Manual for all ARGES scan heads

For InScript 2 Version
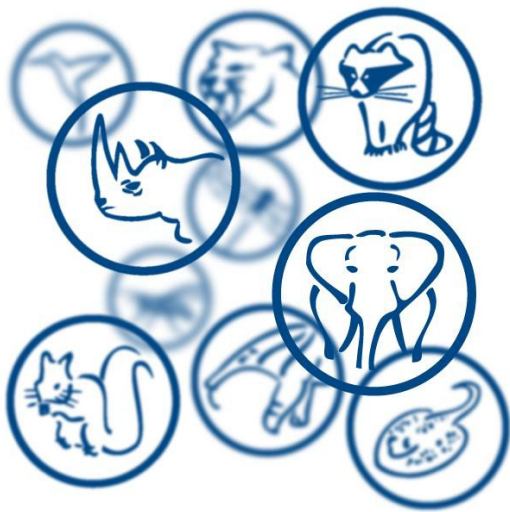
Novanta
PHOTONICS

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1 Read these chapters and sections

This documentation addresses 3 target audiences:

Target audience	Training
System integrator	Qualified personnel with electro-technical or mechatronic profession or personnel trained in handling highly sensitive electronic and optical equipment
Operator	Personnel trained in operating the system
Service personnel	Qualified personnel with electro-technical or mechatronic profession or personnel trained in handling highly sensitive electronic and optical equipment

Depending on the target audience the chapters and sections in this documentation are classified into:

Symbol	Description
►	Read these chapters or sections.
●	We recommend reading these chapters or sections. Use them as reference.
+	We propose reading these chapters or sections.
	You are allowed to execute instructions in a chapter or section only if the chapter or section is marked gray for your target audience.

Each target audience should use this documentation in a way defined by the following table:

Chapter / section		System integrator	Operator	Service personnel
		Target audience		
1	Read these chapters and sections	►	►	►
2	Notation conventions	►	►	►
3	Warning statements and notes of caution This chapter describes the system features relevant for the safety of the user. They must be observed during the entire system life cycle from the activation to the disposal of the system.	►	►	►
4	System scope and functionality This chapter describes the user-relevant features of the system. The user learns the relevant components and functions of the system by reading the description.	►	+	●
5	Installation and operation This chapter describes the proper use of the system. It describes the operations to be executed by the user.	►	+	►
5.1	Unpacking and checking	►	+	+
5.2	Installing	►	+	+
5.3	Commissioning	►	+	+
5.4	Administering	►	+	►
5.5	Operating	►	►	►
5.6	Monitoring errors	►	►	►
5.7	Decommissioning	►	+	►
5.8	Re-commissioning	►	+	►
5.9	Packaging and transporting	►	+	►

Chapter / section		System integrator	Operator	Service personnel
	Target audience			
5.10	Storing	▶	+	▶
5.11	Disposing	●	+	▶
6	Preventive maintenance instructions	▶	▶	▶
	Servicing includes all simple maintenance procedures which can be executed by the user without auxiliary tools, e. g., cleaning of the system, replacement of wear-and-tear parts and operating fluids, and monitoring of operational parameters.			
7	Maintenance	●	+	▶
	This chapter describes all measures required in order to ensure and maintain the functional capability of the system.			
8	Repair	●	+	▶
	This chapter describes all measures required for re-establishing the functional capability of the system. The repair documentation specifies how the cause for a system failure can be discovered and how the discovered malfunction can be repaired afterwards.			
9	Spare parts	●	+	●
	The spare parts catalog is the basis for identifying and ordering a spare part required for maintenance and repair.			
10	Abbreviations	+	+	+
11	References	+	+	+

2 Notation conventions

In this documentation these conventions are used:

Admonitions

⚠️ **Warning**

Refers to a possible dangerous situation that may lead to death or grievous bodily injury, if the safety precautions are ignored.

⚠️ **Caution**

Refers to a possible dangerous situation that may lead to material damage or bodily injury, if the safety precautions are ignored.

General notes

ℹ️ **Note**

Refers to important information.

▶️ **Tip**

Refers to information that eases operating the system.

Calls for action

Procedure

- This call for action has only 1 step.

Procedure

1. Step by step calls for action are designated like this example.

2. This is the second step.

References

References are indicated by an identifier in square brackets, e. g. [ASC]. References can be found in chapter 11.

3 Warning statements and notes of caution

This chapter describes the system features relevant for the safety of the user. They must be observed during the entire system life cycle from the activation to the disposal of the system.

3.1 Intended use

This system is ready for its intended use as a component for incorporation into a laser product, and as such requires additional features for laser safety and to comply with IEC 60825-1.

- Before commissioning the system for the first time ensure your laser product conforms to relevant standards, especially IEC 60825-1; see section 3.2.

- You are not authorized to modify the system.
  Attempts to modify or alter the system

  - o may be dangerous
  - o void warranty
  - o may infringe patents

3.2 Laser safety regulations and provisions

In any case follow:

- **IEC 60825-1**:1993+A1:1997+A2:2001
  (in German: DIN EN 60825-1:2005-10 und VDI 0837-1 Sicherheit von Lasereinrichtungen).

- **BGV B2** (in the past VBG 93)
  Unfallverhütungsvorschrift Laserstrahlung
  in der Fassung vom 1. April 1993 mit Durchführungsanweisungen in der Fassung vom Januar 1993 mit Durchführungsanweisungen

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3.2.1 Danger to eyes and skin by laser radiation

⚠️ **Caution**

Visible and / or invisible laser radiation

Blindness, burns

Procedure

- Wear suitable protective goggles.
- Do not expose eyes and skin to direct, reflected or scattered laser radiation.

Protective goggles

The mandatory protective goggles provide protection against direct radiation, reflected radiation and scattered radiation. None the less, even if you are wearing protective goggles never look directly into the beam or into a reflected beam. Intense laser radiation can destroy the protective filter.

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

ℹ️ **Note**

As the filter in the protective goggles only provides protection for a narrow band of wavelengths, make sure you are wearing the right goggles for the laser device in question. Using the wrong type of protective goggles is dangerous. The most commonly used protective goggles for CO_2 lasers do not, say, protect against the radiation from an Nd:YAG laser.

- Before putting on the protective goggles check them for any obvious defects. If any of the following defects occur, then use protective goggles 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

- o For the cleaning of dirty laser goggles 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.

3.2.2   Fire hazard by laser radiation

⚠️ **Caution**

Class 4 lasers have high output power

Fire hazard

Procedure

- Before opening the beam path appropriate fire prevention must be taken.

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

3.3 Hazardous materials

3.3.1 Laser generated air contaminants

⚠️ **Caution**

Hazardous material is emitted during laser materials processing

Health hazard

Procedure

- 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 must 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 must 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 current is adequate. A very low exhausting volume current, 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 must 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 must 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 must 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 must be instructed about the hazards with LGAC and the required safety measures

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3.3.2 Optics

⚠️ **Caution**

Toxic or radioactive compounds

Materials in optics or in optical coatings may give rise to allergies, eczema and other irritations on the skin and mucous membranes.

Procedure

- Avoid inhaling any dust from faulty or damaged optics.
- Carefully clean the surface of damaged optics.

Optics in lasers, such as mirrors, lenses, plates or windows are made from special materials such as quartz glass, germanium, silicon or zinc selenide. The type of laser, amongst other things, determines which materials are used.

Extremely thin reflection and anti-reflection coatings of metallic elements are deposited by high vacuum vaporization to improve the optical properties of this optics. These thin metallic coatings on optics consist mainly of materials detrimental to health.

For example, thorium fluoride may be present in the coating on mirrors made from zinc selenide. Thorium fluoride is an α-emitter and weakly radioactive. Thorium fluoride is potentially damaging to health if it is inhaled or ingested. Toxic chemical compounds are also produced when zinc selenide comes into contact with acids or alkaline solutions.

- If optical coatings are damaged, e. g. by becoming detached, scratched or etched by chemical substances or if optics are damaged or destroyed, e. g. breakage, splintering, scratches or laser induced destruction then pack the optical element carefully in an airtight, sealable plastic container. Send the material back to the supplier or manufacturer of the optics. He is accountable and responsible for proper disposal of the material.

3.3.3 Cooling water

Lasers, particularly solid-state lasers, generally have an internal cooling loop using double distilled or de-ionized water.

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⚠️ **Caution**

Calcination inhibitors, algae inhibitors, anti-corrosion and anti-freeze agents as well as other additives may have been added to the cooling water.

These additives may give rise, amongst other things, to allergies, eczema and other irritations if they come into contact with the skin or mucous membranes.

Procedure

- When handling cooling water, e. g. refilling, draining or in the event of water leaks in a faulty cooling circuit, always wear appropriate plastic gloves and eye protection.

- Avoid the cooling water to get into contact with skin and mucous membranes, e. g. eyes, nose or mouth.

- Dry the skin or mucous membranes very well with a clean cloth if they come into contact with cooling water.

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4 System scope and functionality

This chapter describes the user-relevant features of the system. The user learns the relevant components and functions of the system by reading the description.

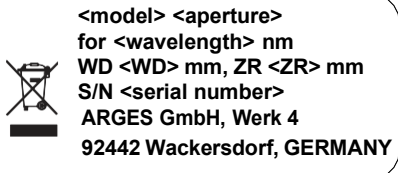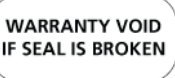## 4.1   Overall view

Find the system overall view in the technical specifications for the relevant scan head; see reference [Specifications].

4.2   Designations

Find the designation and location of system element in the technical specification for the relevant scan head; see reference [Specifications].

4.3   Markings

Marking	Location / Description
<model> <aperture> **for <wavelength> nm** **WD <WD> mm, ZR <ZR> mm** **S/N <serial number>** **ARGES GmbH, Werk 4** **92442 Wackersdorf, GERMANY**	Find the type plate at the scan head base plate. <model> specifies the scan head model. <aperture> specifies the beam entrance diameter in millimeter. If the scan head is driven analog, then the word analog follows. <wavelength> specifies the processing-laser wavelength. The scan head is designed for this wavelength. If the scan head is designed for an additional pointing-laser then its wavelength is given in brackets. <WD> specifies the working distance. <ZR> specifies the Z range. <serial number> specifies the serial number. ARGES... specifies the company address.
WARRANTY VOID **IF SEAL IS BROKEN**	Find one or more warranty seals depending on the scan head model at several locations.

If the scan head contains a laser
then it is labeled:

	Find the laser beam warning label at the right scan head side in beam direction.
Component for Incorporation This product is intended as a component for incorporation into a laser product, an as such requires additional features for Laser Safety and to comply with IEC/EN60825-1 and 21CFR1040.10	Find the Component for Incorporation at the right scan head side in beam direction.
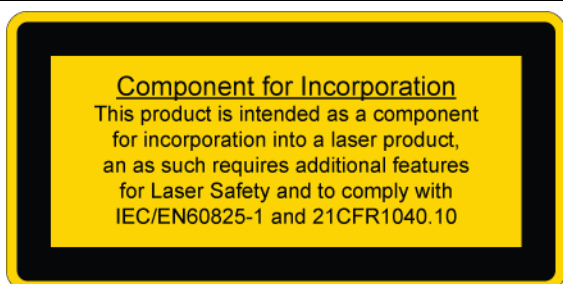
If the scan head contains a laser class 4
then it is additionally labeled:

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Marking	Location / Description
Laser radiation Avoid eye or skin exposure to direct or scattered radiation Class 4 laser product – OR – **Invisible laser radiation** Avoid eye or skin exposure to direct or scattered radiation Class 4 laser product	Find the Class 4 laser product label at the right scan head side in beam direction.
	Find the laser radiation parameters label at the right scan head side in beam direction.
P_0 = _____ W P_P = _____ W t = _____ s F = _____ Hz λ = _____ nm – OR –	For repetitively pulsed lasers (top down): average radiant power radiant power of a single pulse time duration of a single pulse pulse repetition frequency wavelength of laser radiation
P_0 = _____ W λ = _____ nm	For CW lasers (top down): total radiant power wavelength of laser radiation
Aperture for laser radiation – OR – **Aperture for invisible laser radiation**	Find the Aperture label near the aperture.
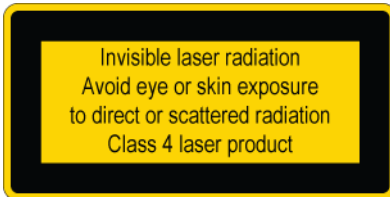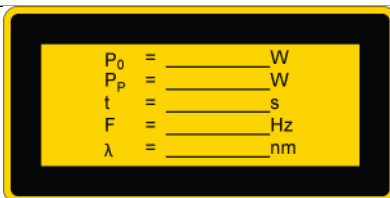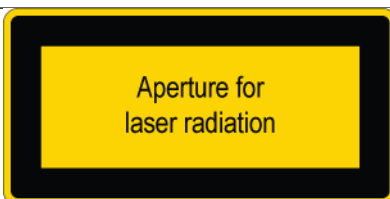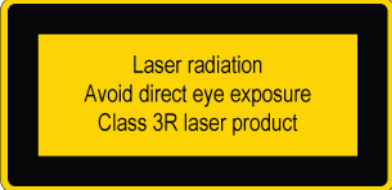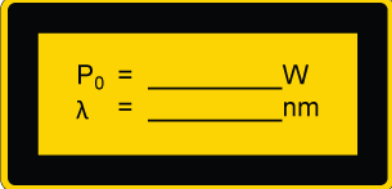
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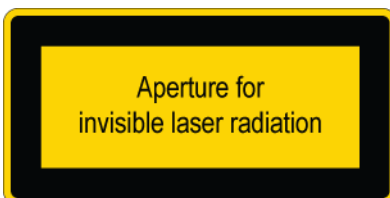
Marking	Location / Description

If the scan head contains pilot-laser (pointing-laser)
then it is additionally labeled:

Marking	Location / Description
Laser radiation Avoid direct eye exposure Class 3R laser product	Find the Class <depending on pointing-laser class> laser product label, see example on the left side, at the right scan head side in beam direction.
$P_0 = \underline{\hspace{2cm}} W$ $\lambda = \underline{\hspace{2cm}} nm$	Find the laser radiation parameters label at the right scan head side in beam direction. For CW lasers (top down): total radiant power wavelength of laser radiation

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4.4   Survey, architecture of the system

4.5   Technical description of the system and system elements

Controller

The user configures, parameterizes and controls the controller via the InScript software or the ControllerLib. Once configured and parameterized the controller can autonomously control connected devices like scan heads, laser, sensors, actuators and other peripherals; see references [ASC] or [NCC].

Power supply

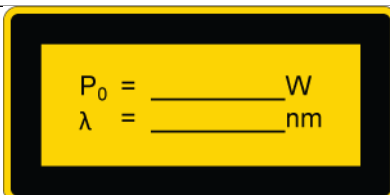An external power supply supplies the scan head with voltage. The power supply either is embedded in an ASC or SC controller or it is a stand-alone power supply.

The power supply creates a dual, symmetrical and stabilized output voltage for the scan head electronics from a not stabilized, unipolar input voltage. The power supply

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contains 2 DC/DC transformer modules, which are connected in parallel at the input and in series at the output. Input and output are galvanically isolated.

The power supply is short-circuit-proofed.

Laser

The scan head optics is designed for the wavelength(s) of the laser radiation.

The laser beam enters the scan head either through an aperture in the housing or via a fiber coupling (scan heads for fiber lasers).

In order to get the focus diameter as small as possible, the laser beam diameter must be adapted to the scan head aperture. For this purpose, a beam expander is used. It is ether located between the laser and the scan head or already embedded in scan head models of type ELEPHANT or larger. At scan head models for fiber lasers the beam expander is located either in the scan head after the fiber coupling or already embedded in the fiber head.

Scan block (XY deflection unit)

Usually there are 2 mirrors in the XY deflection unit, which are mounted on the rotation axis of a galvanometer each. These rotation axes are oriented to each other in a way that the laser beam can be deflected in X- and Y-direction, whereas it hits the X-mirror first and then the Y-mirror.

The controller controls the XY deflection unit.

In nearly all cases it is wanted to focus the laser beam on the work piece; see below.

Focusing

There are 2 methods to focus a laser beam by a scan head. They are called pre objective and post objective scanning. For geometrical reason the scan field is distorted with both methods. In order to specify Cartesian coordinates in a plane or volume, the scan field has to be corrected; see below.

- With pre objective scanning the scan head is located before the objective in the beam path. This method is common with scan heads models RHINO and smaller. There are 2 types of objectives used for pre objective scanning:

  o An f-Theta objective keeps the laser beam focus in a flat plane while scanning the entire scan field. Therefore, these objectives are also called flat field lenses.

  o A telecentric f-Theta objective keeps the laser beam focus in a flat plane while scanning the entire scan field and furthermore keeps the incident laser beam perpendicular to the scan field.

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Sloping beams respectively to the target are not accepted for some applications. For these applications we recommend telecentric f-Theta objectives, where the beam incidents right-angled over the entire scan field.
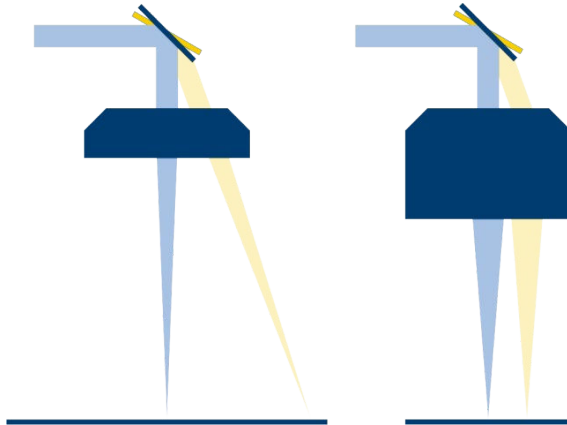
f-Theta objective (left) and telecentric f-Theta objective (right)

- With post objective scanning the scan head is located after the objective in the beam path. This method is common with scan heads models ELEPHANT or larger.

  The laser beam is deflected by 2 mirrors. These mirrors cannot be physically in the same place. For geometrical reason this results in a curved focal plane. To flatten the scan field again, the curvature must be compensated by varying the focal length of the objective. This is done by moving 1 of the 2 lenses of a telescope, which forms the objective. The device to move 1 lens of a telescope is called Focus Translator.

  With a suitable choice of objective and a special scan field correction it is possible to span a 3D scan volume, where Cartesian coordinates can be specified.

  The controller controls the Focus Translator.
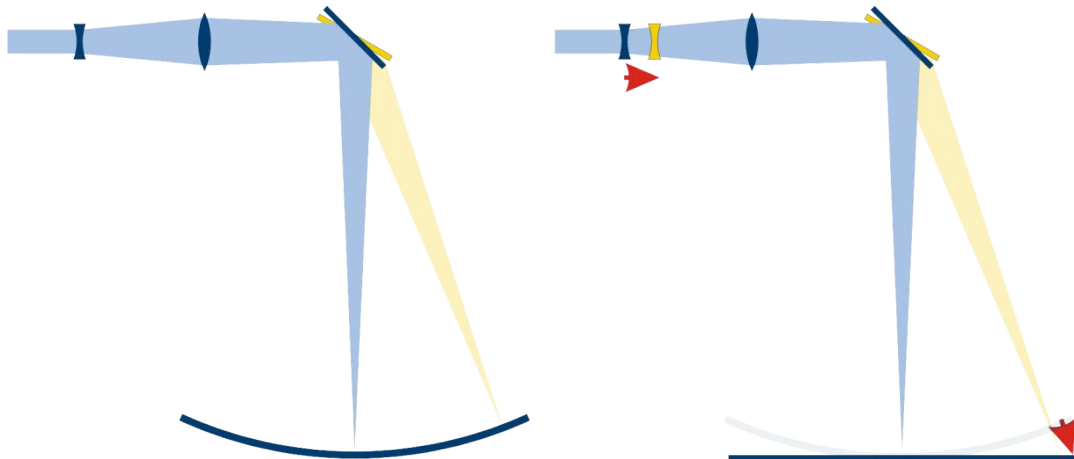
Curved focal plane with fixed telescope lenses (left) and flat focal plane with curvature compensated by moving 1 telescope lens (right)

Scan field correction

In order to correct the scan field distortion, it is necessary to measure the distortion first.

The InScript software calculates the correction from your measurement. The more accurate you measure the scan field distortion, the better the calculated correction will be; see also subsection 5.2.1.

Scan head electronics

The electronics controls the angularity of the X- and Y-galvanometer and optionally of the Z- and A-galvanometer.

Each galvanometer has an optical position detector, which generates an electrical signal corresponding to the rotation angle.

The signal from the position detector is amplified. A variable amplifier stage sets the field scale and makes the actual position available to the position regulator and the controller for function monitoring.

The control value, resulting from the sum of weighted coefficients of the position deviation, is filtered by a notch filter and hereafter used directly to control the output stage.

The digital (or analog) interface predefines the nominal value. A DAC generates the input values for the position regulator.

The electronics on its part gets control signals for the DAC from the controller and returns position data sampled by the ADC at the same time.

The electronics functionality is monitored by several electronic logic modules. This comprises external and internal supply voltages, reference voltage, temperature at the

voltage transformers and the output stages, temperature at the output stages on chip level and the tripping of electronic over-current output stage fuses.

All discovered errors lead to a forced shutdown of the control circuit. Status-LEDs indicate errors.

Attenuator (optional for scan heads models ELEPHANT or larger)
The attenuator variably decreases the laser beam power exiting the scan head without influencing the laser's beam output power itself, i. e. without changing the laser settings.

The controller controls the attenuator as 4th dimension of the scan field correction.

Pilot-laser (pointing-laser) or camera (optional for scan head models RHINO or larger)
In some lasers pilot-lasers are already embedded. Usually these lasers are too weak for a good visible dynamical output of lines by the scan head, e. g. Teach-In. Therefore, an optional pilot-laser provides an adequate brightness.

The controller controls the pilot-laser.

As an alternative to the pilot-laser a camera for vision applications can be embedded. An aperture of 21 mm or more is advisable for vision applications. Further cameras may be outside the scan head.

A vision-PC controls the cameras and evaluates the image data.

4.6   Interfaces

4.6.1   XY4-100 - SLAVE LINK

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.

  NOTE
  The functionality of this interface is restricted to XY2-100 / SLAVE LINK.

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

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 -	I	20	CHA +	I
8	HSSI -	IO	21	HSSI +	IO
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
HSSI connected directly to the DATA I/O interface
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

4.6.2   DATA I/O

Purpose

The scan head communicates with an ASC, NCC 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:	RJ45-Buchse
Maximum wire length:	25 m
Characteristics:	none

DATA I/O

Pin	Signal name	Type
1	RXD +	O
2	RXD -	O
3	TXD +	I
4	TXC +	I
5	TXC -	I
6	TXD -	I
7	RXC +	O

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DATA I/O		
Pin	**Signal name**	**Type**
8	RXC -	O

Signal name

TXD   transmit data
RXD   receive data
TXC   transmit clock
RXC   receive clock
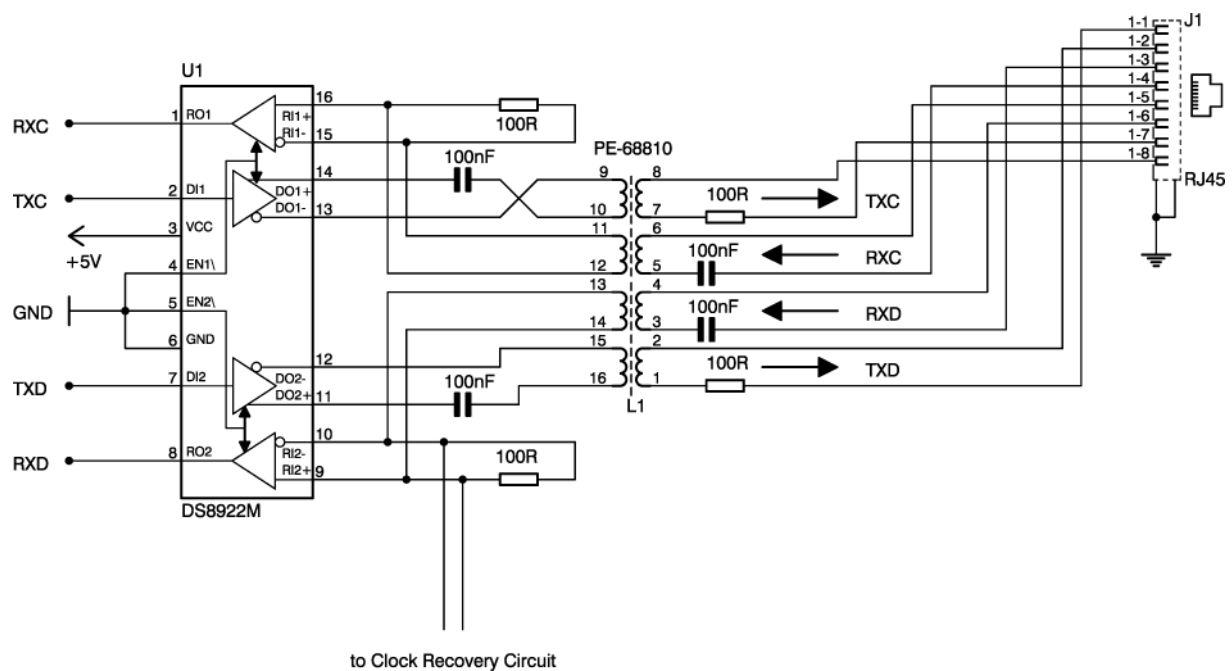
Signal type

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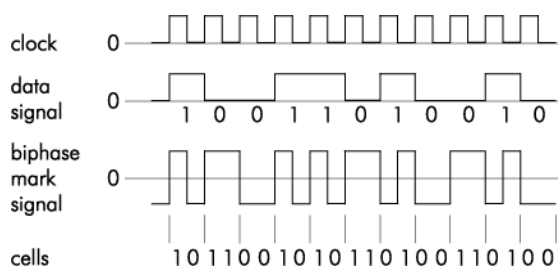
The first 4 bits in a sub frame contain the preamble (PA), which is necessary to synchronize the receiver and to distinguish different sub frame types. The preamble is recognized by containing no change in state between the bits at 2 positions in the data stream.

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 bits (V, U, C, and P).

The following table describes all bit of a sub frame.

Bit	Description
0 : 3	PA (Preamble) For description see above. These bits are differently structured than the others.
4 : 23	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).

Bit	Description
24 : 26	bits set to 0
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.
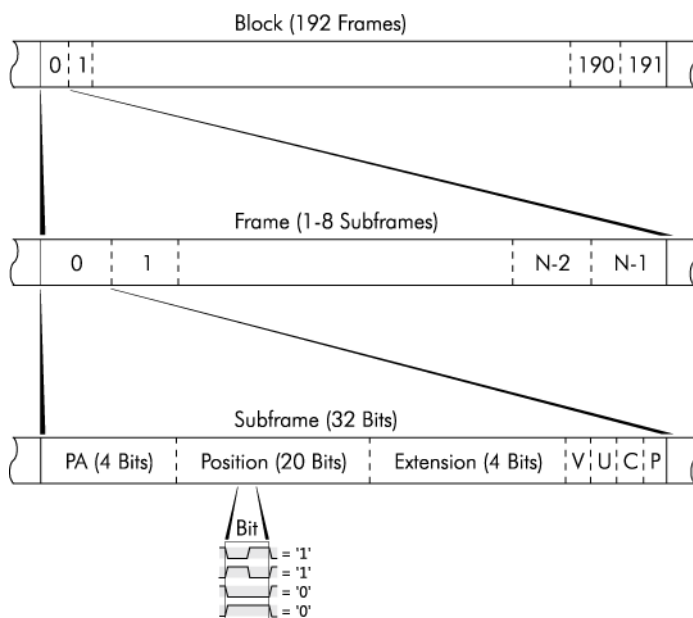
4.6.3 ANALOG INTERFACE

Purpose

This interface replaces the interfaces XY4-100 / SLAVE LINK and DATA I/O, in case of a scan head that can be controlled by analog signals.

Only 2 axes can be controlled by this interface.

Further reading

None

Implementation

Connector name: ANALOG INTERFACE
Connector type: 9W4 D-Sub connector
Maximum wire length: 5 m
Characteristics: signals configured by factory settings according to table below

ANALOG INTERFACE

Pin	Signal name	Type	Pin	Signal name	Type
A1	POSX alternatively configured as: PosAckY shield: GND	O	1	NC	-
A2	POSY alternatively configured as: PosAckX shield: GND	O	2	NC	-
A3	CHX shield: GNDCHX	I	3	IGS (optional)	I
A4	CHY shield: GNDCHY	I	4	AckIGS (optional)	O
S	NC	-	5	$\overline{\text{AckIGS}}$ (optional)	O

Signal name

TTL: low < 0.7 V, high > 2.4 V

POSX actual X-axis position, analog, ± 10 V,
Note: inverted to input signal CHX

PosAckY Y-axis position acknowledge, TTL, high = PosAck

POSY   actual Y-axis position, analog, ± 10 V,
            Note: inverted to input signal CHY

PosAckX   X-axis position acknowledge, TTL, high = PosAck

GND   ground

CHX   X-axis nominal position,
            ± 20 mA, input resistance 500 Ω
            configured alternatively as:
            2.5 V or 5 V or 10 V or adjustable voltage; uni- or bipolar

GNDCHX X-axis ground, internally connected to ground via 47 k Ω

CHY   Y-axis nominal position,
            ± 20 mA, input resistance 500 Ω
            configured alternatively as:
            2.5 V or 5 V or 10 V or adjustable voltage; uni- or bipolar

GNDCHY Y-axis ground, internally connected to ground via 47 k Ω

NC   do not connect

IGS   (optional) Input Gain Switch, TTL

AckIGS   (optional) Acknowledge Input Gain Switch, TTL

$\overline{\text{AckIGS}}$ (optional) Inverted Acknowledge Input Gain Switch, TTL

Signal type
I   Input
O   Output

Internal circuit diagram excerpt
Not available

Installation examples
Not available

4.6.4   DC INPUT

Purpose
The scan head is supplied with voltage via this interface.

Further reading
None

Implementation
Connector name: DC INPUT

Connector type:	male 9-pin D-Sub connector
Maximum wire length:	depending on cable cross section, standard lengths 5 m and 10 m, or customer specific
Characteristics:	The connector provides an additional diagnostic interface. Use the diagnostic interface only if instructed by ARGES to do so; see also subsection .

⚠️ **Caution**

Voltage peaks and leakage currents, when hot plugging the power supply,

destroy the scan head electronics.

Procedure

- 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.

DC INPUT

Pin	Signal name	Type	Pin	Signal name	Type
1	U +	VI	6	U +	VI
2	RXD	I	7	GND	-
3	GND	-	8	GND	-
4	TXD	O	9	U -	VI
5	U -	VI	S	NC	-

Signal name

U positive and negative voltage respectively, 24 V,
   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

RXD do not connect, receive data,
   connect only for diagnostic purpose, when instructed by ARGES

GND ground

TXD do not connect, transmit data,
     connect only for diagnostic purpose, when instructed by ARGES

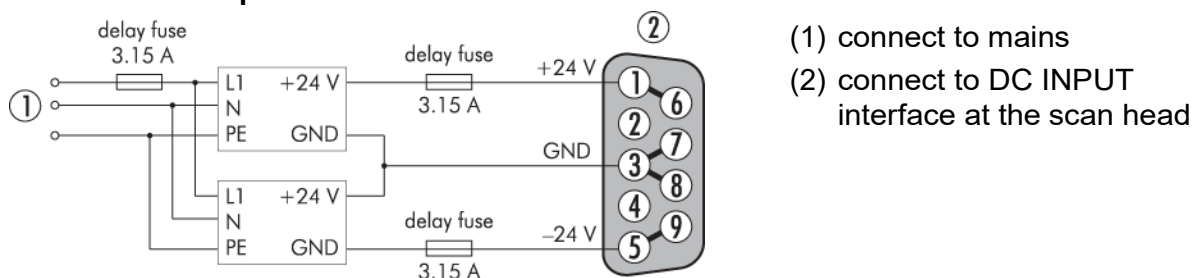NC   do not connect

Signal type
VI   Voltage Input
I   Input
O   Output

Internal circuit diagram excerpt
Not available

Installation examples

(1) connect to mains
(2) connect to DC INPUT
    interface at the scan head

4.6.5 Fiber coupling (some scan head models)

Purpose
Via this interface the scan head is supplied with laser radiation.

Further reading
Documentation for the fiber

Implementation
Find the fiber coupling specifications in the technical specifications for the relevant scan head; see reference [Specifications].

4.6.6 Cooling water connection (some scan head models)

Purpose
Via this interface the scan head is supplied with cooling water.

Further reading
None

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Implementation

Find the cooling water connection specifications in the technical specifications for the relevant scan head; see reference [Specifications].

4.6.7 Pressurized air connection (some scan head models)

Purpose

Via this interface the scan head's cross jet nozzle is supplied with pressurized air.

Further reading

None

Implementation

Find the pressurized air connection specifications in the technical specifications for the relevant scan head; see reference [Specifications].

4.6.8 Incorporation into machine

Purpose

At this (these) interface(s) the scan head can be incorporated into your machine.

Further reading

None

Implementation

Find information about how the scan head can be incorporated into your machine in [Specifications].

4.7 Technical data

Find the system's technical data in the technical specifications for the relevant scan head; see reference [Specifications].

5 Installation and operation

This chapter describes the proper use of the system. It describes the operations to be executed by the user.

5.1 Installing

5.1.1 Incorporating the scan head into a machine

Procedure

1. Incorporate the scan head into your machine according to the technical specifications; see reference [Specifications].

   There you will find, amongst other things, dimensions, screw-on options and offset between beam input and output.

   Find information about the working distance here:

   - scan heads without F-Theta objective: on the type plate

     The working distance (WD) is the distance between working plane and bottom edge of the scan head.

     At 3D scan heads WD is the distance between the plane in the working volume that is farthest away from the scan head and the bottom edge of the scan head.

   - scan heads with F-Theta objective: on the F-Theta objective data sheet

     There you will also find which point on the objective the working distance is referring to.

   If you have a scan head without fiber connector or without embedded laser head, then please note:

   - The laser beam must be centered to the beam entrance hole (aperture).

   - The laser beam must be perpendicular to the aperture.

2. Remove all protective caps from the optics.

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5.1.2 Connecting the scan head to a controller and power supply

Procedure

- Connect the scan head to the controller.

  There are several types of controller. On the following pages select the procedure dedicated to your controller type, please.
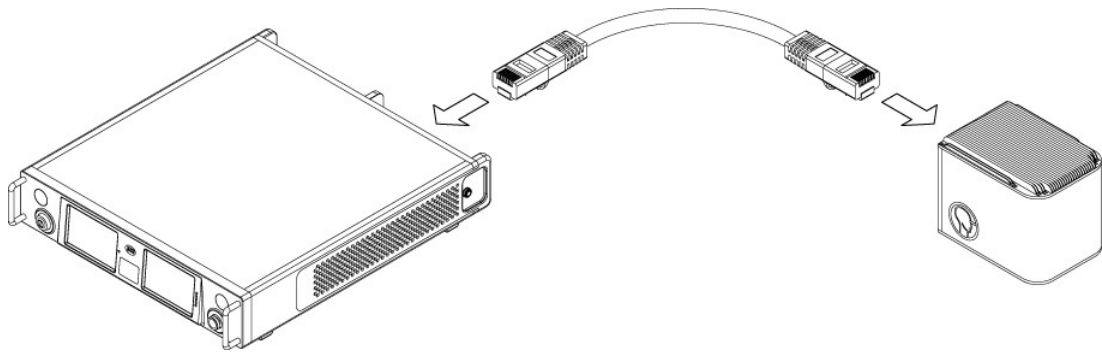
Connecting the scan head to an ASC controller

Procedure

1. Connect the ASC controller via an Ethernet CAT5 cable to the scan head.

   > ℹ️ **Note**
   >
   > Use the SCAN HEAD DATA A connector at the ASC controller.

2.

   > ⚠️ **Caution**
   >
   > Voltage peaks and leakage currents, when hot plugging the power supply, destroy the scan head electronics.
   >
   > **Procedure**
   >
   > - 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.

   Connect the ASC controller via the scan head power cable to the scan head.

   > ℹ️ **Note**
   >
   > Use the SCAN HEAD POWER A connector at the ASC controller.

– **OR** -

Connecting the scan head to a SC controller

Procedure

1. Connect the SC controller via an Ethernet CAT5 cable to the scan head.

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2.

> ⚠️ **Caution**
>
> Voltage peaks and leakage currents, when hot plugging the power supply, destroy the scan head electronics.
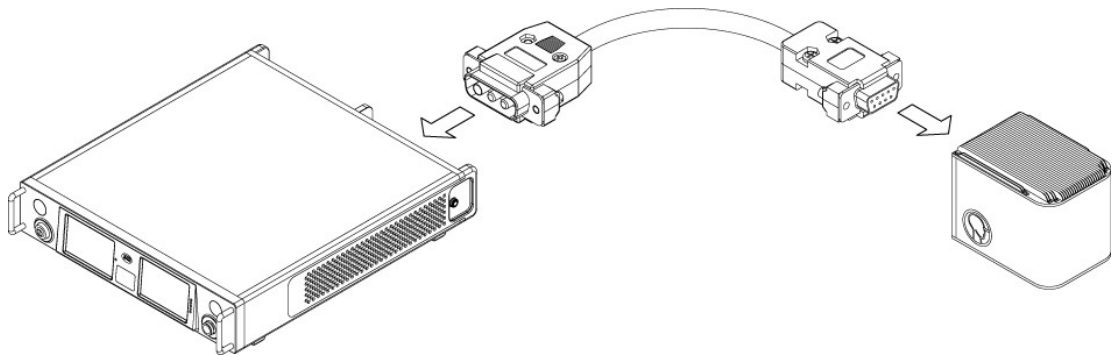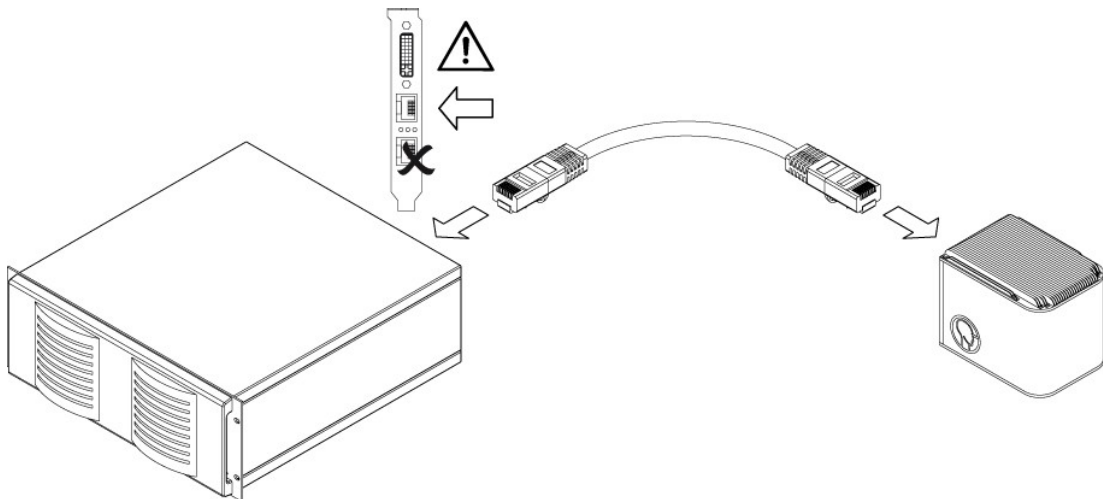>
> **Procedure**
>
> - Before connecting the power supply to the scan head or disconnecting it from the scan head, ensure that no voltage is being applied to the connecting cable.

Connect the SC controller via the scan head power cable to the scan head.

– **OR** –

Connecting the scan head to a NCC controller

Procedure

1. Connect the NCC controller via an Ethernet CAT5 cable to the scan head.

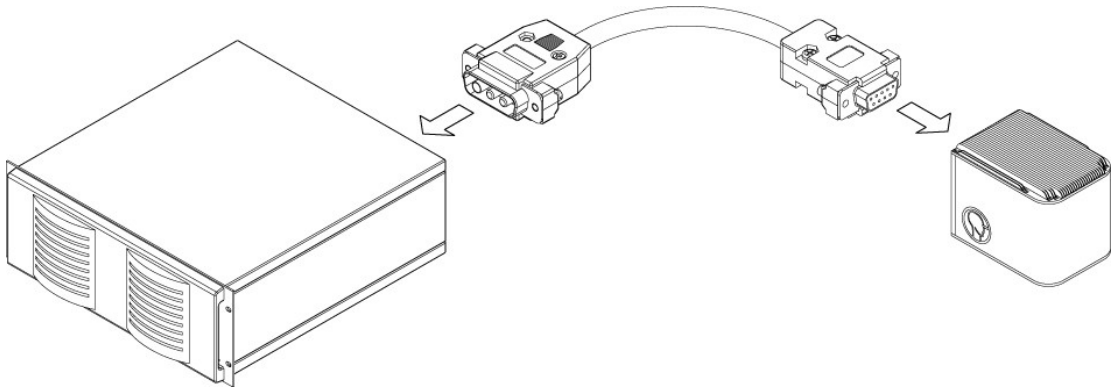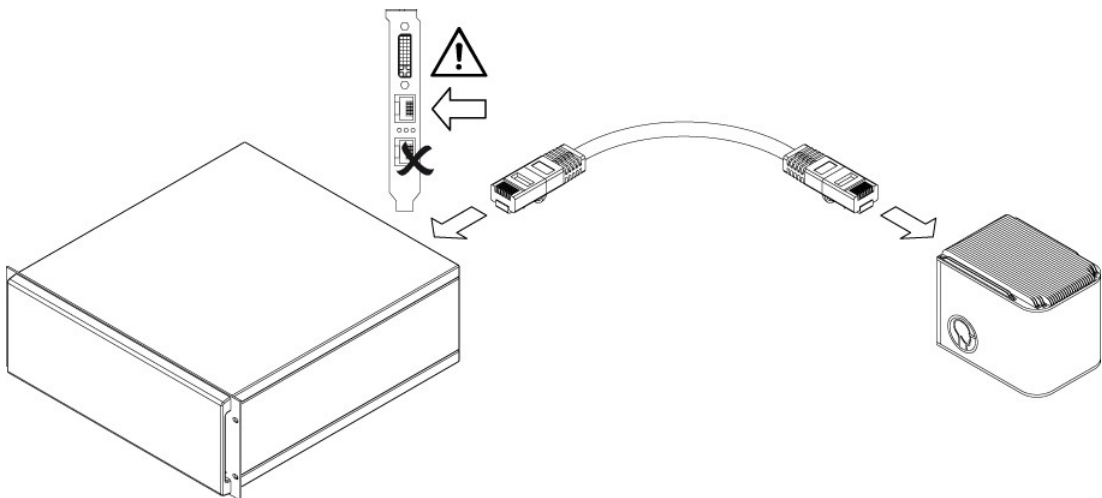39 (118)

2.

> ⚠️ **Caution**
>
> Voltage peaks and leakage currents, when hot plugging the power supply, destroy the scan head electronics.
>
> **Procedure**
>
> - 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.

Connect the HP2 power supply to the scan head

– **OR** –

Connecting the scan head to an analog controller

Procedure

1. Connect the controller to the scan head.

   Do find further information in subsection 4.6.3 and in the documentation of your analog controller.

2.

⚠️ **Caution**

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

Procedure

- 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.

Connect the power supply to the scan head.

Do find further information in subsection 4.6.4 and in the documentation of your power supply.

– **OR** -

Connecting the scan head to a XY2-100 compatible controller

Procedure

1. Connect the controller to the scan head.

   Do find further information in subsection 4.6.1 and in the documentation of your XY2-100 compatible controller.
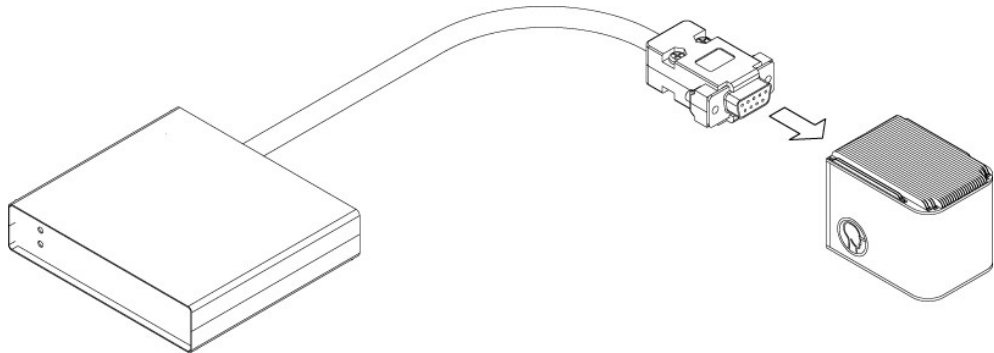
2.

⚠️ **Caution**

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

Procedure

- 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.

Connect the power supply to the scan head.

Do find further information in subsection 4.6.4 and in the documentation of your power supply.

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5.1.3   Connecting scan head to cooling water and/or pressurized air

If your scan head has cooling water connectors and/or connectors for pressurized air, then connect these.

Location and specifications for these connectors can be found in the technical specifications; see reference [Specifications].

There are several connector types. On the following pages select the procedure dedicated to your connector type, please.

On both sides self-sealing quick coupling

← flexible tube

← self-sealing plug nipple

← release bushing

← installed self-sealing quick coupling

ℹ️ **Note**

If this is a cooling water connector then a negligible amount of cooling water may leak.

How to connect:

Procedure
- Quickly press the plug nipple beyond the resistance into the installed quick coupling.

How to disconnect:

Procedure
1. Pull back the release bushing of the quick coupling.
2. Quickly detach the plug nipple.

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Quick connector

← flexible tube

← end piece

← installed quick connector

How to connect:

Procedure

1. Press the end of the flexible tube beyond the resistance into the quick connector.

2. Check, whether the flexible tube is correctly connected by trying to unplug it.

How to disconnect:

Procedure

1. Relieve the pressure from the tubing.
2.

⚠️ **Caution**

Leaking cooling water

Damage to electronics and optics

Procedure

- Ensure that the pressure is sufficiently relieved from the tubing.
- Get some tissues or similar ready in order to absorb leaking cooling water immediately.
- Deposit the open tube endings in a way that cooling water cannot leak or catch the cooling water in a tank.

Press the end piece into the quick connector.

3. Detach the flexible tube.

Quick coupling

← flexible tube (not pictured)

← quick coupling with release bushing (not pictured)

← installed plug nipple

How to connect:

Procedure

1. Press the quick coupling beyond the resistance into the plug nipple.

2. Check, whether it is correctly connected.

How to disconnect:

Procedure

1. Relieve the pressure from the tubing.

2. Pull back the release bushing in tube direction.

3. Detach the flexible tube.

5.1.4   Connecting scan head to a laser fiber

If your scan head has laser fiber coupling, then connect it.

Location and specifications for the coupling can be found in the technical specifications; see reference [Specifications].

There are several coupling types. On the following pages select the procedure dedicated to your coupling type, please.

Type D coupling

← dummy plug (white)

← protective grommet

locking pin (see red arrow)

← installed fiber coupling

Procedure

1. Remove the protective cap from the fiber head and the dummy plug from the coupling.

2.

> ⚠ **Caution**
>
> Dirty or damaged fiber heads
>
> Damage of fiber and / or laser possible
>
> **Procedure**
>
> - Check the fiber heads for dust and dirt before connecting to the laser or scan head.
> - Clean the fiber heads and fiber couplings thoroughly; see subsection 7.2.3.
> - Pay attention not to exceed the fiber's minimal bending radius.

Check the fiber head and coupling for contamination and damage.

3. Insert the fiber head into the coupling until the locking pin clicks.

Clamp coupling

← fiber head with collimation

← installed clamp coupling (left) clamp (see red arrow)

← cooling fins

Procedure

1. Loosen the 4 screws at the clamp until the hole, where the fiber head will be inserted, is unobstructed.

2. Remove the protective caps from the fiber head and coupling.

3.

> ⚠️ **Caution**
>
> Dirty or damaged fiber heads
>
> Damage of fiber and / or laser possible
>
> **Procedure**
>
> - Check the fiber heads for dust and dirt before connecting to the laser or scan head.
> - Clean the fiber heads and fiber couplings thoroughly; see subsection 7.2.3.
> - Pay attention not to exceed the fiber's minimal bending radius.

Check the fiber head and coupling for contamination and damage.

4. Insert the fiber head as far as it will go.

5. If one fiber head side is marked "Front" then turn it facing the scan head's cooling fins.

6. Tighten the 4 screws at the clamp.

QBH coupling

← bayonet ring

← installed QBH coupling

Procedure
1. Remove the protective caps from the fiber head and coupling.

2.

> ⚠️ **Caution**
>
> Dirty or damaged fiber heads
>
> Damage of fiber and / or laser possible
>
> **Procedure**
>
> - Check the fiber heads for dust and dirt before connecting to the laser or scan head.
> - Clean the fiber heads and fiber couplings thoroughly; see subsection 7.2.3.
> - Pay attention not to exceed the fiber's minimal bending radius.

Check the fiber head and coupling for contamination and damage.

3. Orient the fiber head with help of the red dots on fiber head and coupling.

4. Insert the fiber head as far as it will go.

5. Turn the bayonet ring, see figure above, in direction 1.

6. Pull and turn the bayonet ring, see figure above, in direction 2.

Coupling for IPG-laser

fiber head with collimation

fixation ring

Procedure
1. Remove the protective caps from the fiber head and coupling.

2.

> ⚠️ **Caution**
>
> Dirty or damaged fiber heads
>
> Damage of fiber and / or laser possible
>
> **Procedure**
>
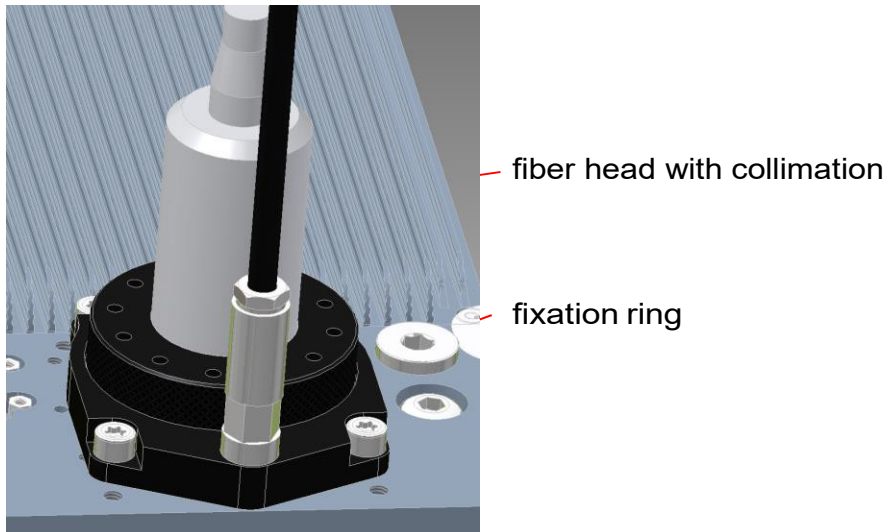> - Check the fiber heads for dust and dirt before connecting to the laser or scan head.
> - Clean the fiber heads and fiber couplings thoroughly; see subsection 7.2.3.
> - Pay attention not to exceed the fiber's minimal bending radius.

Check the fiber head and coupling for contamination and damage.
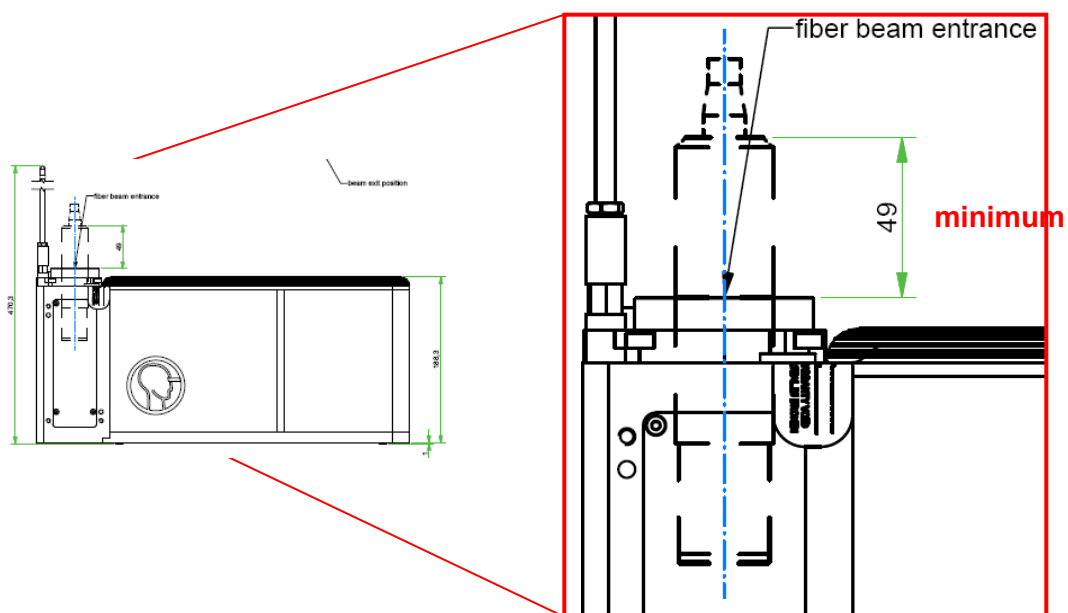
3.

> ⚠️ **Caution**
>
> No mechanical stop when inserting the fiber head
>
> Damage of scan head and / or fiber possible
>
> **Procedure**
>
> - Always keep the distance indicated in the following figure larger than 49 mm .

Carefully insert the fiber head into the scan head's fiber beam entrance.

4. Fix the fiber head to the scan head by fastening the fixation ring.

5.1.5 Connecting the fiber coupling to cooling water / pressurized air

If your scan head has a fiber coupling and this coupling has connectors for cooling water and/or pressurized air then connect these, as described in subsection 5.1.3.

5.2 Commissioning

Requirements

- The scan head is connected to a controller and a power supply; see subsection 5.1.2.

- The controller is connected via Ethernet to a PC; see [ASC] or [NCC].

- The InScript software is installed on this PC; see reference [InScriptInstall].

Procedure

1. If the scan head is supplied with cooling water, then

> ⚠️ **Caution**
>
> Pressure surge
>
> Damage to cooling water system
> Secondary damage to electronics and optics by cooling water
>
> **Procedure**
>
> 1. Open the cooling water outlet.
> 2. Carefully open the cooling water inlet.
> 3. De-aerate the system.

2. If the scan head is supplied with pressurized air, then
   a. Check, whether the settings for the pressurized air are correct.
   b. Turn on the pressurized air.
3. If a separate HP2 power supply is present, then switch it on.
4. Switch on the controller.
5. Switch on the PC, where the *InScript* software is running.
6. Switch on the laser.
7. Proceed to subsection .

5.2.1   Correcting scan field for processing-laser

Requirements

- You have material ready for the output of a test pattern, e. g. an anodized aluminum sheet. This work piece must be flat and when possible of scan field size.

- The processing laser is parameterized in a way the test pattern can be output on the work piece.

  If you realize during the following procedure that the processing laser is not parameterized correctly then it is possible to parameterize the laser without interrupting the procedure.

Procedure

1. Start the *InScript* application.

2. In the *Devices* window, double click **dist_xy**.

   The **DIST_XY** window opens.

3. In the wizard in Step 1 in group *Scan field correction*, select **Create**.

4. Click **Next**.

5. In the wizard in Step 2, select **Processing laser**.

6. Click **Next**.

7. In the wizard in Step 3:

   ℹ **Note**

   If a F-Theta objective and a Focus Translator is present in your scan head, as it is e. g. with the PRECESSION ELEPHANT or the ANTEATER, then make the following steps. Otherwise the data communication to and from the scan head would be configured in a wrong way and the scan head's output would not work correctly.

   a. Deactivate the *Auto set channel parameter in head device and pen* check box.

   b. Configure the default pen and the device driver, as described in subsection 5.2.2.

      ▶ **Tip**

      Leave the *DIST_XY* window open. Configure the default pen and the device driver. Subsequently bring the *DIST_XY* window to the foreground again by clicking **Windows ➜ DIST_XY** in the main menu.

   – OR –

   If an F-Theta objective *or* a Focus Translator is present in your scan head, then we recommend leaving the *Auto set channel parameter in head device and pen* check box activated.

8. If a F-Theta objective is present in your scan head, then:

   a. Select **Scan head with F-Theta lens**.

   b. Click **Next**.

   c. Proceed to subsection 5.2.3.

   – OR –

   If your scan head is without F-Theta objective, then:

a. Select **Scan head without F-Theta lens**.

b. In list *Aperture*, select the aperture of your scan head.

   Find the aperture on the type plate or on the delivery note. If your scan head is of type ELEPHANT 50 then select *50 mm (104)*.

c. Click **Next**.

d. Proceed to subsection .

5.2.2   Configuring the default pen and device driver

This is a sub-procedure of subsection . Proceed only if you were referred to this section in subsection .

Procedure

1. In the *Job Configuration* window, double click **Pens ➔ default ➔ head**.

   The *HEAD usr.pens.default.head* window opens.

2. Click the **Channels** tab.

3. In the following table, select the column that applies to your *Hardware* and *Application / Dimension* and set the parameters accordingly in the *Channels* tab:

Hardware	F-Theta objective	F-Theta and Focus Translator (also Precession ELEPHANT)	Focus Translator (simulates F-Theta)	Focus Translator
Application / Dimension	2D	2.5D	2D	3D
Correction type	Scan head with F-Theta lens	Scan head with F-Theta lens	Scan head without F-Theta lens 2D dynamic flat field correction	Scan head without F-Theta lens 3D Cartesian field correction

Group	Parameter	Setting			
Head 0	Mode x	Normal	Normal	Normal	Normal
	Mode y	Normal	Normal	Normal *	Normal *
Head 1	Mode x	Zero	Specified**	Normal	Normal
	Mode y	Zero	Zero	Normal	Normal

* for 50 mm aperture: Reverse
** value can be set in Pos x

4. Click **OK**.

5. In the *Devices* window, double click **head**.

   The *HEAD - dev.head* window opens.

6. Click the **Channels** tab.

7. In the following table, select the column that applies to your *Hardware* and *Application / Dimension* and set the parameters accordingly in the *Channels* tab in group *Head 1*:

Hardware	F-Theta objective	F-Theta and Focus Translator	F-Theta and Focus Translator **Precession ELEPH.**	Focus Translator simulates F-Theta	Focus Translator
Application / Dimension	2D	2.5D	2.5D	2D	3D
Correction type	Scan head with F-Theta lens	Scan head with F-Theta lens	Scan head with F-Theta lens	Scan head without F-Theta lens 2D dynamic flat field correction	Scan head without F-Theta lens 3D Cartesian field correction

Parameter	Setting				
Vector Processing	Copy VP0 Data	Copy VP0 Data	VP1 Enabled	Copy VP0 Data	VP1 Enabled
Scan Field Correction	Copy COR0 Data	COR1 Enabled	COR1 Enabled	COR1 Enabled	COR1 Enabled
Output Channel Modifiers	OCM1 Enabled	OCM1 Enabled	OCM1 Enabled	OCM1 Enabled	OCM1 Enabled

8. Click **OK**.

   The default pen and the scan head device driver are now configured.

9. Return to subsection 5.2.1.

5.2.3   Correcting the scan field for a scan head with F-Theta objective

This is a sub-procedure. Begin with subsection 5.2.1, if you did not process that subsection yet.

Procedure

1. In the wizard in Step 4, type in the scan head parameters:

> ℹ️ **Note**
>
> We strongly recommend keeping the factory setting for LH-Scale.

LH-Scale

> sets the factor for the usable part of the scan field (0.9 equates to 90 %). The rest is needed for line handling. This does not affect the assured scan field size.
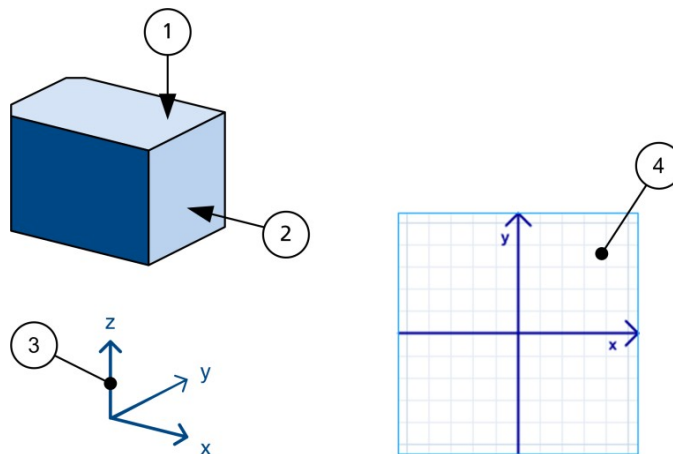>
> Factory setting LH-Scale = 0.900

Rotation

> rotates the scan field relative and counterclockwise to the scan head. Values of 0°, 90°, 180° and 270° each with ± 3° are allowed. The coordinate system, as displayed in the *Vector Editor*, will not be affected by this.
>
> Factory setting Rotation = 0.000
>
> The figure below shows the coordinate system orientation beneath the scan head (factory setting).

(1) Fiber input into the scan head

> - OR -

(2) Beam input into the scan head

(3) Coordinate system

(4) Display of the coordinate system in InScript

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2. Click **Next**.

3. In the wizard in Step 5, set parameters for the test pattern to be output.
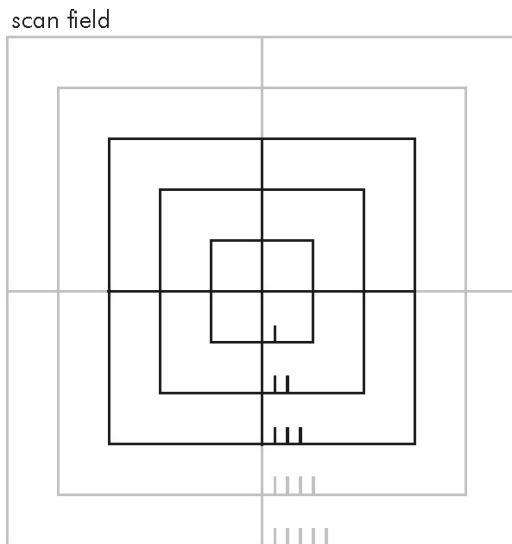
   The test pattern divides the scan field into equidistant, concentric squares, as shown in figure below.

   Number of squares

         sets the number of squares the scan field will be divided in.

   Squares to mark

         sets how many squares shall be output in case the work piece is smaller than the scan field.

scan field

example:
number of squares = 5
squares to mark = 3
squares that will not be marked are gray

4. Place in the work piece.

5.

> ⚠️ **Caution**
>
> Visible and / or invisible laser radiation
>
> Blindness, burns, property damage
>
> **Procedure**
>
> - Wear suitable protective goggles.
> - Comply with laser safety regulations.

Click **Start Testmark**.

The test pattern is being output. As the scan field is not corrected yet, the squares are still distorted.

6. Wait until the test pattern is completed.

7. If the processing laser parameters are not set correctly resulting in an insufficiently output test pattern on the work piece, then

   a. Set the processing laser via the DefaultPen.

   > ▶️ **Tip**
   >
   > Leave the *DIST_XY* window open. In the *Job Configuration* window in *Pens*, open the *DefaultPen*. There set the laser parameters. Subsequently bring the *DIST_XY* window to the foreground again by clicking **Windows ➜ DIST_XY** in the main menu.

   b. Output the test pattern once again.

8. Click **Next**.

9. On the work piece, choose the largest complete square.

   You will measure this square.

10. With the help of the dashes at the square's bottom line, read the number of this square.

11. In the wizard in Step 6, type this number in *Measure Square*.

12. Measure the dimensions asked for by the wizard and type in the values.

    Pay attention to the work piece orientation.

If the corners form a rectangle then correction algorithm *Parabola average* is sufficient for the following scan field correction.
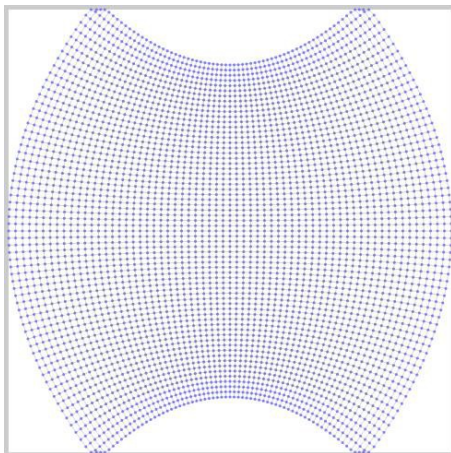
If the corners form a (degenerate) trapezoid, then we recommend correcting the scan field with algorithm *Parabola trapezoid*.

Example for a measured scan field distortion where the corners form a degenerate trapezoid:
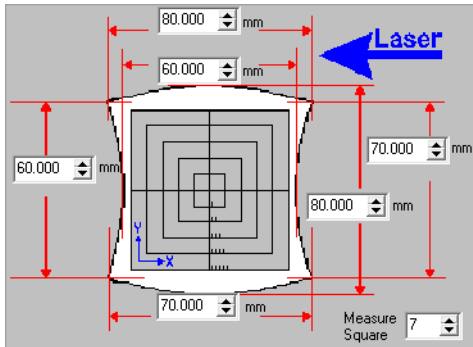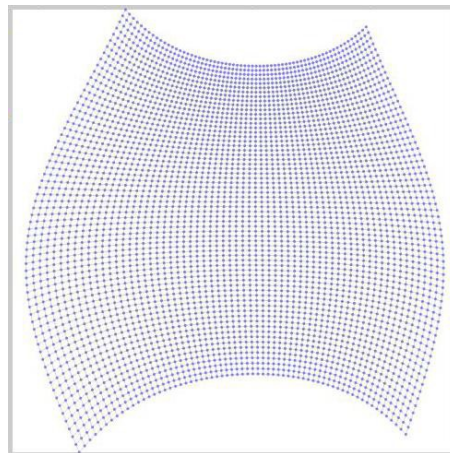

Comparison of scan field correction by algorithm:

Parabola average   *Parabola trapezoid*

In order to switch the correction algorithm from default setting *Parabola average* to *Parabola trapezoid*:

    a. Open the *Xplorer*.
    b. In the variables tree open path **dev ➔ dist_xy**.
    c. Set variable *correctionAlgorithm* to value *Parabola trapezoid*.

d. If the setting *Parabola trapezoid* leads to a *failure* status for device *dist_xy* in window *Devices* –the *dist_xy* device's LED is red– then reset variable *correctionAlgorithm* to *Parabola average*.

e. Continue the correction procedure.

13. Click **Next**.

The scan field correction is automatically calculated.

14. In the wizard in Step 7, check, whether the scan field correction is correct.

As you already entered the test pattern parameters in the wizard in Step 5, there is no need to change them.

15. Place in the work piece.

16.

⚠️ **Caution**

Visible and / or invisible laser radiation

Blindness, burns, property damage

- Wear suitable protective goggles.
- Comply with laser safety regulations.

Click **Start Testmark**.

The test pattern is being output.

17. Wait until the test pattern is completed.

18. Check, whether the lines are straight, and their length is correct:

If the lines are straight and their lengths are correct, then

a. Click **Finish**.

The *Confirm* window opens.

b. In order to save the scan field correction and to apply it, click **Yes**.

c. In the *Devices* window, double click **dist_xy**.

The *DIST_XY* window opens.

d. In the wizard in Step 1 in group *Scan field correction*, select **Save to file**.

e. Click **Next**.

f. In the wizard in Step 2, click **Save Distortion**.

The *Save Distortion* window opens.

> ### ℹ️ Note
>
> Save the Distortion-files in the *dist* folder of the InScript installation. These files have the file name extension `*.dst`. The file name is composed of as follows:
> ```
> <scan head>_<laser>_F<focal
> length>@<wavelength>nm_WD<working distance>mm.dst
> ```

g. Click **Save**.

h. Click **Finish**.

   The scan field for the processing laser is now rectified.

- OR -

If the lines are not straight and their lengths are not correct, then repeat the procedure.

### 5.2.4 Correcting the scan field for a scan head without F-Theta objective

This is a sub-procedure. Begin with subsection 5.2.1, if you did not process that subsection yet.

Requirements

- For this sub-procedure you will need a goniometer.

  If you do not have one, then print the following figure on an overhead transparency. Ensure to keep the aspect ratio, when printing the figure.
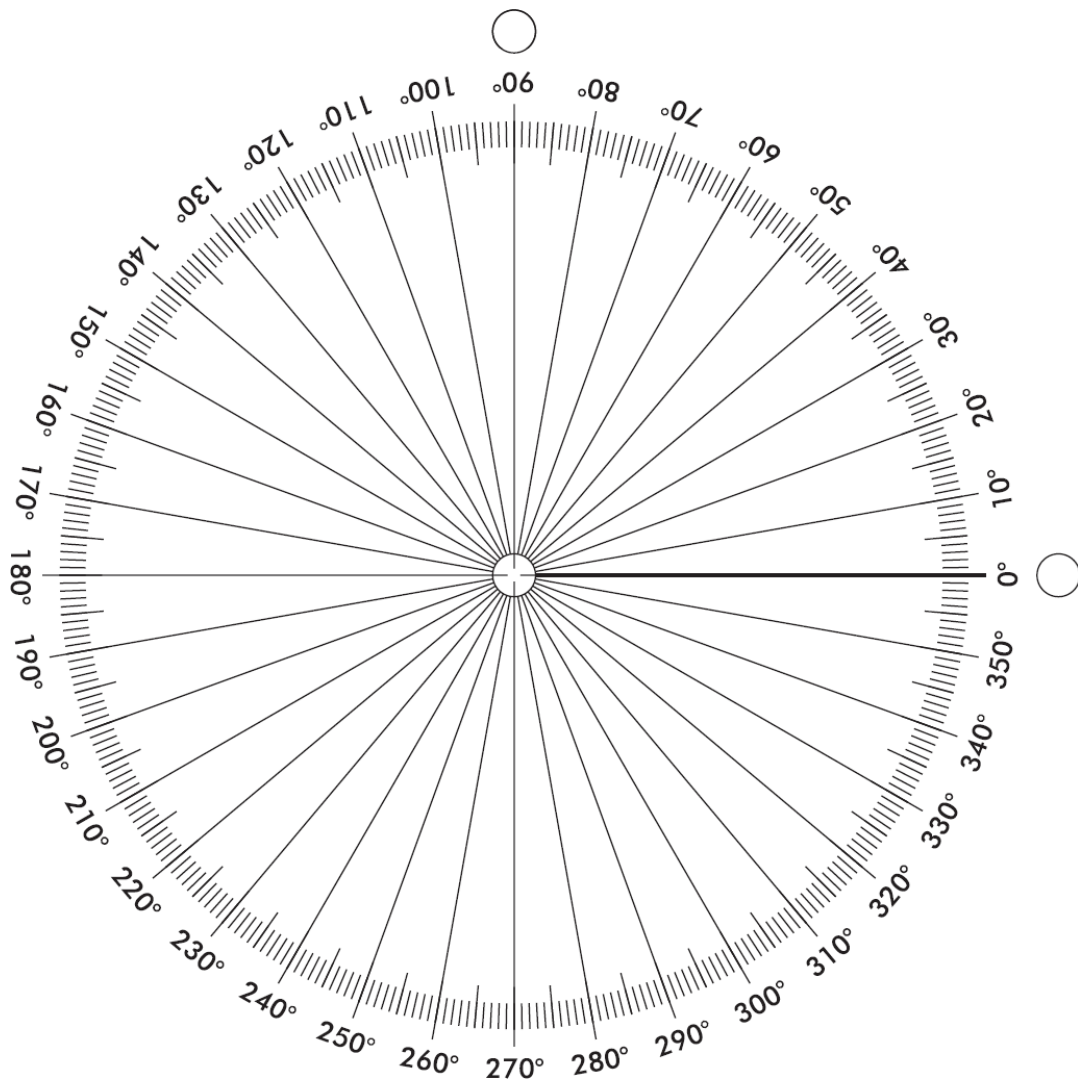
Procedure

1. In the wizard in Step 4, type in the scan head parameters:

> ℹ️ **Note**
>
> We strongly recommend keeping the factory setting for LH-Scale.

LH-Scale

> sets the factor for the usable part of the scan field (0.9 equates to 90 %). The rest is needed for line handling. This does not affect the assured scan field size.
>
> Factory setting LH-Scale = 0.900

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Rotation

rotates the scan field relative and counterclockwise to the scan head.

ℹ Note

Rotation is not supported for scan heads without F-Theta objective.

Procedure

- Keep factory setting for Rotation.
  Factory setting Rotation = 0.000

The figure below shows the coordinate system orientation beneath the scan head (factory setting).

(1) Fiber input into the scan head

   - OR -
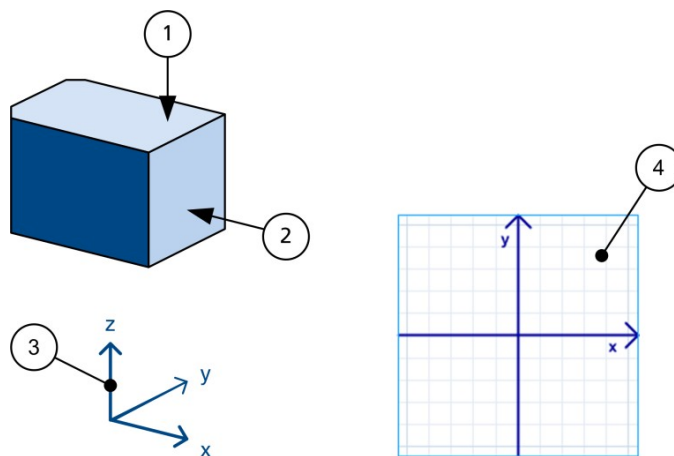
(2) Beam input into the scan head

(3) Coordinate system

(4) Display of the coordinate system in InScript

Working Distance

sets the distance between lower edge of the scan head and the datum plane.

Find the approximate value for working distance WD on the scan head type plate.

> **ℹ Note**
>
> In any case verify the working distance by measuring it.
>
> The correction quality depends strongly on the correct value.
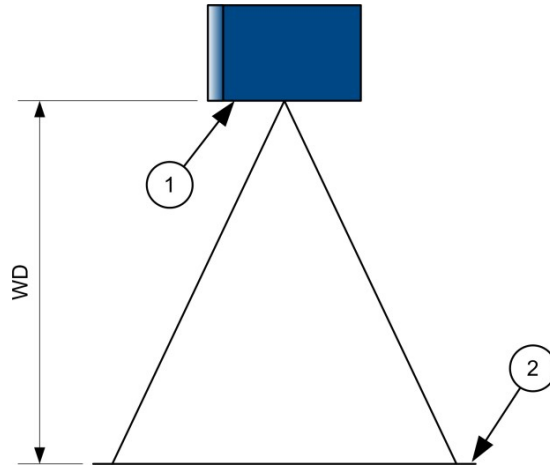

(1)   lower edge of the scan head

(2)   datum plane;

   for illustration see also the following steps (Z range)

2. Click **Next**.

3. In the wizard in Step 5, specify the Focus Translator's function in your scan head. The optical design of your scan head defines the function of the Focus Translator:

   - With the *2D dynamic flat field correction* you will work in a working plane later. The Focus Translator is used to keep the focus over the whole scan field in the working plane.

      Following figure illustrates the Focus Translator's effect.
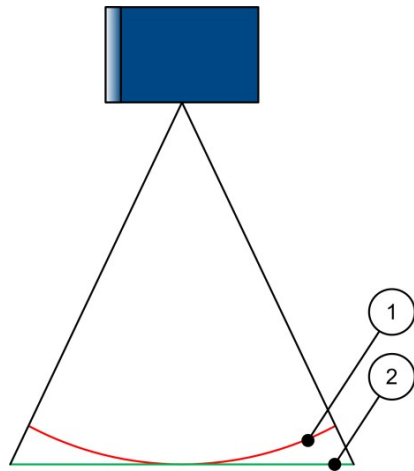
(1) Concavity of scan field without correction

(2) Focus Translator corrects scan field to the datum plane

- With the *3D Cartesian field correction* you will work in a working volume later on. In order to enable the Focus Translator keeping the focal length at constant Z-Coordinates in the whole scan field (volume), there must be measured further planes from datum plane through *Z range* (ZR) in addition to the *2D dynamic flat field correction*.
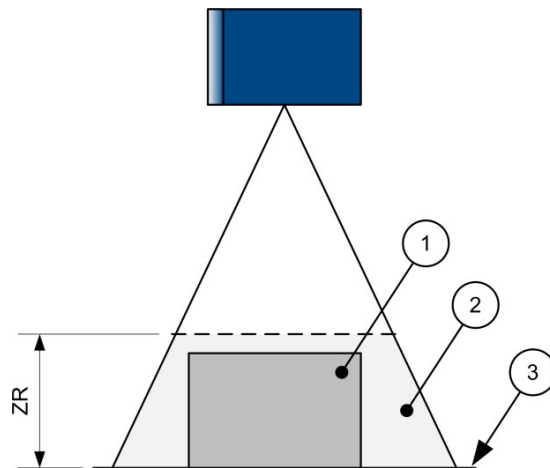
(1) work piece

(2) working volume

(3) datum plane

If the Focus Translator shall simulate an F-Theta objective, then select **2D dynamic flat field correction**.

- OR -

If you want to work in a 3D-volume, then

a. Select **3D Cartesian field correction**.

b. Click **Next**.

c. In the wizard in Step 6, type in the *Z range*.

   Z range equates to the frustum height.

   Find the *Z range* (ZR) on the scan head's type plate.

d. Click **Next**.

4.

ℹ **Note**

In the wizard this "Step" is carried out, only if you selected *3D Cartesian field correction*. So, the "Steps" for *2D dynamic flat field correction* are displayed in brackets from here on.

In the wizard in Step 7 (6), specify the test pattern for the preliminary Z-correction; see figure.

Inner Circle

   sets the diameter of the inner circle.

Outer Circle

   sets the diameter of the outer circle.

If the work piece is sufficiently large, then keep defaults (33 % and 67 %).

scan field 100 %
size of outer circle [%]
size of inner circle [%]
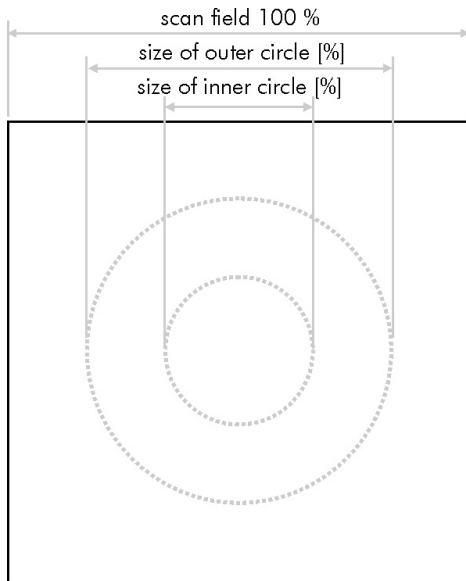
5. Place in the work piece.

6.

> ⚠️ **Caution**
>
> Visible and / or invisible laser radiation
>
> Blindness, burns, property damage
>
> **Procedure**
>
> - Wear suitable protective goggles.
> - Comply with laser safety regulations.

Click **Start Testmark**.

The test pattern is being output.

7. Wait until the test pattern is completed.

8. If the processing laser parameters are not set correctly resulting in an insufficiently output test pattern on the work piece, then

   a. In the *Job Configuration* window in **Pens ➔ default ➔ linepar** in tab *Dot* adjust the *ON time*.

   > ▶️ **Tip**
   >
   > Leave the *DIST_XY* window open. Adjust the *ON time*. Subsequently bring the *DIST_XY* window to the foreground again by clicking **Windows ➔ DIST_XY** in the main menu.

b. Output the test pattern once again.

9. Click **Next**.

10. In the wizard in Step 8 (7):

a. Click an input box.

b. On the work piece measure the distance and the angle respectively. The value to be measured is marked red on the screen.

c. Type the value into the input box.

d. Repeat this procedure until all measurement readings are recorded.
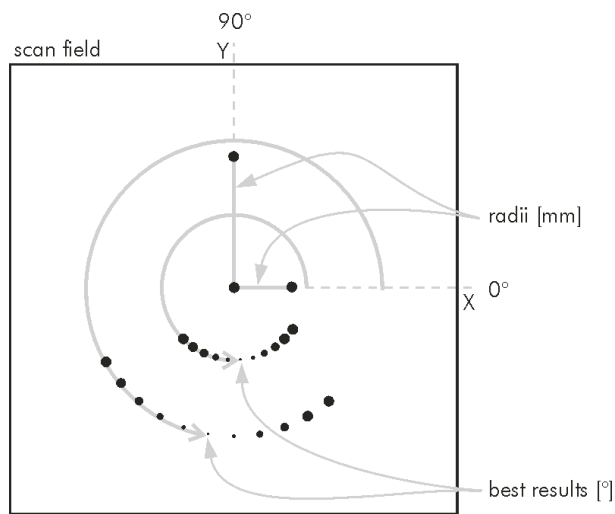
11. Click **Next**.

In the wizard in Step 9 (8) the preliminary Z-correction is calculated automatically.

In the process this message may occur:
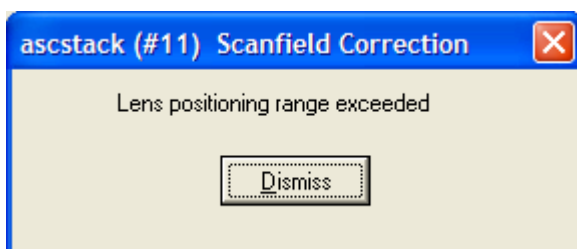
This message mostly is of informational nature and is caused by the linear approximation of the scan field correction:

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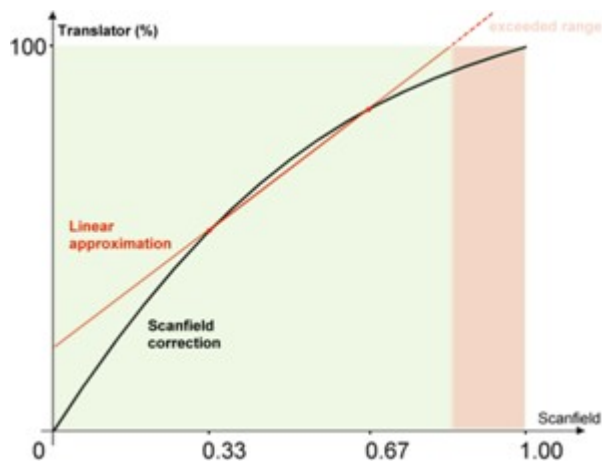
12. In the wizard in Step 10 (9), set parameters for the test pattern to be output for the X/Y-correction.

The test pattern divides the scan field into equidistant, concentric squares, as shown in figure below.

Number of squares

> sets the number of squares the scan field will be divided in.

Squares to mark

> sets how many squares shall be output in case the work piece is smaller than the scan field.
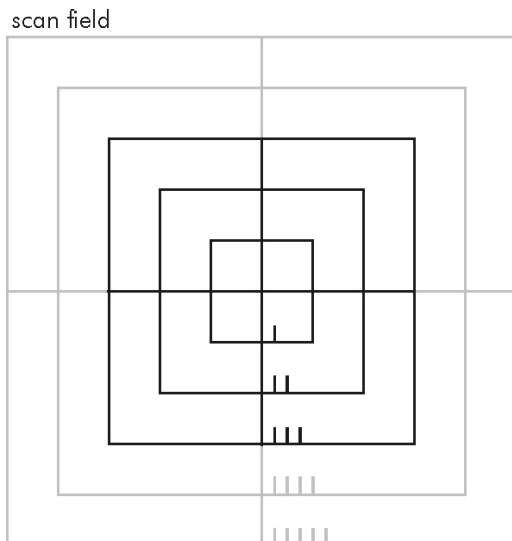
example:
number of squares = 5
squares to mark = 3
squares that will not be marked are gray

13. Place in the work piece.

14.

> ⚠️ **Caution**
>
> Visible and / or invisible laser radiation
>
> Blindness, burns, property damage
>
> **Procedure**
>
> - Wear suitable protective goggles.
> - Comply with laser safety regulations.

Click **Start Testmark**.

The test pattern is being output. As the scan field is not corrected yet, the squares are still distorted.

15. Wait until the test pattern is completed.

16. Click **Next**.

17. In the wizard in 11 (10):

> ℹ️ **Notes**
>
> Pay attention to the work piece orientation.
>
> You have to measure at least 3 squares completely (inner, outer, in between).
>
> The more accurate you measure the better the result will be.

   a. Click an input box.

   b. On the work piece measure the distance marked red on the screen.

   c. Type the value in the input box.

   d. Repeat the procedure until all measurement readings are recorded.

   > ▶️ **Tip**
   >
   > Save the values to a file in order to avoid entering them once again.

18. Click **Next**.

In the wizard in Step 12 (11) the pillow distortion will be corrected automatically then the scan field projection will be simulated and finally the X/Y-correction will be calculated.

This step needs some time.

19. Verify the scan field correction quality by reading the output in the text box; see example below.

- At each measuring point (1) the error square (2) has to be smaller than 1.

- The absolute value of X angle offset and Y angle offset (3) has to be smaller than 1°.

- The following example shows a point that was not measured as precisely as the other points (-X8).

```
①                                                        ②
X:
+1: msr= +54.50 sim= +54.54 err=  +0.04 err²=  +0.00
+2: msr=+109.20 sim=+109.20 err=  -0.00 err²=  +0.00
+4: msr=+219.40 sim=+219.42 err=  +0.02 err²=  +0.00
+6: msr=+332.20 sim=+331.85 err=  -0.35 err²=  +0.12
+8: msr=+448.00 sim=+447.74 err=  -0.26 err²=  +0.07
+9: msr=+507.00 sim=+507.41 err=  +0.41 err²=  +0.17
-1: msr= -54.60 sim= -54.57 err=  +0.03 err²=  +0.00
-2: msr=-109.40 sim=-109.30 err=  +0.10 err²=  +0.01
-4: msr=-220.00 sim=-219.82 err=  +0.18 err²=  +0.03
-6: msr=-332.80 sim=-332.77 err=  +0.03 err²=  +0.00
-8: msr=-448.60 sim=-449.42 err=  -0.82 err²=  +0.66
-9: msr=-510.10 sim=-509.57 err=  +0.53 err²=  +0.28
Y:
+1: msr= +53.65 sim= +53.50 err=  -0.15 err²=  +0.02
+2: msr=+107.40 sim=+107.20 err=  -0.20 err²=  +0.04
+4: msr=+215.80 sim=+215.77 err=  -0.03 err²=  +0.00
+6: msr=+326.80 sim=+326.89 err=  +0.09 err²=  +0.01
+8: msr=+441.90 sim=+441.85 err=  -0.05 err²=  +0.00
+9: msr=+501.20 sim=+501.23 err=  +0.03 err²=  +0.00
-1: msr= -53.70 sim= -53.44 err=  +0.26 err²=  +0.07
-2: msr=-107.50 sim=-106.96 err=  +0.54 err²=  +0.29
-4: msr=-215.00 sim=-214.79 err=  +0.21 err²=  +0.05
-6: msr=-324.60 sim=-324.64 err=  -0.04 err²=  +0.00
-8: msr=-437.40 sim=-437.75 err=  -0.35 err²=  +0.12
-9: msr=-496.20 sim=-495.95 err=  +0.25 err²=  +0.06
-------------------------------------------------------
Results of raytraced fitting:
maximum x scan angle ±25.08° opt
maximum y scan angle ±25.20° opt
X angle offset -0.37° opt  ③
Y angle offset +0.88° opt
mirror axis distance 41.202679 mm
distance between beam entry and target plane 1475.699951 mm
-------------------------------------------------------
**** 35.672149 ****
s->target.p.z = -1475.699951
Computing distorted target points
x0=-8.658156 y0=-12.952831
asx=25.076626 asy=25.202664
lh_scale = 0.900000
maxsize = lh_scale * 1387.502197 mm = 1248.751944 mm
```

20. In the wizard in Step 13 (12), verify the scan field correction.

As you already parameterized the test pattern in the wizard in Step 10 (9), there is no need to change the parameters.

21. Place in the work piece.

22.

> ⚠️ **Caution**
>
> Visible and / or invisible laser radiation
>
> Blindness, burns, property damage
>
> **Procedure**
>
> - Wear suitable protective goggles.
> - Comply with laser safety regulations.

Click **Start Testmark**.

The test pattern is being output.

23. Wait until the test pattern is completed.

The lines should be straight now.

24. Click **Next**.

25. In the wizard in Step 14 (13), specify the test pattern for the final Z-correction; see figure.

Quadrant

sets the mathematical quadrant, where the test pattern shall be output.

```
        ↑Y
  Q2 │ Q1
  ────┼────  →
  Q3 │ Q4   X
```
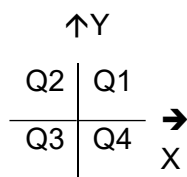
Number of circles

sets the number of circles placed in same distances on the quadrant diagonal. The first circle will be placed in the scan field center. The last circle will be placed in the scan head corner. The higher the number the better the result will be.

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Circles to mark

> sets the number of circled that will be output, in case the work piece is smaller than the scan field.

Dots per circle

> sets the number of dots that will be output on each circle. The dots must not get into contact with each other.

Size of circles

> sets the circle diameter in percent of the distance from circle center to circle center, i. e. at 100 % the circles are in contact with each other. If you want to measure manually then we recommend a value near 100 %. If you want to measure with a microscope then we recommend a value near 1 %.
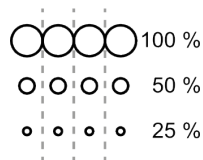
example
  quadrant: 1
  number of circles: 8
  size of circle: 50 %
  dots per circle: 19
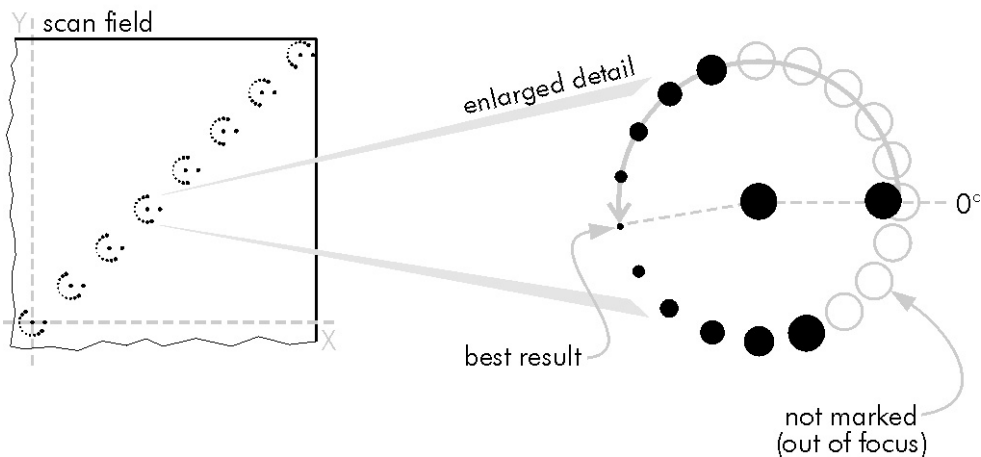
26. Place in the work piece.

27.

> **ℹ Note**
>
> Once you click *Start Testmark*, the table will be emptied in the following dialog.

> **⚠ Caution**
>
> Visible and / or invisible laser radiation
>
> Blindness, burns, property damage
>
> **Procedure**
>
> - Wear suitable protective goggles.
> - Comply with laser safety regulations.

Click **Start Testmark**.

The test pattern is being output.

28. Wait until the test pattern is completed.

29. Click **Next**.

30. In the wizard in Step 15 (14):

> **ℹ Notes**
>
> Pay attention to the work piece orientation.
>
> Pay attention to the order of circles on the work piece and in the table.

    a. Click an input box.

    b. On the work piece measure the angle of the best result (smallest dot).

    c. Type the value in the input box.

    d. Repeat the procedure until all measurement readings are recorded.

▶ **Tip**

This way you can enhance the measurement readings before typing them in.

Procedure

1. In a spreadsheet program enter the measurement readings into a column.
2. Copy this column into a second column in order not to overwrite the original values by accident.
3. Select this second column.
4. Create a point diagram for the second column.
5. Create a polynomic trend line in the point diagram.
6. Values deviating from the trend line can now be easily identified and can be moved nearer to the trend line.

31. Click **Next**.

32. In the wizard in Step 16 (15), the final correction will be automatically calculated.

    This step takes some time.

33. If you selected 2D dynamic flat field correction in Step 5 then

    a. Click **Finish**.

       The *Confirm* window opens.

    b. In order to save and apply the scan field correction click **Yes**.

       ▶ **Tip**

       Additionally, save the scan field correction under a tellingly name to a `*.dst` file.

    c. Verify, whether the scan field is corrected correctly for the processing laser now.

       The scan field is rectified now.

       🛑 **End of 2D scan field correction for the processing-laser**
       (2D dynamic flat field correction)

- OR -

If you selected *3D* Cartesian *field correction* in Step 5 then you will need some more measurement readings in order to do a correction of the volume.

34. In the wizard in Step 16, define the test pattern; output it at different Z-coordinates and type in the measurement readings.

We recommend measuring at least at 4 different Z-coordinates, e. g. at 25 %, 50 %, 75 % and more than 100 % of *Z range* between the datum plane and the scan head, which you entered in Step 6. It is mandatory to measure at more than 100 %, in order to end the test series.

a. Click **Add**.

b. Type in the *Z value*.

This is the work piece height above the original scan field.

c. Click **Next** (top).

d. Type in the test pattern parameters.

Dots per mark

sets the number of dots, that will be output on the circle. The dots must not get into contact with each other.

Radius

sets the circle radius.

e. Click **Next** (top).

f. Place in the work piece at the height entered above.

g.

> ⚠ **Caution**
>
> Visible and / or invisible laser radiation
> Blindness, burns, property damage
>
> **Procedure**
> - Wear suitable protective goggles.
> - Comply with laser safety regulations.

Click **Start Testmark**.

The test pattern is being output.

h. Wait until the test pattern is completed.

i. Click **Next** (top).

j. Measure the angle of the best result (smallest dot).

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    k. Type in the value.

    l. Click **Next** (top).

    m. Repeat the procedure until the *Z range* is covered. In order to end the test series, it is mandatory to measure at *Z range* (100 %) at last.

35. Click **Next** (bottom).

36. In the wizard in Step 17, verify whether the Z-mapping is plausible.

    The resulting curve should be increasing and decreasing respectively.

37. Optionally the Z-mapping can be corrected by hand:

    a. Click **Edit z-mapping**.

       A window opens.

    b. Correct the Z-mapping curve.

       The curve has to be increasing or decreasing. A slight bend in the curve can be removed here.
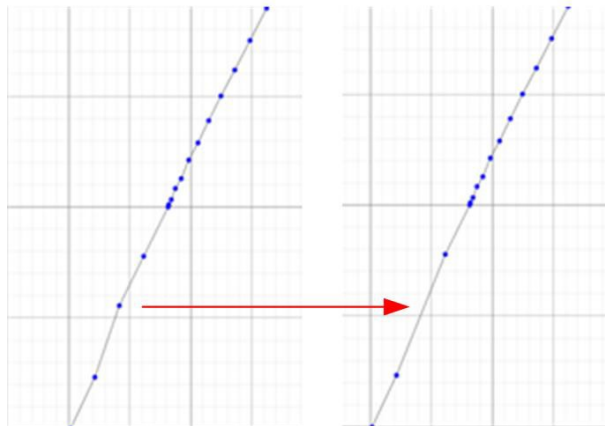
    c. Click **Ok**.

       The window closes.

38. Click **Next**.

    In the wizard in Step 18, the correction is automatically calculated.

39. Click **Finish**.

    The *Confirm* window opens.

40. In order to save and apply the scan field correction, click **Yes**.

    The scan field is rectified now.

> ▶ **Tip**
>
> Additionally, save the scan field correction under a tellingly name to a `*.dst` file.

41. Verify, whether the scan field is corrected correctly for the processing laser now.

> 🛑 **End of 3D scan field correction for the processing-laser**
> (3D Cartesian field correction)

5.2.5   Correcting the scan field for the pointing-laser

If a pointing-laser is present in your scan head then you must correct the scan field for this pointing-laser, as described here. Only that way can be ensured that the pointing-laser output matches the processing-laser output.

Requirements
- You have material ready for the output of a test pattern, e. g. an anodized aluminum sheet. This work piece must be flat and when possible of scan field size.
- The processing laser is parameterized in a way the test pattern can be output on the work piece.
- You have corrected the processing-laser's scan field successfully.

Procedure
1. Start the *InScript* application.
2. In the *Devices* window, double click **dist_xy**.

   The *DIST_XY* window opens.
3. In the wizard in Step 1 in group *Scan field correction*, select **Create**.
4. Click **Next**.
5. In the wizard in Step 2, click **Pointing laser**.
6. Click **Next**.
7. In the wizard in Step 3, type in parameters for the test pattern.

   The test pattern is a rectangle. A diagonal with starting (X1, Y1) and ending (X2, Y2) point spans this rectangle.

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8. Place in the work piece.

9.

> ⚠️ **Caution**
>
> Visible and / or invisible laser radiation
>
> Blindness, burns, property damage
>
> **Procedure**
>
> - Wear suitable protective goggles.
> - Comply with laser safety regulations.

Click **Start**.

The test pattern is being output.

10. Wait until the test pattern is completed.

11. Leave the work piece in the machine.

12. In the wizard in Step 4, type in the laser spot speed.

13. Click **Start**.

The pointing-laser outputs a rectangle continuously. In addition to that it outputs a mouse pointer, which can be moved with the mouse like the mouse pointer on the screen.

14. Adjust the rectangle output by the pointing-laser to that output by the processing-laser. Proceed as follows:

   a. Position the mouse pointer:

      i. In order to **move** the rectangle, position the mouse pointer on the rectangle **center**.

      ii. In order to **rotate** the rectangle, position the mouse pointer **outside** the rectangle.

      iii. In order to **scale** the rectangle in **1 dimension**, position the mouse pointer on the rectangle **edge**.

      iv. In order to **scale** the rectangle in **2 dimensions**, position the mouse pointer on the rectangle **corner**.

   b. Press and hold the left mouse button.

   c. Move the mouse.

d. Release the left mouse button.

15. If the rectangle output by the pointing-laser matches that output by the processing- laser, then press the **Enter key**.

16. Click **Finish**.

The *Confirm* window opens.

17. In order to save and apply the scan field correction, click **Yes**.

The pointing-laser scan field is now corrected.

> ▶ **Tip**
>
> Additionally, save the scan field correction under a tellingly name to a `*.dst` file.

5.2.6 Correcting the scan field for the video capture device

If your scan head has a video capture device then you must correct the image field for this video capture device as described here. Only that way you ensure the image corresponds to the processing laser output.

Requirements
- You have material ready for the output of a test pattern, e. g. an anodized aluminum sheet. This work piece must be flat and when possible of scan field size.

- The processing laser is parameterized in a way the test pattern can be output on the work piece.

- You have corrected the processing-laser's scan field successfully.

Procedure
1. Start the *InScript* application.

2. In the *Devices* window, double click **dist_xy**.

The DIST_XY window opens.

3. In the wizard in Step 1 in group *Scan field correction*, select **Create**.

4. Click **Next**.

5. In the wizard in Step 2, click **Video Capture Device**.

6. Click **Next**.

7. In the wizard in Step 3, type in the test pattern parameters.

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The test pattern is a grid with origin (at X Origin, Y Origin), Width, Height and grid points in X dimension and Y dimension.

8. If you want the grid points to coincide with the scan field correction sampling points, then activate the *Snap to sampling points* check box.

9. Place in the work piece.

10.

⚠️ **Caution**

Visible and / or invisible laser radiation

Blindness, burns, property damage

Procedure

- Wear suitable protective goggles.
- Comply with laser safety regulations.

Click **Start**.

The test pattern is being output.

11. Wait until the test pattern is completed.

12. Leave the work piece in the machine.

13. In the wizard in Step 4, click the ⊞ (Select video capture device) button.

The *Select Video Capture Device* window opens.

14. In list *Select video capture device*, select the device.

15. Click **Ok**.

16. Click the 🖼 (Configure video capture device) button.

The *Configure Video Capture Device* window opens.

17. In the *Mode* tab in group *Capture Mode*, select **Free Run**.

18. In the *Preview* tab, activate the **Show crosshairs** check box.

19. Click **Ok**.

20. In the wizard in Step 4, click **Start**.

21. Measure all test pattern grid point positions by marking them with the crosshairs.

The grid point, you are just measuring the position for, is marked red on the screen.

Select the grid point for measuring its position as follows:

  a. In order to skip grid points, move the mouse wheel.

  b. In order to change directions (horizontal / vertical), press the mouse wheel.

Position the crosshairs on a grid point as follows:

  c. In order to move the crosshairs roughly, press and hold the left mouse button and move the mouse.

  d. In order to move the crosshairs exactly, press and hold the right mouse button and move the mouse.

22. If all grid point positions are measured, then press the **Enter-key**.

23. Click **Finish**.

The *Confirm* window opens.

24. In order to save and apply the scan field correction, click **Yes**.

The scan field is corrected now.

▶ Tip

Additionally, save the scan field correction under a tellingly name to a `*.dst` file.

5.2.7   Verifying the scan field correction for the processing-laser

If you have corrected the scan field for the processing-laser then this is already done.

Proceed only if you want to verify the scan field correction subsequently.

Requirements

- You have material ready for the output of a test pattern, e. g. an anodized aluminum sheet. This work piece must be flat and when possible of scan field size.

- The processing laser is parameterized in a way the test pattern can be output on the work piece.

  If you realize during the following procedure that the processing laser is not parameterized correctly then it is possible to parameterize the laser without interrupting the procedure.

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- You have successfully corrected the scan field for the processing-laser.

Procedure

1. Start the *InScript* application.

2. In the *Devices* window, double click **dist_xy**.

   The *DIST_XY* window opens.

3. In the wizard in Step 1 in group *Scan field correction*, select **Verify**.

4. Click **Next**.

5. In the wizard in Step 2, set the parameters for the test pattern to be output.

   The test pattern divides the scan field into equidistant, concentric squares, as shown in figure below.
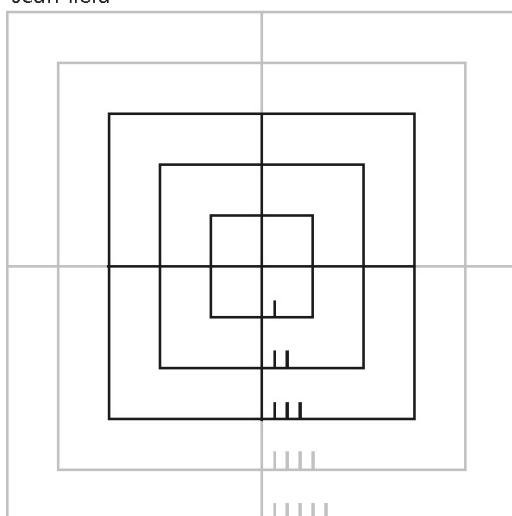
   Number of squares

   > sets the number of squares the scan field will be divided in.

   Squares to mark

   > sets how many squares shall be output in case the work piece is smaller than the scan field.

6. Place in the work piece.

7.

> ⚠ **Caution**
>
> Visible and / or invisible laser radiation
>
> Blindness, burns, property damage
>
> **Procedure**
> - Wear suitable protective goggles.
> - Comply with laser safety regulations.

Click **Start Testmark**.

The test pattern is being output.

8. Wait until the test pattern is completed.

9. If the processing-laser is not parameterized correctly and the test pattern is not output in a sufficient quality on the work piece, then

   a. Parameterize the processing-laser via the DefaultPen.

   > ▶ **Tip**
   >
   > Leave the *DIST_XY* window open. In the *Job Configuration* window in *Pens*, open the *DefaultPen*. There set the laser parameters. Subsequently bring the *DIST_XY* window to the foreground again by clicking **Windows ➔ DIST_XY** in the main menu.

   b. Output the test pattern once again.

10. Click **Finish**.

11. Check, whether the lines are straight, and their length is correct.

5.2.8   Improving the scan field correction

Only if you want to improve the processing-laser scan field correction subsequently then proceed.

Requirements
- You have material ready for the output of a test pattern, e. g. an anodized aluminum sheet. This work piece must be flat and when possible of scan field size.

- The processing laser is parameterized in a way the test pattern can be output on the work piece.

  If you realize during the following procedure that the processing laser is not parameterized correctly then it is possible to parameterize the laser without interrupting the procedure.

- You have successfully corrected the scan field for the processing-laser.

Procedure

1. Start the *InScript* application.

2. In the *Devices* window, double click **dist_xy**.

   The *DIST_XY* window opens.

3. Click **Expert Mode**.

4. Click the **Correction** tab.

5. Note down the value of *Field Scale*.

6. Note down the value of *LH-Scale*.

7. Close the *DIST_XY* window.

8. In the *Job Configuration* window, select the **Exec** node.

9. In the menu click **File ➔ Open Job**.

   The *Open* window opens.

10. Select file **ReferenceGrid.job**.

    Find this file in the InScript installation tools folder.

11. Click **Open**.

    The file will load, and the *Job Configuration* window will show the job's tree structure.

12. In the *Job Configuration* window, double click the Script-node **Init**.

    The *Script Editor* window opens.

13. In *Cells* type in an even number equal to or less than 64, e. g. 14.

    In the square reference grid cells will be numbered in one direction from 0 through the given number. This results in an odd number of cells with one cell at the center.

14. Note down the value of *Cells*.

15. Click **Ok**.

The *Script Editor* window closes.

16. In the *Job Configuration* window, select the Job-node **ReferenceGrid**.

17. Press the **Enter-key**.

This selects the Job-node for execution (red frame).

18. Place in the work piece.

19.

> ⚠️ **Caution**
>
> Visible and / or invisible laser radiation
>
> Blindness, burns, property damage
>
> **Procedure**
>
> - Wear suitable protective goggles.
> - Comply with laser safety regulations.

In the *Job Control* window, click the **Start** button.

The test pattern is being output.

20. Wait until the test pattern is completed.

21. If the processing-laser is not parameterized correctly and the test pattern is not output in a sufficient quality on the work piece, then

   a. Parameterize the processing-laser via the DefaultPen.

   > ▶️ **Tip**
   >
   > Leave the *DIST_XY* window open. In the *Job Configuration* window in *Pens*, open the *DefaultPen*. There set the laser parameters. Subsequently bring the *DIST_XY* window to the foreground again by clicking **Windows ➔ DIST_XY** in the main menu.

   b. Output the test pattern once again.

22. If you want to measure the x- and y-position of each reference grid point automatically then prepare the data for the AED-file format. In this case proceed to subsection 5.2.9.

   - OR -

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If you want to measure the x- and y-position of each reference grid point by hand, then go on reading.

23. In the *Excel* application open file `CalculateDataForAEDFile.xls`.

    Find this file in the InScript installation tool folder.

24. In sheet *Step A*, type the values, you have noted down earlier, into the green colored cells:

    a. Field Scale

    b. LH-Scale

    c. Cells

    The reference positions will be automatically calculated on sheet *Step B*.

25. In sheet *Step B* type the value in the green colored cell *Highlight, when >.*

    This highlights all values of *valuex* and *valuey* greater than the given value in orange color.

26. Measure the x- and y-position of each reference grid point and type it in the respective green colored cell.

    Pay attention to the order in respect to the coordinate system:

indexx / indexy 0 / 14	y	indexx / indexy 14 / 14
↘	↑	↙

    ──────────┼──────→ x

↗		↖
indexx / indexy 0 / 0		indexx / indexy 14 / 0
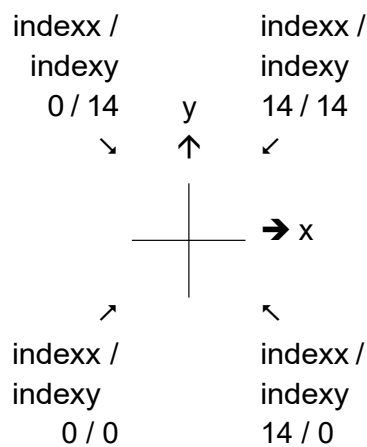
27. Save the data to a file with the file name extension `*.aed` and as file type XML-data (`*.xml`).

    This file can be used directly with InScript later on.

28. Close the *Excel* application.

29. Load the AED-file, as described in subsection .

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5.2.9 AED-file format

This is a sub-procedure. Begin at subsection 5.2.8, if you have not processed this subsection yet.

You may create the AED-file from an automated measuring procedure. The approach how to do this is left to you.

The AED-file is defined as follows:
ASCII-file with XML content

The XML content is defined as follows:
Example for a hypothetical 5×5 grid:

(1)
```
<EXTRAPOLATIONDATA dimension = "5" gridsize = "152.316" >
```

(2)
```
<DELTA indexx ="0" indexy = "4" valuex = "0.36484" valuey=" -0.02570"/ >
<DELTA indexx ="1" indexy = "4" valuex = "0.33813" valuey=" -0.02728"/ >
<DELTA indexx ="2" indexy = "4" valuex = "0.31689" valuey=" -0.02609"/ >
<DELTA indexx ="3" indexy = "4" valuex = "0.29744" valuey ="-0.0232"/ >
<DELTA indexx ="4" indexy = "4" valuex = "0.27526" valuey=" -0.01764"/ >
<DELTA indexx ="0" indexy = "3" valuex = "0.37094" valuey=" -0.00571"/ >
<DELTA indexx ="1" indexy = "3" valuex = "0.34533" valuey=" -0.00567"/ >
<DELTA indexx ="2" indexy = "3" valuex = "0.32521" valuey=" -0.00615"/ >
<DELTA indexx ="3" indexy = "3" valuex = "0.30467" valuey=" -0.00499"/ >
<DELTA indexx ="4" indexy = "3" valuex = "0.28139" valuey=" -0.00163"/ >
<DELTA indexx ="0" indexy = "2" valuex = "0.37705" valuey ="0.01986"/ >
<DELTA indexx ="1" indexy = "2" valuex = "0.35419" valuey ="0.01991"/ >
<DELTA indexx ="2" indexy = "2" valuex = "0.33639" valuey ="0.02109"/ >
<DELTA indexx ="3" indexy = "2" valuex = "0.31695" valuey ="0.02336"/ >
<DELTA indexx ="4" indexy = "2" valuex = "0.29468" valuey ="0.02011"/ >
<DELTA indexx ="0" indexy = "1" valuex = "0.38357" valuey ="0.04703"/ >
<DELTA indexx ="1" indexy = "1" valuex = "0.36127" valuey ="0.04654"/ >
<DELTA indexx ="2" indexy = "1" valuex = "0.34415" valuey ="0.04827"/ >
<DELTA indexx ="3" indexy = "1" valuex = "0.32747" valuey ="0.05"/ >
<DELTA indexx ="4" indexy = "1" valuex = "0.3063" valuey ="0.04786"/ >
<DELTA indexx ="0" indexy = "0" valuex = "0.38845" valuey ="0.07464"/ >
<DELTA indexx ="1" indexy = "0" valuex = "0.36891" valuey ="0.07085"/ >
<DELTA indexx ="2" indexy = "0" valuex = "0.35414" valuey ="0.06983"/ >
<DELTA indexx ="3" indexy = "0" valuex = "0.33911" valuey ="0.07157"/ >
<DELTA indexx ="4" indexy = "0" valuex = "0.32947" valuey ="0.0805"/ >
```

(3)
```
</EXTRAPOLATIONDATA >
```

Explanation:

(1)   This line opens the data.

You will get the values of *dimension* and *gridsize* with the following equations:

$$Move\ Rectangle = \frac{Field\ Scale}{LH - Scale}$$

You have noted down *Field Scale* and *LH-Scale* in subsection 5.2.8.

$$Cell\ Size = \frac{Move\ Rectangle}{Cells}$$

You have noted down *Cells* in subsection 5.2.8.

$$Markable\ Cells = \frac{Field\ Scale}{Cell\ Size}$$

$$dimension = INT\ (\frac{Markable\ Cells}{2}) * 2 + 1$$

$$gridsize = (dimension - 1) * Cell\ Size$$

(2)   *indexx* runs from 0 through (dimension - 1) and start subsequently at 0

indexy runs from (dimension - 1) through 0

see the example above for better understanding

Positions *indexx / indexy* are arranged in the coordinate system as follows:

indexx / indexy 0 / 14	y ↑	indexx / indexy 14 / 14
↘		↙
	─┼─ → x	
↗		↖
indexx / indexy 0 / 0		indexx / indexy 14 / 0
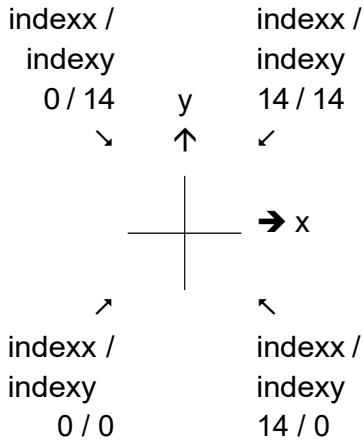
The aberration from the calculated nominal value calculates as follows:

valuex = calculated x-position - measured x-position

valuey = calculated y-position - measured y-position

where the calculated position is:

y
↑

:

...	...	2 × CellSize	...	...
...	...	1 × CellSize	...	...
-2 × CellSize	-1 × CellSize	0	1 × CellSize	2 × CellSize
...	...	-1 × CellSize	...	...
...	...	-2 × CellSize	...	...

... → x

:

(3)   This line concludes the data.

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Procedure

1. Create an AED-file. The format is described above.

2. Load the AED-file, as described in subsection 5.2.10.

5.2.10 Loading an AED-file and applying the scan field correction improvement

This is a sub-procedure. Begin at subsection 5.2.8, if you have not processed this subsection yet.

Procedure

1. Start the *InScript* application.

2. In the *Devices* window, double click **dist_xy**.

   The *DIST_XY* window opens.

3. In the wizard in Step 1 in group *Scan field correction*, select **Improve**.

4. Click **Next**.

5. In the wizard in Step 2, click **Load AED file**.

   The *Load AED File* window opens.

6. Select the `*.aed` file.

7. Click **Load**.

8. Click **Finish**.

9. In order to save and apply the scan field correction, click **Yes**.

   ⏵ **Tip**

   Additionally, save the scan field correction under a tellingly name to a `*.dst` file.

5.2.11 Adjusting the scan field position

Proceed only if operating several scan heads with the same scan field correction *and* only if these scan fields differ slightly in offset and rotation.

Requirements

- You successfully corrected the processing-laser scan field.

- The scan heads are identical in construction and use the same scan field correction.

- The individual scan fields are slightly offset and rotated respectively.

Procedure

1. Start the *InScript* application.

2. In the *Devices* window, double click **dist_xy**.

   The *DIST_XY* window opens.

3. In the wizard in Step 1 in group *Scan field correction*, select **Load from file**.

4. Click **Next**.

5. In the wizard in Step 2, click **Load Distortion**.

   The *Load Distortion* window opens.

   ℹ️ **Note**

   Find distortion-files in the InScript installation *dist* folder. These files have the file name extension `*.dst`. The file name consists of as follows:

   `<scan head>_<laser>_F<focal length>@<wavelength>nm_WD<working distance>mm.dst`

6. Select the file.

7. Click **Open**.

8. Click **Finish**.

   The scan field is corrected now. But it still has to be offset and rotated respectively.

9. In the *Devices* window, double click **dist_xy**.

   The *DIST_XY* window opens.

10. In the wizard in Step 1 in group *Scan head parameters*, select **Edit position adjustment**.

11. Click **Next**.

12. In the wizard in Step 2 type in the scan field *Offset* and *Rotation*.

13. Click **Finish**.

14. In order to save and apply the scan field correction, click **Yes**.

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▶ Tip

Additionally, save the scan field correction under a tellingly name to a `*.dst` file.

5.2.12 Editing the clipping rectangle

Proceed only if you operate

- one scan head and want to clip the scan field, in order to protect e. g. machine parts which extend into the scan field

  - OR -

  several scan heads with the same scan field correction for processing-lasers and only if the scan fields shall be clipped in different ways

Requirements

- You successfully corrected the processing-laser scan field.

- The scan heads are identical in construction and use the same scan field correction.

- The individual scan fields shall be clipped differently

Procedure

1. Start the *InScript* application.

2. In the *Devices* window, double click **dist_xy**.

   The *DIST_XY* window opens.

3. In the wizard in Step 1 in group *Scan field correction*, select **Load from file**.

4. Click **Next**.

5. In the wizard in Step 2, click **Load Distortion**.

   The *Load Distortion* window opens.

ℹ Note

Find distortion-files in the InScript installation *dist* folder. These files have the file name extension `*.dst`. The file name consists of as follows:

`<scan head>_<laser>_F<focal length>@<wavelength>nm_WD<working distance>mm.dst`

6. Select the file.

7. Click **Open**.

8. Click **Finish**.

   The scan field is corrected now. But it still has to be clipped.

9. In the *Devices* window, double click **dist_xy**.

   The *DIST_XY* opens.

10. In the wizard in Step 1 in group *Scan head parameters*, select **Edit clipping rectangle**.

11. Click **Next**.

12. In the wizard in Step 2 in group *Offset*, type in the X- and Y-coordinate for the offset.

13. In group *Fieldsize*, type in the scan field *Width* and *Height*.

    – OR –

    Click **Max Field**.

    The scan field will not be clipped in the latter case.

14. Click **Finish**.

15. In order to save and apply the scan field correction, click **Yes**.

    ▶ **Tip**

    Additionally, save the scan field correction under a tellingly name to a `*.dst` file.

5.3 Administering

Administer the scan head device driver in the InScript software. Find further information in document [InScript], in chapters:

- Devices Window, including its sections
  (These sections describe the usage of devices.)

- Devices ➜ head – Scan Head
  (This section describes the scan head device driver.)

- Job Configuration Window ➜ Manage Pens, including its subsections
  (These subsections describe the usage of pens.)

5.4 Operating

5.4.1 Switching on and off

Procedure

1. If the scan head is supplied with cooling water, then

   ⚠️ **Caution**

   Pressure surge

   Damage to cooling water system
   Secondary damage to electronics and optics by cooling water

   Procedure

   a. Open the cooling water outlet.
   b. Carefully open the cooling water inlet.

2. If the scan head is supplied with pressurized air, then

   a. Check the pressurized air settings.

   b. Open the Pressurized air inlet.

3. If a separate HP2 power supply is present then switch it on.

4. Switch on the controller.

5. Switch on the PC, where the InScript application is running.

6. Switch on the laser.

5.4.2 Operating

The scan head is controlled with the InScript software either via an ASC, NCC, SC, equivalent controller or via an analog controller or via a XY2-100 compatible controller.

- If the scan head is controlled **via an ASC, NCC, SC or equivalent controller** then find more information in [InScript].

  – OR –

  If the scan head is controlled **via an analog controller** then find more information in subsection 4.6.3 and in the documentation of your analog controller.

  – OR –

If the scan head is controlled **via a XY2-100 compatible controller** then find more information in subsection 4.6.1 and in the documentation of your XY2-100 compatible controller.

5.5   Monitoring errors

The scan head is controlled with the InScript software either via an ASC, NCC, SC, equivalent controller or via an analog controller or via a XY2-100 compatible controller.

- If the scan head is controlled **via an ASC, NCC, SC or equivalent controller** with the InScript software then communication to the scan head is monitored. If the communication is not ready, then the head device in the Devices window of the InScript software is not ready (gray LED).

  Find further information in reference [InScript].

  Further error control of the scan head by the InScript software is not standard, but possible. Please ask ARGES.

  ‑ OR ‑

  If the scan head is controlled **via an analog or XY2-100 compatible controller** then error control is only possible within the scope of the ANALOG INTERFACE or Slavelink / XY4-100 interface; see subsections 4.6.3 or 4.6.1.

5.6   Decommissioning

⚠️ **Caution**

Voltage peaks and leakage currents, when hot plugging the power supply,

destroy the scan head electronics.

Procedure

- 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.

Procedure
1. Switch off the laser.
2. If a separate HP2 power supply is present, then switch it off.
3. Switch off the controller.
4. Close the *InScript* application.

5. Switch off the PC, where the *InScript* application was running.

6. If the scan head is supplied with cooling water, then

    a. Close the inlet.

    b. Close the outlet.

7. If the scan head is supplied with pressurized air, then close the inlet.

5.7   Re-commissioning

Procedure

- Proceed, as described in section [5.2](#).

  If you did not change the optical configuration then you may skip the subsections.

5.8   Packaging and transporting

Procedure

1. Re-install the protective caps you got with the delivery on the optics.

2. Pack the system in the way you received it, in its original packaging or in an equivalent packaging.

5.9   Storing

Procedure

1. Check whether the delivery is complete and immaculate.

2. Store the system in its original packaging and under the following environmental conditions:

   - dry and clean storage room

   - storage temperature between 0 and 50°C

   - relative humidity between 10 and 85 %, non-condensing

5.10 Disposing

- 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 household disposal service or ARGES.

6 Preventive maintenance instructions

Servicing includes all simple maintenance procedures which can be executed by the user without auxiliary tools, e. g., cleaning of the system, replacement of wear-and-tear parts and operating fluids, and monitoring of operational parameters.

- Avoid contaminating the scan head.

  This saves unnecessary often cleaning of the optics; see chapter 7. Each cleaning decreases the optics quality.

- Observe the minimal bending radii of supply lines in moving systems.

- In moving systems ensure that supply lines will not be sheared off.

7 Maintenance

This chapter describes all measures required in order to ensure and maintain the functional capability of the system. Maintenance is scheduled and executed at certain intervals.

This chapter addresses persons scheduling and executing maintenance.

ℹ️ Note

Only qualified personnel with electro-technical or mechatronic profession or personnel trained in handling highly sensitive electronic and optical equipment is allowed to maintain the system.

7.1   Maintenance plan

This section describes the individual maintenance measures and their schedule.

- As the intervals strongly depend on the contamination, ARGES asks you kindly to determine the intervals respective the alternative condition by yourself.

- ARGES recommends keeping a machine logbook, where all measures taken can be recorded.

Interval	Alternative condition	Measure
☐ shift ☐ ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ daily ☐ weekly ☐ monthly ☐ quarter-annually ☐ semi-annually ☐ annually	if cleaning was not successful - OR - if the protective glass has weld penetration, scratches, cracks or conchoidal fractures	See subsection 7.2.1

Interval	Alternative condition	Measure
☐ shift ☐ ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ daily ☐ weekly ☐ monthly ☐ quarter-annually ☐ semi-annually ☐ annually	within the maintainer's discretion	See subsection 7.2.2
–	only if you connect the fiber to the scan head	See subsection 7.2.3

7.2 Maintenance instructions

This section describes maintenance measures in repeatable procedural steps.

7.2.1 Replacing protective glass

Tools and utilities

Description	Details
Inbus- or Torx-key	Depending on the scan head model. You do not need tools to replace the protective glass of an F-Theta objective.
Protective glass	Depending on the scan head model
Cotton or nylon gloves	Dry, free of dust and grease, lintless

ℹ️ **Note**

Always wear cotton gloves when replacing the protective glass.

Do not touch the optical surface with bare hands.

Procedure

1.

> ⚠️ **Caution**
>
> Visible and/or invisible laser radiation
>
> Blindness, burns
>
> **Procedure**
>
> - Switch off the laser

2. If your scan head has a F-Theta objective, then

   a. Remove the protective glass from the F-Theta objective.

   b. Attach the new protective glass to the F-Theta objective.

   - OR -

   If your scan head has no F-Theta objective, then

   a. Hold the protective glass frame and remove the screws holding the frame.

   b. Remove the protective glass from the frame.

   c. Place the new protective glass into the frame.

   d. If an O-ring is present, then check and eventually correct its fit.

   e. Fix the frame with protective glass to the scan head.

7.2.2 Cleaning protective glass or optics

Tools and utilities

Description	Details
Isopropanol	Purity grade min. 99,8 % (cosmetically pure)
Acetone Ph. Eur./USP	Purity grade min. 99,8 %
Whatman lens cleaning tissues 100 mm × 150 mm	n/a
Pressurized air 400ML; volume: 0.4 l; EAD 400D	n/a
Cotton swabs; single sided; with PP handle	n/a
Cotton or nylon gloves	Dry, free of dust and grease, lintless

Description	Details
A pair of tweezers	n/a
Bright 50 W Halogen lamp or equivalent LED light	n/a
Black mat	n/a

ℹ️ **Note**

- Always wear cotton gloves when cleaning optics.
  Do not touch the optical surface with bare hands.

- Use each lens cleaning tissue and cotton swab only once.
  Dirty lens cleaning tissues and cotton swabs may damage optics.

When not stated differently clean optics with Isopropanol.

Procedure

1.

   ### ⚠️ **Caution**

   Visible and/or invisible laser radiation

   Blindness, burns

   Procedure

   - Switch off the laser.

2. Have tools and utilities ready; see table above.

3. Wear gloves.

4. Cover the placement area – where to put the optics later – with lens cleaning tissues.

5. Blow the optics clean with pressurized air from the can.

6. Wipe off larger dust particle with an Isopropanol-drenched cotton swab.

7. If the optics are extremely dirty then wipe the surface clean, as follows:

   a. Cover the surface to be cleaned with 1 layer of lens cleaning tissue (not folded).

   b. Apply sparingly Isopropanol, so that the whole area to be cleaned is just moistened.

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The lens cleaning tissue must not float on the Isopropanol in any case.

    c.   Draw the lens cleaning tissue slowly and with constant speed to the side, so that no fluid will remain at the tear-off edge.

In order that the optics does not move, counter with a pair of tweezers.

8. Check, whether the optics are clean:

Most suitable is to hold the optics under a bright 50 W Halogen lamp or equivalent LED light. A black mat is helpful as contaminations are better visible then.

Inspection characteristics:

    a.   The optics is lintless and without dust particles.

    b.   There are no fingerprints on the optics.

    c.   If an optical coating is present, then this is undamaged.

    d.   The optically usable area does not show any visible damage like scratches and conchoidal fractures.

    e.   The optics edge does not show any conchoidal fractures.

    f.   The surface is free of oily or greasy residue.

    g.   The surface is free of streaks.

9. If there is dirt on the surface, that can be removed

- AND -

if you have not cleaned the optics at least 2 times with Isopropanol

then clean the optics with a fresh lens cleaning tissue and Isopropanol once again, as described above

else continue to the next step.

10. If there is still dirt on the surface, that can be removed

- AND -

if you have already cleaned the optics at least 3 times with Isopropanol

then clean the optics with a fresh lens cleaning tissue and Acetone once again.

7.2.3 Cleaning the fiber heads

Tools and utilities

Description	Details
Isopropanol	Purity grade min. 99,8 % (cosmetically pure)
Acetone Ph. Eur./USP	Purity grade min. 99,8 %
Whatman lens cleaning tissues 100 mm × 150 mm	n/a
Pressurized air 400ML; volume: 0.4 l; EAD 400D	n/a
Cotton swabs; single sided; with PP handle	n/a
Cotton or nylon gloves	Dry, free of dust and grease, lintless
A pair of tweezers	n/a
Bright 50 W Halogen lamp or equivalent LED light	n/a
Black mat	n/a
Fiber microscope, e. g. by IPG Photonics	

ℹ️ Notes

- Use only tools listed here.

- Clean the fiber heads only the way described here.

- Always wear cotton gloves when cleaning optics.
  Do not touch the optical surface with bare hands.

- Use each lens cleaning tissue and cotton swab only once.

- Touch only places of lens cleaning tissues and cotton swabs that are not used for cleaning the optics.
  Dirty lens cleaning tissues and cotton swabs may damage optics.

⚠️ Caution

Dirty or damaged fiber heads

Damage of fiber and / or laser possible

Procedure

- Check the fiber heads for dust and dirt before connecting to the laser or scan head.

- Clean the fiber heads and fiber couplings thoroughly.

- Pay attention not to exceed the fiber's minimal bending radius.

Procedure

1.

   ### ⚠️ Caution

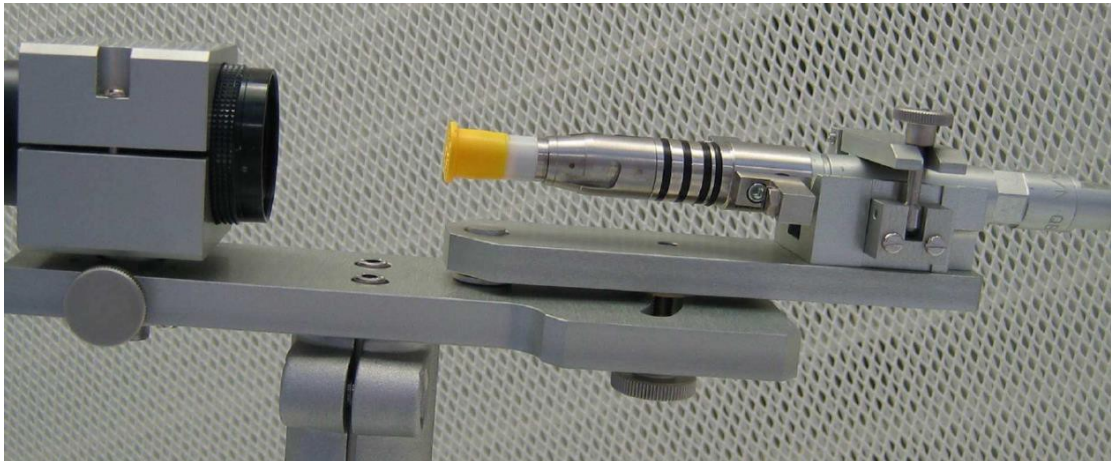   Visible and/or invisible laser radiation

   Blindness, burns

   Procedure

   - Switch off the laser

2. Fix the fiber coupling to the fiber microscope.

   The figure shows the fiber microscope's objective (black) on the left and on the right a fiber head with protection cap (yellow).

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3. Remove the protection cap.

ℹ️ **Note**

Always put the protection cap with its opening down on a flat clean surface, in order to avoid deposition of dust and dirt inside the protection cap.

4. Focus the microscope on the fiber head surface.

5. Look at the surface in a small angle in order to improve visibility.

6. Add a light source in a way that the light is reflected by the fiber head surface into the microscope.

7. Check the surface thoroughly.

8. If the fiber head is dirty, then blow the dust away with pressurized air from the side.

9. If the surface is clean, then end cleaning.

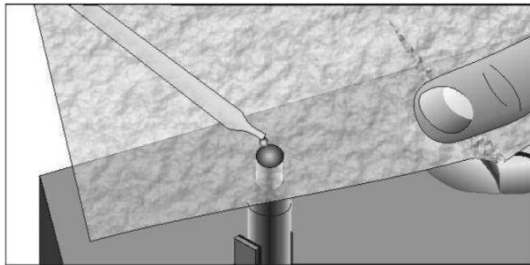10. Wet cleaning:

   a. Get fresh lens cleaning tissue.

   > ⚠️ **Caution**
   >
   > Dirty lens cleaning tissue
   >
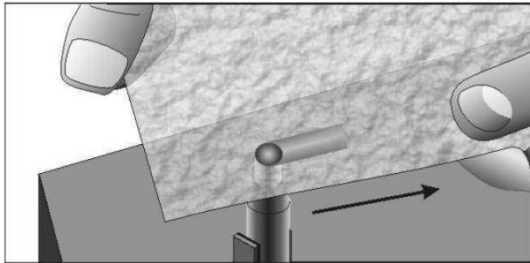   > Damage of fiber and / or laser possible
   >
   > **Procedure**
   >
   > - Touch the fiber head only with places on the lens cleaning tissue; you have not touched with bare hands.

   b. Apply a drop of Isopropanol to the lens cleaning tissue.

   c. Draw the wet spot sideways over the surface until the fiber head is dry.

   d. If the surface is clean, then end cleaning.

   e. Get a fresh cotton swab.

   > ⚠️ **Caution**
   >
   > Dirty cotton swabs
   >
   > Damage of fiber and / or laser possible
   >
   > **Procedure**
   >
   > - Touch only the cotton swab handle.

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  f. Apply Isopropanol to the cotton ball.

  g. Gently wipe the fiber head with the cotton ball in circular moves.

  h. If the surface is clean, then end cleaning.

11. Repeat wet cleaning with Acetone instead of Isopropanol.

12. Repeat wet cleaning with Isopropanol.

13. Clean the protection cap.

14. Plug the protection cap on the fiber head.

8 Repair

This chapter describes all measures required for re-establishing the functional capability of the system. The repair documentation specifies how the cause for a system failure can be discovered and how the discovered malfunction can be repaired afterwards.

This chapter addresses persons executing repairs.

ℹ️ Note

Only qualified personnel with electro-technical or mechatronic profession or personnel trained in handling highly sensitive electronic and optical equipment is allowed to repair the system.

8.1   Diagnosis instructions

This section describes how the reasons for a system failure can be determined and analyzed. The use of the measuring and test equipment required for the diagnosis will be explained.

8.1.1   Reading the status-LEDs at the scan head

ℹ️ Note

At some scan head models the status-LEDs are not visible.

Some fundamental errors can be identified directly via the status-LEDs at the scan head. These errors are listed in the following table.

As diagnostics grew over the years many errors can only be identified via a detailed status report. Read about how to get a status report from the scan head in subsection 8.1.2.
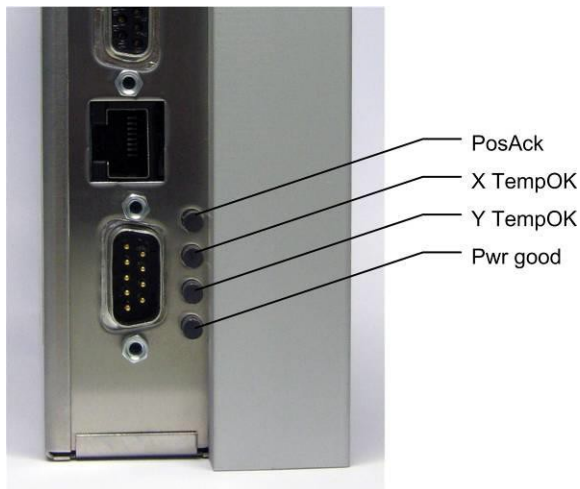
Figure 1: LEDs at the scan head near the DC INPUT interface

Table 1 to Figure 1: Meaning of the LEDs

LED name	LED state	Description	Measures

0 to 1 seconds after switching on:

LED name	LED state	Description	Measures
PosAck	Green	The boot loader is active.	None
X TempOK	Green		
Y TempOK	Green		
Pwr good	Green		None

1 to 6 seconds after switching on:

LED name	LED state	Description	Measures
PosAck	Off	The scan head performs a self-test.	If the self-test fails, then replace the system.
X TempOK	Off		
Y TempOK	Off		
Pwr good	Green/red flashing		

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LED name	LED state	Description	Measures

During operation:

LED name	LED state	Description	Measures
PosAck	Off	If the LED stays off then this may indicate a blown fuse on the amplifier.	Replace the system.
	Green	X- and Y-mirror are within the tolerance at the given position. The LEDs are updated with a frequency of 16 Hz and may be off for short periods. This is normal, while the mirrors are moving.	None
	Yellow	For several microseconds X- and/or Y-mirror are not at the given position. This is normal, while the mirrors are moving.	None
X TempOK and Y TempOK	Off	There is no galvanometer with heater connected or the temperature sensor circuit is open. The heater is switched off.	None
	Green	The heater is switched on. Temperature is within tolerance.	None
	Yellow	The temperature is out of tolerance, but the system is still in the heat-up phase.	None

LED name	LED state	Description	Measures
	Red	The temperature is out of tolerance, even though the heat-up phase is completed.	Reduce speed and amplitude of the mirror movement. - OR - Reduce the environmental temperature. Wait until the system cools down. If the LED is still illuminated red, then replace the system.
	Red flashing	The LED flashes with ca. 2 Hz. The heater was switched off, as the allowed temperature of max. 60°C was exceeded. The galvanometer amplifier is switched off. Possible reasons:	--
		The scan head was operated with high speed and amplitude for a longer period.	Reduce speed and amplitude of the mirror movement. - OR - Reduce the environmental temperature. Wait until the system cools down. If the LED is still illuminated red, then replace the system.
		An oscillating amplifier causes galvanometer overheating. This occurs often at only one galvanometer.	Replace the system.

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LED name	LED state	Description	Measures
		If one LED flashes and both galvanometers feel cool, then the temperature sensor cable is shorted.	Replace the system.
		If both LEDs flash and both galvanometers feel cool, then the reference voltage of 2.5 V is missing.	Replace the system.
Pwr good	Green	All external and internal supply voltages are within tolerance.	None
	Yellow	One or both optional fans do not feedback the speed signal, but the housing temperature is still within tolerance.	Replace the system at the next possible opportunity
	Red	One or more supply voltages are out of tolerance. The galvanometer amplifiers are switched off.	If the external supply voltage is within tolerance, then replace the system else rectify the fault.
	Red flashing	The LED flashes with ca. 2 Hz. In the housing or at the galvanometers the allowed max temperature was exceeded. The galvanometer amplifiers are switched off.	Reduce speed and amplitude of the mirror movement. - OR - Reduce the environmental temperature. Wait until the system cools down. If the LED is still illuminated red, then replace the system.

8.1.2　Getting a status report from the scan head

The DC INPUT interface at the scan head can also be used as diagnostic interface.

ℹ️ **Note**

Use the diagnostic interface only if instructed by ARGES to do so.

For that purpose, you have to establish a 3-wire connection between the DC INPUT interface at the scan head and one of the COM interfaces of your PC.

Procedure

1. Build a diagnosis cable.

   Later on by this cable you will connect simultaneously the power supply and the PC's COM interface to the DC INPUT interface at the scan head; see following figure.
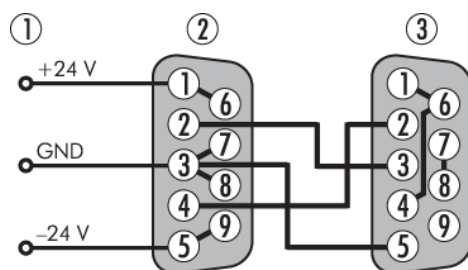
   ⚠️ **Caution**

   Short-circuit

   Damage of scan head electronics and PC electronics

   Procedure

   - Isolate soldering joints with heat shrink tube.
   - Test the diagnostic cable thoroughly.

(1) connect to power supply
(2) connect to DC INPUT interface
(3) connect to COM1 or COM2 interface at the PC

2. Switch off the scan head.

3. Connect the diagnosis cable.

4. Switch on the PC.

5. At the PC start the *HyperTerminal* application.

6. Create a connection via COM1 or COM2 to the scan head.

Use these settings:
Bits per second: 57600
Data bits: 8
Parity: None
Stop bits: 1
Flow control: None

7. In the menu of the *HyperTerminal* application, click **Transfer ➔ Capture Text**.

8. Switch on the scan head.

   You will get a status report like the following one.

   ```
   ### AC2-24  Release V 4.30.1489 2014-06-27_16:12CFG: 0
   ATmega128 running at....: 16.0 MHz
   Flash checksum .........: OK
   EEPROM checksum ........: OK
   etc.
   ```

9. Send the status report for analysis to ARGES.

8.2   Repair instructions

This section describes the execution of individual repair procedures in repeatable steps. The use of the measuring and test equipment and required tools will be explained.

ℹ️ Note

The system contains no user serviceable parts.

You are not authorized to repair the system.

Attempts to repair the system

- – may be dangerous
- – void warranty
- – may infringe patents

The repair instructions for this system are limited to replacement of the defective system by a new fully functional; see also 9.

Procedure

1. Decommission the defective system, as described in section 5.6.

2. Install the new system, as described in chapter 5.

9 Spare parts list

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

Figure	Description	Order number
	Ethernet cable, CAT5, 5 m	419-1007990-00
	Scan head power cable, 3W3 connector (A1 jack, A2 pin, A3 pin) to female 9-pin D-Sub connector, 5 m	419-1008696-00
	HP-2 power supply	409-1009202-00
Figure not available	F-Theta objective with adapter ring and protective glass when indicated	on request
Figure not available	Protective glass for scan head without F-Theta objective	on request

10 Abbreviations

Abbreviation	Explanation
ASC	A controller-model
BMC	Biphasic Mark Code
HP2	A power supply for a scan head
HSSI	High Speed Serial Interface
LGAC	Laser Generated Air Contaminants
LSB	Least Significant Bit
MSB	Most Significant Bit
NCC	A controller-model
SC	A controller-model
WD	Working Distance
ZR	Z Range ()

11 References

ID	Reference
[ASC]	Operator Manual - ARGES System Controller; file: ASC_controller_manual_en.pdf
[InScript]	Interface Description - InScript Software - Graphical User Interface; file: InScript_software_manual_en.pdf
[InScriptInstall]	InScript Software - Installation, Commissioning, Updating, Uninstallation; file: InScript_software_installation_en.pdf
[NCC]	Manual - NCC System Controller; file: NCC_controller_manual_en.pdf
[Specifications]	Technical specifications of scan heads; file: scan_head_data_sheet_en.pdf