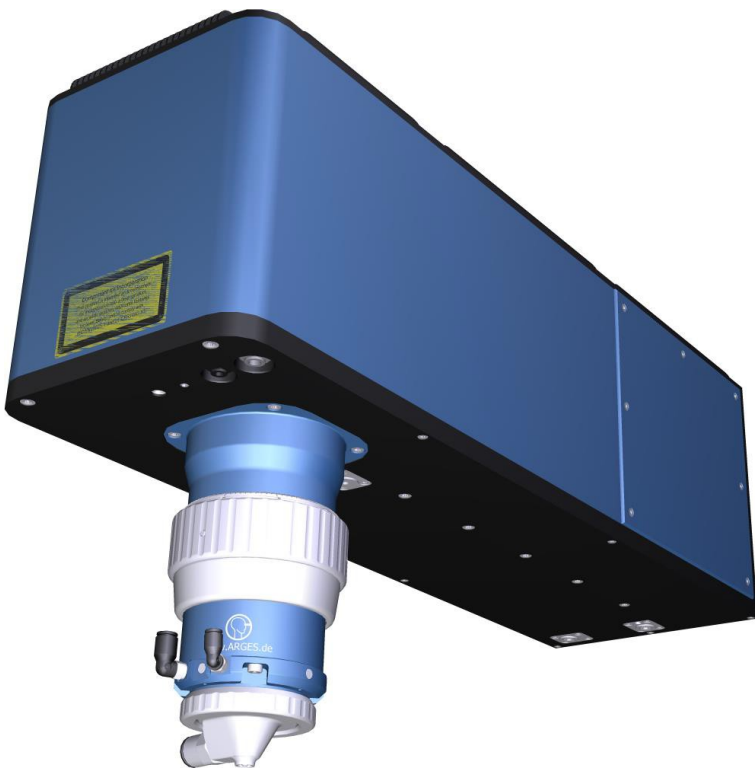


PRECESSION ELEPHANT 2, Scan Head

User Manual

Version 2



Read instructions carefully before use.

Please keep for future reference.

Product

Type: PRECESSION ELEPHANT 2 Scan Head

Version: 2

Document

Type: Original Instruction Manual

Version: 2021-09-22

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1 How to use this document

1.1 Pictographs and signal words

This document uses the following pictographs and signal words for information of particular importance.



WARNING

... indicates a hazardous situation with *average degree of risk* which, if not avoided, *could* result in *death or serious injury*.



CAUTION

... indicates a hazardous situation with *low degree of risk* which, if not avoided, *could* result in *minor or moderate injury*.

NOTICE

... is used to address a practice which, if not followed, could result in *material damage*.

TIP

... is used to address a practice which facilitates work.

1.2 Notation conventions

Table 1: Notation conventions

Notation	Meaning
<u>Underlined</u>	cross reference or hyperlink
[<ID>]	cross reference to external document listed in chapter 14 on page 103
Bold	element in the graphical user interface that shall be clicked
<i>Italic</i>	name of element in the graphical user interface or emphasized text
Teletype	text to be typed in by the user, file name or location in the file system

1.3 Storage and replacement

Keep this document with the product to access the information at any time during the product's lifetime.

This document is part of the product. When selling the product also deliver this document to the new owner.

You can request replacement for this document at the manufacturer.

1.4 Specifics and structure of this document

This document is geared to the product's life cycle.

2 General safety instructions

2.1 Audience and qualification

Before installing and commissioning the scan head, completely read through this instruction manual to employ all functions in a correct and safe way.

This instruction manual addresses qualified personnel who are assigned with installing, commissioning and maintaining or operating the machine where the scan head is incorporated.

Installing, commissioning and maintaining the scan head is only allowed for personnel with electro-technical or mechatronic profession or personnel trained in handling highly sensitive electronic and optical equipment.

Operating the scan head is only allowed for personnel trained in operating the scan head, i.e. the machine where it is incorporated.

2.2 Normal use

The scan head is to be incorporated into a machine, where it is used in combination with a 3rd party class 4 laser for laser material processing.

To read, understand and follow this instruction manual is part of normal use.

Any other use is not considered normal.

2.3 Safety instruction

Operating the scan head is prohibited until it has been established that the machine into which the scan head is incorporated complies with all essential requirements of the 2006-42-EG *Machinery Directive* and the safety requirements and measures of standard DIN EN ISO 11553-1:2009-03 *Safety of machinery - Laser processing machines - Part 1: General safety requirements*.

2.4 General risks

2.4.1 Laser generated air contaminants



Hazardous material is emitted during laser materials processing

Health hazard

- Always provide an adequate exhaustion and subsequent proper disposal of these hazardous materials.

In laser material processing matter will be evaporated when laser beams interact with matter.

Laser Generated Air Contaminants, abbreviated LGAC can compose of multitude hazardous products, such as nickel, chrome, alumina, zinc, butanol, toluol, xylene and formaldehyde. The concentration and the quantity of these aerosols and particles are variable in a wide range.

These LGAC could be hazardous to humans even if they will be respired in lowest concentrations over a long time and can cause sickness, vomiting, cauterization of the respiratory tract, nervous diseases, allergic reactions, spasms and cancer. Even skin contact can cause in hazardous skin irritations and contact eczema.

Because of these risks in all laser thermal processes the LGAC should be complete exhausted by adequate exhaust ventilation with a high air throughput and special paper or active carbon filters.

The customer respectively user of the material processing laser is responsible for the safe exhausting of the LGAC and the right disposal in accordance with local, state and regional threshold limit values for chemical substances. If there are any doubts, these aspects have to be discussed with the relevant authorities and, if necessary, a contaminant measurement can be carried out.

Be sure that all generated fumes, dust and particles will be completely exhausted, even if only a little amount of material shall be processed, or in case of short time laser material processing.

The following safety information has to be taken into account for safe handling of LGAC in laser material processing:

- Be sure, that an adequate working exhaust ventilation system is connected to the material processing laser, that the exhaust ventilation tube is not damaged or plugged, and that the whole exhaust ventilation passage is open
- Be sure, that the exhausting volume flow is adequate. A very low exhausting volume flow, an obstructed exhaust ventilation tube or an obstructed exhausting nozzle can cause a very dirty laser processing area covered with laser generated dust and particles
- Be sure, that the dust filters of the exhaust ventilation system are suitable for the laser material processing. If other materials will be processed by the laser than those intended, ensure that the incorporated filters are suitable for the LGAC of these materials
- Exchanging of dust filters or exhaust ventilation tubes of an exhaust ventilation system has only to be done with suitable respiratory protection, eye protection glasses and protection gloves. Raised dust or fume must not be inhaled and must not get in contact with the human skin
- Exchanged dust filters or exhaust ventilation tubes have to be professionally disposed as hazardous waste, if required
- If the laser processing area with the incorporated components like focusing optics, exhausting nozzles and work piece holders should be cleaned, suitable personal protection devices have to be worn, such as respiratory protection, eye protection glasses and protection gloves. Raised dust or fume must not be inhaled and must not get in contact with the human skin
- If you notice or smell any kind of LGAC probably coming from the material processing laser, you have to immediately switch off the laser system and check the correct function of the exhaust ventilation system and the whole exhaust ventilation passage. If required, exchange the dust filters and clean the laser processing area. The working area around the material processing laser should be well ventilated before starting the laser again
- All personnel operating the material processing laser has to be instructed about the hazards with LGAC and the required safety measures

2.4.2 Laser radiation

During commissioning it is necessary to adjust the laser beam to the scan head and to observe the laser beam.



CAUTION

Visible or invisible laser radiation during commissioning could cause damage to eye or skin.

- Wear protective glasses that are appropriate for adjusting your laser.
- Avoid eye or skin exposure to direct or scattered radiation.
- Parametrize the laser for visual set up with average power and pulse repetition rate as low as possible.

Protective goggles

The mandatory protective glasses provide protection against direct radiation, reflected radiation and scattered radiation. None the less, even if you are wearing protective glasses never look directly into the beam or into a reflected beam. Intense laser radiation is capable of destroying the protective filter.

If alignment or maintenance work on class 4 laser equipment is necessary, everyone in the laser area has to wear appropriate protective glasses. The glasses have to meet the safety requirements for the laser output power in question.

As the filter in the protective glasses only provides protection for a narrow band of wavelengths, make sure you are wearing the right glasses for the laser device in question. Using the wrong type of protective glasses is dangerous. The most commonly used protective glasses for CO₂ lasers do not, say, protect against the radiation from an Nd:YAG laser.

- Before putting on the protective glasses check them for any obvious defects. If any of the following defects occur then use protective glasses that are undamaged:
 - Fissures on the protective filter
 - Scratches on the protective filter
 - Modifications in color
 - Modifications in the light permeability
 - Loosen screws
 - Cracks in the frame

- For the cleaning of dirty laser glasses should be used only water, which is enriched with a common table-ware detergent. Do never use alcohol, benzine, acetone or similar solvents.

Protective clothing

Although the skin can withstand considerably higher radiation intensity than the eyes, tissue may be burned to a greater or lesser degree depending on the irradiation time and the irradiation intensity. Appropriate protective clothing should be worn to protect the skin whenever necessary.



CAUTION

Class 4 laser with high optical output power during commissioning

Fire hazard

- Before opening the beam path take appropriate fire prevention.
- Parametrize the laser for visual set up with average power and pulse repetition rate as low as possible.

Paper (circuit diagrams, leaflets or posters on the wall), curtains that are not impregnated with fire retardants, thin wooden panels or similar materials can be easily set on fire by direct or reflected laser radiation.

Containers holding flammable or explosive cleaning agents, (e.g. used for maintenance) have to be kept away from areas where the laser beam is exposed. Major fires and explosions can quickly result when containers of this kind are accidentally exposed to and destroyed by the intense laser beam.

Nontransparent, hardly inflammable protectors, e.g. laser protectors can help to prevent that laser radiation and scattered radiation discharge from the work area.

3 Overview

3.1 Function

About precession scanning

Precession scan heads allow not only the positioning of a laser beam, but also the setting of the incidence angle of the beam at each point of the workpiece. For a drilling process, the incidence angle is also called the precession angle. When drilling a borehole with high precision, the inclination of the internal hole surface, the so-called taper angle, can only be produced in a reliable and reproducible way if a precession scan head is used. The production of defined edge angles in laser cutting or laser micromachining also requires the use of precession heads.

About the PRECESSION ELEPHANT 2 scan head

The PRECESSION ELEPHANT 2 scan head is designed for high-precision laser drilling, cutting and micromachining applications. It can be used 24/7 in production facilities.

The PRECESSION ELEPHANT 2 scan head offers maximum flexibility for the drilling of innovative borehole- and edge geometries of differing conicity, taper angles and shapes, and allows the production of perfectly round, elliptical and custom-shaped micro holes. The PRECESSION ELEPHANT 2 is available for ultraviolet, green and two infrared wavelength ranges, each with two different focal lengths.

The scan head can be used with all major ultra-short pulsed laser sources available on the market today. In addition, the PRECESSION ELEPHANT 2 makes it possible to monitor the laser process and the laser beam properties during production. The scan head offers improved particle extraction, beam attenuation control and additional functionalities designed for mass production of the highest quality. Several other options, such as tools for the setting and calibration of the polarization, simplify the set-up of the scan head and minimize downtimes for the end-user.

3.2 Controls and signals

At the scan head during normal operation neither there are controls that have to be handled manually nor there are optical or acoustical signals that could be observed.

Controls that need to be operated during commissioning of the scan head are described in the respective sections of chapter 6 on pages 29 ff.

3.3 Labeling

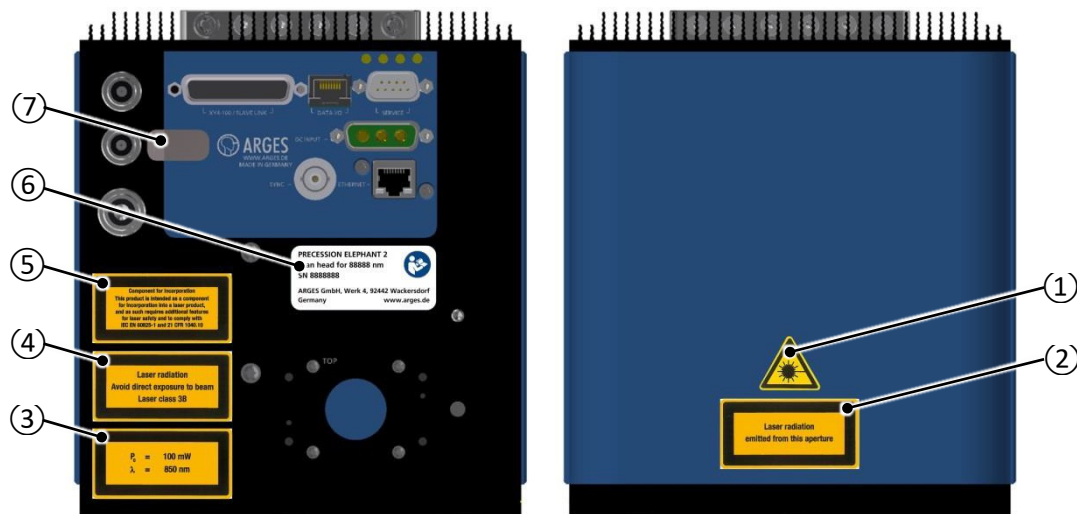

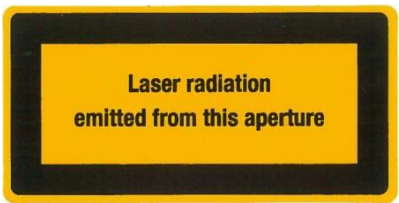
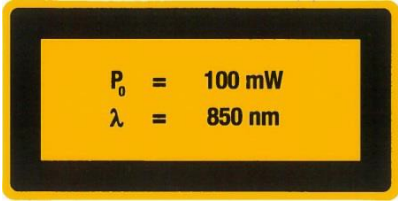

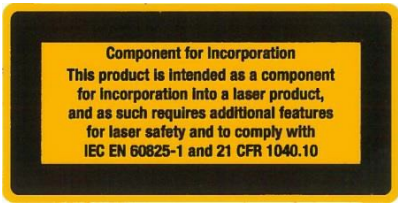

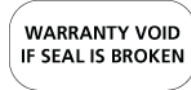


Figure 1: Labels

Table 2: Legend to [Figure 1](#)

No.	Label	Description / Action
①		Triangular <i>Laser beam</i> warning label
②		<i>Laser radiation emitted from this aperture</i> label

No.	Label	Description / Action
③		<p><i>Laser parameters label</i></p> <p>The parameters refer to the built-in laser for scan field illumination.</p> <ul style="list-style-type: none"> Place an additional label for your processing laser according to EN 60825-1:2014.
④		<p><i>Laser radiation</i></p> <p><i>Avoid direct exposure to beam</i></p> <p><i>Laser class 3B label</i></p> <p>This label refers to the built-in laser for scan field illumination.</p> <ul style="list-style-type: none"> Place an additional label for your processing laser according to EN 60825-1:2014.
⑤		<p><i>Component for Incorporation</i></p> <p><i>This product is intended as a component for incorporation into a laser product, and as such requires additional features for laser safety and to comply with IEC EN 60825-1 and 21 CFR 1040.10 label</i></p>
⑥		<p><i>Scan head type label, where the wavelength range is given that the scan head is designed for as well as the serial number, the year of manufacture and the manufacturer's address</i></p>
⑦		<p><i>Warranty void if seal is broken label</i></p>

4 Tools needed

- Hexagon socket screw key set
- Torx key set
- Cutter to cut the cooling water tubes and gas tubes in length
- Tissues to wipe of small amounts of cooling water
- Laser safety glasses appropriate to the laser in use
- If necessary, a suitable indicator card to make an invisible laser beam visible
- *uEye Cockpit* software [[uEye](#)] for viewing the images delivered by the 2 adjustment cameras and the optional through-the-lens vision camera
- Gauge block between 0 mm and 1.5 mm in height to set the distance from the nozzle to the work piece
- Several sheets of metal with a thickness of 0.2 mm as a work piece for drilling tests
- Microscope
- Glan-Thompson polarization meter
- Power measurement device
- Optics spanner wrench for cleaning/replacing protective windows at the beam entrance/exit

5 Installing

5.1 Audience and qualification

Installing the scan head is only allowed for personnel with electro-technical or mechatronic profession or personnel trained in handling highly sensitive electronic and optical equipment.

5.2 Environmental conditions for operation

Table 3: Environmental conditions for operation

Environmental conditions for operation	
Environment	Operate indoors only in a dry and clean environment
Degree of protection by enclosure	IP41
Ambient operation temperature	10 to 40 °C (283-313 K)
Non-condensing humidity	10 to 80 %
Allowed altitude	2,000 m (a. s. l.)
Allowed vibration and shock	Due to the intended processing results in microscopic dimensions the scan head has to be mounted on a vibration-cushioned optical table or an equivalent frame.
Noise emission	[to be defined]

5.3 Safety precautions

- Switch off the machine, where the scan head shall be incorporated, from mains, in particular the laser, the scan head itself and eventually present translation stages.

5.4 Installation

The following procedure describes the installation of a minimal system. A minimal system consists of an ASC system controller, a laser, a scan head and the InScript software. The installation of the scan head is embedded in this procedure.

Install a minimal system in the order as described in the procedure below.

Find further information regarding each step of the following procedure in the corresponding manual in the respective chapter.

Tools

- Hexagon socket screw key set
- Torx key set
- Cutter to cut the cooling water tubes and gas tubes in length
- Tissues to wipe off small amounts of cooling water

Requirements

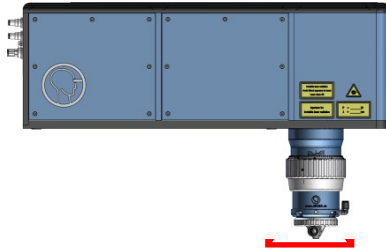
- The ASC system controller is installed, as described in reference [\[ASC\]](#).
- The laser is installed, as described in reference [\[ASC\]](#) and in the laser documentation.

Procedure

NOTICE

Force applied to focusing optics could cause damage to the focusing optics.

- NEVER lift scan heads at the focusing optics.



1. Remove the transportation lock plate from the scan head beam entry, see [Figure 2](#), no. ⑩ on page [20](#).
2. Remove the tape from the scan head beam exit, see [Figure 2](#), no. ⑫ on page [20](#).
3. Mount the scan head into your system.

Please find the scan head dimensions in the respective engineering drawing. This engineering drawing can be obtained either by downloading it from our homepage or directly on request from our engineering and design division.

4. Install the scan head:

Connect the scan head to the supplies, see [Figure 2](#), [Table 4](#) on page [20](#) ff., and to the ASC system controller, see [Figure 3](#) and [Table 5](#) on page [25](#) ff.

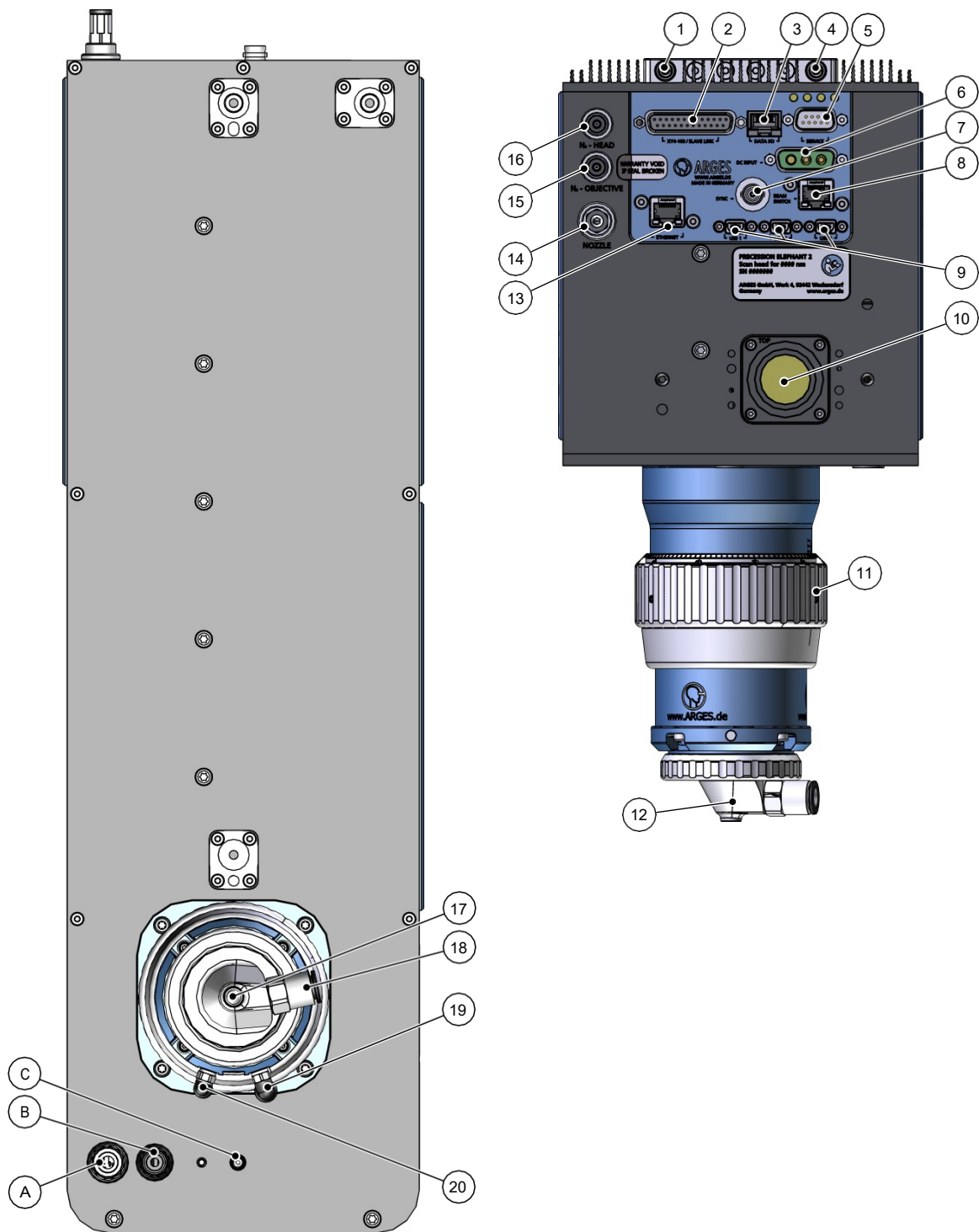


Figure 2: Connectors at the scan head PRECESSION ELEPHANT V2.X

Table 4: Legend to [Figure 2](#)

No.	Label / description	Action
①	<p>Cooling water in- or outlet; Water quality: DI-water, filtered, particle size < 100 µm; Pressure drop: 3 to 4 bar (300 to 400 kPa); Volume flow: 1.2 to 2.2 l/min; Inlet temperature: max. 30 °C (303 K); Recommend tubing material: polyetherurethane; D 6 mm, d 4 mm; The cooling unit is DI-water-proofed with corrosion resistant types of steel.</p>	<p>Connect with tube to cooling water supply; see also section 5.5 on page 26</p>
②	<p>SLAVE LINK / XY4-100</p> <p>This connector is irrelevant for the PRECESSION ELEPHANT scan head, as the scan head already uses all data channels and thus a second scan head cannot be controlled. Furthermore the scan head cannot be controlled by the XY4-100 protocol.</p>	None
③	DATA I/O connector	<p>Connect with CAT-5 patch cable to the SCAN HEAD DATA A connector of the ASC system controller, see Figure 3 and Table 5 on page 25 ff.</p>
④	<p>Cooling water out- or inlet; see also no. 1</p>	<p>Connect with tube to cooling water supply; see also section 5.5 on page 26</p>

No.	Label / description	Action
⑤	<div>DC INPUT</div> <div>- OR -</div> <div>SERVICE connector</div>	<p>If this connector is named DC INPUT then connect it with a power cable to one of the SCAN HEAD POWER connectors of the ASC system controller, see Figure 3 and Table 5 on page 25 ff.</p> <p>If this connector is named SERVICE then do not connect it.</p>

NOTICE

Voltage peaks and leakage currents, when hot plugging the power supply, destroy the scan head electronics.

- Before connecting the power supply to the scan head or disconnecting it from the scan head, ensure that no voltage is being applied to the connecting cable.

⑥	<div>DC INPUT</div> <p>This connector is not present at some variants of the scan head; see also no. 5</p>	<p>If applicable then connect this connector with a power cable to one of the SCAN HEAD POWER connectors of the ASC system controller, see Figure 3 and Table 5 on page 25 ff.</p>
---	--	--

NOTICE

Voltage peaks and leakage currents, when hot plugging the power supply, destroy the scan head electronics.

- Before connecting the power supply to the scan head or disconnecting it from the scan head, ensure that no voltage is being applied to the connecting cable.

No.	Label / description	Action
⑦	SYNC connector for the laser's trigger signal output	<p>This connector is optional.</p> <p>If you wish to measure the energy of single laser pulses then connect it with a BNC-cable to trigger signal output of laser.</p> <p>Find more information in [Firmware] in section <i>Devices:Sensor → AfemLight</i>.</p>
⑧	BEAM SWITCH connector for control of an external beam switch	<p>This connector is optional.</p> <p>If a beam (path) switch is present in your system then connect with a CAT-5 patch cable to the beam switch.</p>
⑨	USB 1 USB 2 USB 3 connectors for the built-in through-the-lens vision camera and 2 alignment cameras	<p>If USB cameras are built-in then connect this to a PC.</p> <p>See also [uEye].</p>
⑩	Beam entry	None
⑪	Objective	None
⑫	Optionally adjustable gas nozzle and optional suction cup	None
⑬	ETHERNET connector for connecting the built-in through-the-lens vision camera and 2 alignment cameras	<p>If Ethernet cameras are built-in then connect this to a PC.</p> <p>See also [uEye].</p>
⑭	NOZZLE Process gas inlet; Process gas quality: non-corrosive gases used commonly as process gases; Inlet pressure: depending on nozzle up to 4 bar (400 kPa); Recommend tubing material: polyetherurethane; D 6 mm, d 4 mm	<p>Connect with tube to process gas supply; see also section 5.6 on page 28</p>

No.	Label / description	Action
⑮	<p>N₂ OBJECTIVE</p> <p>Purge gas inlet for objective;</p> <p>Purge gas: pressurized air (2:4:0 according to ISO 8573-1:2010) or nitrogen gas (N₂ 4.0, oil- and particle-free);</p> <p>Inlet pressure: max. 50 mbar (5 kPa);</p> <p>Volume flow: typ. 2 l/min;</p> <p>Recommend tubing material: polyetherurethane; D 4 mm, d 2.5 mm (or D 4 mm, d 2 mm)</p> <p>Internal restrictor limits pressure to 1 bar (100 kPa);</p>	<p>Connect with tube to purge gas supply; see also section 5.6 on page 28</p>
⑯	<p>N₂ HEAD</p> <p>Purge gas inlet for scan head;</p> <p>Purge gas quality: pressurized air (2:4:0 according to ISO 8573-1:2010) or nitrogen gas (N₂ 4.0, oil- and particle-free);</p> <p>Inlet pressure: max. 50 mbar (5 kPa);</p> <p>Volume flow: typ. 2 l/min;</p> <p>Recommend tubing material: polyetherurethane; D 4 mm, d 2.5 mm (or D 4 mm, d 2 mm)</p> <p>Internal restrictor limits pressure to 1 bar (100 kPa);</p> <p>Internal pressure relief valve opens at 140 ± 50 mbar (14 ± 5 kPa);</p>	<p>Connect with tube to purge gas supply; see also section 5.6 on page 28</p>
⑰	Beam exit and suction cup inlet	None
⑱	Suction cup outlet; tube D 10 mm	<p>If a suction cup is present then connect it to an extraction unit; see also section 5.6 on page 28</p>

No.	Label / description	Action
⑰	Purge gas inlet (objective); connected to no. 20	None
⑳	Process gas inlet (objective); connected to no. 21	None
Ⓐ	Purge gas outlet (scan head); connected to no. 19	None
Ⓑ	Process gas outlet (scan head); connected to no. 20	None
Ⓒ	Purge gas pressure relief valve; see also no. 15	None

TIP

The ASC-2 system controller stands exemplary for other ASC system controllers. Only the connectors essentially necessary to run a minimal system - consisting of the scan head, the ASC system controller and a laser - are listed below. Find more information about your ASC system controller in reference [\[ASC\]](#).

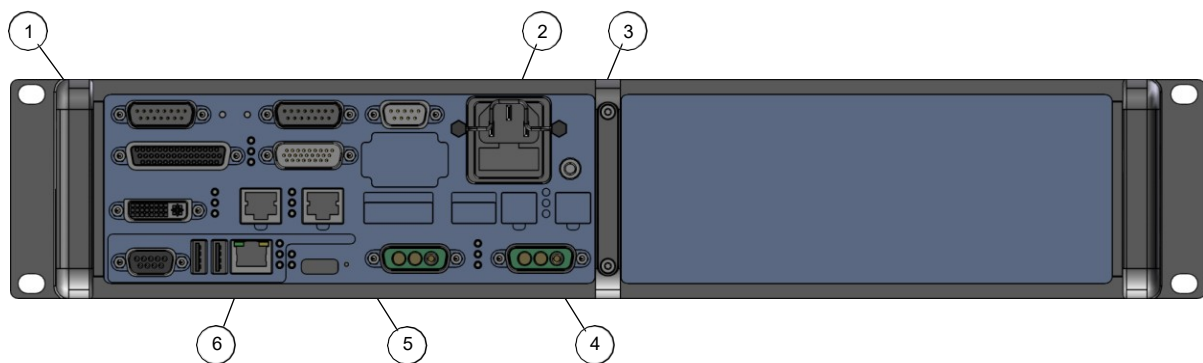


Figure 3: Connectors at the ASC-2 system controller's rear panel

Table 5: Legend to [Figure 3](#)

No.	Label / description	Action
①	LASER	<p>Connect by provided cable and (if applicable) laser adapter to the laser.</p> <p>If your laser device is supported by the InScript software then find more information in [Firmware] in section <i>Devices:Laser</i> → <i><your laser></i>.</p> <p>If your laser device is not supported then find information in [Firmware] in section <i>Devices:Laser</i> → <i>ConfigurableLaser</i>.</p> <p>For further information see [ASC] and (if applicable) the corresponding laser adapter manual and the laser manual.</p>
②	AC input; Connector IEC-60320 C14	Connect by mains cable to mains.
③	Grounding; Screw M5	Additionally to the grounding through the AC input connector ② ground the ASC via this grounding point.
④	SCAN HEAD POWER	Connect by provided power cable to the DC INPUT connector at the scan head.
⑤	SCAN HEAD DATA A	Connect by provided CAT-5 patch cable to the DATA I/O connector at the scan head.
⑥	ETHERNET	<p>Connect by provided CAT-5 patch cable via Ethernet to the PC where the InScript software is installed.</p> <p>For further information see the reference [ASC].</p>

5.5 How to use the cooling water quick coupling

Please find the cooling water specification in [Table 4](#) on page [21](#).

Nomenclature

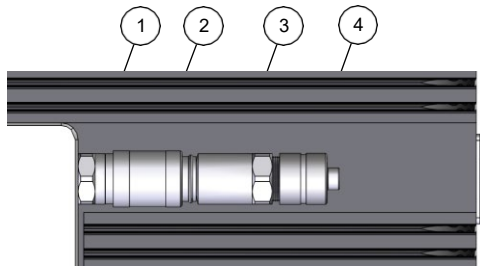


Figure 4: Parts of a cooling water connector

Table 6: Legend to [Figure 4](#)

No.	Name
①	(Self-sealing) quick coupling
②	Release bushing
③	(Self-sealing) plug nipple
④	Coupling nut

How to install the plug nipple to the flexible tube

1. Slip the coupling nut ④ onto the flexible tube.
2. Push the flexible tube onto the plug nipple ③.
3. Tighten the coupling nut ④.

How to connect

1. Turn the cooling water flow off.
2. Relieve the pressure from the tubing.
- 3.

TIP

A small amount of cooling water may leak. Wipe it off with a tissue.

Quickly press the plug nipple ③ beyond the resistance into the quick coupling ①.

4. Check for leakage.

How to disconnect

1. Turn the cooling water flow off.
2. Relieve the pressure from the tubing.
3. Push the release bushing ② in direction of the heat sink.

4.

TIP

A small amount of cooling water may leak. Wipe it off with a tissue.

Quickly detach the plug nipple ③.

5.6 How to use the gas supplies quick connector

Please find the gas supplies specification in [Table 4](#) on page [21](#).

Nomenclature

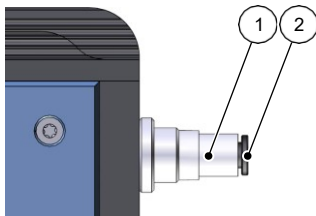


Table 7: Legend to [Figure 5](#)

No.	Name
①	Quick connector
②	End piece

Figure 5: Parts of a gas supplies connector

How to install and connect

1. Relieve the pressure from the tubing.
2. Press the end of the flexible tube beyond the resistance into the end piece ②.
3. Check, whether the flexible tube is correctly connected by trying to pull it out.

How to disconnect

1. Relieve the pressure from the tubing.
2. Press the end piece ② into the quick connector ①.
3. Detach the flexible tube.

6 Commissioning

6.1 Audience and qualification

Commissioning the scan head is only allowed for personnel with electro-technical or mechatronic profession or personnel trained in handling highly sensitive electronic and optical equipment.

6.2 Safety precautions

- Restrict the working area for personnel not involved in commissioning the scan head.
- Shield the area to prevent direct or scattered laser radiation from escaping.
- Any personnel present within the restricted area have to wear protective glasses appropriate to the laser in use.

6.3 Begin commissioning

Requirements

- The ASC system controller is installed, as described in reference [\[ASC\]](#)
- The laser is installed, as described in reference [\[ASC\]](#) and in the laser documentation
- The scan head is installed, as described in chapter [5](#) on page [17](#)
- The InScript software is installed, as described in reference [\[InScript\]](#)
- The InScript software is commissioned, i.e. in the InScript software the devices that are necessary for operating the peripheral devices, that are connected to the ASC system controller, are configured and activated; see reference [\[InScript\]](#) and [\[Firmware\]](#)

- You are familiar with the InScript software's basic functionality; see reference [\[InScript\]](#), e. g. how to start and abort a Job; chapter *Job Control Window*

Procedure

1. Download the separate *uEye Cockpit* software from *Imaging Development Systems GmbH* at <https://en.ids-imaging.com/ids-software-suite.html>.

The software is required for viewing the images delivered by the 2 adjustment cameras and the optional through-the-lens vision camera later on.

2. Login as administrator and install the *uEye Cockpit* software on the PC to which the cameras are connected.
3. Check, if the settings for the cooling water are correct, see also section [13.5](#) on page [86](#).
- 4.

NOTICE

Pressure surge

could cause damage to scan head's cooling water circuit.

Secondary damage to electronics and optics by cooling water is possible.

- Carefully open the cooling water inlet.

5. De-aerate the cooling water system.
6. Check if the settings for the purge gas are correct, see chapter [13.6](#) on page [86](#).
7. Turn the purge gas on.
8. Switch on all peripheral devices that are connected to the ASC system controller and wait until they are ready.
9. Switch on the ASC system controller.
10. Proceed with section [6.4](#) on page [30](#).

6.4 Checking the video capture devices

There may be up to 3 cameras built into the scan head. They are used as alignment cameras 1 and 2 and through-the-lens vision camera. The latter camera is an option.

Procedure

1. Open the *uEye Cockpit* software [[uEye](#)].
2. Click **Monochrome**.
3. In the menu, click **uEye → Initialize**.

The *Select camera* window opens.

TIP




The cameras can be identified by their serial numbers in column *SerNo*.

In document FB198 *Application test protocol of the PRECESSION ELEPHANT V2* find which camera serves which purpose in the PRECESSION ELEPHANT.

4. Select the camera.
5. Click **OK**.
6. The live image will be shown.

TIP

The following will be useful when setting up the laser beam later on.

- Open another program instance of the *uEye Cockpit* software to view the live image of a second camera.
- Scale the live image down to half size by clicking  1:2.
- Mark the image center by clicking  and drawing the diagonals.
- Set the camera parameters by clicking  and then setting the parameters *Pixel clock*, *Frame rate* and *Exposure time* on the *Camera* tab.
- Find the *uEye Manual* in the menu of the *uEye Cockpit* software by clicking **Help → uEye Manual**. There browse to section **B: Operation → Installed programs under Windows → uEye Cockpit**.

7. Leave the *uEye Cockpit* software open.
8. Proceed with section [6.5](#) on page [32](#).

6.5 Checking the settings on the ASC system controller

In the normal case you get an ASC system controller with your scan head, where all required device drivers are already installed.

If this is not the case then you have to create, configure and activate the necessary devices first. This section lists these devices.

TIP

Learn how to manage devices in general from document [\[InScript\]](#), e.g. how to create, configure, activate them.

Learn how to configure and use specific devices from document [\[Firmware\]](#).

Even in the normal case it is advisable to check settings on the ASC system controller with the secondary effect of learning how to manage devices and how to configure, to parametrize and to use them in the InScript software.

- Begin with section [6.5.1](#) on page [32](#).

6.5.1 Head device

Procedure

1. In the InScript software in the *Navigator* view, in the controller's *Devices* subtree, select the **head** device.
2. In the *Node Properties* view on the *Configuration* tab, check, if the following variables are set to the values listed below and correct them if necessary.

Parameter	Value
Vector processing	VP1 Enabled
Scan field correction	COR1 Enabled
Output channel modifiers	OCM1 Enabled
Axis configuration	X/Y/Z/A
Number of subframes	6

1. In the InScript software in the *Navigator* view in the controller's *Pens* subtree, select the **default** → **head** pen-section.

2. In the *Node Properties* view on the *Wobble* tab, set *Type* to **circular**.

You will use mainly the *Precession Drill* job node together with the PRECESSION ELEPHANT scan head. The *Precession Drill* job node needs the *Wobble Type* to be set to *circular*. Generally use all other job nodes with the *Wobble Type* set to *disabled*.

3. Proceed with subsection [6.5.2](#) on page [33](#).

6.5.2 Optional vcsel device

The VCSEL (Vertical Cavity Surface Emitting Laser) device illuminates the scan field for the through-the-lens vision camera. It is bundled with this camera and thus only present in your scan head if the camera is present too.

Table 8: VCSEL parameters

Class 3B laser product according to DIN EN 60825-1:2008-05	
$P_0 = 100 \text{ mW}$	maximum average output power accessible during <i>normal</i> operation with scan head <i>housing closed</i>
$P_0 = 400 \text{ mW}$	maximum average output power accessible during <i>service</i> operation with scan head <i>housing opened and vision unit removed</i>
$\lambda = 850 \text{ nm}$	wavelength

Procedure

1. If your scan head does not have a through-the-lens vision camera then skip this procedure and proceed with the next one.
2. In the InScript software in the *Navigator* view, in the controller's *Devices* subtree, select the **vcsel** device.
3. If the device is not present then create, configure and activate it as described in document [\[InScript\]](#) chapter *Managing Devices* and in document [\[Firmware\]](#) chapter *Devices* → *Miscellaneous* → *Vscel*.
4. In the *Node Properties* view, check, if the following variables are set to the values listed below and correct them if necessary.

Parameter	Value
Channel 1	Disable
Channel 2	Disable

Parameter	Value
Duty cycle	0

5. Proceed with subsection [6.5.3](#) on page [34](#).

6.5.3 Optional afemlight device

The AFEM hardware is optional and may not be present in your scan head.

Procedure

1. If your scan head does not have the AFEM hardware then skip this procedure and proceed with the next one.
2. In the InScript software in the *Navigator* view, in the controller's *Devices* subtree, select the **afemlight** device.
3. If the device is not present then create, configure and activate it as described in document [\[InScript\]](#) chapter *Managing Devices* and in document [\[Firmware\]](#) chapter *Devices* → *Sensor* → *AfemLight*.
4. In the *Node Properties* view, check, if the following variables are set to the values listed below and correct them if necessary.

Parameter	Value
-	-

5. Proceed with subsection [6.5.4](#) on page [34](#).

6.5.4 Optional shutter device

The shutter hardware is optional and may not be present in your scan head.

Procedure

1. If your scan head does not have the shutter hardware then skip this procedure and proceed with the next one.
2. In the InScript software in the *Navigator* view, in the controller's *Devices* subtree, select the **shutter** device.

3. If the device is not present then create, configure and activate it as described in document [\[InScript\]](#) chapter *Managing Devices* and in document [\[Firmware\]](#) chapter *Devices* → *Miscellaneous* → *Shutter*.
4. In the *Node Properties* view, check, if the following variables are set to the values listed below and correct them if necessary.

Parameter	Value
Target state	open
Current state	open

5. Proceed with subsection [6.5.5](#) on page [35](#).

6.5.5 Laser device

Procedure

1. In the InScript software in the *Navigator* view, in the controller's *Devices* subtree, select your laser device.
2. If the device is not present then create, configure and activate it as described in document [\[InScript\]](#) chapter *Managing Devices* and in document [\[Firmware\]](#) chapter *Devices* → *Laser* → *<your laser>* - OR - *Configurable Laser*.
3. In the *Node Properties* view, check, if the variables are set correctly and correct them if necessary.
4. Proceed with section [6.6](#) on page [35](#).

6.6 Setting up the laser beam

TIP

If an already adjusted scan head is removed from the system and thereafter is mounted back to the system then all steps from section [6.6](#) on page [35](#) and further on have to be performed again.

This is the only way to ensure optimal performance and process stability.

The laser beam shall run along the scan head's optical axis. This can be achieved by at least 2 mirrors positioned, in beam direction, before the scan head.

Order and designation

Order and designation of optical elements in the beam path from the laser in direction to the work piece:

Laser → mirror 1 → mirror 2 → scan head → work piece

Tools

- Laser safety glasses appropriate to the laser in use
- If necessary a suitable indicator card to make an invisible laser beam visible
- *uEye Cockpit* software [[uEye](#)] for viewing the images delivered by the 2 adjustment cameras

Procedure - Bringing the laser beam into the scan head

1.



CAUTION

Visible or invisible laser radiation could cause damage to eye or skin.

- Avoid eye or skin exposure to direct or scattered radiation.
- Parametrize the laser for visual set up with average power and pulse repetition rate as low as possible.

Switch on the laser beam:

In the *Node Properties* view of node **Pens** → **default** → **<your laser>** on the *Control* tab, set *Gate control* to **Always on**.

2. Adjust mirror 1 in such a way that the laser beam hits mirror 2 in the center.
3. Adjust mirror 2 in such a way that the laser beam hits the scan head's beam entry in the center.

Now the laser beam is entering the scan head, but it has to be adjusted to the scan head's optical axis yet.

4. Switch off the laser beam:

In the InScript software in the *Node Properties* view of node **Pens** → **default** → **<your laser>** on the *Control* tab, set *Gate control* to **Auto**.

Auto gives control over gate switching to the job.

Procedure - Removing the suction cup and nozzle from the focusing optics

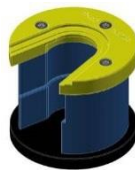
5. Loosen the suction cup retainer ring by 2 turns, but do not remove it yet.



- 6.

TIPP

If you are using this tool from the spare parts list then skip this step.



In order to loosen the nozzle, turn the process gas on (connector NOZZLE; max. pressure 4 bar), just until the nozzle come loose and turn the process gas off again.

7. Remove the retainer ring, the suction cup and nozzle from the focusing optics.



Procedure - Adjusting the laser beam to the scan head's optical axis (raw)

Requirement

- In the InScript software in the *Node Properties* view of node *Pens* → *default* → *<your laser>* on the *Control* tab the *Gate control* has to be set to **Auto**.
8. In the InScript software, load file **AlignmentHelp.jobx** from the **Jobs\PrecessionElephant 1.3 and 2.0** folder of the *InScript Installation*.
- 9.



CAUTION

Visible or invisible laser radiation
could cause damage to eye or skin

- Avoid eye or skin exposure to direct or scattered radiation.
- Parametrize the laser for visual set up with average power and pulse repetition rate as low as possible.

Start the job **AlignmentHelp.jobx**.

The job rotates the laser beam (with approx. 80 % of the possible displacement) around the scan head's optical axis. You can observe a „ring-shaped“ laser beam at the scan head beam exit now.

TIP

If your scan head has an attenuator and/or a polarization unit then you can observe a substantial intensity loss through the scan head in some cases. In these cases the scan head was setup for another polarization than the polarization at your setup. You can preliminary increase intensity by the procedure described in section [6.7.1](#) and then return here.

Condition

The laser beam must not be clipped within the scan head and has to be centered to the beam exit.

not OK



OK



10. If the above condition is *not* OK then adjust the laser beam by mirrors 1 and 2.

TIP

Adjust one axis first and then the other.

11. Abort the job.

Procedure - Adjusting the laser beam to the scan head's optical axis (fine)

Requirement

- The previous raw adjustment is done.

12. View the image delivered by the 2 adjustment cameras with the *uEye Cockpit* software [[uEye](#)].

TIP

Open a second program instance of the *uEye Cockpit* software to view the live image of a second camera.

13.



CAUTION

Visible or invisible laser radiation

Damage to eye or skin

- Avoid eye or skin exposure to direct or scattered radiation.
- Parametrize the laser for visual set up with average power and pulse repetition rate as low as possible.

Switch on the laser beam:

In the *Node Properties* view of node **Pens** → **default** → **<your laser>** on the *Control* tab, set *Gate control* to **Always on**.

Condition

The laser beam must be centered on both cameras.



Figure 6: Camera 1 image (possibly rotated depending on scan head model)

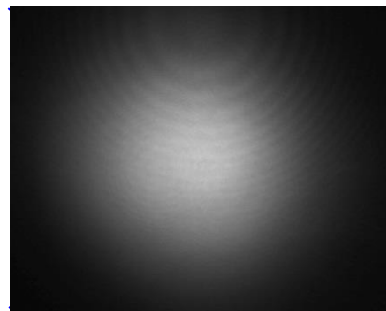


Figure 7: Camera 2 image

14. If the above condition is *not* OK then adjust the laser beam by mirrors 1 and 2.

TIP

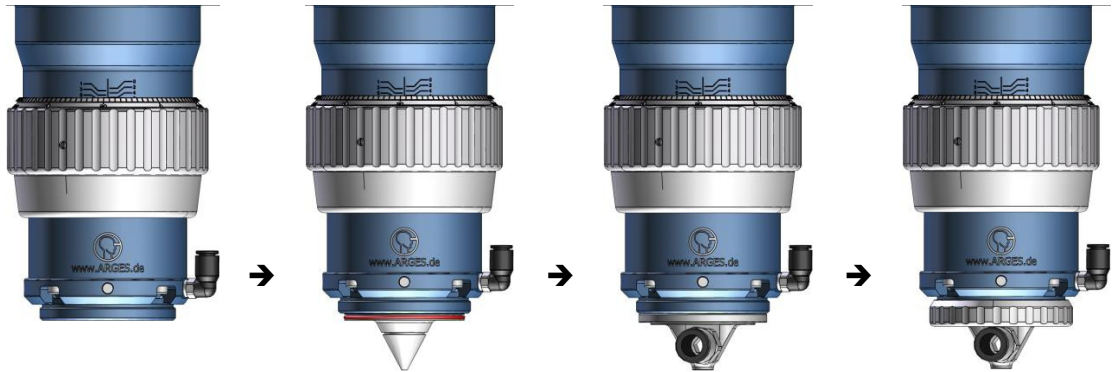
- Camera 1 shows the laser beam and its reflection. Adjust to the laser beam and *not* to its reflection. The laser beam is larger and brighter than its reflection.
- Adjust one axis first and then the other.

15. Switch off the laser beam:

In the InScript software in the *Node Properties* view of node **Pens** → **default** → **<your laser>** on the *Control* tab, set *Gate control* to **Auto**.

Procedure - Mounting the nozzle and the suction cup back to the focusing optics

16. Mount the nozzle and the suction cup back to the focusing optics.



Setting the offset preliminary and checking the quality of previous adjustment

Requirement

- In the InScript software in the *Node Properties* view of node *Pens* → *default* → *<your laser>* on the *Control* tab the *Gate control* has to be set to **Auto**.

17. In the InScript software, load file **AlignmentHelp.jobx** from the **Jobs\PrecessionElephant 1.3 and 2.0** folder of the *InScript Installation*.

18.



Visible or invisible laser radiation

Damage to eye or skin

- Avoid eye or skin exposure to direct or scattered radiation.
- Parametrize the laser for visual set up with average power and pulse repetition rate as low as possible.

Start the job **AlignmentHelp.jobx**.

Condition

The laser beam must not be clipped at the nozzle and has to be centered to the beam exit.

not OK



OK



19. If the above condition is *not* OK then adjust either via the InScript software
- OR - mechanically via the adjustable nozzle at the focusing optics unit.

TIP

Adjust one axis first and then the other.

InScript software:

- In the InScript software in the *Navigator* view, click **Pens** → **default** → **head**.
- In the *Node Properties* view on the *A Data* tab set *Galvo offset dx* and/or *dy* until the condition above is met.

Adjustable nozzle:

- Turn the micrometer screws until the condition above is met.

20. Abort the job.

21. If the abort criterion below is met then repeat section [6.6](#) on page [35](#) else proceed with section [6.7](#) on page [43](#).

Abort criterion

Galvo offset dx and/or *dy* larger than $\pm 1 \%$

- OR -

Limit reached at least at one of the micrometer screws

6.7 Setting up the scan head

Requirement

- The laser beam is set up correctly; see also the abort criterion above.

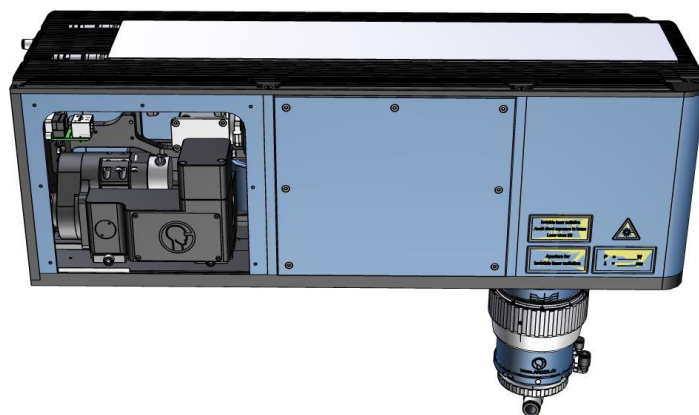
6.7.1 Adjusting the optional attenuator

Tools

- Hexagon socket screw key set
- Torx key set
- Power measurement device

Procedure

1. If your scan head does not have an attenuator then proceed with the next procedure.
2. Only if your scan head has an attenuator and/or a polarization unit that are *not* motorized then remove this side panel to access the attenuator and polarization unit later on:



3.

NOTICE

Focal point

could cause damage to the sensor of the power measurement device.

- Place a power measurement device beneath the beam exit such way, that the laser beam illuminates most part of the sensor.
Do not place the sensor in or near the focal point.

4.



CAUTION

Visible or invisible laser radiation

Damage to eye or skin

- Avoid eye or skin exposure to direct or scattered radiation.
- Parametrize the laser for visual set up with average power and pulse repetition rate as low as possible.

Switch on the laser beam:

In the InScript software in the *Node Properties* view of node **Pens** → **default** → **<your laser>** on the *Control* tab, set *Gate control* to **Always on**.

5. Maximize the optical power at the beam exit:

a. Measure the optical power with a power meter device.

Eventually it may be necessary to increase the optical power to get a significant measurement. After measuring do not forget to reduce the optical power to the previous value.

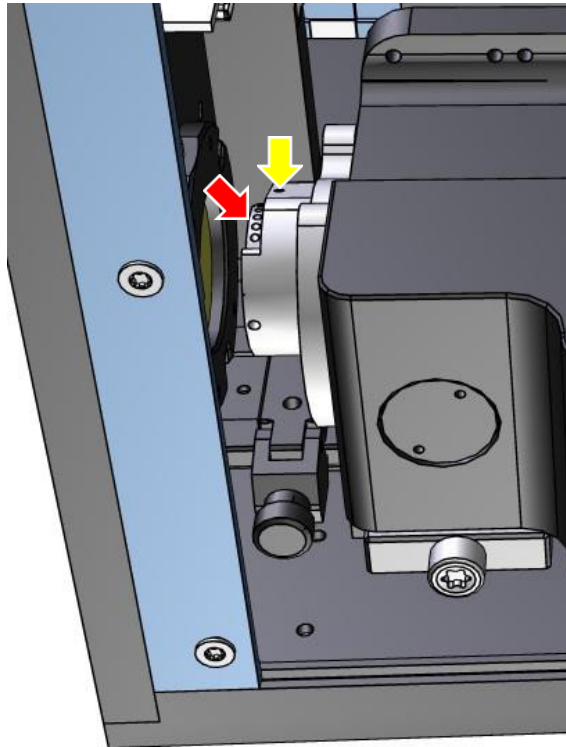
b. If your scan head has a motorized attenuator then:

- i. In the InScript software in the *Node Properties* view of node **Pens** → **default** → **head** on the *A Data* tab, set for *Subframe 3* the *Mode* to **Specified**.
- ii. Increase/decrease the *Position* until the optical power is maximized.

- OR -

If your scan head has a manual attenuator then:

- i. Untighten the M2 hexagon socket set screw (AF 1.5 mm), marked by a yellow arrow in the following figure.
- ii. Turn the attenuator, marked by a red arrow in the following figure until the optical power at the beam exit is maximized.



- c. If you increased the optical power to get a significant measurement then decrease the optical power to the previous value.
 - d. If your scan head has a manual attenuator then tighten the M2 set screw again.
6. Switch off the laser beam:
- In the InScript software in the *Node Properties* view of node **Pens** → **default** → **<your laser>** on the *Control* tab, set *Gate control* to **Auto**.
7. Proceed with subsection [6.7.2](#) on page [46](#).

6.7.2 Adjusting the focus

Tools

- Laser safety glasses appropriate to the laser in use
- Gauge block between 0 mm and 1.5 mm in height to set the distance from the nozzle to the work piece.
- Several sheets of metal with a thickness of 0.2 mm as a work piece for drilling tests
- Microscope

Requirement

- The nozzle incl. the protective glass has to be mounted to the scan head.

Procedure

1. Parametrize the laser for processing the work piece with minimal effect, e.g. with pulse repetition rate between 800 Hz and 1000 Hz and average power as low as possible.
2. Insert the work piece.
3. Set the distance between the nozzle and the work piece to your desired value between 0 mm and 1.5 mm.

The optimum distance depends on the work piece geometry and the gas flow beneath the nozzle.

The factory setting for the distance between nozzle and focus is 1.0 mm. This equals the Z-position of 0 %.

4. If your distance between nozzle and work piece differs from the factory setting mentioned in the previous step then this means that the focus and thus the Z-position needs to be corrected to the surface of the workpiece:

- Turn the silver adjusting ring at the focusing optics to correct the focus.

The nonius at the ring gives the distance in 10 μm per scale gradation.

If your distance between nozzle and work piece is less than 1.0 mm, e.g. 0.6 mm, then decrease the value on the nonius i.e. turn the adjusting ring in this direction: ➔ (regarding the figure below).

If your distance between nozzle and work piece is greater than 1.0 mm, e.g. 1.4 mm, then increase the value on the nonius i.e. turn the adjusting ring in this direction: ➔ (regarding the figure below).

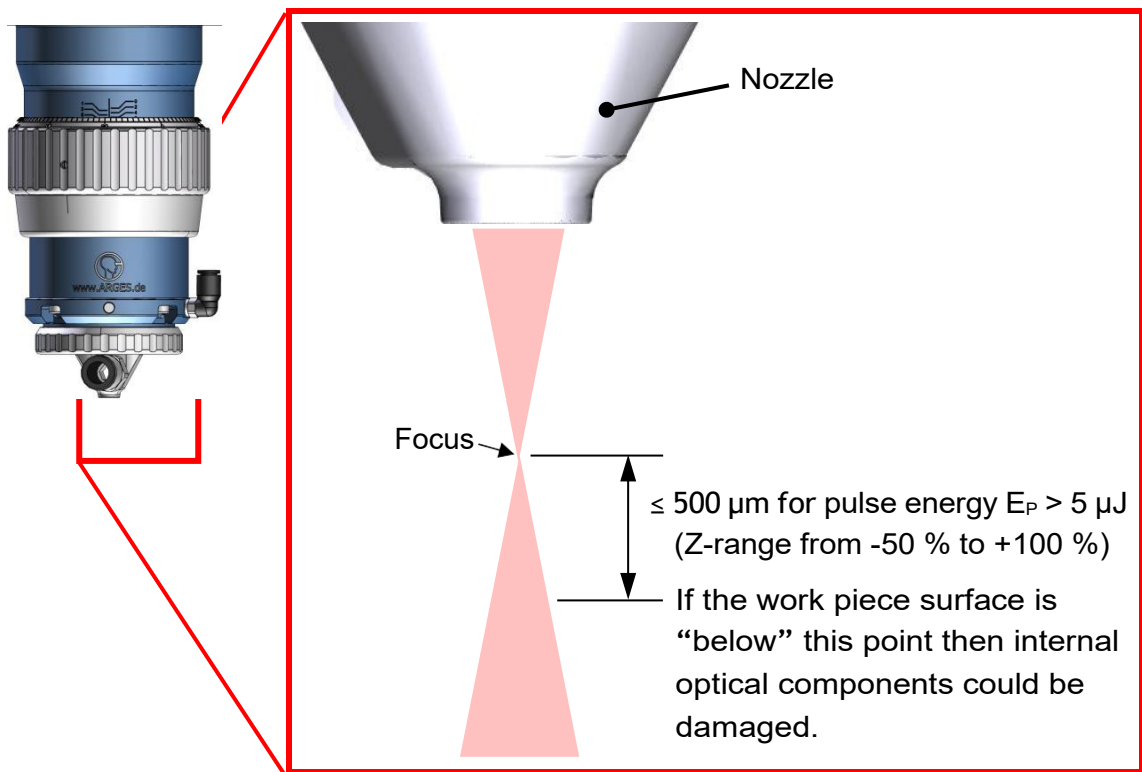


NOTICE

Back reflection

could cause damage to internal optical components.

- Keep the work piece **less than** 500 μm “below” the focus at any time.
The following figure illustrates this.



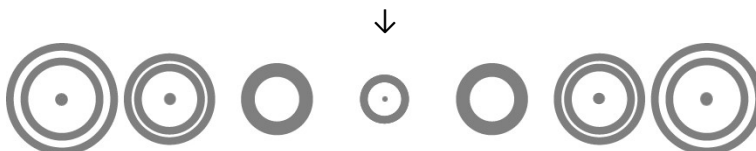
5. In the InScript software, load file **SearchFocus.jobx** from the **Jobs\PrecessionElephant 1.3 and 2.0** folder of the *InScript Installation*.
6. In the *Navigator* view, click the job.

The *Node Properties* view shows the job properties.

The job moves the Z-translator beginning at *Z start* position for *Loop count* times in *Z delta* steps and thus moves the focus.

With each loop the job draws 2 concentric circles and marks their center on the work piece. For convenience the job automatically draws the *Current position*.

Between the loops the work piece has to be manually moved in such way that a new area can be processed. Thereby a sequence of 2 concentric circles with a dot in the center is generated on the work piece. The following idealized illustration abstracts this.



TIP

Cover a range of Z-position, e.g. *Z start* = -20 %, *Z delta* = 5 % and *Loop count* = 9 as it is preset in the job.

Then concentrate on the range near the focus with a higher resolution, e.g. *Z start* = -10 % and *Z delta* = 2 %.

7.



CAUTION

Visible or invisible laser radiation

Damage to eye or skin

- Avoid eye or skin exposure to direct or scattered radiation.

Start the job.

8. In the Node Properties view, click **Continue job**.

9. Wait until the output is completed.

10. Repeat this step until the job is completed:

- Move the work piece.
- In the *Node Properties* view, click **Continue job**.
- Wait until the output is completed.

11. Remove the work piece and determine the focus.

The focus is located at the Z-position where both circles are of smallest, nearly the same, diameter and of narrowest track width and the diameter of the center point is the smallest. In the idealized illustration above this Z-position is marked by an arrow.

12. If the focus is not at the Z-position of 0 % then turn the silver adjusting ring at the focusing optics such a way that the focus at the work piece's surface approaches the Z-position of 0 % as described in step [0](#). Then insert the work piece and repeat this procedure from step [7](#).



13. Check the quality of the marking at the work piece.

not OK
(laser beam tilted to optical axis; Coma)



OK



14. If the above condition is *not* OK then the laser beam has to be newly adjusted as described beginning with section [6.6](#) on page [35](#) else the focus is now adjusted to your desired distance between nozzle and work piece.
15. Proceed with subsection [6.7.3](#) on page [50](#).

6.7.3 Setting the offset

Tools

- Laser safety glasses appropriate to the laser in use

Requirement

- The nozzle incl. the protective glass has to be mounted to the scan head.

Procedure

1. Parametrize the laser for processing the work piece with minimal effect, i.e. with average power and pulse repetition rate as low as possible.
2. Insert the work piece.
3. In the InScript software, load file **SearchOffset.jobx** from the **Jobs\PrecessionElephant 1.3 and 2.0** folder of the *InScript Installation*.
- 4.

NOTICE

Laser beam of high power could cause damage to the nozzle.

- a. Set the laser's pulse repetition rate to 10 kHz.
- b. Set the laser's average output power as low as possible for processing the work piece with minimal effect.
- c. In the InScript software, in the *Navigator* view, click **Pens → default → linepar**.
- d. In the *Node Properties* view on the *Common* tab, set *Processing speed* to **20 mm/s**.



CAUTION

Visible or invisible laser radiation could cause damage to eye or skin.

- Avoid eye or skin exposure to direct or scattered radiation.

Start the Job.

The Job draws a square on the work piece. The laser beam is clipped by the nozzle's aperture and thus the square is cropped at its corners.

The square has to be centered to the nozzle's aperture, i.e. the square's corners have to be symmetrically cropped.



5. If the above condition is *not* OK then set parameters dx and dy in node *Pens* → *default* → *HEAD* on tab *A Data* in group *Galvo offset*.

TIP

With each repetition of this step change only one parameter.

6. If it is necessary to set the *Galvo offset* to values of more than $\pm 1\%$ then the laser beam has to be adjusted again, as described beginning with section [6.6](#) else the scan head's *Galvo offset* is set now.
7. Proceed with subsection [6.7.4](#) on page [52](#).

6.7.4 Setting the ON and OFF delay

Tools

- Laser safety glasses appropriate to the laser in use
- Several sheets of metal with a thickness of 0.2 mm as a work piece
- Microscope

Requirement

- The nozzle incl. the protective glass has to be mounted to the scan head.

Procedure

1. Parametrize the laser for processing the work piece with minimal effect, i.e. with average power and pulse repetition rate as low as possible.
2. Insert the work piece.
3. In the InScript software, load file `OnOffDelay.jobx` from the `Jobs\PrecessionElephant 1.3 and 2.0` folder of the *InScript Installation*.

4.



CAUTION

Visible or invisible laser radiation could cause damage to eye or skin.

- Avoid eye or skin exposure to direct or scattered radiation.

Start the Job.

The Job draws a square on the work piece that is filled with a hatching.

If the parameters in *linepar* (line parameters) are set correctly then the square's outline is closed and the hatching ends at the outline as in the following figure.

not OK



OK



5. If the above condition is OK then proceed with subsection [6.7.5](#) on page [54](#).

6. If the above condition is *not* OK then

- In the *Navigator* view, click **Pens** → **default** → **linepar**.

TIP

With each repetition change only one of the parameters mentioned below.

- On the *Times* tab in group *Open end*, set **On delay** and **Off delay** such way that the horizontal hatching begins and ends at the 2 vertical lines.
- In group *Joint 2*, set **On delay** and **Off delay** such way that the corners of the square look good.
- Insert the work piece and repeat this procedure from step [4](#) on page [53](#).

6.7.5 Correcting the scan field

Tools

- Laser safety glasses appropriate to the laser in use
- Several sheets of metal with a thickness of 0.2 mm as a work piece
- Microscope

Requirement

- The nozzle incl. the protective glass has to be mounted to the scan head.

Procedure

1. Parametrize the laser for processing the work piece with minimal effect, i.e. with average power and pulse repetition rate as low as possible.
2. Insert the work piece.
3. In InScript in the *Navigator* view, select the controller.
4. In InScript in the main menu, click **Controller → Manage scan field correction**.

The *Manage Scan Field Correction* window opens.

5. In *Step 1* in *Scan field correction*, select **Create**.
6. Click **Next**.
7. In *Step 2* in *Optical path*, select **Processing laser**.
8. Click **Next**.
9. In *Step 3* in *Correction type*, select **2D with flat field lens correction for scan heads with f- Θ lens**.
10. Click **Next**.
11. In *Step 4*, leave the values unchanged.
12. Click **Next**.
- 13.

TIP

In any case do the following setting.

In *Step 5*, set *Number of squares* to **100** and *Squares to mark* to **3**.
Leave the *Laser marking parameters* unchanged.

14.



CAUTION

Visible or invisible laser radiation
could cause damage to eye or skin.

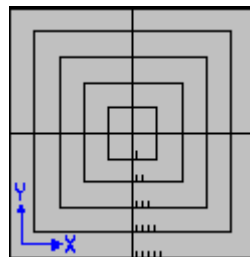
- Avoid eye or skin exposure to direct or scattered radiation.

Click **Start Testmark**.

15. Wait until the marking is done and then remove the workpiece.

16. If the marking is OK then click **Next** - OR - If the marking is *not* OK then repeat the test mark.

17. On the workpiece, select the largest square that is completely marked. As a general rule this is square II. The squares are numbered by marking lines beginning at the most inner square outwards like this:



18. On screen in *Step 6*, type the number of this square in *Measure Square*.

19. Pay attention to the work piece's orientation and measure the distances requested on screen in *Step 6*. Type them in the respective fields.

20. As *Correction algorithm* select **Parabola average**.

21. Click **Start calculation**.

22. Click **Next**.

23. In *Step 7*, check the correction of the scan field by a testmark if necessary.

The procedure is the same as before.

24. Click **Next**.

25. In the *Final Step*, click **Save to controller**.

26. Optionally click **Save to file**.

The correction is saved now.

27. Click **Finish**.

28. Proceed with subsection [6.7.6](#) on page [56](#).

6.7.6 Testing the settings

Tools

- Laser safety glasses appropriate to the laser in use
- Several sheets of metal with a thickness of 0.2 mm as a work piece
- Microscope

Requirement

- The nozzle incl. the protective glass has to be mounted to the scan head.

Procedure

1. Parametrize the laser for the intended processing of the work piece.
2. Insert the work piece.
- 3.



CAUTION

Visible or invisible laser radiation
could cause damage to eye or skin.

- Avoid eye or skin exposure to direct or scattered radiation.

“Drill” a hole with diameter A.

4. Measure the hole.
5. If the hole’s entry is round, but its exit is elliptical then
 - a. Check the settings in Job node *Spiro 3D*.
 - b. Check if the laser beam is circularly polarized; see subsection [6.7.7](#) on page [57](#).
6. If neither the entry nor the exit of the hole are round or if the measured diameter is outside of the tolerance limits (diameter A + focus diameter \pm 30 μ m) then
 - a. Adjust the focus; see subsection [6.7.2](#) on page [46](#).

- b. “Drill” a hole with diameter A and measure it.
- c. If necessary correct the scan field; see subsection [6.7.5](#) on page [54](#).
- d. “Drill” a hole with diameter A and measure it.

All settings should be correct now in order to “drill” holes of good quality.

7. Attach the side panels to the scan head.

The scan head is optically set up now.

8. Optionally test the drilling result with the jobs `HoleOvalExit.jobx`, `HoleOvalEntry.jobx`, `TaperNegative.jobx`, `TaperPositive.jobx` and `TaperZero.jobx` which can be found in the `Jobs\PrecessionElephant 1.3 and 2.0` folder of the *InScript Installation*.
9. Proceed with subsection [6.8.1](#) on page [59](#).

6.7.7 Adjusting the laser beam to circular polarization

TIP

Perform this procedure only when testing the settings, as described in subsection [6.7.6](#) on page [56](#) and if the hole’s entry is round, but its exit is elliptical.

The laser beam’s polarization can be set by 2 levers at the respective unit inside the scan head.

In order to measure the polarization and thus to set it, we recommend a polarization meter, e. g. Glan Thompson. Use the polarization meter according to the respective manual.

Tools

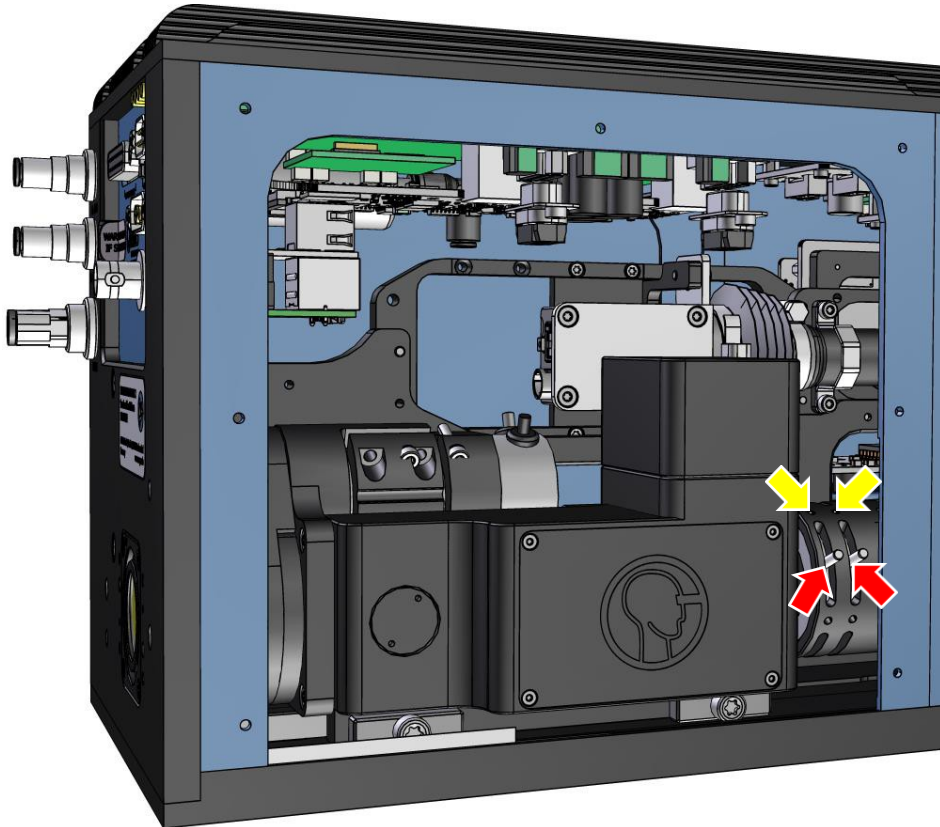
- Laser safety glasses appropriate to the laser in use
- Hexagon socket screw key, AF 1.5 mm
- Glan-Thompson polarization meter

Requirement

- The nozzle including the protective glass has to be mounted to the scan head.

Procedure

1. If your scan head does not have a polarization unit then proceed with the next procedure.
2. Loosen the 2 hexagon socket set screws (M2, AF 1.5 mm), marked by yellow arrows in the next figure, just as far as the 2 levers, marked by red arrows, can be moved.



3. Parametrize the laser for visual set up with average power and pulse repetition rate as low as possible.

4.



CAUTION

Visible or invisible laser radiation could cause damage to eye or skin.

- Avoid eye or skin exposure to direct or scattered radiation.
- Parametrize the laser for visual set up with average power and pulse repetition rate as low as possible.

Switch on the laser beam:

In the *Node Properties* view of node **Pens** → **default** → **<your laser>** on the *Control* tab, set *Gate control* to **Always on**.

5. Adjust the polarization via the 2 levers at the polarization unit inside the scan head.

TIP

Set only one of the levers with each repetition of the steps.

6. Measure the polarization with the Glan-Thompson polarization meter.
7. If the laser beam is *not* circularly polarized then repeat this procedure from step [5](#) on page [59](#) else the polarization is circular now.
8. Switch off the laser beam:

In the InScript software in the *Node Properties* view of node **Pens** → **default** → **<your laser>** on the *Control* tab, set *Gate control* to **Auto**.

9. Tighten the 2 set screws again.
10. Repeat subsection [6.7.6](#) on page [56](#) until the settings are OK.
11. Proceed with section [6.8.1](#) on page [59](#).

6.8 Setting up the optional through-the-lens vision camera

6.8.1 Activating scan field illumination

The VCSEL (Vertical Cavity Surface Emitting Laser) device illuminates the scan field for the through-the-lens vision camera.

Table 9: VCSEL parameters

Class 3B laser product according to DIN EN 60825-1:2008-05	
$P_0 = 100 \text{ mW}$	Maximum average power accessible during <i>normal</i> operation with scan head <i>housing closed</i>
$P_0 = 400 \text{ mW}$	Maximum average power accessible during <i>service</i> operation with scan head <i>housing opened and vision unit removed</i>
$\lambda = 850 \text{ nm}$	Wavelength

Tool

- *uEye Cockpit* software [[uEye](#)] for viewing the images delivered by optional through-the-lens vision camera

Procedure

1. If your scan head does not have a through-the-lens vision camera then proceed with section [6.9](#) on page [62](#).
2. In document [[Firmware](#)], look-up how the *VcseI* device is configured and used.
3. View the image delivered by the through-the-lens vision camera with the *uEye Cockpit* software [[uEye](#)].
4. In the InScript software in the *Navigator* view in the controller's *Devices* subtree, select the **vcseI** device.
- 5.



CAUTION

Invisible laser radiation

could cause damage to eye or skin.

- a. Avoid eye or skin exposure to direct or scattered radiation.
- b. In the *Node Properties* view, set the following variables as needed.
 - i. Set *Channel 1* to **Enable**.
 - ii. Slowly turn up *Duty cycle* and watch the image delivered by the camera. Turn Duty cycle up until the scan field is well lit and the image is not saturated yet.

6. Proceed with subsection [6.8.2](#) on page [61](#).

6.8.2 Focusing the camera

Tools

- Torx-key, size T6
- *uEye Cockpit* software [[uEye](#)] for viewing the images delivered by optional through-the-lens vision camera

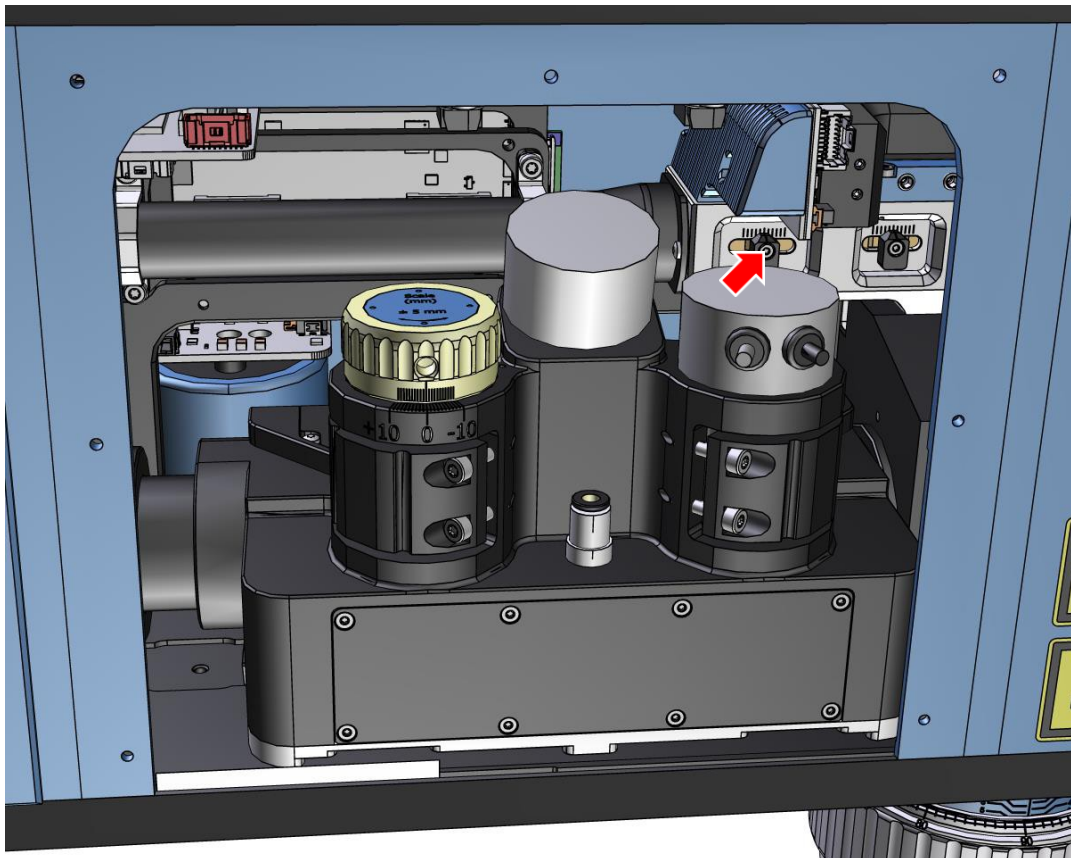
Requirement

- The scan field illumination is set appropriately, see subsection [6.8.1](#) on page [59](#)

Procedure

1. Remove the scan head's side panel; see also the following figure.
2. Untighten, *but do not remove*, the Torx-screw (T6, M2×5), marked by a red arrow in the following figure.

Leave the screw at the right slider untouched.



3. Move the left slider in such a way that the through-the-lens vision camera's image gets focused.

not OK

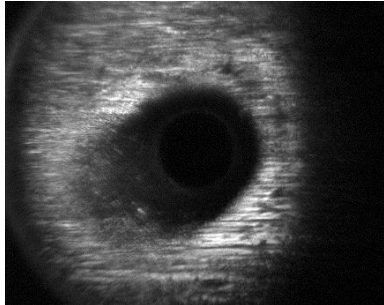


Figure 8: Vision camera out of focus on object

OK

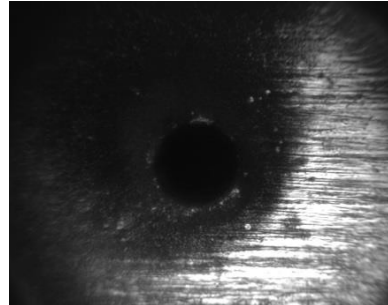


Figure 9: Vision camera focused on object

4. Tighten the Torx-screw again.
5. Proceed with section [6.9](#) on page [62](#).

6.9 Complete commissioning

Tools

- Torx key set

Procedure

1. In the InScript software in the *Navigator* view, select the controller.
2. In the menu, click **Controller** → **Save configuration**.
3. Fix the side panels back to the scan head again.

Your scan head should be adjusted now.

7 Operating

7.1 Audience and qualification

Operating the scan head is only allowed for personnel trained in operating the scan head, i.e. the machine where it is incorporated.

7.2 Safety precautions

The safety precautions for operation depend on the machine where the scan head is incorporated. Please refer to the documentation for this machine.

7.3 Control and signaling by the InScript software

At the scan head during normal operation neither there are controls that have to be handled manually nor there are optical or acoustical signals that could be observed.

The scan head is controlled by the InScript software and signaling is done via the InScript software.

Read the InScript and Firmware documentation relevant for operation

- General description of the InScript software [\[InScript\]](#)
- General procedures about how to use the InScript software [\[InScript\]](#)
- Specific usage of job nodes in the InScript software that are supported by the ASC system controller [\[Firmware\]](#)

Job nodes relevant specifically for the PRECESSION ELEPHANT scan head:

- Job nodes: Drawing
 - Precession Drill
- Specific description of devices supported by the ASC system controller as well as, their configuration and usage in the InScript software [\[Firmware\]](#)

Devices relevant specifically for the PRECESSION ELEPHANT scan head:

- Devices: Sensor
 - AfemLight
- Devices: Scan head
 - Head
- Devices: Miscellaneous
 - Shutter
 - Vcsl

7.4 External control devices that are not described here

The through-the-lens vision camera is controlled by the *uEye Cockpit* software. Please refer to the *uEye Cockpit* software documentation [[uEye](#)].

The cooling water, process and purge gas supply as well as the optional particle extraction have to be controlled by external devices. Please refer to the respective documentation.

8 Maintaining and repairing

8.1 Audience and qualification

Only qualified personnel trained in handling and cleaning sensitive optical equipment is allowed to perform the described procedures.

8.2 Safety precautions

- Switch off the machine where the scan head is incorporated from mains, in particular the laser, the scan head itself and eventually present translation stages.

8.3 Maintenance plan

As the intervals strongly depend on the optics contamination, we kindly ask you to determine the intervals respective the alternative condition by yourself.

We recommend keeping a machine logbook, where all measures taken can be recorded and thus the intervals deduced.

8.4 Removing the protective window at the beam entrance

Requirement

- The protective window is contaminated or damaged.

Tools

- Torx key set
- Optics spanner wrench
- Pair of cotton gloves

- Lens cleaning paper

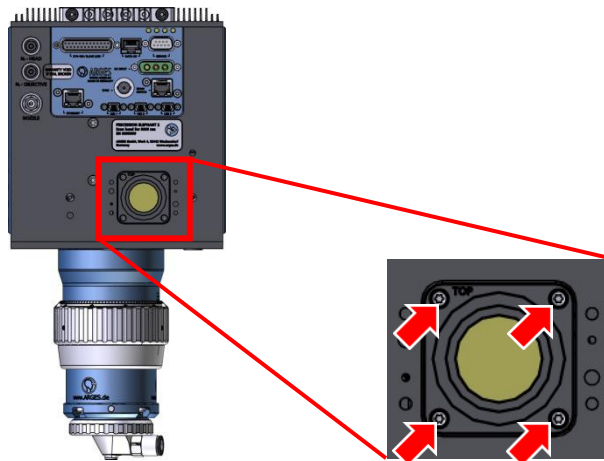
Procedure

1. Cover the place where the optics shall be temporarily placed on with lens cleaning paper.
- 2.

NOTICE

Contact with the optical surface of the protective window could cause damage to the optical surface.

- a. Wear cotton gloves.
- b. Do not touch or scratch the optical surface.
- c. Carefully remove these 4 Torx screws:



The square plate comes off including the protective window. The protective window is held in place by a retainer ring.

3. Use the optics spanner wrench to remove the retainer ring.
4. There is an O-ring between the square plate and the protective window.
5. Replace or carefully clean the protective window; see section [8.6](#) on page [70](#).
6. Proceed with assembling in the reverse order.

The protective window has the same coating on both sides, i.e. its mounting direction is irrelevant.

8.5 Removing the protective window at the beam exit

Requirement

- The protective window is contaminated or damaged.

Tools

- Optics spanner wrench or alternatively this tool from the spare parts list:



- Pair of cotton gloves
- Lens cleaning paper

Procedure

1. Cover the place where the optics shall be temporarily placed on with lens cleaning paper.
2. Loosen the suction cup retainer ring by 2 turns, but do not remove it yet.



3.

TIPP

If you are using this tool from the spare parts list then skip this step.



In order to loosen the nozzle, turn the process gas on (connector NOZZLE; max. pressure 4 bar), just until the nozzle come loose and turn the process gas off again.

4. Remove the retainer ring, the suction cup and nozzle from the focusing optics.



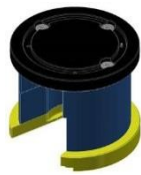
The protective window is held in place by a retainer ring.

5.

NOTICE

Contact with the optical surface of the protective window could cause damage to the optical surface.

- Wear cotton gloves.
- Do not touch or scratch the optical surface.
- Use the optics spanner wrench or the following tool to remove the retainer ring:



6. Replace or carefully clean the protective window; see section [8.6](#) on page [70](#).

7. Proceed with assembling in the reverse order.

The protective window has the same coating on both sides, i.e. its mounting direction is irrelevant.

8.6 Cleaning optics

Tools

- Air duster (pressurized air aerosol can)
- Cotton swabs
- Cleansing agents:
 - 2-propanol, purity grade 99.8 %
 - Acetone, purity grade 99.8 %
 - Acetone HPLC grade, purity grade 99.9 %, nonvolatile part ≤ 0.0002 %



CAUTION

Listed cleansing agents are highly flammable
Fire hazard

- Avoid contact with ignition source.



CAUTION

Listed cleansing agents are irritant
to skin, eyes and respiratory system.

- Do not breath in vapor and avoid contact with skin and eyes.

- Pipette
- Lens cleaning paper
- Pair of cotton gloves
- Bright lamp
- Matte black background

Procedure - rough cleaning

1. Read and follow the instructions on the air duster can.
2. If there are particles on the optics clear of the particles with pressurized air from the can.

3. If there are still adhering particles to the optics then carefully remove them with a cotton swab soaked in 2-propanol.
4. Only if the optics is still contaminated with particles then try remove these particles with lens cleaning paper soaked in 2-propanol under light pressure.
5. If the particles cannot be removed or the optics is damaged the replace the optics. In this case the cleaning procedure ends here.

Else continue with *procedure - cleaning*.

Procedure - cleaning

1. Carefully apply 2-propanol with a pipette so the optical surface is completely covered but the lens cleaning paper does not aquaplane.
2. In the next step you will pull the lens cleaning paper sideways. Counter this movement by holding the optics e.g. with a cotton swab in place.
3. Slowly and with constant speed pull the lens cleaning paper to the side. The tear-off edge of the paper must be nearly dry.
4. Continue with *procedure - checking if the optics is clean*.
5. If the optics is clean then the procedure ends here.

Procedure - checking if the optics is clean

1. Check if the optics is clean by illuminating the optics with a bright lamp and examining it in front of a matte black background...

Characteristics:

- The optics and the optical coating, if present, must be undamaged. Otherwise replace the optics.
- The optical surface must be free of particles.
- The optical surface must be free of greasy and oily residues.
- The optical surface must be free of streaks by the cleansing agent.

... otherwise repeat (for max. 2 times) *procedure - cleaning* with 2-propanol as cleansing agent and new cotton swabs and new lens cleaning paper.

2. If the contamination persists then repeat (for max. 2 times) *procedure - cleaning* with *acetone* as cleansing agent and new cotton swabs and new lens cleaning paper.

3. If the contamination persists then repeat *procedure - cleaning* with *acetone HPLC grade* as cleansing agent and new cotton swabs and new lens cleaning paper.

8.7 Replacing the complete focusing unit

Requirement

- The focusing unit is damaged.

Tools

- Torx key set

Procedure

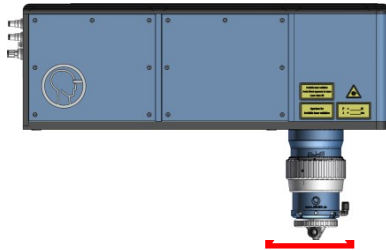
1. Switch or turn off :
 - a. Electrical power
 - b. Process gas and purge gas supplies
 - c. Cooling water supply
2. Disconnect at the scan head:
 - a. Electrical lines
 - b. Gas lines; see also section [5.6](#) on page [28](#)
 - c. Cooling water lines; see also section [5.5](#) on page [26](#)
3. It is not necessary to drain the scan head from the remaining cooling water. The couplings are self-sealing.

4.

NOTICE

Force applied to focusing optics could cause damage to the focusing optics.

- NEVER lift scan heads at the focusing optics.



Remove the scan head from the machine. Due to the weight we recommend 2 persons for handling.

5. Put the scan head down on its cooling fins so the focusing unit points upwards.
6. Unplug the gas lines, which are connecting the focusing unit to the scan head, directly at the focusing; see also section [5.6](#) on page [28](#).
7. Unscrew the 4 Torx screws fixing the focusing unit to the scan head base plate.
8. Carefully pull the focusing unit upwards and remove it.
9. Assemble the scan head and install it in the machine in the reverse order.
10. Commission the scan head as described in chapter [6](#) on pages [29](#) ff.

You may skip sections [6.4](#), [6.5](#) and [6.6](#) in doing so.

9 Spare parts list

The spare parts catalog is the basis for identifying and ordering a spare part required for maintenance and repair.

Table 10: Spare parts list







Figure	Description	Part number
	Protective glass for the beam entrance; wavelength 515 nm	111-1007556-00
	Protective glass for the beam entrance; wavelength 1020-1080 nm	111-1007557-00
	Lens for ratio 1:3 Z-translator; wavelength 515 nm	160-1109851-00
	Lens for ratio 1:5 Z-translator; wavelength 515 nm	160-1109855-00
	Lens for ratio 1:3 Z-translator; wavelength 1020-1080 nm	160-1106176-00
	Lens for ratio 1:5 Z-translator; wavelength 1020-1080 nm	160-1106224-00


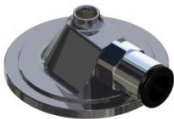
Figure	Description	Part number
	Complete focusing optics unit; wavelength 515 nm ; focal length 60 mm	162-1109937-00
	Complete focusing optics unit; with nozzle that is adjustable in XY- plane wavelength 515 nm ; focal length 60 mm	162-1111886-00
	Complete focusing optics unit; wavelength 515 nm ; focal length 120 mm	162-1109702-00
	Complete focusing optics unit; wavelength 1020-1080 nm ; focal length 60 mm	162-1105973-00
	Protective glass for the beam exit at the gas nozzle; wavelength 515 nm	111-1101309-00
	Protective glass for the beam exit at the gas nozzle; wavelength 1020-1080 nm	111-1105806-00
	Standard extraction hood	352-1101907-00




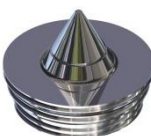
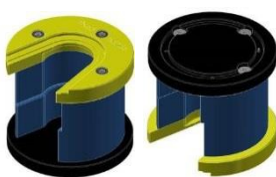





Figure	Description	Part number
	Gas nozzle; 1 mm exit diameter	211-1104335-01
	Gas nozzle; 2 mm exit diameter	211-1106687-00
	Gas nozzle; 3 mm exit diameter	211-1106688-00
No image available	O-ring set for gas nozzle	313-2001439-00
	Gas nozzle with centering-cone; 1 mm exit diameter	211-1112727-00
No image available	O-ring set for gas nozzle with centering-cone	300-2001252-00
	Combined tool for the installation of the gas nozzle and the protective glass at the beam exit	350-1115424-00
	Purge gas filter	307-1006855-00
	Gas flowmeter with flow adjustment screw	307-2000395-00

Figure	Description	Part number
	Needle valve to adjust the flow rate for tubes with outer diameter 6 mm	307-2000396-00
	Set up tool for adjusting the laser beam to the optical axis of the scan head: diaphragm for beam entry	216-1107955-01
	Set up tool for getting the laser beam through TPU and Scanner: aperture with 1.5 mm diameter	112-1112943-01
No image available	Detector card for wavelength 1030 nm, 1550 nm	350-2001051-00
No image available	Detector card for wavelength 515 nm, 1030 nm	350-2001139-00

10 Decommissioning and removing from the machine

Procedure

1. Switch or turn off :
 - a. Electrical power
 - b. Process gas and purge gas supplies
 - c. Cooling water supply
- 2.

NOTICE

Voltage peaks and leakage currents, when hot plugging the power supply, destroy the scan head electronics.

- Before connecting the power supply to the scan head or disconnecting it from the scan head, ensure that no voltage is being applied to the connecting cable.

Disconnect at the scan head:

- a. Electrical lines
- b. Gas lines; see also section [5.6](#) on page [28](#)
- c. Cooling water lines; see also section [5.5](#) on page [26](#)

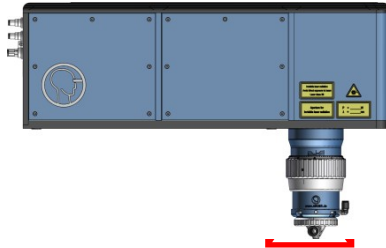
It is not necessary to drain the scan head from the remaining cooling water. The couplings are self-sealing.

3.

NOTICE

Force applied to focusing optics could cause damage to the focusing optics.

- NEVER lift scan heads at the focusing optics.



Remove the scan head from the machine. Due to the weight we recommend 2 persons for handling.

4. Fix the transportation lock plate back to the scan head beam entry; see also [Figure 2](#), no. ⑩, on page [20](#).
5. Seal the scan head beam exit with tape, see also [Figure 2](#), no. ⑫, on page [20](#).

11 Transporting and Storing

- Transport and store the system in its sealed cardboard box.

Table 11: Environmental conditions for transporting and storing

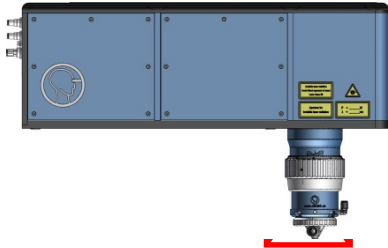
Environmental conditions for transporting and storing		
Cardboard box	dimensions	660 × 550 × 350 mm ³
	volume	0.13 m ³
	weight incl. scan head and accessories	23 kg
	handling	2 persons recommended
Ambient transport and storage temperature		0 to 50 °C (273 to 323 K)
Non-condensing humidity		10 to 80 %
Allowed atmospheric pressure		> 0.65 bar (> 65 kPa) This approximately corresponds to 3,500 m (a. s. l.). Hence the system is suitable for air freight.
Allowed vibration and shock		[to be defined]

Packing procedure

NOTICE

Force applied to focusing optics could cause damage to the focusing optics.

- NEVER lift scan heads at the focusing optics.



1. For packing use the packaging delivered together with the scan head.
2. Wrap the scan head into the ESD plastic bag and seal the bag with tape.
3. Place the scan head into the lower molded foam part as in the following figure.



4. Place the upper molded foam part on top and strap the upper and lower molded foam part together.



5. Put the package into the cardboard box.



6. Put the rectangular cardboard on top.
7. Put accessories on top of the cardboard.



8. Close the cardboard box and seal it with tape.



12 Disposal

This system shall not be treated as household waste. Instead it shall be handed over to the applicable collection point for the recycling of electrical and electronic equipment.

By ensuring this product is disposed correctly, you will help prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. The recycling of materials will help to conserve natural resources. For more detailed information about recycling of this product, please contact your local city office, your disposal service or the manufacturer.

13 Technical specification

13.1 General specification

Table 12: General specification

General specification		
Number of axes		8 axes: 3 coordinates X Y Z 2 beam inclination angles 2 polarization parameters 1 beam attenuation value
Designed for	laser wavelength	343 to 355 nm (ultraviolet) or 515 to 532 nm (green) or 1020 to 1080 nm (near infrared) or 1500 to 2100 nm (infrared)
	laser pulse energy	300 μ J
	average optical power	100 W
	irradiation rate for internal shutter	max. 2 W The internal shutter is not applicable as a permanent shutter.
	pulse length	800 fs to 20 ps
Adjustment of the spot geometry and beam caustic		Manual or motorized
Focal length of objective lens (2 nd generation)		60 mm or 120 mm
Focal diameter		10-30 μ m
Polarization in the focus		Circular or elliptical, with optional electronic control
Z positioning		\pm 1 mm electronical, \pm 2 mm manually
Maximum mechanical Z velocity		500 mm/s

General specification	
Theoretical Z positioning resolution	30 nm
Aperture	26 mm
Precession frequency	200 to 600 Hz (12.000 to 36.000 rpm), depending on incidence angle
Maximum precession angle (full cone angle)	18°
Field size	0.8 to 3.0 mm, depending on nozzle
Hole diameter accuracy	< 0.2 µm
Step width adjustment of hole diameter	0.015 µm

13.2 Cameras

Table 13: Cameras

Cameras	
Vision-camera	1280 × 1024 pixel, pixel size 4.65 µm
Adjustment-cameras	1280 × 1024 pixel, pixel size 5.2 µm

13.3 Dimensions, possibilities for mounting and weight

Table 14: Dimensions, possibilities for mounting and weight

Dimensions, possibilities for mounting and weight	
Dimensions	Please find the scan head dimensions in the respective engineering drawing. This engineering drawing can be obtained on request from our engineering and design division.
Possibilities for mounting	
Weight	

13.4 Power supply

Table 15: Power supply

Power supply is provided by the ASC system controller	
Supply voltage	± 24 V, DC
Voltage tolerance	$\pm (13.5 \text{ to } 28 \text{ V})$, DC

13.5 Cooling water

Table 16: Cooling water

Cooling water	
Quality	DI-water, filtered, particle size $< 100 \mu\text{m}$
Pressure drop	3 to 4 bar (300 to 400 kPa)
Volume flow	1.2 to 2.2 l/min
Inlet temperature	max. 30°C (303 K)
Recommend tubing material	polyetherurethane; D 6 mm, d 4 mm
Specifics	The cooling unit is DI-water-proofed with corrosion resistant types of steel.

13.6 Gasses and particle extraction

Table 17: Purge gas for the objective (focusing optics unit)

Purge gas for the objective (focusing optics unit)	
Quality	pressurized air (2:4:0 according to ISO 8573-1:2010) or nitrogen gas (N_2 4.0, oil- and particle-free)
Inlet pressure	max. 50 mbar (5 kPa)
Volume flow	typ. 2 l/min
Recommend tubing material	polyetherurethane; D 4 mm, d 2.5 mm (or D 4 mm, d 2 mm)

Purge gas for the objective (focusing optics unit)	
Specifics	Internal restrictor limits pressure to 1 bar (100 kPa)

Table 18: Purge gas for the scan head

Purge gas for the scan head	
Quality	pressurized air (2:4:0 according to ISO 8573-1:2010) or nitrogen gas (N ₂ 4.0, oil- and particle-free)
Inlet pressure	max. 50 mbar (5 kPa)
Volume flow	typ. 2 l/min
Recommend tubing material	polyetherurethane; D 4 mm, d 2.5 mm (or D 4 mm, d 2 mm)
Specifics	Internal restrictor limits pressure to 1 bar (100 kPa) Internal pressure relief valve opens at 140 ± 50 mbar (14 ± 5 kPa)

Table 19: Process gas

Process gas	
Quality	non-corrosive gases used commonly as process gases
Inlet pressure	depending on nozzle up to 4 bar (400 kPa)
Recommend tubing material	polyetherurethane; D 6 mm, d 4 mm

Table 20: Suction cup for particle extraction

Suction cup for particle extraction	
Recommend tubing material	polyetherurethane; D 10 mm

13.7 Environmental conditions

Table 21: Environmental conditions for transporting and storing

Environmental conditions for transporting and storing		
Cardboard box	dimensions	660 × 550 × 350 mm ³
	volume	0.13 m ³
	weight incl. scan head and accessories	23 kg
	handling	2 persons recommended
Ambient transport and storage temperature		0 to 50 °C (273 to 323 K)
Non-condensing humidity		10 to 80 %
Allowed atmospheric pressure		> 0.65 bar (> 65 kPa) This approximately corresponds to 3,500 m (a. s. l.). Hence the system is suitable for standard air freight.
Allowed vibration and shock		[to be defined]

Table 22: Environmental conditions for operation

Environmental conditions for operation	
Environment	Operate indoors only in a dry and clean environment
Degree of protection by enclosure	IP41
Ambient operation temperature	10 to 40 °C (283 to 313 K)
Non-condensing humidity	10 to 80 %
Allowed altitude	2,000 m (a. s. l.)
Allowed vibration and shock	Due to the intended processing results in microscopic dimensions the scan head has to be mounted on a vibration-cushioned optical table or an equivalent frame.
Noise emission	[to be defined]

13.8 Options

Process control options

- Customized suction cups for integrated particle extraction with external pressure control
- Through-the-lens vision module with internal sample illumination
- Polarization control for sharpest edges over complete circumference
- High-speed laser stop for consistent edge results on exit surface
- Energy monitor for long-time process stability
- Optical beam attenuator
- Confocal detector
- Plasma emission sensor
- Single pulse energy measurement sensor
- Beam position and profile monitor

Set-up options

- 2 alignment cameras for beam adjustment
- Beam position and beam profile monitoring
- Automatic calibration of the beam position and direction
- Safety shutter

13.9 Typical process parameters

Table 23: Typical process parameters

Typical process parameters	
Material thickness	0.02 to 1.5 mm
Hole processing time	0.5 s
Hole diameters	25 to 700 µm
Negative taper full angle	> 16°
Hole aspect ratio	> 12:1

Typical process parameters	
Diameter repeatability	< 0.25 % variation
Hole diameter accuracy	< 0.2 µm
Hole circularity	> 95 %
Hole position accuracy	< 1 µm
Wall surface quality	R _a < 0.1 µm

13.10 Electrical and electronical interfaces

13.10.1 XY4-100 - SLAVE LINK

See also [Figure 2](#), no. ② on page [20](#)

Purpose

This interface provides 2 alternative functions:

- If an ASC, NCC or equivalent controller is connected to the DATA I/O interface then a further (slave) scan head can be connected to the XY4-100 / SLAVE LINK interface.

In this case the slave scan head will be connected to the master scan head via an adapter and an Ethernet CAT5 cable.

- OR -

If no controller is connected to the DATA I/O interface then a controller, using the XY2-100 protocol, can be connected to the XY4-100 / SLAVE LINK interface.

Further reading

None

Implementation

Connector name: XY4-100 / SLAVE LINK
Connector type: female 25-pin D-Sub connector
Maximum wire length: 5 m
Characteristics: none

Table 24: Pin assignment of the XY4-100 / SLAVE LINK connector

XY4-100 / SLAVE LINK					
Pin	Signal name	Type	Pin	Signal name	Type
1	CLK -	I	14	CLK +	I
2	SYNC -	I	15	SYNC +	I
3	CHX -	I	16	CHX +	I
4	CHY -	I	17	CHY +	I
5	CHZ -	I	18	CHZ +	I
6	STATUS -	O	19	STATUS +	O
7	CHA - alternatively configured as: POSX -	I O	20	CHA + alternatively configured as: POSX +	I O
8	HSSI - alternatively configured as: POSY -	IO O	21	HSSI + alternatively configured as: POSY +	IO O
9	U +	VO	22	U +	VO
10	NC	-	23	GND	-
11	GND	-	24	GND	-
12	NC	-	25	U -	VO
13	U -	VO	S	NC	-

Signal name

CLK clock, according to RS-422
 SYNC synchronization, according to RS-422
 CHX nominal X-axis position, according to RS-422
 CHY nominal Y-axis position, according to RS-422
 CHZ nominal Z-axis position, according to RS-422
 STATUS scan head status, polarity configured by factory settings
 CHA nominal A-axis position, according to RS-422
 POSX actual X-axis position, analog, ± 3.1 V for $R_L = 10\text{ k}\Omega$
 HSSI connected directly to the DATA I/O interface
 POSY actual Y-axis position, analog, ± 3.1 V for $R_L = 10\text{ k}\Omega$
 U voltage, connected directly to the DC INPUT interface

NC do not connect
GND ground

Signal type

I Input
O Output
IO Input / Output
VO Voltage output

Internal circuit diagram excerpt

Not available

Installation examples

Not available

13.10.2 DATA I/O

See also [Figure 2](#), no. ③ on page [20](#)

Purpose

The scan head communicates with an ASC or equivalent controller via the DATA I/O interface. The scan head is connected to the controller via an Ethernet CAT5 cable.

Further reading

None

Implementation

Connector name: DATA I/O
Connector type: female RJ45-connector
Maximum wire length: 25 m
Characteristics: none

Table 25: Pin assignment of the DATA I/O connector

DATA I/O		
Pin	Signal name	Type
1	RXD +	O
2	RXD -	O
3	TXD +	I

DATA I/O		
Pin	Signal name	Type
4	TXC +	I
5	TXC -	I
6	TXD -	I
7	RXC +	O
8	RXC -	O

Signal name

TXD transmit data

RXD receive data

TXC transmit clock

RXC receive clock

Signal type

I Input

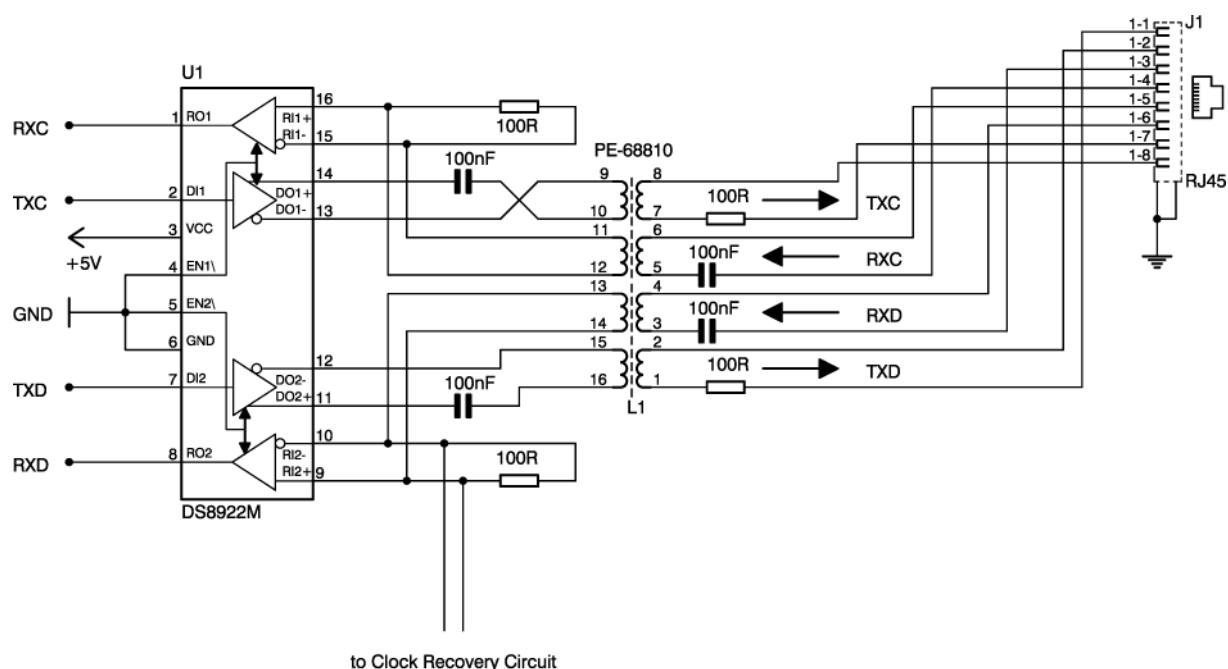
O Output

Internal circuit diagram excerpt

Not available

Installation examples

If you want to control a scan head via the DATA I/O interface and do not want to use an ARGES system controller then use the following adapter circuit and HSSI data transfer protocol.



HSSI data transfer protocol

Scan head and controller communicate via the HSSI data transfer protocol based on the S/PDIF protocol.

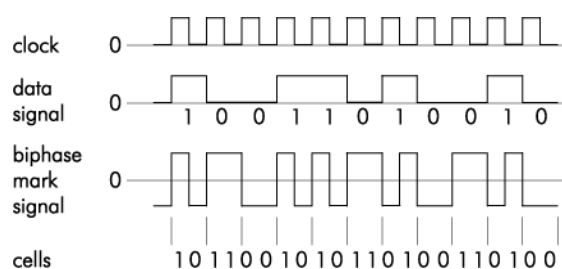
In order to code the digital signals the Biphasic Mark Code (BMC) is used. The BMC is a kind of phase modulation, where 2 signal zero-crossings correspond to a logical "1" and 1 signal zero-crossing correspond a logical "0".

The following table shows the allowed bit rates and the resulting sub frames.

Bit rate	Sub frames	Update rate per channel
6.144 Mb/s	192000/s	48 kHz (factory setting)
12.288 Mb/s	384000/s	96 kHz (optional for IDB416-30 or higher)

The clock frequency is twice the bit rate. In a Biphasic Mark signal each bit of the original signal is composed of 2 logical states which represent a so called cell. The length of a cell corresponds to the length of a data bit. The logical state at the beginning of a cell is always the inverted state of the previous cell. The logical state at the ending of a cell either will be inverted (if a logical "1" is transmitted in the original signal) or levels off (if a logical "0" is transmitted in the original signal).

The following figure shows an example.



The first 4 bits in a sub frame contain the preamble (PA), which is necessary to synchronize the receiver and to distinguish different sub frame types. The preamble is recognized by containing no change in state between the bits at 2 positions in the data stream.

There are 3 preambles that may occur in 2 forms each. Which of these 2 forms is used is dependent on the last cell (parity) of the previous 32-bit sub frame; see also the following table.

Preamble	Previous cell		Description
	0	1	
B	11101000	00010111	tags a sub frame, which contains data for the X-channel and which stands at the beginning of a data block at the same time
M	11100010	00011101	tags a sub frame, which contains data for the X-channel and stands not at the beginning of a data block
W	11100100	00011011	Tags a sub frame, which contains data for the Y-channel. If more than 2 channels are used then this may be any other channel than the X-channel

Within the next 20 bits the position data is transmitted with the most significant bit transmitted first of all.

4 extension bits follow. These bear different meanings depending on the device controlled:

Data to the scan head	The 20 position data bits set the nominal position for the channel; the four extension bits shall contain the pattern 0001.
------------------------------	---

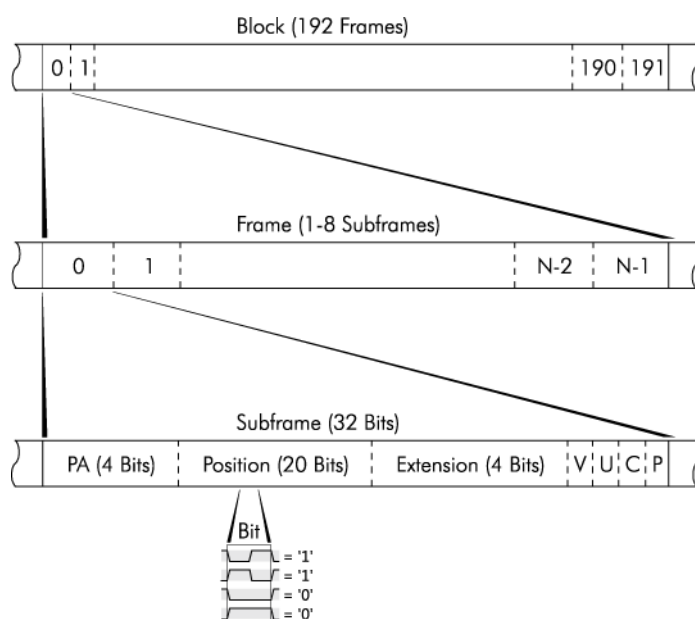
Data from the scan head	Within the 20 position data the actual position of the channel is returned (possibly only the first 16 bits are valid, the remaining four bits are "0" then). The last of the 4 extension bits contains the Position Acknowledge signal of the channel.
--------------------------------	---

The sub frame is concluded by 4 bit (V, U, C, and P).

The following table describes all bit of a sub frame.

Bit	Description
0	PA (Preamble)
:	For description see above. These bits are differently structured than the others.
3	
4	Position data in two's complement representation, 0 is the center position. Bit 4 is the most significant bit (MSB); bit 23 is the least significant bit (LSB).
:	
23	
24	bits set to 0
:	
26	
27	bit set to 1
28	V (Validity) If this bit is set then the pattern should not be analyzed by the receiver.
29	U (sUb code data) Bit set to 0. The sub code data is not used, but reserved for future application.
30	C (Channel status information) Bit set to 0. The channel status information is not used, but reserved for future application.
31	P (Parity) The preamble is not accounted for.

The number of sub frames depends on the number of channels to be transmitted. For a scan head with up to 4 channels a frame consists of 4 sub frames. A block consists of 192 frames and begins with the preamble "B". The following figure shows schematically, how blocks are based on sub frames and bits.



13.10.3 SERVICE

See also [Figure 2](#), no. ⑤ on page [20](#)

Purpose

This connector is for service purposes only.

- Do not connect.

Further reading

None

Implementation

Connector name: DC INPUT

Connector type: male 9-pin D-Sub connector

Signal name

Not available

Signal type

Not available

Internal circuit diagram excerpt

Not available

Installation examples

Not available

13.10.4 DC INPUT

See also [Figure 2](#), no. ⑥ on page [20](#)

Purpose

The scan head is supplied with voltage via this interface.

Further reading

None

Implementation

Connector name:	DC INPUT
Connector type:	3W3 D-sub connector, 3F3CS, keyed
Maximum wire length:	depending on cable cross section, standard lengths 5 m and 10 m, or customer specific
Characteristics:	none

Table 26: Pin assignment of the DC INPUT connector

DC INPUT		
Pin	Signal name	Type
1	U +	VI
2	GND	-
3	U -	VI

Signal name

U+	positive and negative voltage respectively, 24 V,
U-	a voltage between 13.5 and 28 V is allowed; standby consumption per scan head axis 7 W (typically); load per scan head axis max. 2 A; recommended fuse T 3.15 A each
GND	ground

Signal type

VI Voltage Input
I Input
O Output

Internal circuit diagram excerpt

Not available

Installation examples

Not available

13.10.5 SYNC

See also [Figure 2](#), no. ⑦ on page [20](#)

Purpose

This connector is optional.

If you wish to measure the energy of single laser pulses then connect it with a BNC-cable to trigger signal output of laser.

Further reading

None

Implementation

Connector name: SYNC
Connector type: male BNC-connector
Maximum wire length: not available
Characteristics: none

Table 27: Pin assignment of the SYNC connector

SYNC		
Pin	Signal name	Type
1	Al_Laser_Trig	I
Shielding	GND	-

Signal name

AI_Laser_Trig high level: 3.5 to 5 V
 low level: 0 to 1.5 V

GND ground

Signal type

I Input

Internal circuit diagram excerpt

Not available

Installation examples

Not available

13.10.6 BEAM SWITCH

See also [Figure 2](#), no. ⑧ on page [20](#)

Purpose

An optional external device can be connected here that can switch the beam path between 2 scan heads.

Further reading

See section [13.10.2](#) on page [92](#)

Implementation

Connector name: BEAM SWITCH
Connector type: female RJ45-connector
Maximum wire length: 25 m
Characteristics: DATA O (output only)

Signal name

See section [13.10.2](#) on page [92](#)

Signal type

See section [13.10.2](#) on page [92](#)

Internal circuit diagram excerpt

Not available

Installation examples

See section [13.10.2](#) on page [92](#)

13.10.7 USB 1, USB 2, USB 3

See [Figure 2](#), no. ⑨ on also page [20](#)

Purpose

If the built-in cameras are USB cameras then this connects them to the PC where the *uEye Cockpit* camera software is running.

Further reading

[\[uEye\]](#)

Implementation

Connector name:	USB 1, USB 2, USB 3
Connector type:	female Mini-B-connector
Maximum wire length:	25 m
Characteristics:	USB 2.0

Signal name

Not available

Signal type

Not available

Internal circuit diagram excerpt

Not available

Installation examples

Not available

13.10.8 ETHERNET

See also [Figure 2](#), no. ⑬ on page [20](#)

Purpose

If the built-in cameras are Ethernet cameras then this connects them to the PC where the *uEye Cockpit* camera software is running.

Further reading

[\[uEye\]](#)

Implementation

Connector name:	ETHERNET
Connector type:	female RJ45-connector
Maximum wire length:	25 m
Characteristics:	none

Signal name

Not available

Signal type

Not available

Internal circuit diagram excerpt

Not available

Installation examples

Not available

14 Bibliography

Table 28: Bibliography

ID	Literature
[ASC]	<i>Operator Manual - ARGES System Controller</i> ; files ASC_controller_manual_en.pdf and ASC_IFs_GPIO_LASER_PLC_en.pdf
[Firmware]	<i>Firmware 3 - User Manual</i> ; see the tip below for how to access the manual The InScript 3 software can connect to multiple ASC system controllers. Each ASC system controller provides by its firmware controller-specific functionality and a firmware user manual. That firmware user manual contains, amongst others, information on supported devices and job nodes.
[InScript]	<i>InScript 3 - User Manual</i> ; file InScript_<version>_manual_en.pdf and see the tip below for how to access the manual The user manual contains instructions for the InScript 3 software's life cycle and information on the basic concepts and operations of the InScript 3 software.
[uEye]	The <i>uEye Cockpit</i> software is required for the built-in cameras. It can be downloaded from <i>Imaging Development Systems GmbH</i> at https://en.ids-imaging.com/ids-software-suite.html Find the <i>uEye Manual</i> in the menu of the installed <i>uEye Cockpit</i> software by clicking Help → uEye Manual . There browse to section B: Operation → Installed programs under Windows → uEye Cockpit .