provides a valid info all other strings (e.g x and z values) must be valid. Otherwise wrong values could be sent to the robot. E.g. if error handling is applied to string #2 (x coordinate), then "Error###" from Device TCP is interpreted as 0. Then the x value 0 might be sent to the robot which could lead to crashes of the robot.

NOTE!
Character strings 1 to 3 are mandatory. Linking all other strings is optional.

7.9.2 Error Handling

In the templates, the substitution text is preset to "Error###" for a fix string length. The default substitution text "Error" from Device TCP is also possible for the robot interfaces.

7.9.3 Formatting Options

In the templates, the formatting options are preset to the following values for a fix string length:

- Integer:
    - » Digits: 7
    - » Print+: Active
- Floating Point:
    - » Digits Before Comma: 4
    - » Digits After Comma: 2
    - » Print+: Active
- Boolean:
    - » Mode: 0/1

7.10 Save Project and Setup Startup Behavior

Save the project with a project number and set it as start project in the global properties of the device.

Example:

- Job number on robot side: 1
- Matching name of the uniVision project: 1.u_p

8.   Robot Interface

The robot interface is a separate program that only runs on Control Units (not on 2D/3D Profile Sensors).
It is possible to download it from:
https://www.wenglor.com/en/Safe-Welding-Seam-Tracking-in-Welding-Systems/s/Themenwelt-Schweissnaht-fuehrung

8.1 Changelog

The version compatibly of the robot interface and the uniVision software is summarized in the following table.

Robot interface	Version	Date	Description
Generic Weld Seam Track-ing Interface	1.0.4	13.12.2023	Support of Control Units BB1C0xx, BB1C1xx and BB1C5xx with uniVision 2.6.1

8.2 Installation

To install the software add-on on the Control Unit proceed as follows:

1. Download the file and save it to an USB stick

2. Connect the USB stick to one of the USB ports on the Control Unit

3. Select the file and copy it to the /media/card/firmware directory

4. Restart the Control Unit

The software add-on is installed and will start the next time the system is booted.

8.3 Licensing

The robot interface needs to be licensed in order to accept a connection from the robot controller.
Click in the menu under "Help" on "License" to open the lincense dialog window:
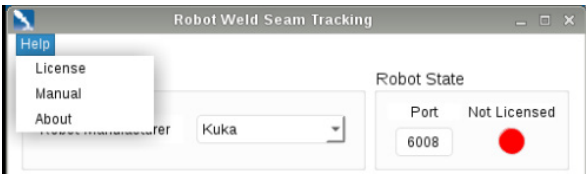
Fig. 4: Robot interface licensing

Enter your data under the "License Request tab". Click "Generate request", save the displayed license request key on the desktop and send it by email to
order@wenglor.com
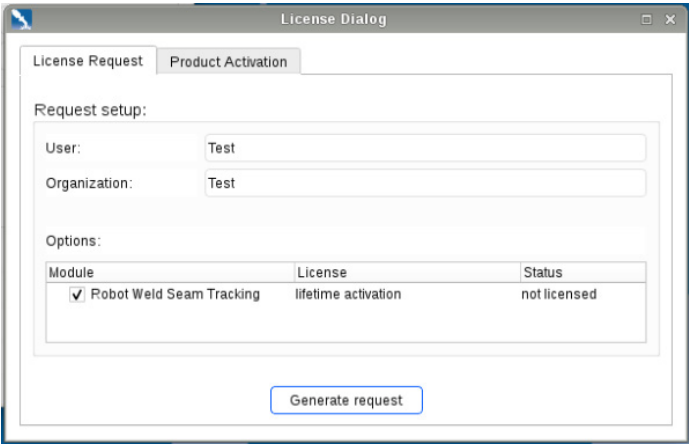
Fig. 5: License window

> **NOTE!**
> Please make sure that the licensing process is executed on the Control Unit which will actually be used in the applicaton. The license is restricted to the respective Control Unit.

You will receive your license activation key. Save it on your desktop. Select the "Product Activation" tab in the license dialog box and open the corresponding file. Click "Activate License" in order to enable the software.
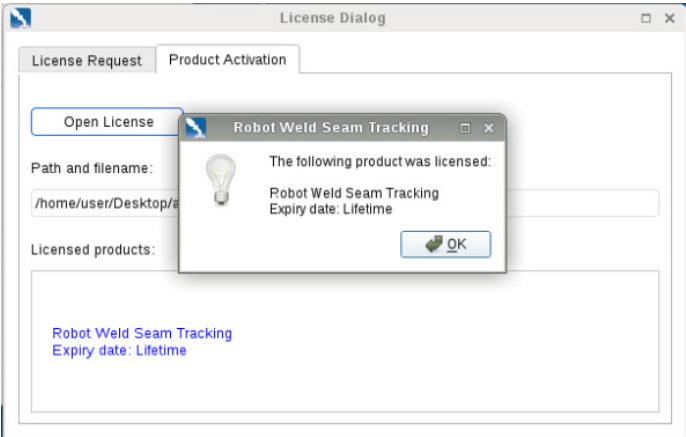
Fig. 6: License activation window

8.4 Robot Weld Seam Tracking Interface

The robot weld seam tracking interface DNNP012 runs on the Control Unit. Connect monitor, keyboard and mouse on the Control Unit or create a VNC connection from the Windows PC to the Control Unit (for details, see uniVision operating instruction).
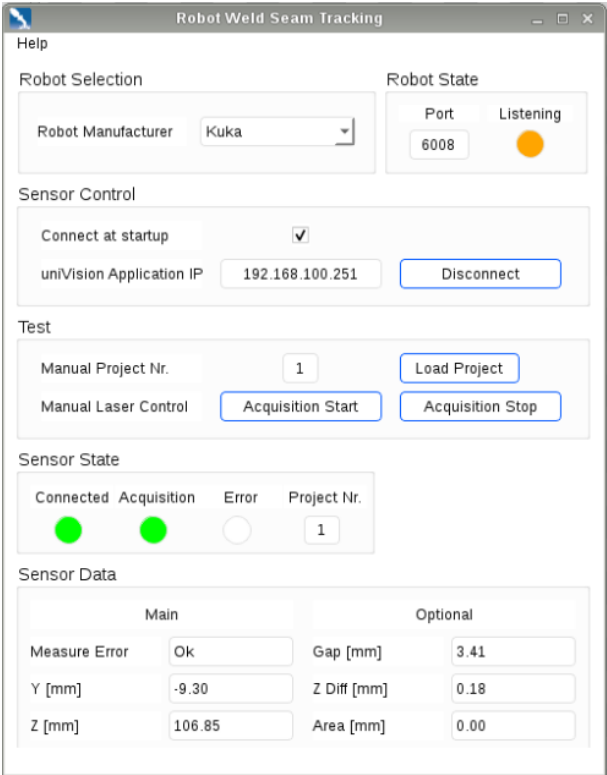
Fig. 7: Robot Weld Seam Tracking Interface

The menu bar "Help" contains the following entries:

- License: Opens separate window for license generation and activation (see section „8.3 Licensing")
- Manual: Opens operating instruction for weld seam tracking interface (PDF file).
- About: Shows current version of robot weld seam tracking interface. Furthermore, it contains a link to the third-party licenses of the robot weld seam tracking interface.

Robot Selection and Robot State

Select relevant robot manufacturer and port:

• ABB (default port 5020)

• Fanuc (default port 5020)

• Kawasaki (default port 5000)

• Kuka (default port 6008)

• Yaskawa (default port 5020)

The LED for Robot State shows the connection status of the robot:

• Green (Connected): Robot is connected to robot weld seam tracking interface.

• Orange (Listening): Robot is not connected to robot weld seam tracking interface. Interface waits for a connection request from the robot.

• Red (Not Licensed): Robot weld seam tracking interface has no valid license. Buy license in order to use the robot weld seam tracking interface (see section „8.3 Licensing").

Sensor Control

Connect at startup: If activated, the robot weld seam tracking interface automatically connects to the uniVision Application after starting the interface (default).

Enter IP address of uniVision Application (default 192.168.100.251).

Option to disconnect in order to edit the uniVision job via the uniVision software and to connect again to the uniVision Application.

> **NOTE!**
>
> • For safety reasons, the interface automatically deactivates the laser of the 2D/3D Profile Sensor after establishing a connection from the interface to the uniVision Application. Use the test section to start or stop the acquisition from the weld seam tracking interface.
>
> • The robot weld seam tracking interface connects via port 32001 to the uniVision Application. The software wenglor uniVision 2 uses the same port in Edit Mode. Make sure to disconnect at the weld seam tracking interface first in order to edit the job in the uniVision software. After editing the job, save the job and switch to run mode in order to connect again via the weld seam tracking interface to the uniVision Application.

Test

The test section enables to send commands from the robot weld seam tracking interface to the uniVision Application.

• Load project: Loads project at uniVision Application defined via "Manual Project Nr.". Make sure that uniVision job name is set correctly (see section „7.10 Save Project and Setup Startup Behavior").

• Acquisition Start/Stop: Starts or stops the acquisition at the 2D/3D Profile Sensor (laser on/off) that belongs to the uniVision Application.

Sensor State

Shows state of uniVision Application and 2D/3D Profile Sensor:

• Connected:
    » Bright green: Connected to uniVision Application
    » Orange: Not connected to uniVision Application. E.g. in case of an open connection of the uniVision software in Edit Mode. Switch to Run Mode in the uniVision software in order to connect from the robot weld seam tracking interface to the uniVision Application. Also possible in case of entering a wrong IP address for the uniVision Application. Enter the correct IP address of the uniVision Application at the weld seam tracking interface.

• Acquisition:
    » Bright green: Laser of 2D/3D Profile Sensor is on.
    » Dark green: Laser of 2D/2D Profile Sensor is off.

• Error: Red in case of any error (e.g. 2D/3D Profile Sensor is off or not available).

• Project Nr.: Returns the current uniVision project number.

Sensor Data

Shows the sensor data of Device TCP (see section „7.9 Setup Device TCP (for Robot Interface)"):

• Main:
    » Measure Error: Returns OK if results are valid or Error in case of no valid results (e.g. joint not found or acquisition stopped).
    » Y [mm]: Returns x coordinate of tracking point.
    » Z [mm]: Returns z coordinate of tracking point.

• Optional:
    » Gap [mm]: Returns gap of joint.
    » Z Diff [mm]: Returns height (z) difference of joint.
    » Area [mm]: Returns area at joint.
    » Angle [°]: Returns the inclination angle (only necessary for calibration template via calibration plate at ABB robots).
    » Y 2nd Point [mm]: Returns x coordinate of second (right) tracking point (only necessary for calibration template via calibration plate at ABB robots).
    » Z 2nd Point [mm]: Returns z coordinate of second (right) tracking point (only necessary for calibration template via calibration plate at ABB robots).

8.5 Robot Manufacturer

Connect the Control Unit with the robot controller via network (TCP/IP).

	NOTE!
ℹ	For details about robot and calibration, check the operating instructions of the robot manufacturer.

8.5.1 ABB

System requirements

- Controller: IRC5
- Software: RobotWare 6.0
- Sensor Interface: Optical Tracking Arc

Use port X4 (LAN2) or X5 (LAN3) on the ABB robot controller for connecting the Control Unit.

Adjust the default configuration of the software "Optical Tracking Arc" accordingly:

Parameter	Description
Name	Enter the name of the sensor (e.g. MLZL121)
Type	Select LTAPPTCP
Serial port	Not used
Remote address	Enter IP address of Control Unit (default: 192.168.100.252)
Remote port	Enter port (default: 5020)

Enter properties of the sensor (e.g. with sensor MLZL121):

ABB property name	wenglor property value (datasheet)	Property value*
Name	MLZL121	MLZL121
Dimension		2
Angle camera to laser		16,5
Frequency		20
Close width of field Y**	Measuring range X (small value)	38 (field width X start, recommended: 30)
Far width of field Y**	Measuring range X (large value)	62 (field width X end, recommended: 50)
Close width of field X		0
Far width of field X		0
Close StandOff*	Working range Z (small value; must be converted to negative value)	-74 (working range Z start)
Depth of Field	Measuring range Z	84 (working range Z)
Far StandOff*	Working range Z (large vlaue; must be converted to negative value)	-158 (working range Z end)
Optimal TCP Stand-Off*		-115 (working range Z at center of field of view)
Frame alignment		Camera aligned

Frame Z orientation		Into camera
Brand		wenglor
Camera compensates X measurement		false

* Some values must be negative values because the coordinate system of the sensor is different to the coordinate system of the ABB robot.

** For some sensor properties, use smaller values than described in the sensor datasheet. The ABB controller uses the sensor properties for the calibration. Limiting the range makes the calibration more stable.

Calibration

Calibrate robot and sensor via the calibration plate. The following image shows the orientation of sensor, robot and calibration plate .
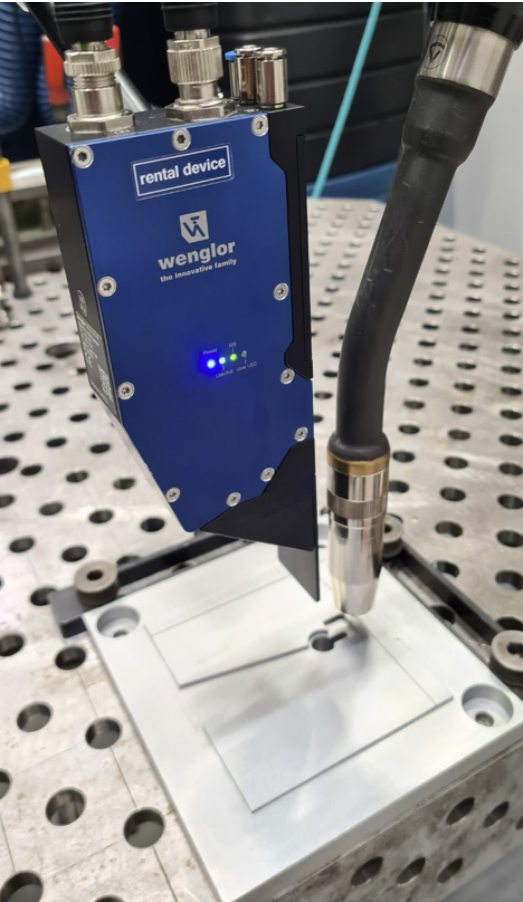
Load the template "Calibrate robots (calibration plate)" in the uniVision software, adjust the settings and save the project with the name "90.u_p". Make sure that the left tracking point is the first tracking point and that the right tracking point is the second tracking point in Device TCP (see section „7.9 Setup Device TCP (for Robot Interface)").

- String #1: Provides info if tracking point is valid or not.
- String #2: X coordinate of left tracking point.
- String #3: Z coordinate of left tracking point.
- String #4: Not needed for calibration.
- String #5: Not needed for calibration.
- String #6: Not needed for calibration.
- String #7: Angle between detected line segment and x axis of the 2D/3D Profile Sensor.
- String #8: X coordinate of right tracking point.
- String #9: Z coordinate of right tracking point.

The robot requests the coordinates of the left and right tracking points and the inclination angle to the x axis at a very high frequency.

- Left joint: Job number 90 on robot side
- Right joint: Job number 91 on robot side
- Butt joint: Not used
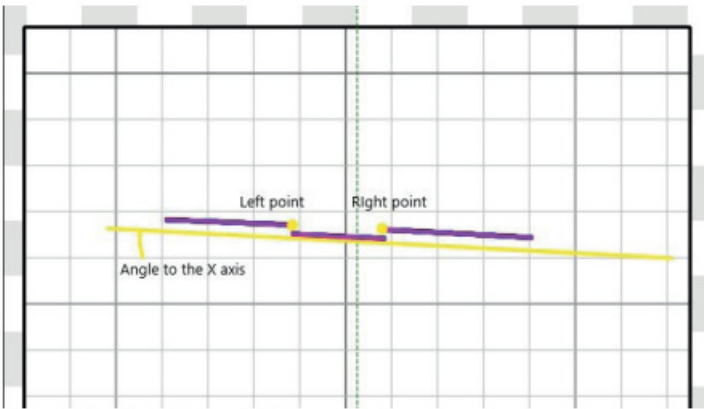
Fig. 8: Tracking data for calibration

NOTE!

- In order to change left and right joints, open RobotWeldSeamTrackingSettings.xml in /opt/WenglorMEL-RobotWeldSeamTracking/bin/ on the file system of the Control Unit and set the values for "CalibrationJointLeft" and "CalibrationJointRight". Save the xml file and close it. Then close the interface so that it automatically starts again with the new settings.
- Use job number 90.u_p only for the calibration project and do not save any project with the job number 91 (91.u_p).

For the ABB robot, job 90 for the left joint and job 91 for the right joint are different jobs. The weld seam tracking interface remains at job 90 for performance reasons. It uses either the coordinates of the left or the coordinates of the right tracking point. Requesting data during calibration is at a very high frequency and every result must be valid. So make sure that the uniVision job is set correctly for all orientations. Directly use the relevant job 90.u_p as start job to avoid an additional job change at the beginning of the calibration process.

> **i** **NOTE!**
> In case of calibration error 80001 at the ABB robot, mount the sensor nearer to the calibration plate and check the sensor properties.

Check the calibration results at the ABB robot.
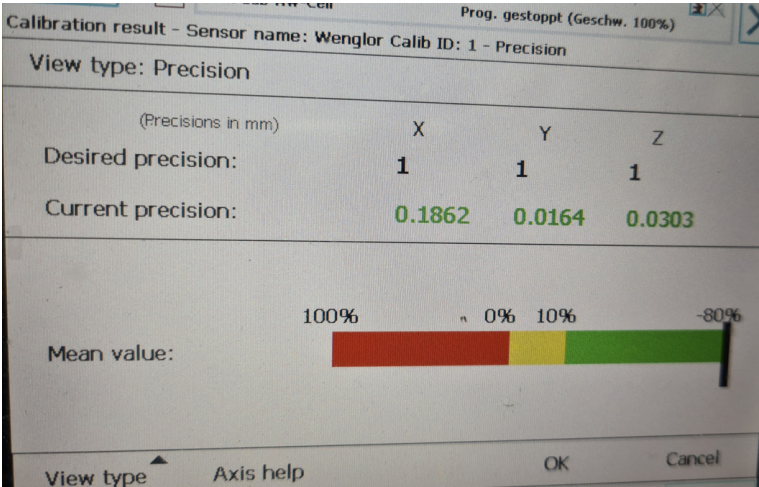
Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side. Job number 0 with name "0.u_p" is not supported.

8.5.2 Fanuc

System requirements

- Controller: R-30iB or R-30iA
- Software ArcTool SW V8.30P/36
- Software options: R691 (Universal Sensor Interface) and R648 (User Socket Messaging)

Or

- Controller: R-30iBPlus or R-30iA
- Software ArcTool SW V9.40P/27
- Software options: R901

Use one of the Ethernet ports on the FANUC robot controller for connecting the Control Unit.
Enter IP address of Control Unit (by default 192.168.100.252) and port (by default 5020) on FANUC robot side. Press "Menus", select "Setup" and press [F1]. Select "Host Comm" and "TCP/IP" to configure the network settings of the host (Control Unit). Test the connection from the robot to the Control Unit by pressing the ping [F4] in the robot controller .
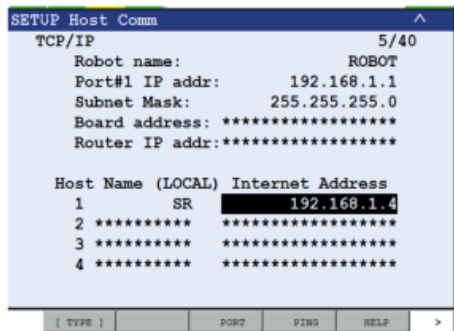

Fig. 9: Setup host communication

Calibration

Calibrate robot and sensor via an overlap joint with two positions at a certain distance (Ten Point Teaching Method).

Load the template "Calibrate robots (calibration plate)" in the uniVision software, adjust the settings and save the project with a number (e.g. 10.u_p).

For details, see Ten Point Calibration Method at FANUC operating instructions.

Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side.

8.5.3   KUKA

System requirements

- Controller: KR C5
- Operating system: KSS 8.7
- Software: KUKA SeamTech Tracking 4.0

Use one of the Ethernet ports on the KUKA robot controller for connecting the Control Unit.

Enter IP address of Control Unit (by default 192.168.100.252) and port (by default 6008) on KUKA robot side.

Calibration

Calibrate robot and sensor via an overlap joint with one position.

Load the template "Calibrate robots (calibration plate)" in the uniVision software, adjust the settings and save the project with a number (e.g. 10.u_p).

For details, see operating instructions of KUKA.

Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side.

The error codes at the KUKA robot have the following meaning:

Error code on KUKA robot	Error description	Possible solution
420	No connection to uniVision	Make sure that the robot weld seam tracking interface can connect to the uniVision Application. Check that port 32001 is not blocked (e.g. by uniVision software in edit mode → switch to run mode in uniVision software). Check that the IP address of the uniVision Application in the weld seam tracking interface is correct.
610	Seam not detected	Adjust the uniVision project so that Module Pointcloud Seam Tracking detects the seam and that correct results are linked to Device TCP.
710	Laser is off	Send start acquisition command in order to set the laser to on.
820	No new data	Check that acquisition line rate at Device weCat3D is fast enough for the frequency the robot asks for new results.

8.5.4 Yaskawa

System requirements

- Controller: DX200 or YRC 1000
- Software: MOTOEYE-LT
- Function specification D2-D2013-028
- DX 200 software version DN1.83.00A(--)-00
- Macro Job's and MACRO.DAT fitting to the application
- Sensor-app / motoPlus-interface LTRACK-DX200.out

Use one of the Ethernet ports on the YASKAWA robot controller for connecting the Control Unit.

Enter IP address of Control Unit (parameter SXE160-163; by default 192.168.100.252) and port (parameter SXE164; by default 5020) on robot side.

Select sensor model 1 in MOTOEYELT-SETTING-JOB.

Calibration

Calibrate robot and sensor via an overlap joint. Create JOB calibration [LT-CALIB] and teach six reference positions at the robot.

Load the template "Calibrate robots (calibration plate)" in the uniVision software, adjust the settings and save the project with a number (e.g. 10.u_p).

For details, see operating instructions of Yaskawa.

Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side.

8.5.5 Kawasaki

System requirements

- Controller: E series
- Software: Option Laser Tracking

Use port LAN 1 on the KAWASAKI robot controller for connecting the Control Unit.

- Communication system: Ethernet
- Communication Protocol: KHI
- Sampling time of communication: 120 ms (increase default value to 120 ms!)
- Sensor Type: Finding + Tracking
- IP Address of Sensor: Enter IP address of Control Unit (by default 192.168.100.252)
- Port No.: Enter port (by default 5000)
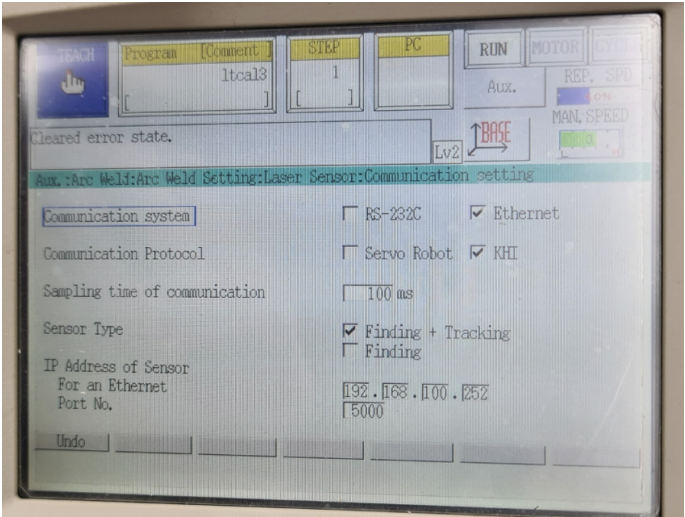
Calibration

Calibrate robot and sensor via an overlap joint.

Load the template "Calibrate robots (calibration plate)" in the uniVision software, adjust the settings and save the project with a number "30.u_p".

Use calibration jobs 30 and 40 on KAWASAKI robot side. In reality, the robot uses only the project 30.u_p including only one tracking point at an overlap joint.

For details, see operating instructions of Kawasaki.

Tracking

Use the uniVision templates (e.g. Find butt joint) to create projects for tracking. Save the project files with numbers in order to load them from robot side.

9. Activating the Debug Output Log

The debug output log saves the communication beween the robot controller and the uniVision application. The debug output log helps the support team finding an appropriate solution. To activate the debug output log go to the RobotWeldSeamTrackingSettings.xml file located in

/opt/WenglorMEL-RobotWeldSeamTracking/bin/

and change the value of the variable EnableLogging to 1 (default is 0).

Restart the robot interface to activate the logging.
The robot interface will create a file RobotWeldSeamTrackingLog.txt. After doing the tests, disconnect the robot controller from the robot interface, copy the file and send it to your support team for further analysis.

NOTE!
In order to avoid an out of memory of the hard disk, please deactivate the debug output log at the end of the test.