COMPex 4.0

Sections of Instruction Manual with Pre-Installation Information

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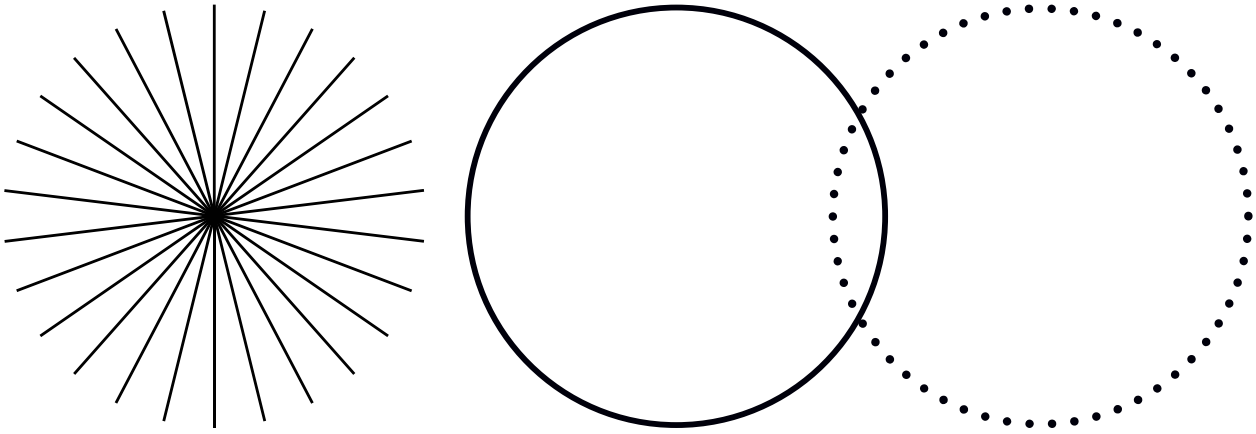

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COHERENT

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Dear Customer,

This document provides advance information that may be required by you to evaluate the requirements for an installation of the Coherent laser product indicated on the cover sheet. It is an excerpt from the Instruction Manual that is supplied with the completion of a system order or, at the latest, with the shipment of the laser product.

Permission is limited to use of this document, i.e. the aforementioned excerpt from the Instruction Manual. This excerpt from the Instruction Manual must be used in its entirety. Note that this document may contain references to other sections of the Instruction Manual that will only become available after ordering or shipment of the laser product.

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Thank you,

Coherent Documentation Department

2 SAFETY

Never switch on or attempt to operate, maintain or service the COMPex laser device before reading, understanding and fully familiarizing yourself with the content of this section.

This section is divided into three sections:

– General Safety Aspects (Section 2.1 on page 23), which explains aspects relating to the safe handling of the laser device

– Special Safety Aspects (Section 2.2 on page 30), which outlines the specific hazards when working with and on the laser device and describes the safety measures that minimize these hazards

– Overview of safety-relevant labels (Section 2.3 on page 59)

2.1 General Safety Aspects

2.1.1 Safety Compliance

The COMPex laser device has been designed and tested to comply with the directives and standards that are indicated on the Declaration of Conformity certificate provided with this manual.

To legally enter the USA, a laser product must have been registered by the FDA (Food and Drug Administration). The accession number for the COMPex laser device is

– COMPex 50/100/200 Series: 7810443-054

– COMPex F2: 7810443-057

2.1.2 Designated Use

The COMPex laser device has been built in accordance with state-of-the-art standards and recognized safety rules. Nevertheless, its use may constitute a risk to life and limb of the user or of third parties or cause damage to other material property. The specific hazards resulting from the use of the laser device are described in Section 2.2 on page 30.

The laser device shall only be used in technically perfect condition and in accordance with its designated use and the instructions set out in this manual, and only by safety conscious persons who are fully aware of the risks involved in operating the laser device. Any functional disorders, especially those affecting the safety of the laser device, should therefore be rectified immediately.

The expected lifetime of the COMPex laser device is estimated (see Section 9.1 on page 393). This estimation is based on the assumption that the COMPex laser device is operated under the specified environmental conditions, is used according to its designated purpose, and all maintenance, service and repair work is performed according to Coherent requirements. Whereby such work may be scheduled or unscheduled, and be carried out at the customer's expense or under the terms of the warranty. In all cases, original Coherent spare parts or parts that have been officially authorized by Coherent shall be used. Please, refer to the corresponding sections in this Instruction Manual as well as other relevant sales and service documents for further information. Note that in the case that an external supplier discontinues a part of the COMPex laser device that is needed as a spare part or consumable, the actual lifetime of the COMPex laser device may be reduced so that it becomes shorter than the expected lifetime.

The COMPex laser device is a UV laser light source that is primarily designed for use in medium duty-cycle industrial and high-end scientific applications such as pulsed-laser deposition (PLD), precise material processing and solid sampling for material research. It is solely intended for professional use and is not intended for sale to the general public. Using the laser device for purposes other than those mentioned above is considered contrary to its designated use. The manufacturer/supplier cannot be held liable for any damage resulting from such use. The risk of such misuse lies entirely with the user.

Operating the laser device within the limits of its designated use also involves observing the instructions set out in this manual and complying with the inspection and maintenance directives.

Any unauthorized modifications to the laser device principally results in the loss of liability from Coherent concerning all subsequent damage that may occur.

2.1.3 Organizational Requirements

In accordance with the valid national regulations for prevention of accidents (in USA: ANSI Z 136.1, in Germany: DGUV Vorschrift 11) a responsible person should be designated as the Laser Safety Officer (LSO) with the responsibility to effect the knowledgeable evaluation of laser hazards and to monitor and enforce their control.

The specific hazards that are present during the installation, operation, maintenance set-up and servicing of an excimer laser device (see Section 2.2 on page 30) should be addressed by a locally applicable risk management plan in which the respective personal responsibilities are clearly indicated.

This Instruction Manual must always be at hand at the place of use of the laser device.

In addition to the instructions in this manual, observe and instruct the user in all generally applicable legal and other mandatory regulations relevant to accident prevention and environmental protection. These compulsory regulations may also deal with the handling of hazardous substances, the issuing and/or wearing of personal protective equipment and waste management.

All persons that work on the laser device must have read this Instruction Manual and in particular the safety instructions before beginning work. Reading the instructions after work has begun is too late. The need to read this Instruction Manual also applies to persons that only occasionally work on the laser device, e.g. during setting up, service or maintenance.

Use appropriate personal protective equipment (PPE), e.g. protective eyewear, wherever required by the circumstances or by law.

Ensure that all safety-relevant labels are attached to the laser device in accordance with the label location diagrams in Section 2.3 on page 59. Make sure that these labels are always complete and perfectly legible. If any labels are missing, immediately inform Coherent.

Never make any modifications, additions or conversions which might affect safety without the manufacturer’s approval. This also applies to the installation and adjustment of additional safety equipment.

Never modify the software of programmable control systems.

To ensure safe operation of the laser device only ever use original Coherent spare parts.

Adhere to prescribed intervals or those specified in the manual for routine checks and inspections.

For the execution of maintenance work, always use tools and equipment that are suitable for the specific task.

All interlock defeat keys provided with the laser device must be assigned to a responsible person, personalized and locked away. Only specifically trained and authorized persons that are fully aware of the hazards relating to their use shall have access to interlock defeat keys.

2.1.4 Selection and Qualification of Personnel

Make sure that only authorized persons work on or with the laser device. Statutory minimum age limits must be observed.

Employ only trained or specifically instructed staff and set out clearly the individual responsibilities of each person regarding operation, set-up, maintenance and repair.

Do not allow persons that are being trained or instructed to work on or with the laser device unless they are being permanently supervised by an experienced person.

Work on electrical components and systems shall only be carried out by an authorized and electrically skilled technician in accordance with electrical engineering rules and regulations. This also applies to any measurement of electrical quantities.

Work on gas fueled equipment shall only be carried out by specially trained and instructed personnel.

All installation, de-installation and servicing work as well as detailed troubleshooting shall only be performed by correspondingly trained and instructed personnel. These persons are skilled specialists that have successfully completed the appropriate Coherent advanced training course for COMPex excimer laser devices.

2.1.5 Specific Operational Phases

Take the necessary precautions to ensure that the laser device is only used when in a safe and reliable state.

Before starting up the laser device ensure that nobody is at risk.

Only operate the laser device if all protective and safety oriented devices, such as removable safety devices, emergency shut off equipment and exhausters, are in place and fully functional.

To prevent injury or serious material damage in case of emergencies, immediately switch off the laser device with an Emergency Off (EMO) switch. After use of the EMO switch, always contact appropriate safety or maintenance personnel (e.g. laser safety officer) before restarting the laser device.

In the event of malfunctions or changes in the operating behavior, immediately switch off and lock out the laser device’s main switch, and report the event to the competent authority or person (e.g. Coherent Service). Ensure that any defects are rectified immediately.

Never switch off or remove suction and ventilation devices when the laser device is in operation.

Observe the adjustment, maintenance and inspection activities and intervals set out in this Instruction Manual including information on the replacement of parts and equipment. These activities shall only be carried out by authorized and correspondingly trained persons.

Brief operating personnel before beginning special operations and maintenance work, and appoint a person to supervise the activities.

Regardless of the work that is to be performed on or with the laser device (e.g. operation, set-up, adjustment, maintenance, inspection, service and repair), always observe the start-up and shut-down procedures set out in this Instruction Manual as well as the information on maintenance activities.

Ensure that the maintenance area is adequately secured before employees perform any servicing or maintenance. The laser device is to be stopped, isolated from all potentially hazardous energy sources and locked out and/or tagged out where the unexpected energization or start-up of the laser device or release of stored energy could cause injury.

Always tighten any screwed connections that have been loosened during maintenance and repair. Any safety devices removed for set up, maintenance or repair purposes must be refitted and checked immediately upon completion of the maintenance and repair work.

The used laser device as well as certain components, such as the laser tube, inherently contain hazardous and toxic substances. In particular, the laser tube shall never be opened or disassembled in the field. This item can be returned to Coherent for reconditioning or recycling.

Ensure that the laser device itself as well as all consumables and replacement parts are disposed of safely, with minimum environmental impact and in accordance with the valid national and local regulations for waste disposal. For further information about the disposal of the laser device and specific components, contact Coherent.

2.1.6 Laser Safety Classification

IEC-60825-1, FDA 21 CFR 1040.10 and 1040.11 and ANSI Z-136.1 indicate the requirements and procedures that are to be followed to ensure the safe use of laser products. These standards and regulations classify each laser product according to the potential hazards arising in its use. In each case, the laser class indicates the accessible emission limit (AEL), i.e. the maximum emission level that humans can access.

The lowest laser class is Class 1 and the highest is Class 4.

– Class 1 laser products are laser products that are safe under reasonably foreseeable conditions of operation.

– Class 4 laser products are laser products that permit human access to emission levels that represent an acute hazard to the eyes and skin from direct and scattered radiation.

Within this classification, the COMPex, as a stand-alone laser device, is a Class 4 laser product. It must, consequently, be regarded as a potential hazard to the human operator. Each laser beam must also be regarded as a potential fire hazard.

When a Class 4 laser device is integrated in a laser product that has been designed and engineered to prevent human access to laser emission exceeding Class 1 levels during normal operation, the laser product can be classified as a Class 1 laser product. Such a Class 1 laser product must have a protective housing and safety interlocks on all removable housing access panels. Laser operation shall only be possible when all access panels are in place and human access to hazardous levels of laser radiation (including scattered laser radiation) is prevented.

Wherever technically feasible, the product or system into which the laser device is integrated should be designed and engineered as a Class 1 laser product. Nevertheless, the high power laser device incorporated in such a laser product remains a Class 4 laser product. If access panels are removed and safety interlocks defeated (e.g. to perform servicing, adjustment or alignment work), there is the risk of exposure to Class 4 laser radiation.

The laser safety classification of the laser product into which the COMPex laser device is integrated is to be indicated by the laser product manufacturer (system integrator). For further information, refer to the system integrator’s documentation.

To assist with the alignment of the beam path, the laser device may be equipped with a Class 2 (IEC 60825-1) alignment laser. These are low power products (max. 1 mW) that emit laser radiation in the visible wavelength range from 400 nm to 700 nm. Nevertheless, do not stare directly into the beam. Staring directly into the beam or the reflected beam can cause permanent eye damage.

2.1.7 Gas Hazard Communication

The EU regulation EC 1272/2008 provides the criteria for the classification of substances and mixtures, and the rules on labeling for hazardous substances and mixtures. Of the health hazards that are addressed in this regulation, the acute inhalation toxicity of gas mixtures containing halogen gas are of the greatest relevance to operators of excimer lasers. Depending on the type and concentration of the halogen gas, the gas mixture in an excimer laser is classified as being either toxic if inhaled or harmful if inhaled according to EC 1272/2008, annex 1, part 3.1 (acute toxicity).

The label elements specified in EC 1272/2008, annex 1, part 3.1.4.1 that apply for the individual excimer laser gas mixtures that are typically used with COMPex excimer laser devices are indicated in the following table:

Gas Mixture	Classification of Acute Toxicity (EC 1272/2008)	Hazard Statement	Typical Concentration in
5% F_2	Category 3	Toxic if inhaled	Halogen gas cylinder / supply line COMPex F-version
4.5% HCl	Category 4	Harmful if inhaled	Halogen gas cylinder / supply line COMPex XeCl-version
Less than 0.4% F_2	Not categorized	Harmful if inhaled	Laser tube COMPex F-version
Less than 1% HCl	Not categorized	Harmful if inhaled	Laser tube COMPex XeCl-version

In the above table, gas mixtures are denoted as being “not categorized” according to the classification in EC 1272/2008 when the acute inhalation toxicity is less harmful than that of a category 4 gas mixture. As EC 1272/2008 does not provide standardized label elements in such cases, Coherent uses the label elements of category 4 gas mixtures to alert the user to the inherent inhalation toxicity of such non-categorized gas mixtures.

Label elements that indicate the risk of exposure to a category 3 gas mixture will always be used when the design of the laser device enables the use of a category 3 gas mixture. This is also the case even if the software settings at shipment are such that the laser device operates with a category 4 gas mixture.

2.2 Specific Safety Aspects

2.2.1 Physical Hazards

This section describes the main hazards that are inherent to the Class 4 excimer laser device. When the hazard is only present during particular operational phases, this will be indicated in the respective description.

2.2.1.1 Laser Radiation

The COMPex as a stand-alone laser device is classified as a Class 4 laser product. Class 4 is the most powerful (and potentially hazardous) category of laser products (see Section 2.1.6 on page 28).

In most cases, the radiation of an excimer laser is within the ultra-violet spectrum and invisible. When operating the COMPex F2 laser device at 157 nm, the radiation is within the vacuum ultraviolet (VUV) spectrum and additionally emits visible light.

Laser radiation is emitted as a narrow beam of almost parallel rays, the intensity of which will remain high even at some distance of the laser.

Although excimer laser radiation is nonionizing, damage can still occur to living tissue, if exposed for too long, as a result of heat produced during radiation absorption.

Direct and scattered radiation from a Class 4 laser is to be considered as an acute hazard to the eyes and skin. In general, the maximum permissible radiation exposure for the skin is several times greater than for the eye. Safety measures with regard to the radiation hazard are, therefore, mainly based on dangers for the eye. Nevertheless, chronic skin exposure may have long-term adverse health effects which are not fully understood at the time.

A potential chemical hazard originates from interaction between the laser beam and an obstruction. The high irradiance could result in the liberation of hazardous fumes, gases, dusts and aerosols. In addition, the heat generated is sufficient to ignite many materials.

Not only is the direct laser beam hazardous, but uncontrolled reflections of laser light also constitute a potential hazard. This risk is excluded when the laser beam is contained within a protective enclosure. However, when personnel are working in an open beam situation (e.g. during maintenance or service actions), protective measures must be taken.

2.2.1.2 Fire

The high output power Class 4 laser device is a potential source of ignition for a wide range of materials. The intense beam of the laser can directly ignite combustible materials (e.g. paper, wood, cloth) or vapors from many fluids and solvents (e.g. cleaning agents used for maintenance).

Never use the laser device in potentially explosive atmospheres as it contains components that do not conform to the European Union directive 2014/34/EU (equipment and protective systems intended for use in potentially explosive atmospheres).

In case of fire in the area of the laser device, fire fighters have to take into account the secondary hazard of halogen gases described in Section 2.2.1.4 on page 31.

2.2.1.3 High Voltage / Electric Energy

High voltages within the laser device that exceed the Safety Extra Low Voltage levels (SELV) of 42 V AC or 60 V DC introduce the potential hazard of electric shock and might cause serious injury by passing electricity through the body.

The equipment is provided with a protective housing. Therefore, accidental contact with current-carrying conductors during normal operation is impossible. However, if an appropriate protective cover is removed, potentially lethal hazards exist when the housing interlocks are defeated. There is also the risk of contact with residual voltages during servicing when the protective cover is removed.

2.2.1.4 Halogen Gas and Gaseous Halogen Compounds

The gas system of an excimer laser device is supplied with a halogen gas mixture that contains fluorine or hydrogen chloride (depending on the wavelength of the laser, see Section 9.2 on page 393 for exact specifications). This is further diluted with other gases in the laser. However, halogen gas is still present in sufficient quantities in the gas supply to cause serious injury in case of leaks or if not correctly handled and used. For further information about the classification of the gas mixture in the laser device, refer to Section 2.1.7 on page 29.

Fluorine and hydrogen chloride are characterized by an extremely stinging odor in very low concentrations. They are extremely reactive and highly toxic gases which can cause severe chemical and thermal burns and, in sufficient concentrations, can cause death due to respiratory damage and pulmonary edema.

The workplace concentration of halogen gas shall, therefore, never exceed the maximum permissible occupational exposure limit (OEL). This limit is defined by the administration responsible for occupational safety and health at the installation site. For example, in the United States, this limit is the general industry permissible exposure limit (PEL) set by the U.S. Department of Labor Occupational Safety and Health Administration (OSHA).

Refer to documents such as the gas supplier's Material Safety Data Sheet (MSDS) or the International Chemical Safety Card (ICSC) for the respective halogen gas (available from the International Labour Organization, ILO) for more precise health hazard information. Make sure that applicable legal limits for personal exposure to halogen gas are never exceeded. Consult the locally responsible occupational safety and health administration for further information.

The possibility of over-pressure of the gas mixture containing halogen creates potential hazards with the risk of leakage from the laser tube and gas pipes. In the event of a leak occurring, the release of halogen gas constitutes the greatest hazard.

The worst-case accidental release scenario is the sudden release of the complete contents of the halogen gas cylinder (the exact halogen concentration is indicated in Section 9.3 on page 399). The risk of exposure to a leaking halogen gas mixture in the area of the laser device increases when the housing covers are removed and/or the exhaust is disabled.

Further potential chemical hazards exist due to the formation of hydrofluoric acid or hydrochloric acid if the halogen gas comes into contact with water. Make sure that fire fighters are aware of this additional hazard when fighting fires involving halogen gases.

Hydrofluoric acid (in the form of KHF_2) or hydrochloric acid can also be formed in the halogen filter used in the system due to the appropriate halogen gas coming into contact with the hygroscopic components of the filter.

2.2.1.5 Ozone

The formation of ozone due to the interaction of the ultra-violet light with oxygen constitutes a potential hazard when operating the laser at wavelengths shorter than approx. 240 nm (i.e. 193 nm). Ozone is a colorless to bluish gas with a very pungent odor. Exposure to ozone can cause irritation to the eyes and respiratory tract, asthmatic reactions, impaired vigilance and performance and can even result in pulmonary edema.

The workplace concentration of ozone shall, therefore, never exceed the maximum permissible occupational exposure limit (OEL) defined by the administration responsible for occupational safety and health at the installation site. For example, in the United States, this limit is the general industry permissible exposure limit (PEL) set by the U.S. Department of Labor Occupational Safety and Health Administration (OSHA).

Refer to the International Chemical Safety Card (ICSC) for Ozone (available from the International Labour Organization, ILO) for more precise health hazard information. Make sure that applicable legal limits for personal exposure to ozone are never exceeded. Consult the locally responsible occupational safety and health administration for further information.

2.2.1.6 Asphyxiant Gases

Apart from the halogen gas described in Section 2.2.1.4 on page 31, the excimer laser gas consists of a mixture of simple asphyxiant gases. A large proportion of neon and small proportion of other gases is mixed with either argon, krypton or xenon (depending on the wavelength of the laser, see Section 9.3 on page 399 for exact specifications). In addition, the laser tube is filled with helium during certain maintenance actions and neon for transport. Nitrogen is used to purge the beam path.

The asphyxiant gases that are used with the excimer laser device are non-toxic gases that reduce or displace the normal oxygen concentration in breathing air. Breathing of oxygen-depleted air can cause unconsciousness or death by asphyxiation (suffocation). As asphyxiant gases are relatively inert, colorless and odorless, persons may not realize that they are in danger until it is too late.

The risk of exposure to the asphyxiant gas hazard is at its highest in case of a leakage or escape of gas in a confined space. This scenario will rapidly decrease the concentration of oxygen in the air.

Nitrogen represents a particular hazard as it produces an oxygen-deficient environment close to the ground. Consequently if a person becomes unconscious and falls to the ground their condition will rapidly worsen.

Refer to documents such as the gas supplier’s Material Safety Data Sheet (MSDS) or the International Chemical Safety Card (ICSC) for the respective asphyxiant gas (available from the International Labour Organization, ILO) for more precise health hazard information. Ensure that there is adequate ventilation in the area of the laser device.

2.2.1.7 Over-Pressure

According to the definition contained in the European directive for pressure equipment (2014/68/EU), the laser tube in the COMPex laser device is a pressure vessel. The laser tube is supplied with the required operating gases from an external gas supply system that also operates with over-pressure. Internal pressure monitoring devices prevent malfunctions during normal operation. In case of emergencies, a rupture disk prevents bursting of the pressure vessel. Nevertheless, the potential hazard of a sudden release of pressure exists during maintenance and servicing operations as well as when installing or de-installing the laser device.

To ensure conformity with 2014/68/EU, the gas mixture in the laser tube has to be classified as being within the limits for fluids in Group 2. This means that the halogen concentration of the gas mixture in the laser tube shall be such that it remains within the threshold where the gas can be classified as being harmful (see Section 2.1.7 on page 29). In cases where a gas mixture that is classified as toxic is connected to the laser device, the laser device manufacturer shall provide safety accessories that protect the pressure equipment against the allowable limits being exceeded.

Also take into account that the operating gases are commonly shipped and stored in compressed gas cylinders. These can be extremely hazardous if misused. In addition to the chemical hazard of the cylinder contents (for example, halogen gas mixture), there is also the hazard associated with the high pressure inside the cylinder. For further information, refer to gas supplier's Material Safety Data Sheet (MSDS).

2.2.1.8 Cooling Water

All COMPex laser devices are fitted with cooling water connections (see Section 8.2.5 on page 365). Consequently, in case of a water leak, all equipment installed in the area of the laser device should be protected against the ingression of water. This particularly applies to equipment installed immediately below the laser device.

2.2.1.9 Tipping, Crushing and Pinching

The weight of the laser device and its submodules creates a crushing hazard during transport, installation and servicing. The laser device has a high center of gravity (see Section 9.9.1 on page 420). During the exchange of heavy modules, such as the laser tube, there is an increased risk of the laser device tipping. When the laser tube has been removed, the laser device housing may slip out of position.

The risk of the laser device tipping or crushing will be significantly increased by a seismic event. Consequently, particular protective measures are required when the laser device is to be operated in an area that is susceptible to seismic activity.

A pinching hazard exists when closing the access covers or during module exchange procedures.

2.2.1.10 Noise

Under normal operating conditions with the laser device housing closed, noise levels remain below 80 dB(A).

When operating the laser device with the housing open (to perform certain servicing work), the noise exposure exceeds 80 dB(A) and, under certain circumstances, can exceed 85 dB(A).

Noise exposures that are loud enough and last long enough can cause noise-induced hearing loss (NIHL). NIHL is a permanent and irreversible condition resulting in a loss of hearing ability. An eight hour time-weighted average exposure to sound levels that equal or exceed 85 dB(A) is considered as critical. Further information about permissible noise exposures and necessary preventive measures is contained in directives, regulations and standards such as the EU Directive 2003/10/EC, OSHA 1910.95, EN 61010-1 and SEMI S2.

2.2.1.11 Electromagnetic Interference

The electrical circuits within the laser device are an inherent source of electromagnetic interference (EMI). Filters within the laser device as well as an EMI shielded housing provide electromagnetic compatibility according to EN 61000-6-4 during normal operation with all housing covers closed. In addition, the COMPex laser device was tested for exposure to low-frequency alternating magnetic fields and high-frequency electromagnetic fields, and according to the specifications of DGUV Regulation 15, no measures are required for employees without or with active and passive body aids with the laser device housing closed or open.

If the laser is operated with the housing covers removed, EMI is no longer contained within the housing. This can indirectly cause injury through the malfunctioning of devices in the area of the laser device. Should operation of the open laser device be necessary (e.g. for maintenance or servicing), always correspondingly inform and obtain permission from the person responsible for occupational safety and health at the installation location.

2.2.1.12 X-Radiation

The high voltage (HV) circuit uses a hydrogen thyratron as an active switch. This device inherently produces X-rays during operation. X-ray photons carry sufficient energy to ionize atoms and disrupt molecular bonds. A sufficient dosage of this type of ionizing radiation is harmful to living tissue and can increase the risk of radiation-induced cancer.

The thyratron is placed within the EMI shielded housing made of sheet steel panels. This housing also provides sufficient X-ray shielding. In addition the HV is limited to max. 30 kV. This voltage is equivalent to the max. voltage for acceleration of the electrons in the thyratron. Both measures ensure that the local dose rate at a distance of 0.1 m is less than 1 µSv/h. Consequently, according to the German X-Ray Ordinance (RöV §5) no special permit is required for operation of the COMPex laser device.

Further protection is provided by the fully-interlocked protective housing, which has to be closed during normal operating and routine maintenance procedures (see Section 2.2.4.7 on page 50).

2.2.2 Personal Protective Equipment

This section outlines personal protective equipment (PPE) that may be required during specific operational phases of a Class 4 excimer laser device or in case of an emergency. This includes the items listed below:

– Protective Eyewear (see Section 2.2.2.1 on page 37)
– Skin Protection (see Section 2.2.2.2 on page 38)
– Protective Gloves (see Section 2.2.2.2 on page 38)
– Dust Mask (see Section 2.2.2.3 on page 39)
– Hearing Protection (see Section 2.2.2.4 on page 39)

The indicated subsections provide information on the basis of the hazards inherent to Class 4 excimer laser devices and commonly applied risk management procedures. Exact PPE requirements depend on local regulations and the conditions under which the laser device is operated, maintained and serviced.

All persons that are required to use PPE should be instructed in the correct use of the equipment. Any necessary maintenance work and maintenance intervals must be observed to ensure that the equipment remains in a ready-to-use condition at all times. For further information, refer to the equipment suppliers' instructions.

2.2.2.1 Protective Eyewear

Laser Radiation

If work on open Class 4 laser equipment is necessary (e.g. alignment or servicing), everyone in the area of the laser shall be ordered to wear appropriate protective eyewear. The mandatory protective eyewear provides protection against direct radiation, reflected radiation and scattered radiation within the respective wavelength range.

NOTICE
COMPex F2 (157 nm) only: Special eye protection is necessary. When operating the COMPex F2 laser device at 157 nm an additional visible wavelength between 620 nm and 800 nm is emitted. This additional visible wavelength is approx. 5% of the output energy. Normally, maintenance procedures can be carried out with shielded and purged beam path or in OFF mode with service panel removed (interlock is triggered).

Contact a manufacturer of protective eyewear for information about appropriate eyewear. Specifications needed to select the appropriate protective eyewear are:

– Laser wavelength
– Laser power
– Beam size
– Repetition rate
– Max. pulse duration.

The laser radiation safety specifications are indicated in Section 9.2.1 on page 393 and on the warning label according to IEC 60825-1 that specifies the emitted laser radiation.

IEC 60825-1 stipulates that eye protection designed to provide adequate protection against the specific wavelength of the laser should be used in all hazard areas where Class 4 lasers are in use. The laser protective eyewear shall be clearly labeled (e.g. with the optical density and wavelength) to ensure the proper choice of eyewear with a particular laser. To avoid confusion, keep laser protective eyewear separate from other safety glasses and other personal protective equipment. ANSI Z136-1 suggests color coding or some other form of distinctive identification of laser protective eyewear for situations when rapid eyewear identification is required.

The filter in the protective eyewear only provides protection for a narrow band of wavelengths. Therefore, always make sure to wear the appropriate eyewear. Using the wrong type of eyewear is dangerous. It can be worse to have improper eyewear and a false sense of security than to have no eyewear and take precautions based on the absence of protection.

Halogen Gases

Gas suppliers also usually specify that suitable safety glasses should be worn when handling equipment containing halogen gases. Such safety glasses are to be made of chemical resistant materials that are suitable for impact or particle hazards. For further information consult the halogen gas supplier's Material Safety Data Sheet (MSDS).

2.2.2.2 Skin Protection / Protective Clothing

Laser Radiation

Although the skin can withstand a considerably higher radiation intensity than the eyes, tissue may be burned to a greater or lesser degree, depending on the radiation time and the irradiation intensity.

ANSI Z136-1 stipulates that when using excimer lasers operating in the ultraviolet range, the use of skin cover shall be employed if chronic (repeated) exposures are anticipated at exposure levels at or near the applicable maximum permissible occupational exposure limit (OEL) for the skin.

If there is the risk of harmful skin exposure, cover the skin e.g. by wearing suitable protective clothing and/or use "sun screen" creams. Most gloves will provide some protection against laser radiation. Tightly woven fabrics and opaque gloves provide the best protection. A laboratory jacket or coat can provide protection for the arms.

When choosing protective clothing, take into account that Class 4 lasers present a potential fire hazard. Protective clothing should, therefore, be made from materials that will not be ignited by the laser radiation.

Halogen Gases

Protective gloves are also required when exchanging halogen filters or when working on or with other equipment containing halogen gas. The type of gloves to be worn depends on the work to be performed and the gas mixture being used. Consult the appropriate Material Safety Data Sheet (MSDS) for more information. This MSDS will also specify any other protective clothing (e.g. chemical resistant aprons or suits) that should be worn when handling equipment containing halogen gas mixtures.

2.2.2.3 Dust Mask

The halogen filter in the laser device's vacuum line contains impregnated activated carbon. When the halogen filter is used or handled correctly, there is no risk of hazardous dust being released. In the unlikely event of dusts being released, a dust mask with a suitable filter should be worn.

For further information, consult the institute responsible for occupational safety and health at the installation location (for example, NIOSH, National Institute for Occupational Safety and Health, in the USA).

2.2.2.4 Hearing Protection

Individual hearing protectors (e.g. ear defenders) should be worn when performing servicing work that requires operation of the laser device with an open housing. Make sure that individual hearing protectors are available for all persons that are working in the area of the open laser device. The type of hearing protection to be chosen depends on the operating environment and local regulations.

Depending on the overall noise level in the area of the laser device, further protective measures may be necessary. For further information consult the applicable occupational noise exposure regulations and directives.

2.2.3 Safe Working Practices

This section describes how operators or users of the excimer laser device are to protect themselves against the inherent hazards. It contains behavior guidelines that minimize the risks relating to the physical hazards described in Section 2.2.1 on page 30.

2.2.3.1 Laser Radiation Safety Precautions

Particular attention is to be given to the following precautions when working on or with an open Class 4 laser:

- Only qualified personnel shall be permitted to operate the laser.
- Always switch off the laser before working on the beam delivery system. There is the risk of the loaded capacitors causing the spontaneous emission of a laser pulse (for approx. 15 seconds). Any residual risk is indicated by the laser radiation warning lamp remaining illuminated after switching off the laser.
- Report all incidents of exposure to laser radiation to your supervisor.
- Always wear appropriate laser protective eyewear and protect the skin against the effects of ultraviolet laser radiation.
- Even when wearing protective eyewear, never look directly into the beam; the intense laser radiation may destroy the protective filter.
- Avoid indirect viewing of direct or reflected laser radiation. Specular reflections (from reflective surfaces) can be as dangerous as the direct laser beam.
- Do not view the beam through optical instruments unless the optics are designed to filter the laser wavelength.
- Avoid contact between the skin and the beam or specular reflections of the beam. Reflections of the beam may be as dangerous as the beam itself.
- Ensure that there are no objects in the beam path that may cause uncontrolled reflection or scattering of the laser beam.
- Ensure that all personnel in the area observe proper safety precautions.
- Use lasers only in approved applications and locations. Take adequate precautions to prevent unauthorized personnel from entering the area where a Class 4 laser is operating.
- Ensure that all laser radiation warning devices (e.g. lamps) that are connected to the laser device are correctly working.
- Do not use lasers around untrained personnel who may injure themselves accidentally.
- Do not assume that the laser system is aligned. Misaligned optics can cause unintended exposure.
- Ensure that all measures to secure the work area of an open laser remain implemented even when laser operation has been switched to the OFF mode.
- Local and national regulations governing the safe use of lasers should be adhered to all times.

2.2.3.2 Fire Prevention

Observe the following instructions and precautions to minimize the fire hazard in the work area of the laser device:

- Always keep a fire extinguisher or provide an equivalent fire fighting system in the area of the laser device in case a fire occurs (see Section 2.2.5.4 on page 56).
- Flammable items must be isolated from the laser beam and from the laser system.
- There should be no paper (circuit diagrams, leaflets or even posters on the wall), curtains (unless coated with fire retardant), wooden panels or similar materials in the area of the open laser. These items can be easily set on fire by direct or reflected laser radiation.
- Never operate the laser device in a potentially explosive atmosphere.
- Take into account that many fluids and solvents (e.g. cleaning agents) are combustible. Vapors from these materials can be ignited by the intense beam of the laser. Prevent the laser beam from coming into contact with combustible materials.
- Move containers of flammable materials out of the area of the laser system and shield them from the beam with opaque materials. Under no circumstances should these solutions and vapors be placed in the beam path or near the laser system. Never use flammable fluids and solvents to clean the laser device.
- Only use beam stops made of non flammable materials (not asbestos!).

2.2.3.3 Electrical Safety Precautions

High voltages greater than mains voltage are generated within the laser device. Always act in accordance with the following precautions to prevent electric shocks when working on or with the laser device:

- Work on electrical components and systems shall only be carried out by an authorized and electrically skilled technician in accordance with electrical engineering rules and regulations.
- Local safety regulations must always be strictly complied with.
- Make sure that the laser device is always properly grounded.
- Connect the laser device to the overall system’s Emergency Off (EMO) circuit in such a way that the mains power to the laser device will be disconnected when the overall system’s EMO function is activated.

- Fault finding and troubleshooting in high voltage circuits shall only be performed by authorized persons that have received specific instruction at a Coherent training course.
- Never open any electrical module or disconnect any high voltage cables (e.g. cables connected to the HV power supply and gas purifier) unless the mains power cord has been disconnected and the high voltage capacitors are completely discharged.
- Take into account that capacitors may remain energized for at least 10 minutes after disconnecting the mains power.
- If the laser device is completely shut down for maintenance and repair work, it must be secured against accidental starting. Ensure that the electrical system is locked out and tagged out prior to servicing by locking the main switch and key switch of the laser device and tagging appropriate warning signs. Secure the complete work area with a safety chain and a warning sign in accordance with locally applicable safety regulations.
- Before starting any work, check the de-energized parts for the presence of power and ground or short circuit them in addition to insulating adjacent live parts and elements.
- Cut off the mains power to parts of the laser device on which inspection, maintenance and repair work is to be carried out.
- If work on or near any live conductor is necessary this shall only ever be carried out in the presence of a second person who can cut off the mains power in case of danger. Use insulated tools only.
- Only use original fuses with the specified current rating.
- Inspect and check the electrical equipment of the laser device at regular intervals. Defects such as loose connections or scorched cables must be rectified immediately. This is particularly important in the case of high voltage cables.
- Prevent the ingression of fluids or dust into the laser device. Note the IP rating indicated in Section 9.7.1 on page 413. Never soak the laser device or use spray bottles for cleaning.

2.2.3.4 Gas and Chemical Safety Precautions

The end user is responsible for providing an external gas installation that fulfills local gas safety regulations and the requirements of the locally applicable risk management plan.

The properties of compressed gases, such as pressure and diffusibility, make their handling hazardous. Laser gas mixtures invariably contain components which are corrosive, toxic or harmful and oxidizing. Therefore, extreme care must be taken when handling these mixtures.

As a general guide to safe working practices, observe the following precautions when working with gas equipment. Always follow these guidelines and take additional precautions as instructed.

- All persons that work on or with the laser device shall be familiar with the locally applicable risk management plan respecting the handling and accidental release of halogen gas mixtures.
- Whenever stipulated by local requirements, always install an appropriate halogen monitoring and leak alarm system in the area of the laser device and gas supply system. For further information, contact the gas supplier and locally responsible health and safety administration.
- Fluorine and hydrogen chloride have a pungent, irritating odor. When this odor is sensed or a halogen leak is suspected, always follow the locally applicable evacuation and containment plan.
- Ensure that there is no indication of a halogen gas leak inside the laser device before removing the housing covers and/or interrupting the exhaust flow. A possible indication of a leak is when the laser tube pressure is outside of the permitted range. Whenever a leak is suspected, always purge the gas lines and laser tube before opening the housing.
- Personnel should work in pairs and within sight and sound of each other, although not necessarily in the same work area. Only trained and competent personnel should be permitted to handle gas cylinders and pressure regulators.
- Always strictly obey local safety regulations concerning the emission of chemical vapors as well as the recommendations made in this section and throughout this manual.
- Any equipment that has contained halogen should be thoroughly purged with helium or argon and evacuated prior to opening.
- The necessary over-pressure of the gas mixture containing halogens increases the risk of a release of halogen gas due to a leak from the laser tube and/or gas pipes. The most vulnerable parts are the laser tube optics. Consequently, the equipment must be used in such a way that the beam exit is not directed at personnel.
- Avoid repeated bending and excessive vibration of gas piping and equipment.

- All areas containing pressurized halogen gas mixtures should be inspected for leaks periodically. In the event of a leak occurring, the release of halogen gas constitutes the greatest hazard.
- All leaks should be repaired immediately, but not while the system contains a halogen gas mixture.
- Adequate laser device ventilation is essential. Ensure that all ventilators in the area of the laser device are correctly operating.
- Always wear protective gloves and glasses when changing halogen filters as they are hygroscopic and contain oxidizing agents.
- In the event of impregnated activated carbon dust being released from the halogen filter always wear a dust mask with an appropriate filter.
- A needle valve or cut-off valve should be installed in the halogen gas line. The additional valve is to be located near the gas cylinder to protect the gas line and pressure regulator against corrosion and provide additional gas protection. Do not solely rely on the main gas cylinder valve to provide adequate protection.
- The pressure regulator, situated between the external gas cylinder and the laser device, should be checked regularly.
- Ozone is formed when operating the laser at wavelengths shorter than approx. 240 nm (i.e. 193 nm). This should be removed with a proper air exhaust and by purging the beam path with nitrogen or argon. In addition, ensure that the shielding of the external beam path will not allow ozone to escape into the adjacent work area.
- Interaction between the high irradiance of the laser beam and materials in the beam path could result in the liberation of hazardous fumes, gases, dusts and aerosols. The end user is responsible for performing a risk analysis of the laser machining process to determine if such hazardous by-products are produced. If this is the case, the end user is responsible for the provision of a suitable means of safely extracting hazardous by-products from the work area.

2.2.3.5 Pressure Equipment Safety

Observe the following pressure equipment safety precautions:

- The laser shall only be operated with the housing closed.
- In accordance with the European Pressure Equipment Directive (2014/68/EU), Coherent recommends that the laser tube is checked by a specialist every 5 years. Call Coherent Service for further information.
- Note the Declaration of Conformity to 2014/68/EU that is provided with the laser device as well as the corresponding labels attached to the laser tube.
- Never unscrew any component or cover attached to the laser tube or gas system before ensuring that the laser tube and/or gas system is adequately de-pressurized.

The system operator is responsible for ensuring that pressure equipment is safely handled and operated at the laser device's installation site.

2.2.4 Constructional Safety Features

This section summarizes the safety features incorporated in the design of the COMPex laser device to provide protection against the inherent hazards. These safety features are to be taken into account by the system integrator when planning the complete system. The section first describes safety features that provide protection against multiple hazards and then summarizes the features that are provided to minimize the risks relating to the specific hazards described in Section 2.2.1 on page 30.

When, respecting any of the features described in this section, the system integrator or operator has to take further action to minimize a remaining risk, this will be clearly indicated in the corresponding section.

2.2.4.1 Summary of Laser Radiation Safety Features

In accordance with IEC 60825-1, the COMPex laser device is equipped with a number of safety features that minimize the risk of human access to hazardous levels of laser radiation.

- Fully-interlocked protective housing (see Section 2.2.4.7 on page 50)
- REMOTE connector (see Section 2.2.4.8 on page 52)
- Key controlled laser device operation (see Section 2.2.4.9 on page 53)
- Laser radiation warning lights (see Section 2.2.4.10 on page 53) that illuminate when the laser can emit or is emitting radiation. Additionally, emission of radiation can be recognized by an inherent clicking noise, the frequency of which increases as the repetition rate increases.
- Emergency Stop circuit that immediately stops the emission of laser radiation in an emergency (see Section 2.2.4.12 on page 55)
- All versions except COMPex F2: Manually operated beam shutter (see Figure 3, A) enables the beam exit from the laser housing to be closed.

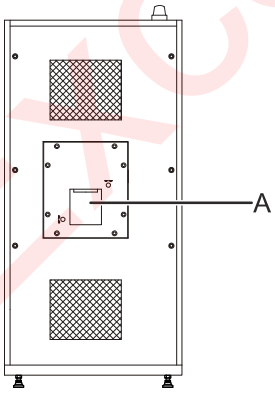


Figure 3: *Beam shutter*

- An optional handheld keypad that can be connected to one of the serial ports enables the laser device to be operated without exposure to Class 4 laser radiation. A laser radiation warning LED on the handheld keypad lights whenever the laser device can emit radiation.
- Laser radiation warning labels according to IEC 60825-1 are affixed to the housing and covers of the laser device (see Section 2.3.1 on page 59).
- The laser device has been designed to enable resonator alignment without exposure to excimer laser radiation.

2.2.4.2 Summary of Electrical Safety Features

The following safety features protect the user from the potentially lethal hazards associated with high voltage power sources:

- Fully-interlocked protective housing (see Section 2.2.4.7 on page 50)
- Emergency Stop circuit that immediately shuts down the HV power supply in an emergency (see Section 2.2.4.12 on page 55)
- REMOTE connector (see Section 2.2.4.8 on page 52) with EMS contacts enabling shut down of the high voltage power supply
- Main switch with fast acting magnetic circuit breakers, a lockable disconnect means and an Emergency Off function (see Section 2.2.4.9 on page 53)
- Key controlled laser device operation (see Section 2.2.4.9 on page 53)
- Mains voltage warning light (see Section 2.2.4.10 on page 53)
- Fully protected or grounded enclosures within the laser device prevent accidental contact with potentially lethal voltages.
- High voltage warning labels are prominently displayed on all high voltage modules inside the laser device.
- For servicing the capacitors are forcibly discharged through a shortcut plate to ground that is automatically activated when the corresponding shielding is removed.
- Multinorm (e.g HAR, UL and CSA) recognized AC power wiring rated at 600 V. Black or brown is used for line phases, blue or white is used for neutral and green or yellow-green is used for ground (depending on the mains power version).
- A yellow-green grounding conductor is included in every AC power module. All power connectors have grounding pins that make first and break last.
- All ground conductors are equipped with a ring lug and external tooth lock washer.
- Fuses are used to provide branch circuit protection against low level faults.
- AC power and signal lines are never combined in the same connector and are always separated by double insulation.

2.2.4.3 Summary of Gas Handling / Over-Pressure Safety Features

The excimer laser device has the following gas handling and over-pressure safety features:

- Fully-interlocked protective housing (see Section 2.2.4.7 on page 50)
- Emergency Stop circuit that immediately closes the halogen valve in an emergency to prevent halogen gas from entering the laser device (see Section 2.2.4.12 on page 55)
- REMOTE connector (see Section 2.2.4.8 on page 52) with additional contacts that enable the input of an external gas warning signal
- The pressure vessel is designed in accordance with the European “Pressure Equipment Directive” (2014/68/EU).
  Every pressure vessel is tested according to the European “Pressure Equipment Directive” (2014/68/EU).

  A EU Declaration of Conformity according to Annex IV of 2014/68/EU is provided with each laser device. Conformity is also confirmed by a corresponding label attached to the laser tube.
- If the pressure in the laser tube rises above the maximum permitted pressure, a built-in rupture disk releases the over-pressure via the halogen filter into the exhaust.
- A halogen filter fully absorbs the halogen exhausted during the gas exchange procedures. No toxic or harmful gases will leave the laser device. The halogen filter filling ratio is monitored by the laser control software which indicates when the filter requires replacement.
- Gas valves are electrically operated, normally closed.
- Whenever required due to the configuration of the laser device, hardware and software safety features prevent the halogen concentration in the laser tube from exceeding the upper limit for harmful gases (see Section 2.1.7 on page 29).
  - A laser tube pressure sensor and a gas manifold pressure sensor provide separate readings whenever gas is filled into the laser tube. If the deviation between the two sensor readings is too high, the gas action will be interrupted with an interlock.
  - A hardware time-delay relay that operates independently of the laser control software ensures that the halogen gas valve will automatically close after a predetermined time period.
  - The laser control software continually monitors the halogen concentration in the laser tube and prevents additional halogen from being filled if the halogen concentration limit is exceeded.
  - The gas manifold pressure sensor also detects excess or insufficient pressures in the external gas supply lines.

- A powerful ventilation system causes continuous underpressure in the tube chamber during laser operation. This prevents toxic or harmful gas from escaping into the ambient air in case of a leak.

  Nevertheless, to remain below the general industry permissible occupational exposure limit (OEL) for halogen gas even in a worst-case situation, the laser device has to be connected to a suitable air extraction system (see Section 2.2.5.5 on page 57). Never operate the laser unless it is correctly connected to the air extraction system.

  The exhaust enclosure is designed to ensure ventilation of all components.

- A halogen protection cover is provided as an accessory with the laser device. This is fitted to the halogen or premix gas connection to ensure that no halogen gas can escape in case of a leak at the gas connection.

2.2.4.4 Summary of Fire Prevention Features

The fire safety features designed into the laser device eliminate the use of materials which are combustible or produce toxic vapors as well as preventing flames from spreading or burning materials from dripping. The design incorporates the following specific fire safety features:

- No easily inflammable materials touch potential sources of ignition or hot surfaces.
- Except for electrical wire insulation polyvinyl chloride (PVC) is not used.
- No ventilation holes in fire break enclosures are in excess of 5 mm (0.20") in diameter. Hole arrays are used as required.
- Only material rated UL 94-V1 or better is used.

2.2.4.5 Summary of Mechanical Safety Features

Mechanical safety design provides protection against any hazards which could cause physical injury or burns. Specific mechanical safety features are listed below.

- Exposed corners are radiused.
- Air fans have grill guards with openings less than 6.4 mm.
- The laser center of gravity is centrally located within the enclosure to minimize tipping hazard.
- Threaded holes are provided in the base of the housing to allow suitable seismic anchorage of the laser device.
- Rotating parts within the laser device are protected by covers that can only be removed with corresponding tools. If the purpose of the cover is not evident, a suitable warning label is attached to the cover.

2.2.4.6 Materials Safety

The materials used in the laser device and its sub-assemblies and components have been chosen in accordance with the EU Restriction of Hazardous Substances (RoHS) directive. In addition, no asbestos or polychlorinated biphenyl (PCB) is used.

2.2.4.7 Fully-Interlocked Protective Housing

In accordance with IEC 60825-1, the COMPex laser device is equipped with a fully-interlocked protective housing. This prevents access to laser radiation exceeding Class 1 levels (Providing that the additional engineering measures described in Section 2.2.5 on page 55 are correctly implemented and maintained), protects against accidental contact with high voltages or current-carrying conductors, ensures electromagnetic compatibility and minimizes the risk of exposure to halogen gas and X-radiation.

All service panels allowing access to potentially hazardous equipment are equipped with interlock switches (see Figure 4) which will immediately shut off the high voltage and, consequently, the laser beam as well as shut-off the internal halogen gas supply if the corresponding panel is removed during operation.

Additionally, the use of tools is required to remove each of the service panels.

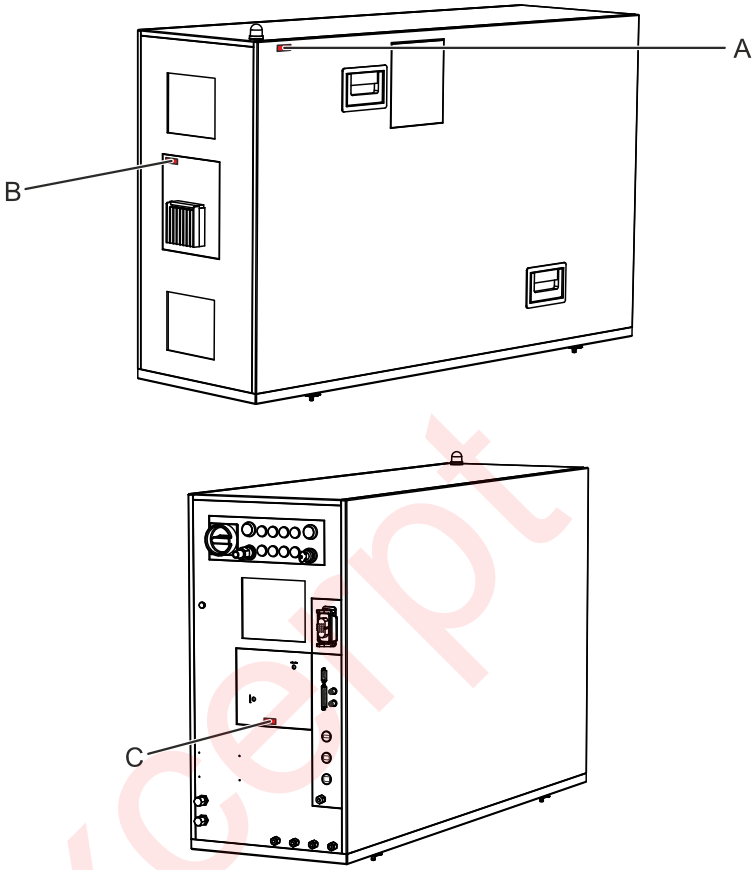


Figure 4: *Location of cover interlocks*

A Service panel interlock

B Front mirror access panel interlock

C Rear mirror access panel interlock

No service panels need to be removed to operate or routinely maintain the laser device when laser radiation is being emitted.

When, in exceptional circumstances, servicing work on an open laser device is unavoidable, dedicated and correspondingly marked interlock defeat keys are provided to override the housing interlocks. These keys shall only be made available to trained and authorized persons that are fully aware of the hazards relating to their use. They are to be locked away to prevent unauthorized use. It is mechanically impossible to refit a service panel when the corresponding interlock defeat key is inserted.

2.2.4.8 REMOTE Connector

The REMOTE connector on the connection side (see Figure 5, A) enables the laser device to be linked to an external safety circuit.

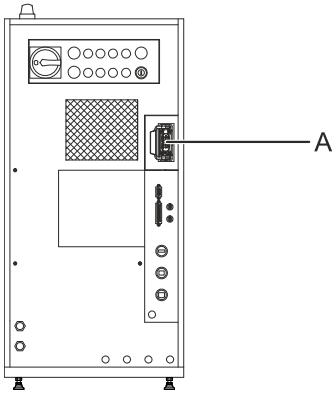


Figure 5: *REMOTE connector*

The HV power supply and, consequently, emission of laser radiation as well as the opening of the halogen valve is only enabled when one pair of contacts is open and another pair of contacts is closed (level d according to ISO 13849-1). If the status of either or both of the contacts is changed during laser operation i.e. an Emergency Stop (EMS) is triggered, the HV power supply will be immediately shut down, thereby stopping laser emission, and the halogen valve will close. For further information about the laser device's emergency shutdown function, refer to Section 2.2.4.12 on page 55.

Contacts for the connection of an external laser radiation warning lamp and the input of an alarm signal are also provided in the REMOTE connector.

The remote safety shut down (emergency stop) interrupts HV generation within the laser device and consequently prevents further emission of laser pulses according to the requirements of performance level d (ISO 13849-1). Nevertheless, for a period of up to 15 seconds after activating the remote safety shut down there remains a minimal risk of unintentional and random emission of a single laser pulse. This remaining risk shall be taken into consideration when determining occupational safety measures for working on or with the laser device. Any residual risk is indicated by the laser radiation warning lamp remaining illuminated after switching off the laser.

For further information about the REMOTE connector, refer to Section 8.2.7.1 on page 369.

2.2.4.9 Key Control and Lockout Facility

The laser device can only be switched on with the key switch (see Figure 6, A). This prevents accidental or unauthorized start-up of the laser device. It cannot be operated with the key in the “0” position and the key cannot be removed in the “I” position.

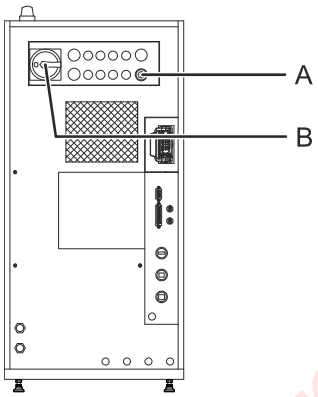


Figure 6: *Key switch and main switch*

The main switch (B) is designed to enable the insertion of a lockout device that corresponds with OSHA 29 CFR 1910.147 when the switch is set to “OFF”. This ensures that the laser device can be locked out to perform servicing or maintenance.

2.2.4.10 Warning Lights and Indicators

The laser device is equipped with the following warning lights:

- White laser radiation warning lamp (see Figure 7, A)
  illuminates when laser radiation is being emitted or can be emitted. The light will continue to light for 15 seconds after emission has stopped.
- Green mains voltage warning light (B)
  illuminates when mains voltage is applied to the laser device.
- White control voltage warning light (C)
  illuminates when the control voltage (24 V) is switched on.

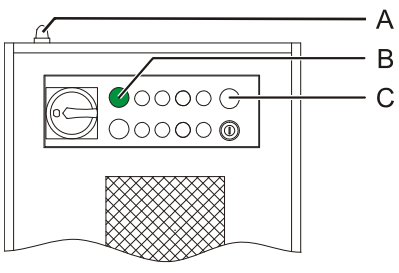


Figure 7: *Warning lights*

As soon as the emission of laser radiation is started, the Laser Radiation On indicator with wavelength and the laser icon appear on the screen of the LASCONTROL software (see Figure 8). Additionally, in the Overview menu the laser warning lamp turns from black to white.

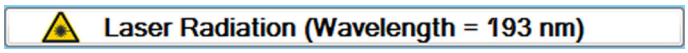


Figure 8: *Laser Radiation On indicator*

The optional handheld keypad is equipped with a white laser radiation warning LED (see Figure 9, A) that lights whenever the radiation warning light on the laser device housing is illuminated.

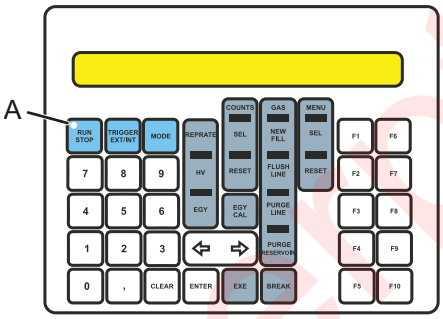


Figure 9: *Laser radiation LED on handheld keypad*

2.2.4.11 Over-Temperature Switch

The laser tube is fitted with a hardware over-temperature switch. If the temperature of the laser tube exceeds a predetermined limit, the HV power supply will be immediately shut down, thereby stopping laser emission, and the halogen valve will close.

2.2.4.12 Emergency Shutdown Function

An Emergency Stop (EMS) circuit is provided in the form of EMS contacts at the REMOTE connector (see Section 2.2.4.8 on page 52), cover interlocks (see Section 2.2.4.7 on page 50), and hardware switches (see Section 2.2.4.11 on page 54) that are linked to the safety control module. If the Emergency Stop circuit is interrupted, the safety control module is set to off. This switches off the HV power supply, thereby inhibiting laser emission, and closes the halogen gas valve. After removing the cause of the interruption, e.g. by resetting the external contact (e.g. door switch) or re-installing the housing cover, the laser device can be manually restarted.

An Emergency Off (EMO) function is provided through the main switch (see Section 4.5 on page 180). When integrated into a laser system, the COMPex laser device should be connected to the overall system's EMO circuit in such a way that the mains power to the laser device will be disconnected when the overall system's EMO function is activated. This measure assumes that the COMPex laser device receives its mains power from the overall system.

2.2.5 Plant Requirements

This section describes the measures that are required to safely install and integrate the COMPex laser device into its working environment. It is the responsibility of the end user to ensure implementation according to local regulations and within the context of a risk management plan.

2.2.5.1 Beam Shielding

The entire beam path including the target area must be hermetically sealed by a suitable enclosure (see Section 2.1.6 on page 28).

COMPex 50/100/200 Series: Threaded holes are provided at the beam exit aperture to enable mechanical attachment of the enclosure (see Section 8.3.1.1 on page 373). Use fastening elements that require tooling to facilitate their removal.

COMPex F2: The flanged beam delivery tube enables the connection to the beam delivery system (see Section 8.3.1.2 on page 374).

Any removable elements of the enclosure, such as access panels, shall be equipped with interlocks that prevent operation of the laser system unless the respective element is properly secured.

2.2.5.2 Hardwired Interlock Circuit

The laser device has a provision for the connection of hardwired interlock signals (see Section 2.2.4.8 on page 52). Depending on locally applicable safety regulations and operator demands, the system integrator shall connect external detection devices and/or switches to the corresponding connections.

The EMS circuit within the laser device fulfills the requirements of performance level d according to ISO 13849-1. The external EMS circuit that is to be provided and connected by the user has to fulfill the requirements of at least the performance level d. Cables for the external EMS circuit should have an adequate wire cross section and be laid so that they are protected. The switches that are used shall not reduce the performance level of the overall circuit.

The external interlock circuit should be configured so that the SELV (separated extra low voltage) requirements regarding separation from circuits that carry dangerous voltages are complied with.

For further information about the interfacing of the laser device, refer to Section 7 on page 309.

2.2.5.3 Laser Area Warning Signs

Make sure that the laser radiation warning lamp and warning labels on the laser device are clearly visible.

Ensure that warning signs indicating the laser enclosed area (according to locally applicable standards, e.g. IEC 60825-1) are in place.

The end user is responsible for providing an external laser radiation indicator (e.g. warning lamp) in addition to the laser radiation warning lamp fitted to the laser device (see Section 2.2.4.10 on page 53). The external laser radiation indicator has to be connected to the corresponding REMOTE connector outputs (see Section 8.2.7.1 on page 369). Before starting the laser device, always ensure that the external laser radiation indicator is connected and correctly operating.

2.2.5.4 Fire Extinguisher

Always keep a fire extinguisher or provide an equivalent fire fighting system in the area of the laser device. The fire extinguisher or fire fighting system should be suitable for fighting “shock risk” classes of fire and be chosen according to local fire safety regulations. For further information, consult the fire safety officer that is responsible for the installation site.

2.2.5.5 Air Extraction System

To remain below the general industry permissible exposure limit for halogen gas even in a worst-case situation, the laser device exhaust has to be connected to a suitable air extraction system. Make sure that the exhaust is not connected to a system used to process breathing air (e.g. air conditioning or ventilating systems). Never operate the laser unless it is correctly connected to the air extraction system.

The fundamental design of the air extraction system (i.e. the edges, corners and transitions within the system) should ensure that no unnecessary air flow noises can occur.

Even when the laser device is switched off, preventative measures are necessary to ensure that no halogen gas escapes from the area of the laser device into the surrounding environment in a worst-case situation. To ensure that the specified exhaust flow rate is present at all times, a suitable monitoring system is required for the external exhaust system. The end user is responsible for the provision and installation of a suitable external exhaust monitoring system as well as providing the specified ventilation.

Should an insufficient exhaust flow rate, smoke or excess halogen levels be detected, the complete system, including the laser device, has to be immediately switched to a safe state through a mechanism provided by the end user. This safety shutdown system has to be connected to the laser device through the corresponding inputs of the REMOTE connector (see Section 8.2.7.1 on page 369).

The system integrator / system operator should carry out their own risk analysis of the air extraction system together with the required monitoring and safety shutdown devices. The design, implementation and operation of the air extraction system is within the responsibility of the system operator.

2.2.5.6 Halogen Exposure Monitor

The design of the laser device is such that apart from the measures described in Section 2.2.5.5 on page 57 no additional halogen exposure controls or protective devices are required for the laser device under normal operating, maintenance and servicing conditions.

Nevertheless, the instructions provided by halogen gas suppliers as well as generally applicable occupational safety and health regulations normally stipulate the use of additional exposure controls and personal protective equipment at sites where halogen gases are in use. Such instructions and regulations outline, for instance, requirements and procedures in case of an accidental release of a halogen gas mixture or when handling gas cylinders.

It is the responsibility of the end user of the laser device to incorporate the recommendations and instructions provided by the halogen gas supplier as well as locally applicable directives and regulations into the appropriate work instructions and risk management plan. For further information, consult the institute responsible for occupational safety and health at the installation location (for example, NIOSH, National Institute for Occupational Safety and Health, in the USA) and the gas supplier.

2.2.5.7 Gas Supply Line Pressure and Flow Restrictors

The end user is responsible for the safe and correct installation of the external gas supply and handling system. Each of the gas lines requires a single fault safety overpressure limiting device that limits the line pressure at the connection to the laser device to 6 bar (g). In addition, the gas flow in each line shall not exceed the specified upper limit of the flow rate range (see Section 9.3 on page 399). The end user has to provide suitable control devices and fail-safe means of pressure and flow limitation to ensure that there is no risk of excess pressure or flow at the respective gas inlet connections.

2.2.5.8 Seismic Protection

For installations in areas that are susceptible to seismic activity, the end user is responsible for appropriately securing the laser device within their facility. Alternatively, the system integrator is responsible if the laser device is to be installed as part of a system.

For the exact configuration of the protective devices, always follow local regulatory requirements. Take into account the center of gravity of the laser device and site vulnerability of the facility or plant (e.g. soil conditions and total system design).

Provision is to be made for the following:

- Anchors to prevent movement or overturning of the laser device during a seismic event

  The locations of suitable anchoring points on the laser device are indicated in Section 8.3.5 on page 379.

- Suitable strain relief devices for all supply lines

  These are to control the risks through leakage or escape of gases, liquids and electricity etc. during a seismic event

2.3 Safety Labels

This section describes the location and purpose of the safety-relevant labels attached to the laser device.

If warning labeling is missing or incomplete, persons are not made aware of potential exposure to specific hazards. Make sure that all warning labels are affixed to the laser device according to the plans given in this section.

Misuse or improper handling of the laser device can cause serious or, in certain situations, even lethal injuries. Therefore, never put the laser device into operation if the labeling is incomplete. Immediately replace missing labels or inform Coherent of their absence.

To simplify the ordering of labels, the appropriate Coherent part number (P/N) is indicated behind the position number of the corresponding label.

2.3.1 Labels on Laser Device Housing

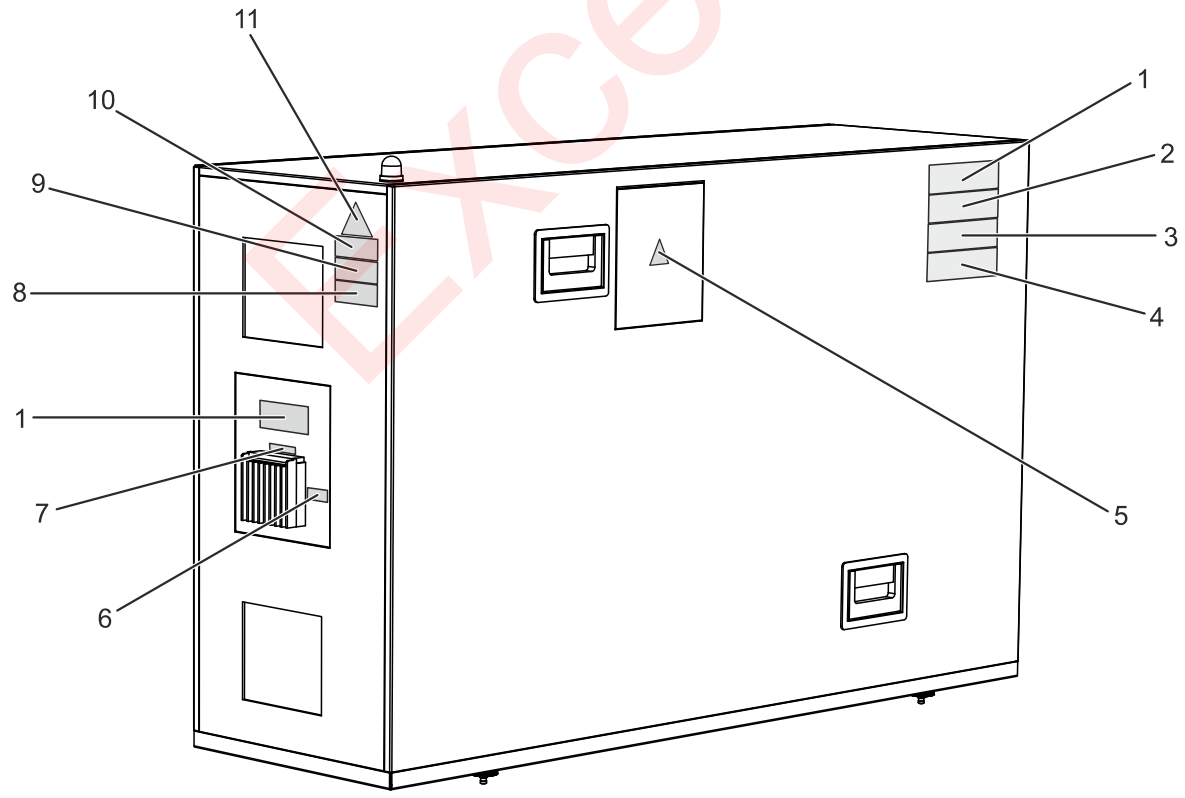


Figure 10: *Labels on beam exit and service side*

D165188 AJ

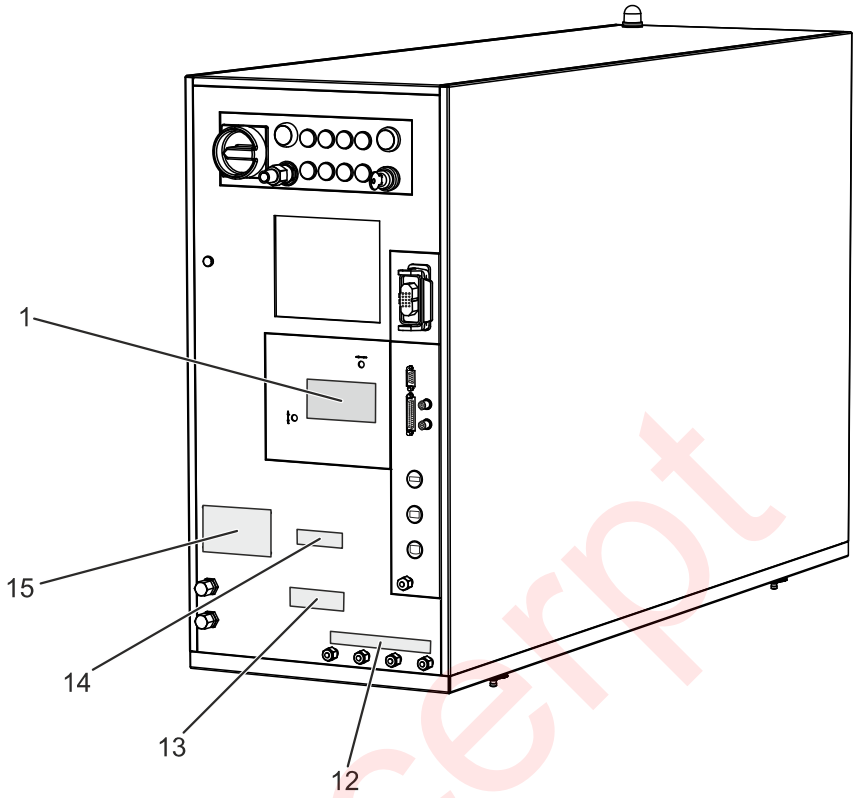
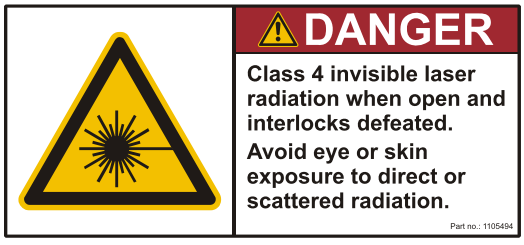


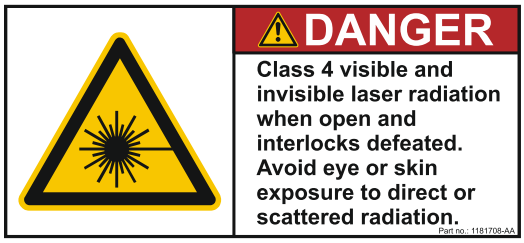
Figure 11: *Labels on connection side*

Pos. 1 (P/N 1105494 or P/N 1181708)
Label warning of possible exposure to hazardous Class 4 invisible laser radiation when the panel to which it is attached is removed and the interlock is defeated.

P/N 1105494
COMPex 50/100/200 Series

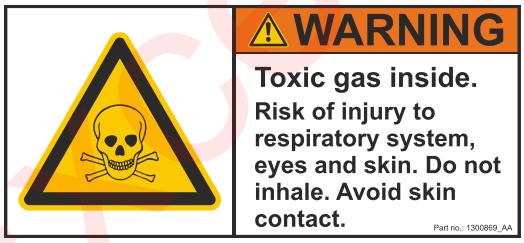


P/N 1181708
COMPex F2



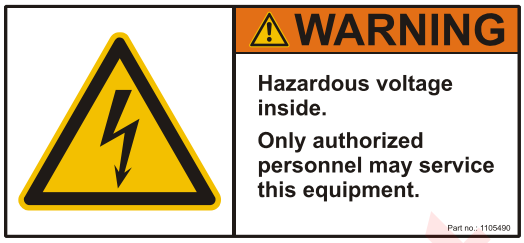
Pos. 2 (P/N 1300869 or P/N 1264371)
Label warning that a toxic or harmful halogen gas mixture is contained within the enclosure to which the label is attached. Further information about the gas mixture, inherent hazards, safety precautions and procedures required in the case of an accident are contained in the gas supplier's material data safety sheet (MSDS).

P/N 1300869: COMPex F-version.
For laser operation at 157 nm, 193 nm, 248 nm or 351 nm, the label warns of a toxic halogen gas mixture.



P/N 1264371: COMPex XeCl-version.
For laser operation at 308 nm, the label warns of a harmful halogen gas mixture.

Pos. 3 (P/N 1105490)
Label warning of the risk of electrical shock or even electrocution if components situated behind the cover to which it is affixed are touched or treated improperly. Only correspondingly qualified and authorized personnel may open the cover to work on the equipment situated behind!



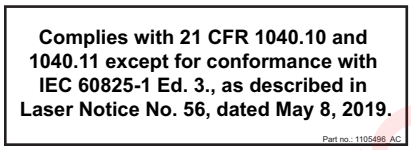
Pos. 4 (P/N 1264375)
Safety notice instructing all persons that intend to work on or with the laser device to read the relevant section of this Instruction Manual and understand the consequences of their actions before starting work.

Pos. 5 (P/N 1158150)
Label warning of the risk of an electrical shock if a component behind the cover on which the label is affixed is touched or treated improperly. Only correspondingly qualified and authorized personnel may open the cover or work on the component situated behind.

Pos. 6 (P/N 1105489)
Label according to IEC 60825-1 indicating that laser radiation is emitted from the aperture next to the label.

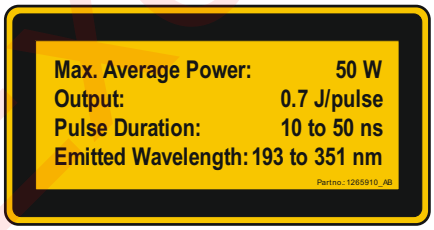
Pos. 7 (P/N 1105907)
Label warning that the surfaces in the area where the label is affixed may be hotter than 60 °C.

Pos. 8 (P/N 1105496)
Label to certify that the laser complies with FDA/CDRH performance standards.

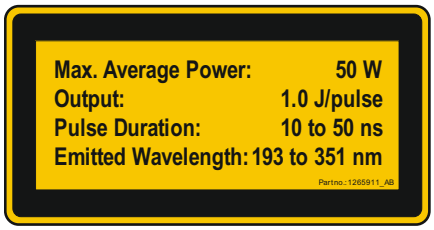


Pos. 9 (P/N 1265910, P/N 1265911 or P/N 1601382)
Warning label according to IEC 60825-1 specifying the emitted laser radiation. The information indicated on this label is important for the choice of laser protective eyewear.

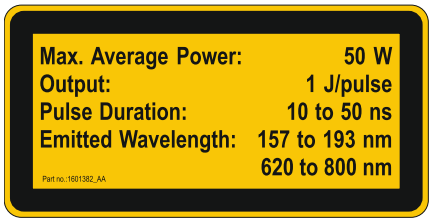
P/N 1265910
COMPex 50/100 Series



P/N 1265911
COMPex 200 Series



P/N 1601382
COMPex F2



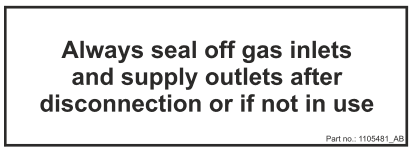
Pos. 10 (P/N 1105499 or P/N 1181709)
Class 4 laser radiation explanatory warning label according to IEC 60825-1.

P/N 1105499
COMPex 50/100/200 Series

P/N 1181709
COMPex F2

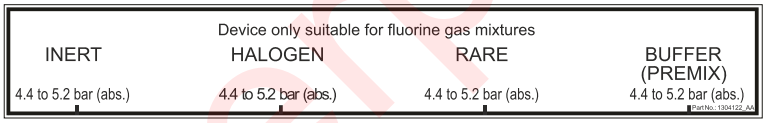
Pos. 11 (P/N 1105500)
Laser radiation warning label according to IEC 60825-1.

Pos. 12 (P/N 1105481)
Advisory notice indicating that any gas inlets that are not in use should be sealed off with the appropriate sealing plug.

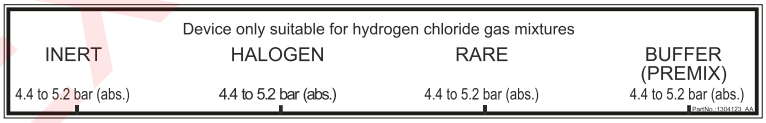


Pos. 13 (P/N 1304122 or P/N 1304123)
Label indicating the gas connections and permitted pressure range at each gas connection.

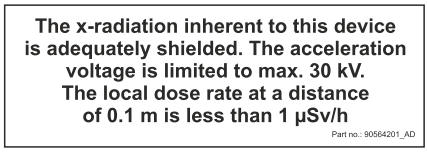
P/N 1304122: COMPex F-version
For lasers that operate at 157 nm, 193 nm, 248 nm or 351 nm, the label also contains a notice that stipulates that only fluorine gas mixtures shall be used.



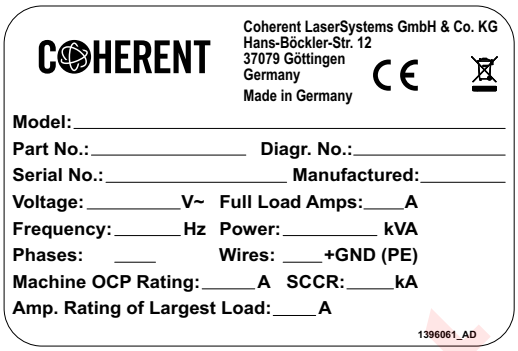
P/N 1304123: COMPex XeCl-version
For laser operation at 308 nm, the label also contains a notice that stipulates that only hydrogen chloride gas mixtures shall be used.



Pos. 14 (P/N 90564201)
Advisory notice indicating that the local dose rate of the X-radiation inherent to the COMPex excimer laser device at a distance of 0.1 m is less than 1 µSv/h. Consequently, according to the German X-Ray Ordinance (RöV §5) no special permit is required for operation.



Pos. 15 (P/N 1396061)
Identification label for the laser device indicating the model, serial number, year of manufacture and electrical connection data.



The electrical connection data (see Section 9.4 on page 410) and additional applicable conformity markings are entered.

2.3.2 Labels Inside Laser Device Housing

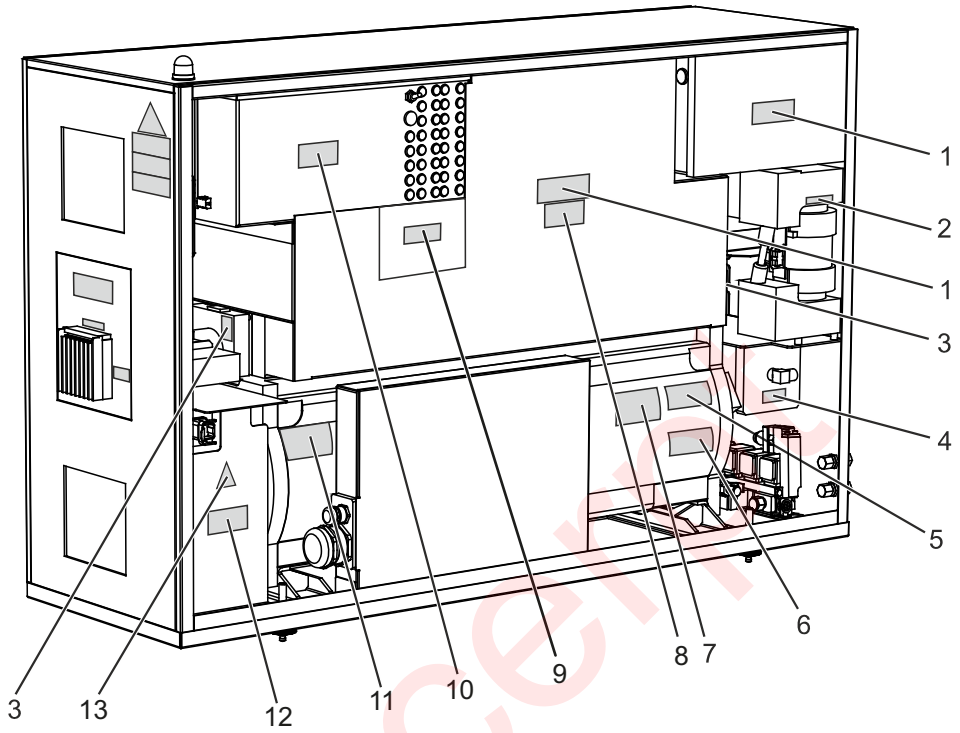
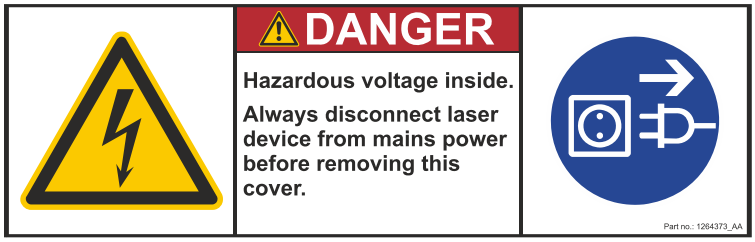


Figure 12: *Labels inside*

Pos 1: (P/N 1264373)
Label indicating that mains voltages can be directly accessed when the cover to which it is attached is removed. Always disconnect the mains power supply cord from the wall socket before removing the cover.



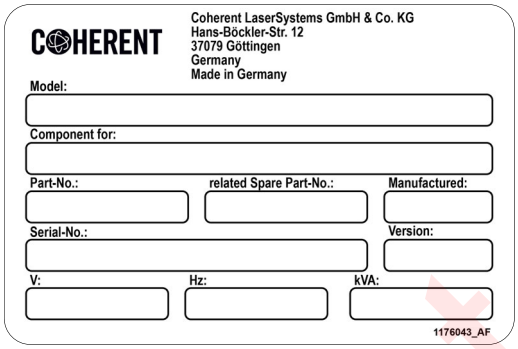
Pos. 2 (P/N 1105907):
Label warning that the surfaces in the area where the label is affixed may be hotter than 60 °C.

Pos. 3 (P/N 1264372)
Label warning of the risk of exposure to the harmful halogen gas mixture inside the laser tube if the optics exchange procedure described in Section 5.6.1 on page 219 of this manual is not strictly followed.

Pos. 4 (P/N 1105478):
Label warning that corrosive chemicals are contained in the filter which is located within the enclosure to which the label is attached. Always strictly follow the corresponding instructions in this Instruction Manual when working on or exchanging the filter.

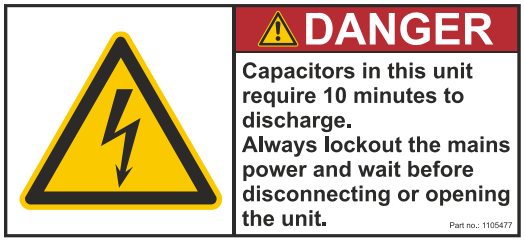
Pos. 5 (P/N 1105475):
Label warning that the module to which the label is attached is too heavy to be lifted or transported without mechanical assistance (e.g. hoist, crane or cart). Manual lifting can cause serious back strain. There is also a high risk of serious injury through crushing if the object is dropped.

Pos. 6 (P/N 1176043)
Additional identification label that is only attached to components that are shipped as spare parts. It indicates the part number of the spare part and other relevant information.



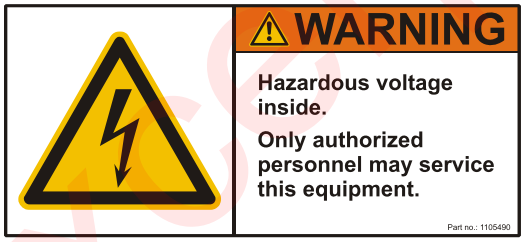
Pos. 7 (P/N 1264371):
Label warning that a harmful halogen gas mixture is contained within the enclosure to which the label is attached. Further information about the gas mixture, inherent hazards, safety precautions and procedures required in the case of an accident are contained in the gas supplier's material data safety sheet (MSDS).

Pos. 8 (P/N 1105477):
Label warning that there are capacitors within the enclosure to which the label is attached. Only authorized and correspondingly trained persons are permitted to remove the cover to which the label is attached. The safety measures indicated on the label shall always be followed.

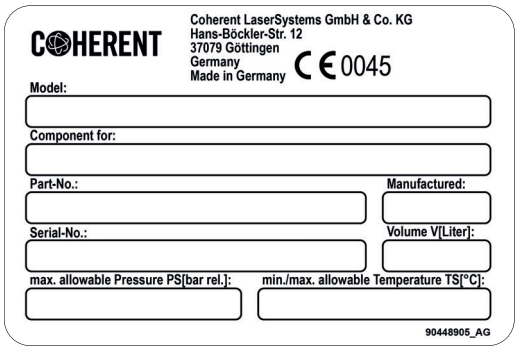


Pos. 9 (P/N 1266443):
Label warning that hazardous voltages can be directly accessed when the cover to which the label is attached is removed. Only authorized and specifically trained persons are permitted to remove the cover. Always disconnect the laser device from the mains power before starting to remove the cover. Always refit the cover after completing work.

Pos. 10 (P/N 1105490):
Label warning that there are hazardous voltages within the enclosure to which the label is attached. Only authorized and correspondingly trained persons are permitted to remove the cover to which the label is attached.



Pos. 11 (P/N 90448905)
Laser tube identification label indicating the name and address of the manufacturer, CE-marking with the number of the organization that is responsible for certification and monitoring (according to the European Pressure Equipment Directive (2014/68/EU)) and data relating to the pressure vessel. Additional applicable conformity markings are entered.



Pos. 12 (P/N 1105906):
Label warning that a rotating part is located behind the cover to which the label is attached. Always switch off the laser device before removing the cover. Ensure that the cover is refitted before restarting the laser device.

Pos. 13 (P/N 1158150)
Label warning of the risk of an electrical shock if a component behind the cover on which the label is affixed is touched or treated improperly. Only correspondingly qualified and authorized personnel may open the cover or work on the component situated behind.

8 SITE PREPARATION / TRANSPORT

8.1 Facility Requirements

8.1.1 Support Surface / Floor

Static Load

The locating surface must be capable of sustaining the weight of the fully configured laser device as indicated in Section 9.9 on page 418. The weight of the laser device is borne by four feet (see Section 8.3.3 on page 376).

Surface Area

The floor surface area and height requirements for the installation of the laser device are indicated in Section 8.1.2 on page 356.

8.1.2 Space

The laser device must be located in sufficient space to allow the maintenance covers to be removed and installation and maintenance work to be performed.

Maintenance Area

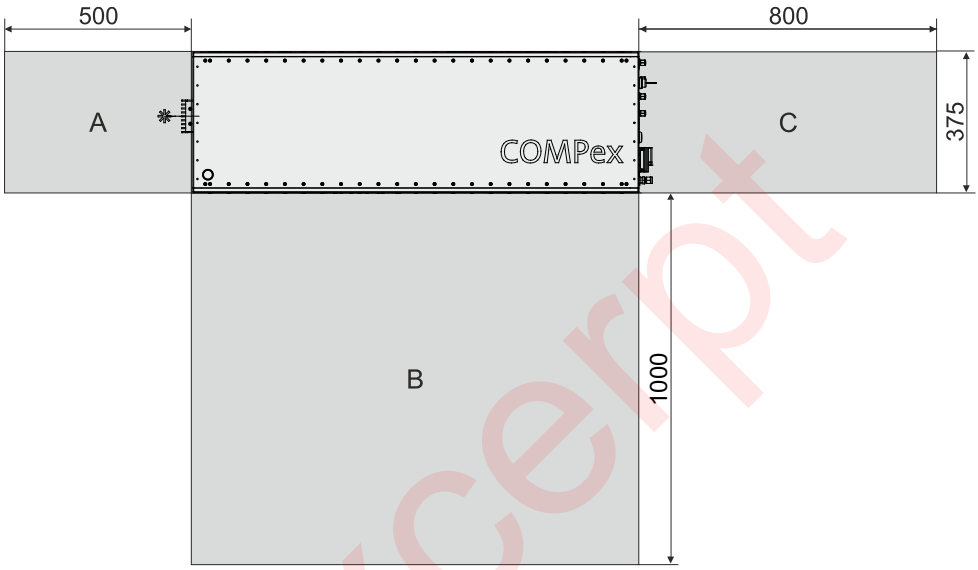


Figure 169: *Maintenance area*

Maintenance Height

All COMPex laser devices require a maintenance height (height above base) of 1350 mm. When determining the necessary room height, take into account the required position of the main switch (see Section 8.3.4 on page 378).

8.1.3 Safety Equipment

The measures and additional equipment required to safely install and integrate the COMPex laser device into its working environment are described in Section 2.2.5 on page 55.

In addition to the implementation of the necessary plant requirements, all persons working on or within the area of the laser device should be instructed to wear the appropriate personal protective equipment (PPE) during specific operational phases (see Section 2.2.2 on page 36). Locally applicable regulations, standards or risk management plans may require the placement of mandatory action signs relating to the required PPE. It is the responsibility of the end user to provide and install such signs.

8.1.4 Seismic Protection

For installations in areas that are susceptible to seismic activity, the end user is responsible for appropriately securing the laser device within their facility. Alternatively, the system integrator is responsible if the laser device is to be installed as part of a system.

For the exact configuration of the protective devices, always follow local regulatory requirements. Take into account the center of gravity of the laser device and site vulnerability of the facility or plant (e.g. soil conditions and total system design).

Provision is to be made for the following:

- Anchors to prevent movement or overturning of the laser device during a seismic event

  The locations of suitable anchoring points on the laser device are indicated in Section 8.3.5 on page 379.

- Suitable strain relief devices for all supply lines

  These are to control the risks through leakage or escape of gases, liquids and electricity etc. during a seismic event

8.2 Connections

8.2.1 Overview

All external systems and devices are connected to the connection side of the COMPex laser device.

All COMPex laser devices are equipped with the connections shown in Figure 170.

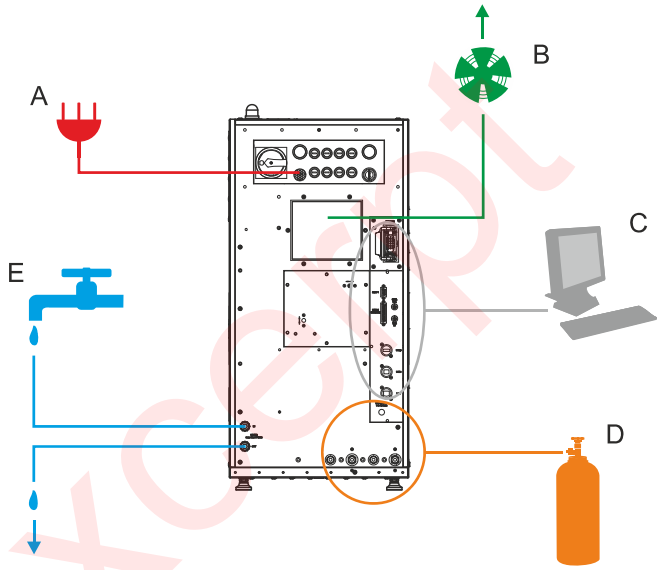


Figure 170: *Overview of connections*

A Electricity (see Section 8.2.4 on page 363)
B Exhaust (see Section 8.2.6 on page 366)
C Control and signal lines (see Section 8.2.7 on page 367)
D Gases (see Section 8.2.3 on page 360)
E Cooling water (see Section 8.2.5 on page 365)

The exact connection and utility requirements depend on the version of the COMPex laser device, the wavelength it is to be operated at and the selected gas supply mode (separate gases or premix gas).

8.2.2 Connection Examples

This section provides examples of the minimum utility connection requirements for different version, wavelength and gas supply mode configurations.

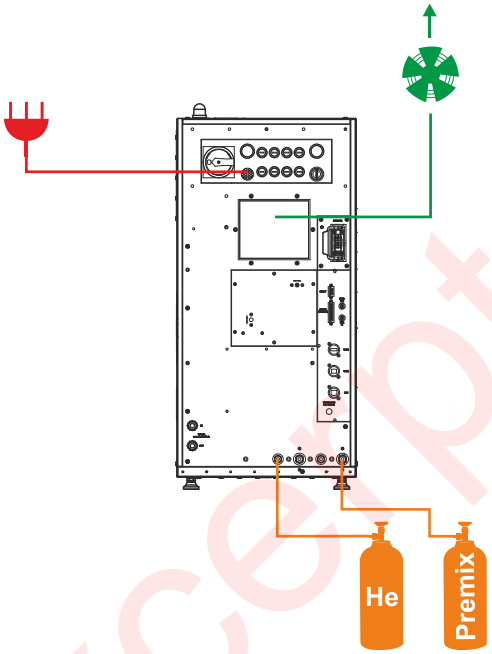


Figure 171: *Connections COMPex 102 / 201, 248 nm, premix gas*

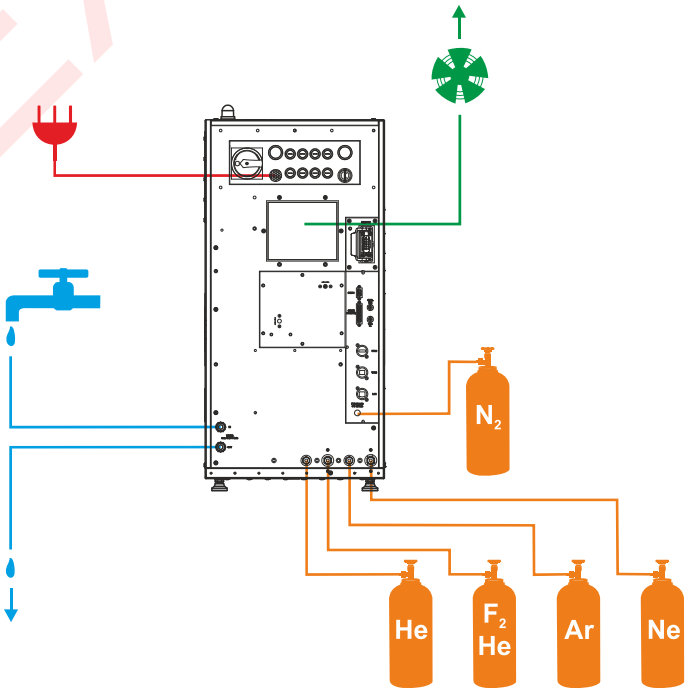


Figure 172: *Connections COMPex 50 / 110 / 205, 193 nm, single gases*

8.2.3 Gases

This section describes the requirements for the gas connections to the laser device and gas connections inside the laser device.

For information about requirements for the external gas supply system installation, see Section 8.4 on page 380. The end user is responsible for providing suitable control devices and fail-safe means of pressure and flow limitation to ensure that there is no risk of excess pressure or flow at the respective gas inlet connections.

Excimer Laser Gas Mixture

Ensure that either the appropriate premix gas or single gases are available for the wavelength at which the laser device is operated.

The required wavelength has to be specified when the laser device is ordered. Fluorine gas mixtures cannot be used with the XeCl-version laser device and XeCl cannot be used with the F-version laser device.

F-version laser devices and XeCl-version laser devices can either be supplied with a premix excimer laser gas or with single excimer laser gases (rare gas, halogen gas and buffer gas) externally supplied from separated gas cylinders and mixed for use in the laser device.

Inert Gas Helium

The inert gas helium (He) is required to purge and fill the laser tube and gas lines when certain maintenance procedures are performed.

Purge Gas Nitrogen

NOTICE
Risk of seriously damaging the laser tube!
Do not connect purge gas lines to other gas lines. Nitrogen is only used for optics purging. Nitrogen should never enter the laser tube.

Nitrogen is used to purge the beam path.

To prevent ozone production, the external beam path must be purged with the purge gas nitrogen (N_2) when operating the laser device at 193 nm. When operating the laser device at 157 nm, the external beam path must be purged with nitrogen or evacuated. At other wavelengths, the use of purge gas minimizes contamination and increases optics lifetimes.

The gas flow shall also not exceed the specified upper limit (see Section 9.3 on page 399). The gas supply has to be set up accordingly.

8.2.3.1 Gas Line and Fitting Specifications

	Standard	Alternatively
Gas lines - Outer diameter	6 mm (or ¼")	Halogen or premix gas line: 10 mm (double wall) recommended
- Material and finish	- Stainless steel, type 316L - Electropolished inside - Degreased - Seamless - Free of burrs - Inside and connection area (20 mm) chemically cleaned - Gas line ends Rz4 (peak-to-valley), circumferential, at 20 mm length	Purge gas (nitrogen) gas line: PE hose can be used
Standard gas line fittings	- 6 mm GYROLOK female (metric male thread on laser device) - All connectors have to be fitted according to the "HOKE GYROLOK Assembly Instructions". Refer to the HOKE website or contact the local HOKE representative for further information about the selection and installation of suitable gas fittings.	
VCR gas line fittings (optional)	¼" VCR Required glands ¼" to metric (6 mm), to be welded onto the tubes, are available e.g. from Swagelok or Hoke. Only use gaskets that are approved by Coherent or by the gas supplier.	

8.2.3.2 Gas Connections

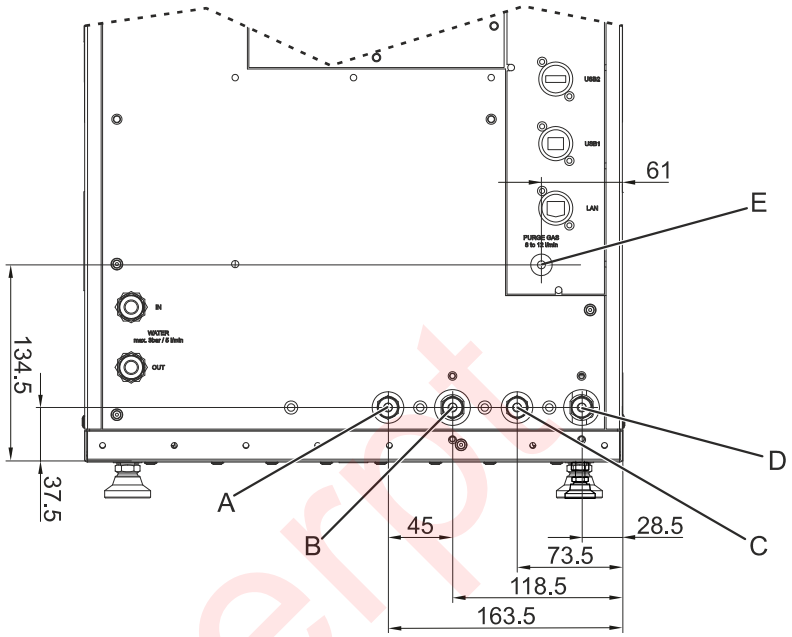


Figure 173: *Gas connections positions*

A Inert gas connection
B Halogen gas connection
C Rare gas connection
D Buffer (Premix) gas connection
E Purge gas connection

A halogen protection cover is provided as an accessory with the laser device. This cover shall always be fitted to the gas connection that contains halogen, i.e. it has to be fitted to the Halogen connection with single gas supply or Buffer connection with premix gas supply.

Gas Supply Mode: Premix

The premix gas cylinder has to be connected to the Buffer (Premix) gas connection and a helium cylinder to the Inert gas connection.

Gas connections that are not used have to be sealed with the stainless steel caps that are supplied with the laser device.

8.2.4 Electricity

NOTICE
To prevent serious mains supply line damage, the mains supply line must be installed with strain-relief in a cable channel.

NOTICE
If there is the theoretical risk of a short circuit current of more than 1 kA occurring in the mains supply line, insert an appropriate current limiting circuit breaker in the mains supply line for the laser device.

NOTICE
In certain areas, local regulations require a breaking capacity larger than 1.5 kA for 208 V or 230 V operation. In this case, a 16 A, characteristic C circuit breaker with a minimum breaking capacity of 10 kA has to be inserted in the mains supply line for the laser device.

NOTICE
If operation with an external transformer is necessary, make sure that the transformer is correctly connected to the mains power source. Otherwise, there is the risk of serious damage to the laser device.

The COMPex laser device has an internal mains transformer that enables connection to a local mains electrical supply.

The internal mains transformer is factory set according to the required local voltage and frequency.

The COMPex 200 Series and COMPex F2 laser devices are intended for connection to a private low voltage system. Such systems contain a step-down transformer that enables them to interface with the public network at distribution voltage levels. Direct connection to the public low voltage network is not permitted.

Connection through an extension cable or a power strip is not permitted. Connection to the mains power supply wall socket is provided through a 5 m long mains cable that is hard wired to the laser device. No mains plug is fitted.

The end user is responsible for obtaining and fitting a mains wall plug suitable for the applicable specifications (see Section 9.4 on page 410). This plug shall be configured in accordance with electrical engineering rules and regulations (e.g. EN 61010-1) and be fitted by an authorized and electrically skilled technician.

The mains cable wiring depends on the nominal voltage indicated when ordering the laser device. Two wiring configurations are available (see Section 9.4 on page 410).

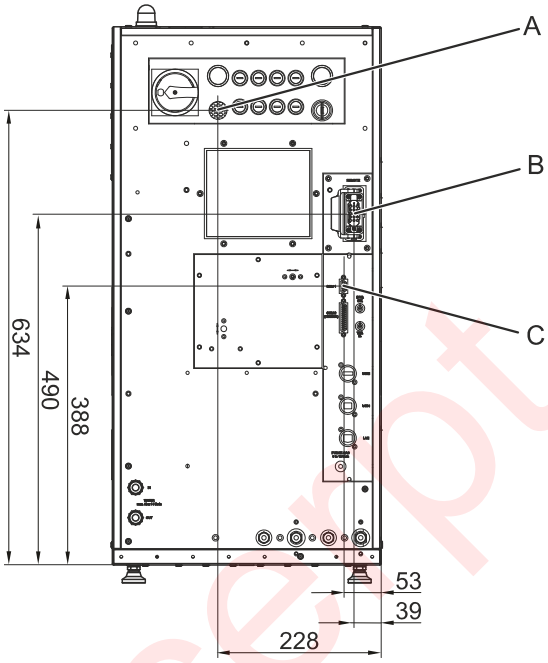


Figure 174: *Positions of electrical connections*

A Mains cable

B REMOTE connector (see Section 8.2.7.1 on page 369)

C COM1 connector (see Section 8.2.7.2 on page 370)

8.2.5 Cooling Water

All COMPex laser devices are fitted with cooling water connections which enable the laser tube to be cooled at higher repetition rates.

As an option, the cooling water circuit can be equipped with automatic temperature regulation. As particles in the cooling water can clog the coolant circuit, the end user is to provide and maintain a fine line filter in the external cooling water supply line immediately in front of the shut-off valve for the laser device.

Do not use pure de-ionized water.

Ensure that the cooling water corresponds with the specifications (see Section 9.5 on page 412).

Additives

When the laser device is cooled by a once-through cooling system, cooling water additives are not required.

If the laser device is to be operated in conjunction with a recirculating cooling water system, the following additives can be used:

Recommended additive:

- for corrosion protection and anti-freeze protection — Antifrogen N®
- for corrosion protection — 10 ppm 1H-Benzotriazol

8.2.5.1 Cooling Water Connections

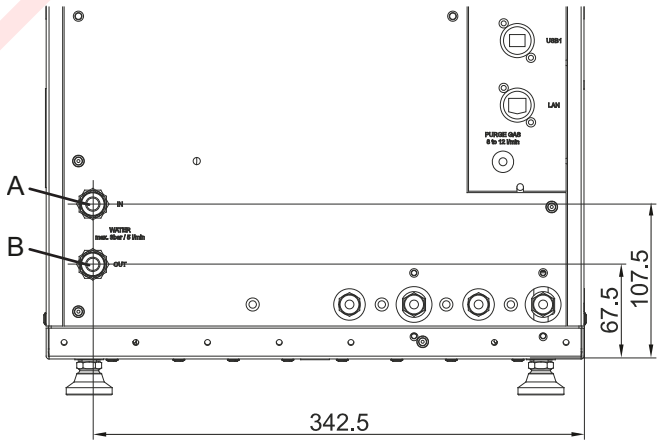


Figure 175: *Cooling water connections*

A Cooling water inlet (SERTO SO 41521-10)

B Cooling water outlet (SERTO SO 41521-10)

8.2.6 Air Intake / Exhaust

To ensure an adequate supply of cooling air, the laser device has to be situated in the specified maintenance area (see Section 8.1.2 on page 356). This area has to comply with the specified environmental conditions (see Section 9.7.1 on page 413).

The COMPex laser device has two air intakes on the beam exit side (see Figure 176, A) and a central exhaust outlet with moderate flow rate on the connection side (B).

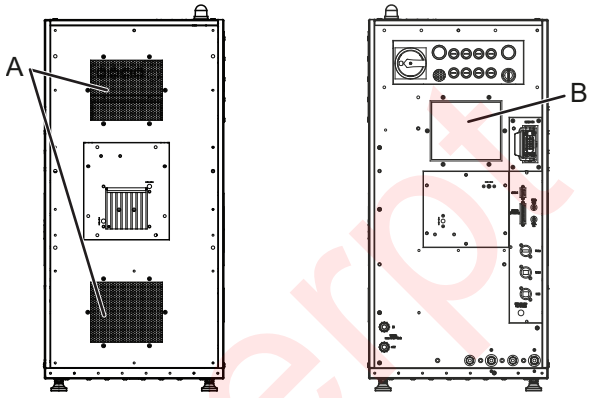


Figure 176: *Location of air intake and exhaust*

WARNING
Toxic gas hazard!
Permanently connect the laser device exhaust to an appropriate ventilation system. Make sure that the exhaust is not connected to the ducting of systems that are used to process breathing air (e.g. air conditioning systems).

Under normal operating conditions, the exhaust air does not contain toxic gases or by-products. With certain failure scenarios the exhaust air may contain small concentrations of halogen gas or ozone. Consequently, the laser device has to be connected to an appropriate fume extraction or industrial ventilation system. A 3 m long exhaust hose and the required attachment fittings are supplied with the laser device.

When planning the external air extraction system, always take into account the plant requirements (see Section 2.2.5.5 on page 57).

8.2.6.1 Air Flow in the Area of the Laser Device

Make sure that the air flow in the area of the laser device is sufficient to continually replace the quantity of air that is extracted through the exhaust. Depending on the size and configuration of the room containing the laser device, it may be advisable for the user to provide forced ventilation and/or an air flow monitoring system.

The required air intake and exhaust specifications are provided in Section 9.6 on page 412.

8.2.7 Control and Signal Lines

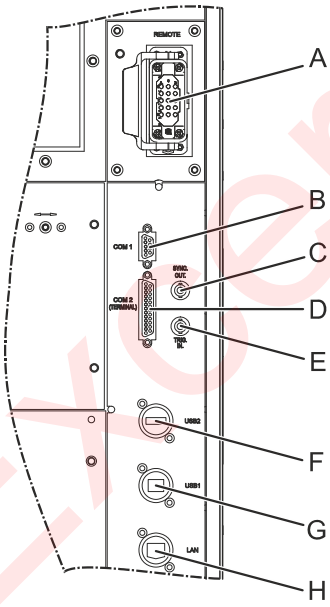


Figure 177: *Layout of connector panel*

The table below provides an overview of the control and signal connections. The gender of the connector (where indicated) relates to the chassis part on the laser device and not the connector on the cable. The cables have to be provided with the corresponding plugs.

Pos.	Designation	Type	Purpose	Further Information
A	REMOTE	15 pin Harting, female	Safety connections	Section 8.2.7.1
B	COM1	9 pin sub D, male (standard RS232C serial interface interconnecting cable)	Serial interface for input/output of operating modes and parameters	Section 8.2.7.2
C	Sync Out	BNC	Output of synchronization signal	Section 8.2.7.7
D	COM2 (TERM.)	25 pin sub D, female (original Coherent cable)	Handheld keypad configuration serial interface for input/output of operating modes and parameters	Section 8.2.7.3
E	Trigger In	BNC	Input of external trigger signal	Section 8.2.7.6
F	USB 2	Hi-speed USB 2.0 Standard-A	Connection for USB mass storage devices to upload / download data	Section 8.2.7.5
G	USB 1 (COM3)	USB 2.0 Standard-B	Virtual serial port for input/output of operating modes and parameters	Section 8.2.7.4
H	LAN	RJ45	Ethernet network connection to upload / download data	Section 8.2.7.8

As a positioning guide, Figure 174 on page 364 shows the exact locations of the REMOTE and COM1 connectors.

The following subsections provide an overview of the control and signal lines. For detailed information about signal definitions and commands/signals used refer to Section 7 on page 309. For specifications refer to Section 9.10 on page 421.

8.2.7.1 REMOTE Connector

The REMOTE connector is a 15 pin Harting HAN 15D female connector that enables the laser device to be connected to external emergency shutdown circuits.

Pin Assignment and Connections

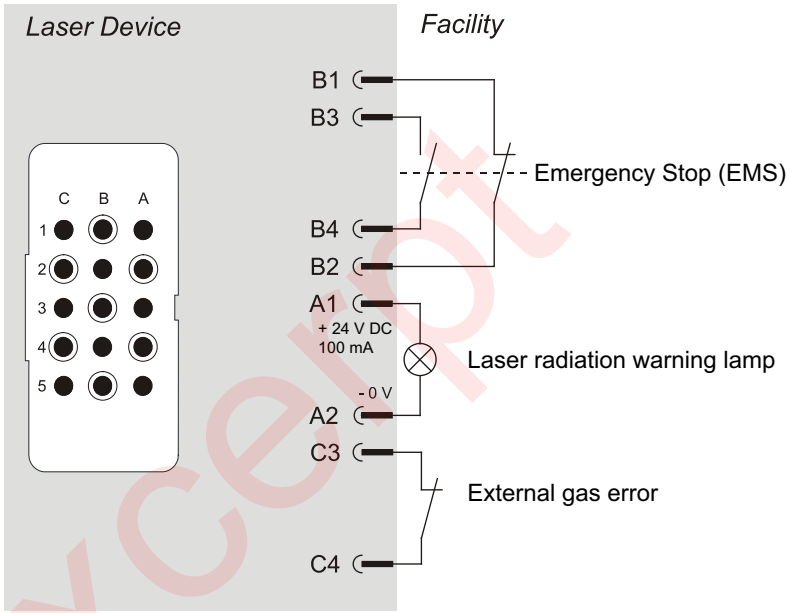


Figure 178: *REMOTE connector pin assignment and connections*

The laser device is shipped with a dummy plug that enables laser operation during setup and troubleshooting operations. Do not use this plug for normal laser operation. The specifications in this section and Section 9.4 on page 410 enable the system operator to obtain the necessary components to safely connect the laser device to the facility's external emergency shutdown circuits.

Tools and Materials Required for Connection Plug Assembly

1 Crimp terminal HAN-15D, 15+PE, male, 10A
(Harting part no.: 09 21 015 3001; see Figure 179, A)

8 Crimp contacts HAN-D, male 1 mm^2, silver plated
(Harting part no.: 09 15 000 6102; B)

1 Hood, metal M25, size 10A (Harting part no.: 19 20 010 0546; D)

1 Brass cable gland, SKINTOP, MS-M M25X1.5
(Lappkabel part no.: 53112030; C)

1 Crimping tool (incl. pin locators) (Harting part no.: 09 99 000 0021)

1 Pin removal tool (Harting part no.: 09 99 000 0052)

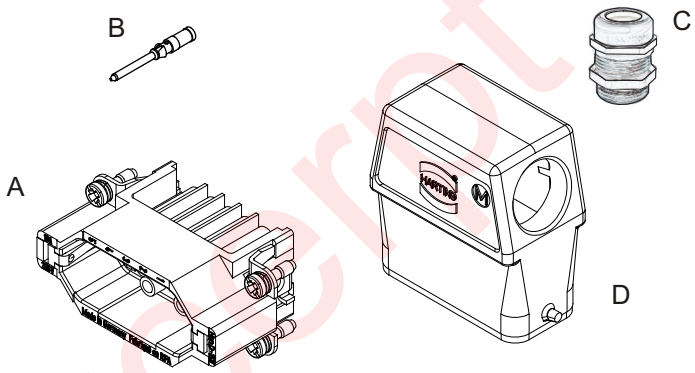


Figure 179: *Components required for REMOTE connector*

8.2.7.2 Serial Interface COM1

COM1 can be switched by the user through LASCONTROL or the optional handheld keypad to enable the connection of one of the following:

– Diagnostics computer

– External computer control system (remote computer) that uses the current protocol (see Section 7 on page 309)

– Control system designed for an earlier version of the COMPex laser device (backward compatibility). With this setting, not all commands offered by the current laser control software will be supported. In addition, as the status code table has changed, status codes sent by the laser device may not be recognized or correctly interpreted by the external control system. A list of the currently applicable status codes is contained in Section 6.1 on page 293.

Alternatively, this port can be deactivated by the user to prevent the input of conflicting commands.

8.2.7.3 Serial Interface COM2 (Terminal)

COM2 (Terminal) is configured for the connection of the optional handheld keypad. If required, an external computer can be connected to this port instead of the handheld keypad. This computer has to use the same protocol as the handheld keypad (see Section 7 on page 309).

8.2.7.4 USB1 COM3

USB1 (COM3) is a USB 2.0 standard-B interface that operates as a virtual serial port. This port can be used as an alternative to the COM1 port described in Section 8.2.7.2 on page 370 i.e. it can be used for the connection of the following devices:

– Diagnostics computer
– External computer control system that uses the current protocol
– Control system designed for an earlier excimer laser device (backward compatibility)

Alternatively, this port can be deactivated by the user to prevent the input of conflicting commands.

After establishing the connection with the laser device, the USB port on the external computer is automatically allocated a COM number. For communication with the laser control software, the virtual serial port (USB1) on the laser device is always defined as COM3.

8.2.7.5 USB2

USB2 enables data to be uploaded to or download from the laser device controller.

8.2.7.6 Trigger In

NOTICE
Unexpected triggering may damage the laser tube.
To avoid unexpected triggering, never connect or disconnect the external trigger cable while the laser is running.

TRIG. IN is a BNC socket that enables the laser be triggered from an external source (trigger generator).

The external trigger (TRIG. IN) port is only active in one of the external trigger modes, i.e. when the laser device expects external signals. The signals received through the TRIG. IN port can either be trigger signals for externally triggered laser operation or gate signals for operation in the internal gated trigger mode.

8.2.7.7 Sync. Out

SYNC. OUT is a BNC socket that enables the output of a signal that informs an external device that a trigger signal (either internal or external) has just been given.

Synchronization pulses (Sync. Out) are generated when the laser controller recognizes a trigger signal, regardless of whether the signal is internally or externally generated. These pulse signals inform an external device that a trigger signal has been received. This enables the triggering of the laser device to be synchronized with external operating sequences.

8.2.7.8 Ethernet (LAN)

The Ethernet (LAN) port enables timestamped operating data record (DRC) files to be downloaded onto an external computer for subsequent evaluation.

8.3 Mechanical Interface

8.3.1 Beam Delivery System

A guiding system is required to deliver the laser beam from the beam exit of the laser device to the processing station. The beam delivery system is to be configured in accordance with the layout of the end user's fabrication facility. For laser devices purchased together with a beam delivery system, refer to the beam delivery system documentation for further information. The exact position of the beam exit from the laser device is indicated in Section 8.3.2 on page 375.

The responsibility for the correct and sufficient connection of the laser beam exit to an appropriate beam delivery system lies with the supplier of the final equipment assembly.

The entire beam path of Class 4 lasers, including the target area, should be hermetically sealed by an enclosure equipped with interlocks that prevents operation of the laser system unless the enclosure is properly secured. In addition this enclosure shall be secured in such a way that the complete or partial removal or displacement of it requires the use of tools. The beam path shall be free of specularly reflective surfaces and materials which would be combustible if irradiated by the beam.

After installation of the beam delivery system the supplier of the final equipment assembly should ensure that no laser radiation exceeding maximum permitted exposure (MPE) values arises at the connection between the laser device and the beam delivery system. Measurements in accordance with statutory requirements must be carried out by an authorized body to ensure that the MPE-values are not exceeded.

8.3.1.1 COMPex 50/100/200 Series

To connect the beam delivery system with the laser device's beam exit, the external beam delivery tube is to be mounted on the beam shutter using the four 10 mm M4 threaded holes provided.

The dimensions and hole pattern of the shutter plate are shown in Figure 180. The shutter is manufactured from aluminum alloy (AlMg3).

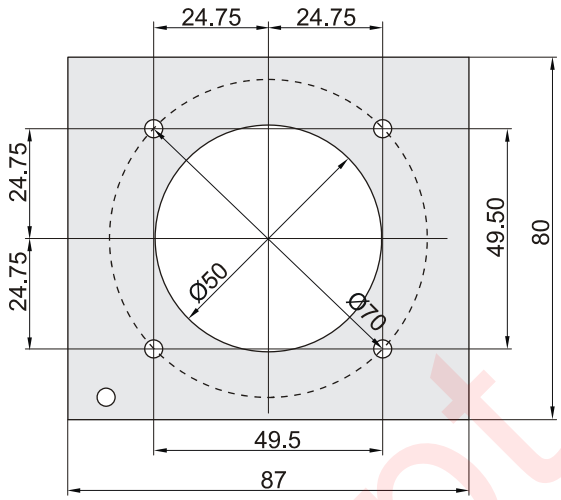


Figure 180: *Mechanical interface of the beam shutter*

8.3.1.2 COMPex F2

On delivery the laser device is not ready for operation. During installation by Coherent Service, the flanged beam delivery tube with beam dump has to be fitted.As the laser device is designed for operation at VUV wavelengths of below 200 nm, the beam delivery system has to be suitable for vacuum operation. To enable the vacuum-tight connection of the beam delivery system at the beam exit, a beam delivery tube with a DN40 ISO-KF flange s provided with the laser device (see Figure 87 on page 199). During installation by Coherent Service, the transport protection plate (see Figure 181, A) is removed and the flanged beam delivery tube with beam dump is fitted at the energy monitor instead of the blind cap.

Figure 181: *Delivery status: Beam exit transport protection plate*

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The front view and dimensions of the flanged beam delivery tube at the beam exit of the laser device are shown in Figure 182. An equivalent DN40 ISO-KF flange is required to attach the external beam delivery system to the laser device.

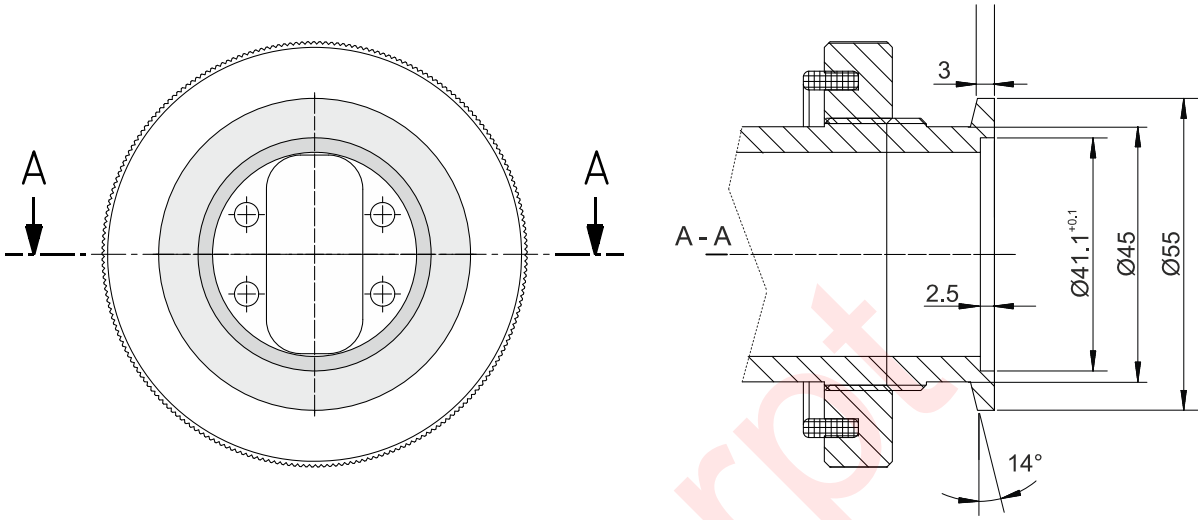

Figure 182: *Dimensions of DN40 KF flange*

8.3.2 Beam Exit Position

The COMPex laser device is equipped with four height-adjustable feet (see Section 8.3.3 on page 376). These enable the beam exit position to be vertically adjusted from 378 mm to 418 mm above the base (locating surface) of the laser device.

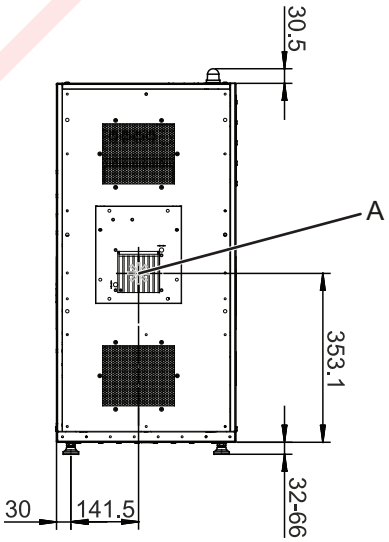

Figure 183: *Beam exit position*

The shutter plate at the beam exit position enables attachment of a beam delivery system (see Section 8.3.1 on page 373).

8.3.3 Foot Configuration

The laser device is equipped with four height-adjustable feet. The positions of the feet in relation to the footprint of the laser device and beam axis are shown Figure 184.

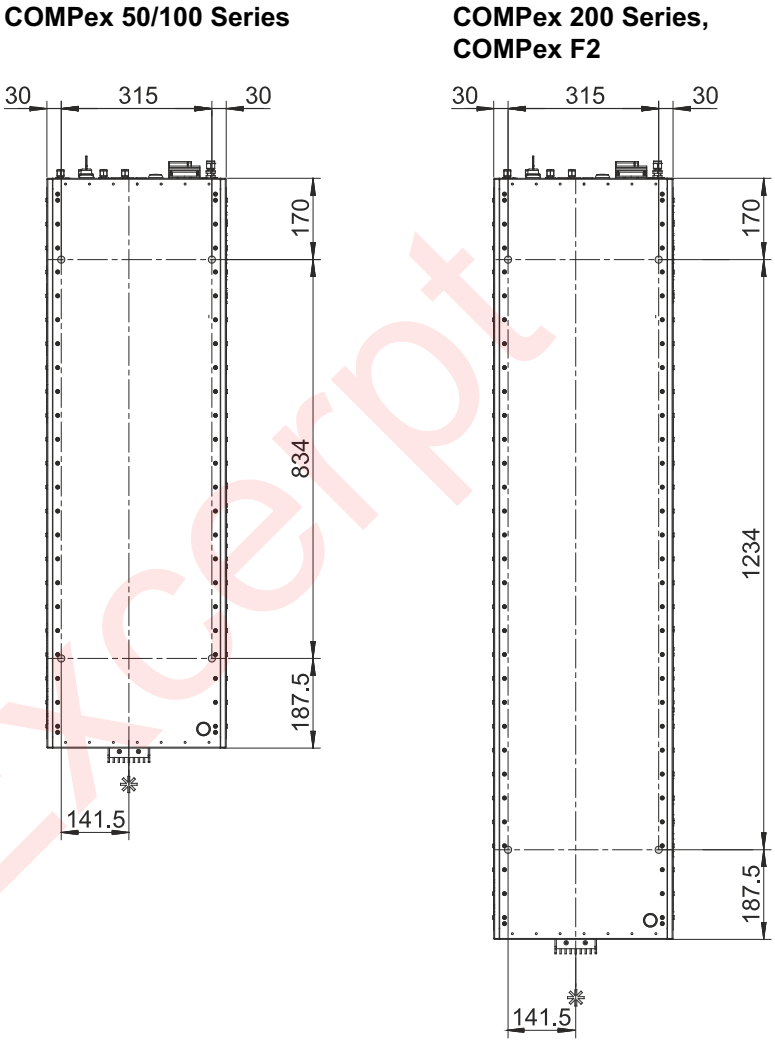

Figure 184: *Positions of feet (top view)*

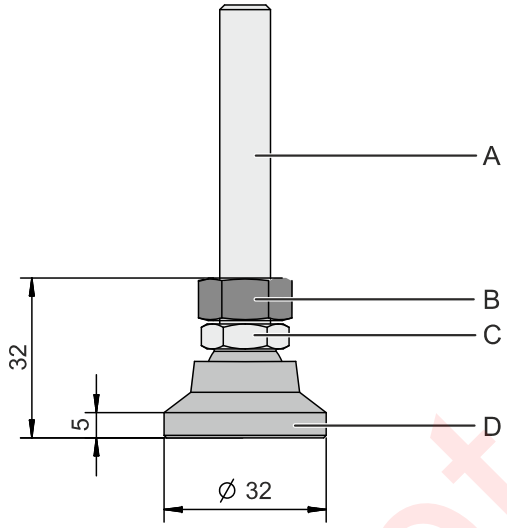

Figure 185: *Foot configuration*

A Threaded rod
B Counter nut
C Adjustment nut
D Foot

To compensate for permissible variations in the flatness of the floor, the four feet are height-adjustable within an adjustment range of 35 mm. Taking into account the minimum foot height of 32 mm, this means that the foot height adjustment range is from 32 mm to 66 mm.

Each foot has a diameter of 32 mm. The shank of the foot has a size M10 thread. The maximum permissible load on each foot is 11 kN.

8.3.4 Main Switch Position

According to EN 60204-1, the main switch has to be positioned between 0.6 m and 1.9 m above the level of the floor on which the operator is to stand (see Figure 186). Where possible, this distance is not to exceed 1.7 m.

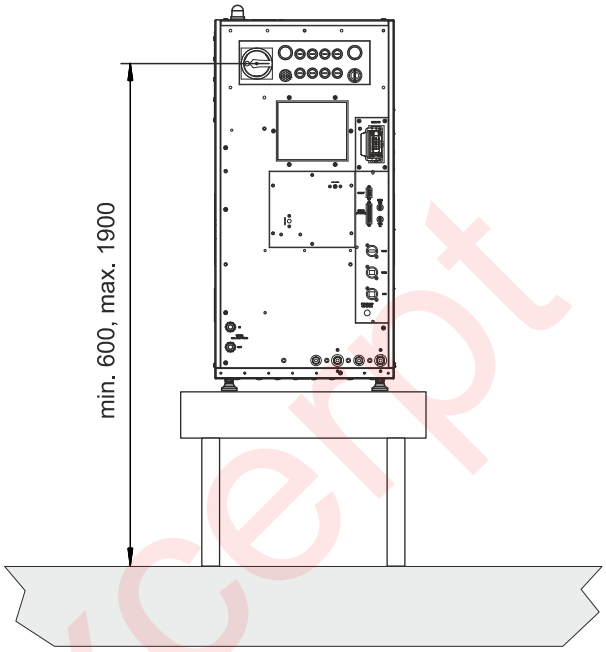

Figure 186: *Required main switch position*

The required position of the main switch is to be taken into account when choosing or configuring the supporting table or base for the COMPex laser device.

If the main switch is not able to be positioned as indicated in Figure 186, the end user is responsible for providing a suitable external device to disconnect the mains power to the laser device.

8.3.5 Anchoring Points

The laser device housing has 8 threaded holes in the bottom. The laser device feet are screwed into 4 of them, the 4 other threaded holes (20 mm, M10 internal thread) are available for seismic protection.The maximum length that screws can be turned into the threaded holes is 15 to 20 mm.

Figure 187 indicates the positions of the threaded holes (A) in relation to the beam exit position, sides of the housing and laser device feet (B). For further information about the location and configuration of the feet refer to Section 8.3.3 on page 376.

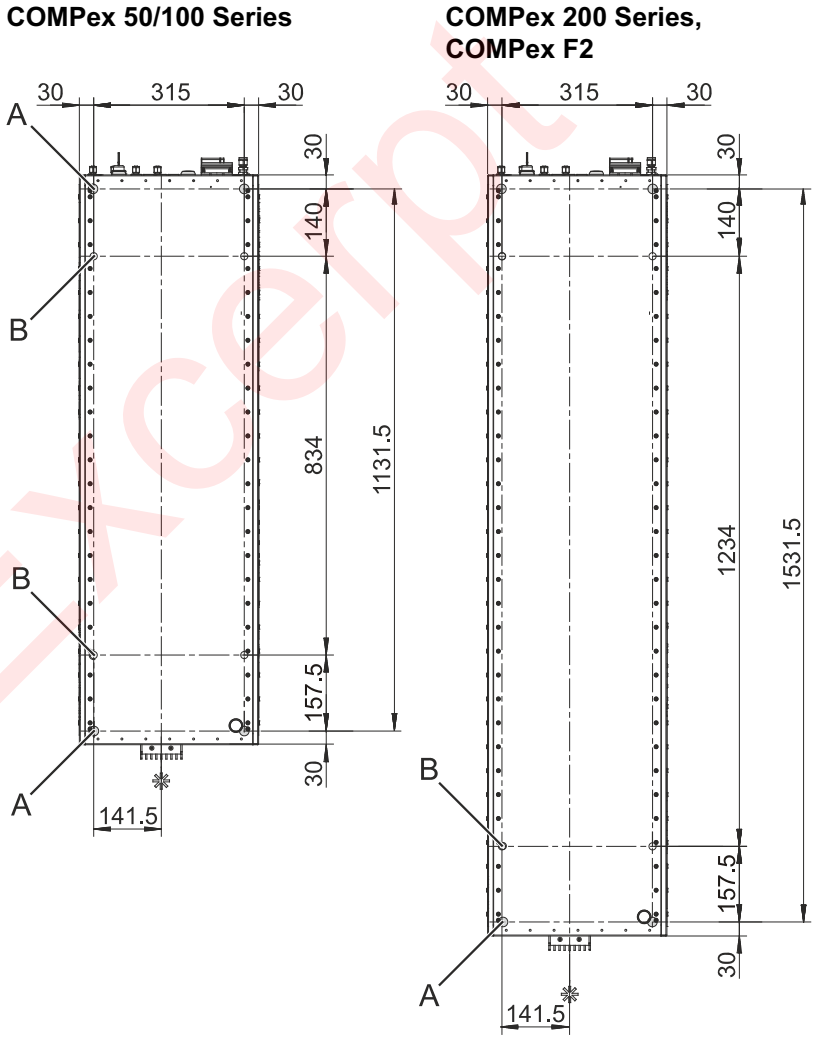

Figure 187: *Position of threaded holes for anchoring device (top view)*

8.4 Preparing the External Gas System

WARNING
Toxic gas hazard!
The excimer gas system of the COMPex laser device is supplied with a gas mixture that contains up to 5% halogen gas. Halogens are extremely reactive and highly toxic gases which can cause severe chemical and thermal burns and in sufficient concentrations can cause death due to respiratory damage. Never inhale the halogen gas mixture. Avoid eye or skin contact.

CAUTION
High quantities of nitrogen may cause asphyxiation!
Keep gas cylinders in a well ventilated place.
Do not breathe the gas.

This section describes the requirements for the external gas supply system installation.

The end user is responsible for providing an external gas supply and handling system that fulfills local gas safety regulations and the requirements of the locally applicable risk management plan. For further information, consult the gas supplier and the institute responsible for occupational safety and health at the installation location (for example, NIOSH, National Institute for Occupational Safety and Health, in the USA).

The gas connections on the laser device are described in Section 8.2.3 on page 360.

In addition to inherent safety considerations (e.g. prevention of spillage and leaks), the purity of the supplied gases is an important issue. Any impurities in the gases will impede laser performance by lowering the output power, disturbing the uniformity of the beam and reducing the lifetime of the laser optics.

The most harmful impurities have been identified as water vapor and hydrocarbons. These impurities can be introduced through a poorly designed and set-up external gas supply and distribution system. Selection of appropriate components for the gas supply system and expert installation are, therefore, crucial for reliable and satisfactory laser operations.

8.4.1 Planning and Installation

The exact configuration of the external gas supply and handling system depends on local requirements and regulations. To ensure safe and correct installation, appoint an approved gas installation expert to plan, install, test and prepare the external gas system.

The external gas system has to be configured to ensure that the gas specifications detailed in Section 9.3 on page 399 exist at the respective inlet valve of the laser device.

Gases and Gas Cylinder

As the quality of the gas is critical to ensure correct performance of the laser, only use gases and gas cylinders as specified (see Section 9.3 on page 399).

NOTICE
If the remaining gas cylinder pressure drops below a critical value, the humidity in the gas may significantly increase. Only use gas cylinders with a remaining pressure of more than 20% of the initial value.

NOTICE
Coherent recommends using premix / halogen gas cylinders for max. 1 year and all other gas cylinders for max. 2 years.

External Gas Lines

As the quality of the gas is critical to ensure correct performance of the laser device, only use gas lines and gas fittings as specified (see Section 8.2.3.1 on page 361).

Coherent recommends a double wall halogen or premix gas supply line from an external gas cylinder for safety reason.

All gas lines and connections should be properly labeled.

Keep the length of the gas lines as short as possible. The max. length of a gas line depends on the gas line diameter and gas cylinder pressure. Longer gas lines require a larger gas line diameter and/or higher gas cylinder pressure. Ensure that the length and diameter of the gas line in conjunction with the gas cylinder pressure enable the specified gas flow rate to be attained.

The software routines Flush Gas Line and Purge Gas Line are applicable for gas lines up to a length of 20 m. If longer gas lines are required, a suitable dedicated mechanical shut-off valve must be installed in the area up to 20 m (the closer to the laser device the better).

For further information, contact the gas installation supplier.

Gas Cabinets

The risk of leakage from gas cylinders, particularly the halogen gas mixture, is a potential health hazard. To minimize this hazard, Coherent recommends the use of safety gas cabinets. Contact the laser gas installation supplier for more information.

Pressure Regulators

NOTICE
Halogen gas mixtures corrode most metals. In addition, unsuitable pressure regulators can cause impurities in the laser gas mixture. Always use stainless steel pressure regulators that are suitable for use with halogen gas mixtures. Consult the pressure regulator supplier to ensure the suitability of the pressure regulator.

Pressure regulators have to be installed in the gas supply lines. Suitable pressure regulators are supplied by gas manufacturers. Coherent recommends pressure regulators which are designed to operate well within the pressure range of the respective gas (see Section 9.3 on page 399).

Pressure and Flow Restrictors

Suitable control devices and fail-safe means of pressure and flow limitation have to be provided to ensure that there is no risk of excess pressure or flow at the respective gas inlet connections.

Each of the gas lines requires a single fault safety overpressure limiting device that limits the line pressure at the connection to the laser device to 6 bar (g).

In addition, the gas flow in each line shall also not exceed the specified upper limit of the flow rate range (see Section 9.3 on page 399).

Environmental Air Quality

End users should check with their local air quality control authority for locally applicable standards and regulations regarding a potential discharge of the specified gases fluorine (F_2) or hydrogen chloride (HCl) into the atmosphere.

Provided that the maintenance instructions indicated in Section 5 on page 183 are observed, no further environmental requirements are foreseen for the excimer laser device.

8.4.2 Cleaning and Testing

NOTICE
To avoid internal contamination or damage, do not use the laser device gas system to clean and test external gas lines immediately after a new gas supply installation or similar.

The purity / freeness of contamination of the gas system obtained must correspond with the required purities of the laser gases (see Section 9.3 on page 399). Where necessary, contact high purity gas specialists for further information.

During installation, take care to ensure that all gas lines remain completely free of oil and grease. It is essential that no contamination be present on the walls of the tubing. Hydrocarbon contamination from even a finger print may degrade laser performance.

Use suitable leak testing procedures to ensure that the acceptable leak limit of ≤ 1 x 10^{-8} mbar l/s (≤ 1 x 10^{-6} Pa l/s) is not exceeded.

After assembly and leak testing, remove all moisture from the gas lines. Following this, completely flush all gas lines for several times using the software routine Flush Gas Line (in accordance with Section 5.4.2 on page 203) to minimize excess levels of contaminants such as oxygen, nitrogen, carbon compounds and water in the gas lines.

8.4.3 Passivation

Any clean metal surface exposed to normal atmosphere can form oxides and other compounds. Passivation is the process in which halogen reacts with these surfaces to form a stable layer which will not undergo further reaction with halogen.

Only the halogen line or premix line needs to be passivated. The passivation process has to be performed after the gas distribution system has passed the leakage and cleanliness checks (see Section 8.4.2 on page 383) and before the laser device is commissioned. It generally consists of repeatedly filling the gas line to operating pressure with the halogen gas mixture, allowing the halogen in the gas mixture time to react and evacuating the line. The exact procedure depends on influencing factors such as the configuration of the external gas system, available tools and materials and the time line of the installation. For further information contact Coherent Service.

8.4.4 Certification

The user should retain the certification of all materials used in the construction of the gas lines. These should be available for inspection by personnel from Coherent or the system integrator upon request.

All test results documenting the checks for cleanliness and leaks should be maintained by the user and be available for inspection by personnel from Coherent or the system integrator upon request.

8.5 Storing, Moving and Unpacking

WARNING
Risk of crushing!
The COMPex 50/100 Series weighs approx. 376 kg together with its rigid transport packaging and approx. 280 kg without packaging.
The COMPex 200 Series and COMPex F2 weighs approx. 401 kg together with its rigid transport packaging and approx. 325 kg without packaging.
Prevent tipping or dropping during lifting and transportation.

To ensure that the laser device is stored, moved and unpacked safely and that no damage occurs, strictly adhere to the requirements in this section.

When externally or internally moving the laser device and its components, always follow all standard safety precautions and practices for the transportation and handling of heavy equipment.

NOTICE
Risk of damage through shocks and excess vibration!
Shocks and excess vibration can damage sensitive and precision components of the laser device, including the laser device's feet.
Avoid sudden shocks, especially when the laser device is attached to the base plate of the rigid transport packaging.

NOTICE
Risk of damage through excess tilting!
Keep the laser device as horizontal as possible during transportation and installation. If tilting is necessary, ensure that the maximum permissible tilting gradients are not exceeded. Only tilt for short periods.

The maximum permissible tilting gradients are 10° around the beam axis and 20° longitudinally.

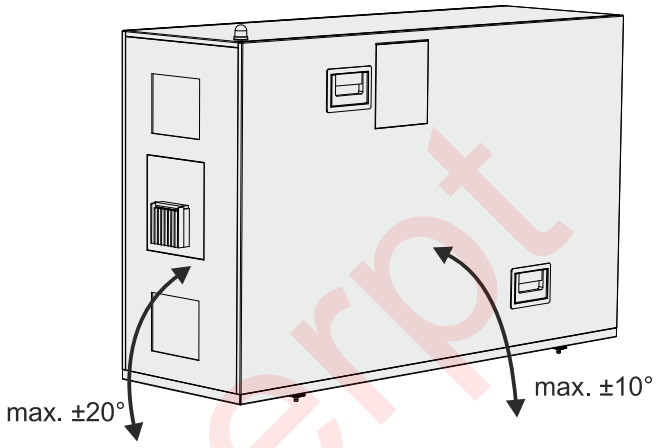

Figure 188: *Permitted tilting gradients during transport*

Avoid vibrations when the laser device is tilted.

8.5.1 Transport Packaging

This section describes the means of packaging of the COMPex laser device to ensure safe shipment and delivery in the required condition.

NOTICE
Risk of transport damage!
Always retain the transport packaging to ensure optimum protection of the laser device during sub sequent shipment.

The size, weight and configuration of the transport packaging is indicated in Section 9.9.2 on page 421.

Each COMPex laser device has two-stage transport packaging.

– Rigid transport packaging
– Anti-static (polyethylene) inner cover

The rigid transport packaging (see Figure 189) fully encapsulates the laser device and inner cover. It consists of a plywood base pallet (C) and plywood upper panels (A) at the sides, front rear and top.

Figure 189: *Rigid transport packaging*

Shock absorbing foam packaging bags are placed at all sides between the laser device and the rigid transport packaging.The base pallet has two shock absorbing buffers (see Figure 190). The laser device feet are placed in the locating holes (A). This fixing of the feet and the foam packaging bags secure the laser device in position when the rigid packaging is closed.

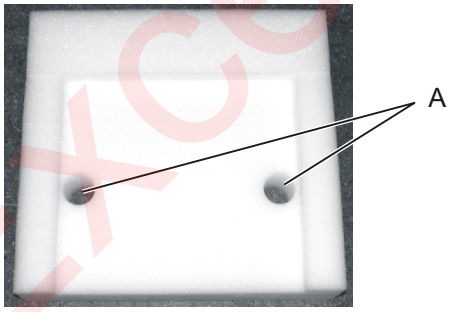

Figure 190: *Shock absorbing buffers*

The laser device is to be stored in the rigid transport packaging. Remove the anti-static inner cover immediately prior to installing the laser device.

8.5.2 Transport / Lifting With Rigid Packaging

WARNING
Risk of crushing!
The heaviest version of the COMPex laser device in its rigid transport packaging weighs approx. 401 kg.
Prevent tipping or dropping during lifting and transportation.

Transport / Lifting device

A suitable fork lift truck or similar transport device is required to safely lift the laser device. Ensure that the fork length and loading capacity is sufficient to safely lift the laser device in its packaging. The dimensions and weight of the packed laser device are indicated in Section 9.9.2 on page 421.

The laser device can be lifted longitudinally from the side. Set the forks as far apart as possible to safely lift the laser device.

8.5.3 Initial Inspection of Delivery

Purpose

Check that no damage has occurred to the laser device during transportation and that the shipment is complete.

To monitor the handling of the laser device during transportation, a SHOCKWATCH indicator (see Figure 189, B) is fixed to the transport packaging. It changes to red when subject to excess shocks.

To detect tipping, a tilt indicator is fitted to a short side of the transport packaging. Blue beads in the arrowhead indicate that the container was tipped.

Tools and Materials

- None

Initially Checking the Laser Device Packaging

1. Ensure that the SHOCKWATCH indicator on the rigid transport packaging has not turned to red.
2. Ensure that there are no beads in the arrowhead of the tilt indicator.
3. Inspect for visible signs of damage to the rigid transport packaging.

Checking the Contents of Shipment

4. Check the contents of the shipment against the packing list provided.
5. Sign the delivery note.

If any parts are missing, immediately contact Coherent. The contact address is indicated on the reverse side of the cover sheet of this manual.

Damaged Deliveries

If the initial inspection of the delivery indicates mishandling or tipping of the laser device during transport, proceed as follows:

- Do not refuse the shipment.
- Make a corresponding notation on the delivery receipt document.
- If there are visible signs of damage, leave the laser device in the original transport packaging and request immediate inspection from the carrier within 3 days of delivery. Take photographs of the damage.
- If there are no visible signs of damage to the packaging, remove the packaging and check for visible signs of damage to the laser device.
- If there are signs of damage to the laser device, immediately contact Coherent for further inspection and rectification. Take photographs of the damage.

8.5.4 Remove Rigid Packaging

Purpose

Remove of the top and side panels from the rigid transport packaging.

Tools and Materials

- Suitable fork-lift truck or similar device
- Screwdriver for removal of clips

Preparation

1. Using the fork-lift truck or appropriate device, move the laser device to the location where it is to be unpacked.
2. Set down the laser device in the unpacking location.

Removing the Rigid Packaging

NOTICE
The original packaging is needed to reship the laser device. Remove and store the removed packaging in such a way that no parts are lost or damaged.

CAUTION
Risk of injury through incorrect removal of the clips!
The transport packaging clips are under tension.
Do not use excess force to remove.
While levering off, use the other hand to restrain movement.

3. Working from the top downwards, using a screwdriver remove the clips from the rigid transport packaging.
4. When the corresponding clips have been removed, remove the top, front, rear and side panels of the packaging.

Storing the Transport Packaging

5. Stack the disassembled panels of the rigid transport packaging (COMPex 200 Series, COMPex F2: and accessory package) onto the base pallet.

   When stacking, ensure that the outer cover does not become contaminated or damaged and that the inside surfaces of the panels cannot become contaminated.

8.5.5 Transport / Lifting Without Rigid Packaging

WARNING
Risk of crushing!
The COMPex 50/100 Series laser device weighs approx. 280 kg without packaging
The COMPex 200 Series and COMPex F2 laser device weighs approx. 325 kg without packaging.
Prevent tipping or dropping during lifting and transportation.

NOTICE
Risk of contaminating or damaging the laser optics!
To avoid the formation of condensed water, ensure that the max. permissible temperature gradient (5 °C / h) is maintained while moving the laser device from the storage area.

Ensure that all passageways, corridors and access points have sufficient clearances. Pay particular attention to the clearances required to turn the laser device. The dimensions of the laser device are indicated in Section 9.9 on page 418.

A suitable lifting device is required to lift and transport the laser device.

Regardless of the chosen means of lifting and transport, always take into account the position of the center of gravity of the laser device (see Section 9.9.1 on page 420).

NOTICE
Incorrect lifting can cause serious damage to the laser device!
Use lifting points as far apart as possible to safely lift the laser device.

When using a fork lift truck, always transport the laser device together with the base pallet. Ensure that the fork length and/or the loading capacity are sufficient to safely lift and transport the laser device. Always use suitable tie-down straps to secure the laser device to the pallet that prevent it from tipping or slipping during transport.

After removing the pallet for final positioning, always lift the laser device from the service side and position the forks between the feet.

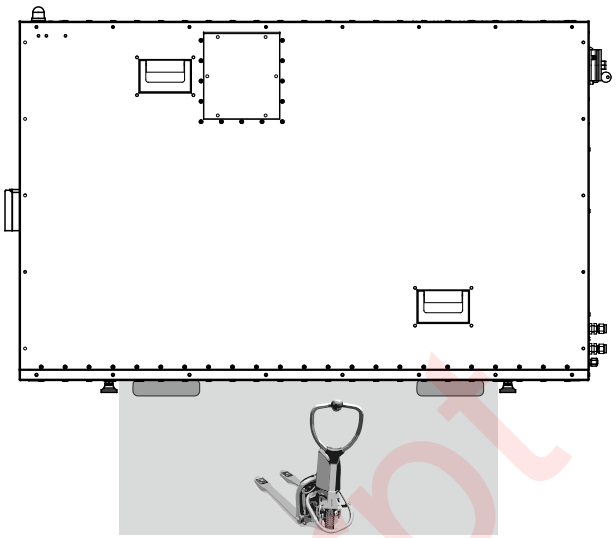

Figure 191: *Fork lift area for final positioning*

When using a crane, position the lifting harness or belt as near to the laser device's feet as possible. The belts should be placed outside of the feet.

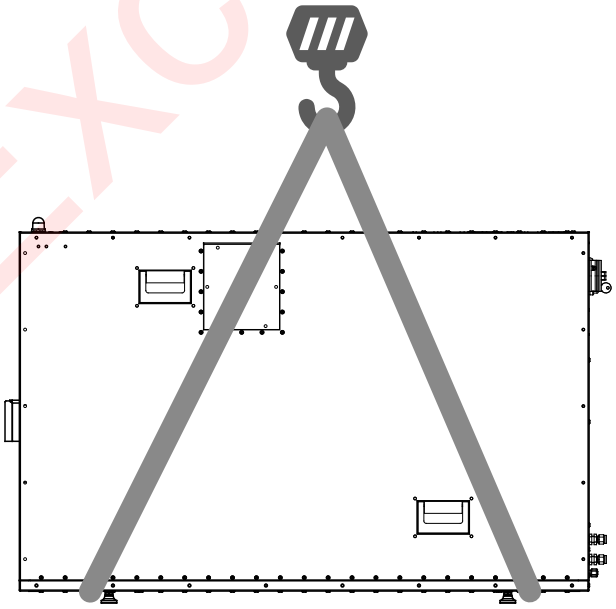

Figure 192: *Positioning the belts for crane lifting*

8.5.6 Remove Anti-Static Inner Cover

Purpose

Remove the anti-static inner cover from the laser device and unpack the accessories.

Tools and Materials

- Knife for cutting sealing tape

Preparation

1. Move the laser device and accessories to the installation area.

Removing the Inner Covers

NOTICE
The original packaging is needed to re-ship the laser device. Store the removed packaging in such a way that no parts are lost or damaged.

2. Remove the tape that seals the anti-static inner cover onto the laser device and lift the anti-static inner cover off the laser device.
3. Take the accessories out of the package and carefully clean them as required.

9 SPECIFICATIONS

Should information on separate sheets (e.g. laser data sheets) attached to or provided together with this Instruction Manual contradict the information in this section, the information on the separate data sheets has priority.

9.1 Lifetime

Expected lifetime laser device 10 years

9.2 Laser Beam Parameters

9.2.1 Laser Radiation Safety Specifications

The specifications are required for ordering safety equipment (e.g. protective eyewear).

Laser Radiation Safety Specification	COMPex 50	COMPex 50 FBG	COMPex 102	COMPex 110	COMPex 201	COMPex 205	COMPex F2
Laser class (IEC 60825-1)	4	4	4	4	4	4	4
Max. average power	50 W	50 W	50 W	50 W	50 W	50 W	50 W
Max. output / pulse	0.7 J	0.7 J	0.7 J	0.7 J	1.0 J	1.0 J	1.0 J
Pulse duration	10 ns to 50 ns	10 ns to 50 ns	10 ns to 50 ns	10 ns to 50 ns	10 ns to 50 ns	10 ns to 50 ns	10 ns to 50 ns
Emitted wavelength	193 nm to 351 nm	193 nm to 351 nm	193 nm to 351 nm	193 nm to 351 nm	193 nm to 351 nm	193 nm to 351 nm	157 nm to 193 nm 620 nm to 800 nm[a]

a. COMPex F2 (157 nm): Max. average power of visible light (620 nm to 800 nm) is approx. 5% of the max. UV average power. The max. UV average power at 157 nm does not reach more than 2.5 W (50 mJ). More than 95% of the visible light is emitted in the range from 725 nm to 765 nm.

9.2.2 Integration Specification

Integration specification are subject to change without notice due to product improvements.

COMPex 50

Integration Specification	ArF	KrF
Spectral Beam Properties		
Nominal wavelength	193 nm	248 nm
Repetition Rate		
Max. repetition rate	50 Hz	50 Hz
Pulse Energy, Power and Duration		
Max. pulse energy	100 mJ	150 mJ
Max. average power	4 W	7 W
Energy stability, 1 Sigma	1.5%	0.75%
Pulse duration (FWHM), typ.	15 ns	20 ns
Beam Characteristics		
Beam size, vertical (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	14 mm	14 mm
Beam size, horizontal (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	5 mm	5 mm
Beam divergence, vertical (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	2 mrad	2 mrad
Beam divergence, horizontal (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	1 mrad	1 mrad

COMPex 50 FBG

Integration Specification	KrF
Spectral Beam Properties	
Nominal wavelength	248 nm
Repetition Rate	
Max. repetition rate	100 Hz
Pulse Energy, Power and Duration	
Max. pulse energy	140 mJ
Max. average power	12 W
Energy stability, 1 Sigma	0.75%
Pulse duration (FWHM), typ.	20 ns
Beam Characteristics	
Beam size, vertical (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	12 mm
Beam size, horizontal (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	4.5 mm
Beam divergence, vertical (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	0.3 mrad
Beam divergence, horizontal (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	0.2 mrad
Spatial coherence, horizontal (FWHM), typ.	800 µm

COMPex 102

Integration Specification	ArF	KrF	XeCl	XeF
Spectral Beam Properties				
Nominal wavelength	193 nm	248 nm	308 nm	351 nm
Repetition Rate				
Max. repetition rate	20 Hz	20 Hz	20 Hz	20 Hz
Pulse Energy, Power and Duration				
Max. pulse energy	240 mJ	400 mJ	250 mJ	200 mJ
Max. average power	4.8 W	8 W	5 W	4 W
Energy stability, 1 Sigma	1.5%	0.75%	1.2%	1%
Pulse duration (FWHM), typ.	15 ns	20 ns	20 ns	20 ns
Beam Characteristics				
Beam size, vertical (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	24 mm	24 mm	24 mm	24 mm
Beam size, horizontal (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	10 mm	10 mm	10 mm	10 mm
Beam divergence, vertical (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	3 mrad	3 mrad	3 mrad	3 mrad
Beam divergence, horizontal (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	1 mrad	1 mrad	1 mrad	1 mrad

COMPex 110

Integration Specification	ArF	KrF	XeCl	XeF
Spectral Beam Properties				
Nominal wavelength	193 nm	248 nm	308 nm	351 nm
Repetition Rate				
Max. repetition rate	100 Hz	100 Hz	100 Hz	100 Hz
Pulse Energy, Power and Duration				
Max. pulse energy	240 mJ	400 mJ	250 mJ	200 mJ
Max. average power	12 W	30 W	16 W	12 W
Energy stability, 1 Sigma	1.5%	0.75%	1.2%	1%
Pulse duration (FWHM), typ.	15 ns	20 ns	20 ns	20 ns
Beam Characteristics				
Beam size, vertical (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	24 mm	24 mm	24 mm	24 mm
Beam size, horizontal (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	10 mm	10 mm	10 mm	10 mm
Beam divergence, vertical (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	3 mrad	3 mrad	3 mrad	3 mrad
Beam divergence, horizontal (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	1 mrad	1 mrad	1 mrad	1 mrad

COMPex 201

Integration Specification	ArF	KrF	XeCl	XeF
Spectral Beam Properties				
Nominal wavelength	193 nm	248 nm	308 nm	351 nm
Repetition Rate				
Max. repetition rate	10 Hz	10 Hz	10 Hz	10 Hz
Pulse Energy, Power and Duration				
Max. pulse energy	400 mJ	750 mJ	500 mJ	300 mJ
Max. average power	4 W	7.5 W	5 W	3 W
Energy stability, 1 Sigma	1.5%	0.75%	1.2%	1%
Pulse duration (FWHM), typ.	15 ns	20 ns	20 ns	20 ns
Beam Characteristics				
Beam size, vertical (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	24 mm	24 mm	24 mm	24 mm
Beam size, horizontal (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	10 mm	10 mm	10 mm	10 mm
Beam divergence, vertical (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	3 mrad	3 mrad	3 mrad	3 mrad
Beam divergence, horizontal (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	1 mrad	1 mrad	1 mrad	1 mrad

COMPex 205

Integration Specification	ArF	KrF	XeCl	XeF
Spectral Beam Properties				
Nominal wavelength	193 nm	248 nm	308 nm	351 nm
Repetition Rate				
Max. repetition rate	50 Hz	50 Hz	50 Hz	50 Hz
Pulse Energy, Power and Duration				
Max. pulse energy	400 mJ	750 mJ	500 mJ	300 mJ
Max. average power	15 W	33 W	20 W	15 W
Energy stability, 1 Sigma	1.5%	0.75%	1.2%	1%
Pulse duration (FWHM), typ.	15 ns	20 ns	20 ns	20 ns
Beam Characteristics				
Beam size, vertical (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	24 mm	24 mm	24 mm	24 mm
Beam size, horizontal (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	10 mm	10 mm	10 mm	10 mm
Beam divergence, vertical (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	3 mrad	3 mrad	3 mrad	3 mrad
Beam divergence, horizontal (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	1 mrad	1 mrad	1 mrad	1 mrad

COMPex F2

Integration Specification	F_2	ArF
Spectral Beam Properties		
Nominal wavelength	157 nm	193 nm
Repetition Rate		
Max. repetition rate	50 Hz	50 Hz
Pulse Energy, Power and Duration		
Max. pulse energy	32 mJ	400 mJ
Max. average power	1.6 W	15 W
Energy stability, 1 Sigma	5%	1.5%
Pulse duration (FWHM), typ.	15 ns	20 ns
Beam Characteristics		
Beam size, vertical (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	22 mm	22 mm
Beam size, horizontal (FWHM), typ., (at shutter plane, max. HV for ext. trigger, 5 Hz)	8 mm	8 mm
Beam divergence, vertical (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	3 mrad	3 mrad
Beam divergence, horizontal (FWHM), typ., (at focal plane of 1 m lens, max. HV for ext. trigger, 5 Hz)	1 mrad	1 mrad

9.3 Gases

Always follow the gas manufacturer’s instructions and local regulations.

The purity of a gas mixture and the max. H_2O fraction in a gas mixture results from the specified purity of the single gases.

9.3.1 Gas Supply Mode: Premix

Inlet pressure	4.4 bar (abs) to 5.2 bar (abs)
Flow rate Buffer (Premix)	0.8 l/s to 3.0 l/s
Flow rate Inert	0.8 l/s to 3.0 l/s

9.3.1.1 Premix

COMPex 50

193 nm (ArF)

Type of gas	4.51% Ar, 0.13% F_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration Ar	4.51% ± 0.0902%
Purity Ar	99.995% (4.5)
Max. H_2O fraction in Ar	5 ppm
Concentration F_2	0.13% ± 0.0065%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

COMPex 50, COMPex 50 FBG

248 nm (KrF)

Type of gas	3.42% Kr, 0.13% F_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration Kr	3.42% ± 0.0684%
Purity Kr	99.995% (4.5)
Max. H_2O fraction in Kr	5 ppm
Concentration F_2	0.13% ± 0.0065%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

COMPex 100 Series

193 nm (ArF)

Type of gas	16.5% He, 5.33% Ar, 0.17% F_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration He	16.5% ± 0.165%
Purity He	99.995% (4.5)
Max. H_2O fraction in He	5 ppm
Concentration Ar	5.33% ± 0.0533%
Purity Ar	99.995% (4.5)
Max. H_2O fraction in Ar	5 ppm
Concentration F_2	0.17% ± 0.0085%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

248 nm (KrF)

Type of gas	3.03% Kr, 0.12% F_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration Kr	3.03% ± 0.0606%
Purity Kr	99.995% (4.5)
Max. H_2O fraction in Kr	5 ppm
Concentration F_2	0.12% ± 0.006%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

308 nm (XeCl)

Type of gas	1.88% Xe, 0.13% HCl, 0.03% H_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration Xe	1.88% ± 0.0376%
Purity Xe	99.995% (4.5)
Max. H_2O fraction in Xe	5 ppm
Concentration HCl	0.13% ± 0.0026%
Purity HCl	99.995% (4.5)
Max. H_2O fraction in HCl	2 ppm
Concentration H_2	0.03% ± 0.0015%
Purity H_2	99.995% (4.5)
Max. H_2O fraction in H_2	10 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Aluminum, 10 l or 40 l, max. 150 bar

351 nm (XeF)

Type of gas	0.46% Xe, 0.18% F_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration Xe	0.46% ± 0.0092%
Purity Xe	99.995% (4.5)
Max. H_2O fraction in Xe	5 ppm
Concentration F_2	0.18% ± 0.009%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

COMPex 200 Series

193 nm (ArF)

Type of gas	6.25% Ar, 0.16% F_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration Ar	6.25% ± 0.0625%
Purity Ar	99.995% (4.5)
Max. H_2O fraction in Ar	5 ppm
Concentration F_2	0.16% ± 0.008%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

248 nm (KrF)

Type of gas	3.82% Kr, 0.09% F_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration Kr	3.82% ± 0.0764%
Purity Kr	99.995% (4.5)
Max. H_2O fraction in Kr	5 ppm
Concentration F_2	0.09% ± 0.009%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

308 nm (XeCl)

Type of gas	2.78% Xe, 0.08% HCl, 0.02% H_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration Xe	2.78% ± 0.0556%
Purity Xe	99.995% (4.5)
Max. H_2O fraction in Xe	5 ppm
Concentration HCl	0.08% ± 0.004%
Purity HCl	99.995% (4.5)
Max. H_2O fraction in HCl	2 ppm
Concentration H_2	0.02% ± 0.001%
Purity H_2	99.995% (4.5)
Max. H_2O fraction in H_2	10 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Aluminum, 10 l or 40 l, max 150 bar

351 nm (XeF)

Type of gas	12.83% He, 0.45% Xe, 0.19% F_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration He	12.83% ± 0.1283%
Purity He	99.995% (4.5)
Max. H_2O fraction in He	5 ppm
Concentration Xe	0.45% ± 0.009%
Purity Xe	99.995% (4.5)
Max. H_2O fraction in Xe	5 ppm
Concentration F_2	0.19% ± 0.0095%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

COMPex F2

157 nm (F_2)

Type of gas	0.087% F_2 in He
Purity He	99.995% (4.5)
Max. H_2O fraction in He	5 ppm
Concentration F_2	0.087% ± 0.0087%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

193 nm (ArF)

Type of gas	6.25% Ar, 0.16% F_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration Ar	6.25% ± 0.0625%
Purity Ar	99.995% (4.5)
Max. H_2O fraction in Ar	5 ppm
Concentration F_2	0.16% ± 0.008%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

9.3.1.2 Inert

Type of gas	He 4.5
Purity	99.995% (4.5)
Max. H_2O fraction	5 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 200 bar

9.3.2 Gas Supply Mode: Single Gases

Type	Wavelength	Required Laser Gases			
		Halogen	Rare	Buffer	Inert
COMPex 50	248 nm	F_2 in He[a]	Kr	Ne	He[b]
	193 nm	F_2 in He[a]	Ar	Ne	He[b]
COMPex 50 FBG	248 nm	F_2 in He[a]	Kr	Ne	He[b]
COMPex 100 Series	351 nm	F_2 in He[a]	Xe	Ne	He[b]
	308 nm	HCl, H_2 in He	Xe	Ne	He[b]
	248 nm	F_2 in He[a]	Kr	Ne	He[b]
	193 nm	F_2 in He[a]	Ar	Ne	He
COMPex 200 Series	351 nm	F_2 in He[a]	Xe	Ne	He
	308 nm	HCl, H_2 in He	Xe	Ne	He[b]
	248 nm	F_2 in He[a]	Kr	Ne	He[b]
	193 nm	F_2 in He[a]	Ar	Ne	He[b]
COMPex F2	157 nm	F_2 in He	-	-	He
	193 nm	F_2 in He[a]	Ar	Ne	He[b]

a. Ne can be used instead of He
b. Required for laser maintenance only

9.3.2.1 Laser Gases

Inlet pressure	4.4 bar (abs) to 5.2 bar (abs)
Flow rate Halogen	0.1 l/s to 0.5 l/s
Flow rate Rare	0.1 l/s to 0.5 l/s
Flow rate Buffer (Premix)	0.8 l/s to 3.0 l/s
Flow rate Inert	0.8 l/s to 3.0 l/s

Halogen

Fluorine (F_2 in He)

Type of gas	5% F_2 in He
Purity He	99.995% (4.5)
Max. H_2O fraction in He	5 ppm
Concentration F_2	5% ± 0.1%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 10 l, max. 200 bar

Fluorine (F_2 in Ne)

NOTICE
Do not use F_2 in Ne when operating the COMPex F2 laser device at 157 nm.

Type of gas	5% F_2 in Ne
Purity Ne	99.995% (4.5)
Max. H_2O fraction in Ne	3 ppm
Concentration F_2	5% ± 0.1%
Purity F_2	99.0% (2.0)
Max. HF fraction in F_2	3000 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 10 l, max. 150 bar

Hydrogen Chloride (HCl, H_2 in He)

Type of gas	4.5% HCl, 0.9% H_2 in He
Purity He	99.995% (4.5)
Max. H_2O fraction in He	5 ppm
Concentration HCl	4.5% ± 0.09%
Purity HCl	99.995% (4.5)
Max. H_2O fraction in HCl	2 ppm
Concentration H_2	0.9% ± 0.018%
Purity H_2	99.995% (4.5)
Max. H_2O fraction in H_2	10 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 10 l or 50 l, max. 150 bar

Rare

Argon (Ar)

Type of gas	Ar 4.5
Purity	99.995% (4.5)
Max. H_2O fraction	5 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 200 bar

Krypton (Kr)

Type of gas	Kr 4.5
Purity	99.995% (4.5)
Max. H_2O fraction	5 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 10 l or 50 l, max. 200 bar

Xenon (Xe)

Type of gas	Xe 4.5
Purity	99.995% (4.5)
Max. H_2O fraction	5 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 10 l, max. 50 bar

Buffer

Neon (Ne)

Type of gas	Ne 4.5
Purity	99.995% (4.5)
Max. H_2O fraction	3 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 150 bar

Inert

Helium (He)

Type of gas	He 4.5
Purity	99.995% (4.5)
Max. H_2O fraction	5 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 200 bar

9.3.3 Purge Gas

NOTICE
Risk of seriously damaging the laser tube
Nitrogen is only intended for purging the beam path and optics.
Never fill nitrogen into the laser tube or excimer laser gas supply lines.

Nitrogen (N_2)

Type of gas	N_2 5.0
Purity	99.999% (5.0)
Max. H_2O fraction	5 ppm
Remaining gas cylinder pressure	> 20% of the initial gas cylinder pressure
Recommended cylinder	Steel, 50 l, max. 200 bar
Flow rate	
- COMPex 50/100/200 Series: required for ArF, recommended for all other gases	8 l/min to 12 l/min
- COMPex F2: required	4 l/min to 8 l/min

9.4 Electricity

	Voltage	Phases	Full load amps	Machine OCP rating	Power	Amp rating largest load	Short circuit current rating
COMPex 50	104 V AC	1	15 A	12 A	1.5 kVA	12.5 A	1 kA
	120 V AC	1	13 A	12 A	1.5 kVA	12.5 A	1 kA
	208 V AC	2	7 A	16 A	1.5 kVA	12.5 A	1 kA
	230 V AC	1	6 A	16 A	1.5 kVA	12.5 A	1 kA
COMPex 50 FBG	104 V AC	1	21 A	12 A	2 kVA	12.5 A	1 kA
	120 V AC	1	19 A	12 A	2 kVA	12.5 A	1 kA
	208 V AC	2	10 A	16 A	2 kVA	12.5 A	1 kA
	230 V AC	1	10 A	16 A	2 kVA	12.5 A	1 kA
COMPex 102	104 V AC	1	12 A	12 A	1.5 kVA	12.5 A	1 kA
	120 V AC	1	11 A	12 A	1.5 kVA	12.5 A	1 kA
	208 V AC	2	8 A	16 A	1.5 kVA	12.5 A	1 kA
	230 V AC	1	6 A	16 A	1.5 kVA	12.5 A	1 kA
COMPex 110	104 V AC	1	24 A	12 A	3 kVA	12.5 A	1 kA
	120 V AC	1	22 A	12 A	3 kVA	12.5 A	1 kA
	208 V AC	2	15 A	16 A	3 kVA	12.5 A	1 kA
	230 V AC	1	13 A	16 A	3 kVA	12.5 A	1 kA
COMPex 201	104 V AC	1	12 A	12 A	1.5 kVA	12.5 A	1 kA
	120 V AC	1	11 A	12 A	1.5 kVA	12.5 A	1 kA
	208 V AC	2	8 A	16 A	1.5 kVA	12.5 A	1 kA
	230 V AC	1	6 A	16 A	1.5 kVA	12.5 A	1 kA
COMPex 205	104 V AC	1	24 A	12 A	3 kVA	12.5 A	1 kA
	120 V AC	1	22 A	12 A	3 kVA	12.5 A	1 kA
	208 V AC	2	15 A	16 A	3 kVA	12.5 A	1 kA
	230 V AC	1	13 A	16 A	3 kVA	12.5 A	1 kA
COMPex F2	104 V AC	1	23 A	12 A	2.2 kVA	12.5 A	1 kA
	120 V AC	1	20 A	12 A	2.2 kVA	12.5 A	1 kA
	208 V AC	2	11 A	16 A	2.2 kVA	12.5 A	1 kA
	230 V AC	1	10 A	16 A	2.2 kVA	12.5 A	1 kA

Wiring for 104 V / 120 V

Wire	Color	Type	Gauge
Phase L	Black	S0	AWG12
N	White	S0	AWG12
PE	Green	S0	AWG12

Wiring for 208 V

Wire	Color	Cross Section
Phase L1	Brown	2.5 mm²
Phase L2	Blue	2.5 mm²
PE	Yellow/Green	2.5 mm²

Wiring for 230 V

Wire	Color	Cross Section
Phase L	Brown	2.5 mm²
N	Blue	2.5 mm²
PE	Yellow/Green	2.5 mm²

Required Rating of Wall Socket Fuse

104 V / 120 V	max. 25 A
208 V / 230 V	max. 16 A

Mains Power Supply Requirements

Mains voltage range	± 10%
Frequency	50 Hz / 60 Hz

Overvoltage category of the laser device: II (acc. to IEC 60364)

9.5 Water Cooling

Water cooling required at repetition rate	
- COMPex 50 / 50 FBG / 110	> 20 Hz
- COMPex 205 / F2	> 10 Hz
Water flow rate	≤ 5 l/min
Water temperature at inlet	10 °C to 20 °C[a]
Static water pressure	≤ 3 bar
Dynamic water pressure drop in/ out	≤ 3 bar
Heat transfer to water	< 1.5 kW
Electrical resistance	10 kΩ cm to 100 kΩ cm
Suspended particle size	< 200 µm
Hardness	< 100 mg/l Ca
pH range	6.5 to 8
Water connector size	10 mm (outer diameter) pipe or ½" (inner diameter) hose with nozzle and clamp (in laser device tool case)
Tube optimum operating temperature	approx. 36 °C

a. When setting the cooling water temperature, take into account the dew point. Set the inlet temperature of the cooling water in accordance with the ambient air temperature and relative humidity to prevent dew forming on the water lines in the laser device. The operating temperature of an external cooling system should also be set so that it operates above the dew point or the water lines will have to be insulated.

9.6 Air Intake / Exhaust

Air flow rate	200 m³/hour to 300 m³/hour
Air intake temperature	15 °C to 25 °C
Heat transfer to air	< 1 kW
Max. exhaust length	4 m[a]
Exhaust diameter	150 mm

a. An additional blower is required if the max. length is exceeded.

9.7 Environmental Conditions

9.7.1 Operating Environmental Conditions

Air temperature	15 °C to 25 °C
Max. temperature change	2 °C/h
Humidity	30% RH to 70% RH
Pressure change	< 10 mbar/hour
Altitude above sea level	< 2000 m
Pollution (according to ISO 14644-1)	Class 9 or better
Recommended illumination[a]	more than 500 lx
Housing IP classification[b]	IP20

a. For operation with handheld keypad; according to DIN 5035, part 2 for precise machining
b. If the housing IP classification is not sufficient for the selected operating environment, an additional housing or filter system may be provided. In this case, ensure that adherence to the other operating requirements indicated in this section will not be affected.

9.7.2 Electro-Magnetic Compatibility

Conformity to the relevant Union harmonization legislation to other relevant directives: 2014/30/EU Electromagnetic Compatibility (EMC)

– EN61000-6-2:2005 Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments

– COMPex 50/100 Series:
EN61000-6-3:2007 + A1:2011 Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments

– COMPex 200 Series, COMPex F2:
EN61000-6-4:2007 + A1:2011 Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments

– IEC 61010-1: 2010 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

9.7.3 Transport and Storage Conditions

The following climatic conditions must be maintained while transporting and during temporary storage of the laser device:

Air temperature	-25 °C to +55 °C[a]
Humidity	< 70% RH
Max. temperature gradient	5 °C/h
Max. temperature and humidity gradient	The laser device should not be subjected to rapid changes in temperature or relative humidity.
Max. pressure gradient	75 mbar/h
Laser device can be transported by airfreight	Yes

a. Blow out all cooling water before transport and storage

The parameters specified in IEC 60721-3-2, class 2M4, must be complied with during temporary storage as well as transportation.

9.8 Control and Signal Lines

9.8.1 Remote Connector

Connector type: 15 pin Harting HAN 15D female

Signal	Pins	Type	Purpose	Specifications	
				Output from Laser Device	Input to Laser Device
Laser radiation warning lamp	A1 + A2	Output	External warning lamp that lights when laser radiation can be emitted or is being emitted (high voltage power supply enabled)	24 V DC 100 mA	Corresponding lamp or relay
Emergency Stop (EMS)	B1 + B2	Input	ISO 13849-1 performance level d connection. B3 and B4 have to be open and B1 and B2 have to be closed to enable the emission of laser radiation	< 30 V DC < 1 A	Potential-free contacts
	B3 + B4	Input			
External gas error	C3 + C4	Input	Contact has to be closed if the external gas supply system is correctly operating	< 30 V DC < 1 A	Potential-free contacts

9.8.2 Serial Interface

Signals	compatible to standard RS232 levels
SPACE	+5 to +15 V
MARK	-5 to -15 V
Baud rate	9600 bps (standard) / 115200 bps (HBR option)
Number of data bits	8
Number of start bits	1
Number of stop bits	1
Parity	none
Handshake	none
Message format	uppercase and lowercase ASCII characters using clear text full word commands

COM1

Connector type	RS232C 9 pin Sub-D
Gender	male

COM2

Connector type	RS232C 25 pin Sub-D
Gender	female

9.8.3 USB2

Connector type	Hi-speed USB 2.0 Standard-A

9.8.4 Trigger In

Connector type	BNC, galvanic isolation through optocoupler
Gender	female
Impedance	approx. 5 kΩ
Signal level	+3.3 V DC to +5 V DC, TTL if no signal is connected, the input will be +5 V DC (through pull-up resistor)
Trigger In pulse width	10 µs to 100 µs
Trigger edge	positive slope

9.8.5 Sync. Out

Connector type	BNC, galvanic isolation through optocoupler
Gender	female
Impedance	approx. TTL load
Signal level	+3.3 V DC to +5 V DC, positive slope
Sync. Out pulse width	approx. 50 µs

9.8.6 Timing Trigger / Pulse / Sync Out

Delay trigger to laser pulse	
COD mode enabled (default)	
- COMPex 50	9432 µs
- COMPex102	12432 µs
- COMPex110 ≤ 26 kV	9432 µs
- COMPex110 > 26.kV	12432 µs
- COMPex 200 Series	17862 µs
- COMPex F2	17862 µs
COD mode disabled	2 µs
Delay, drift	< 1 µs
Jitter ext. trigger to laser pulse	< ± 50 ns (pulse-to-pulse)
Delay sync. out to laser pulse	
COD mode enabled (default)	50 µs
COD mode disabled	0.5 µs

9.8.7 Ethernet (LAN)

Connector type	RJ45
IP-address factory setting	192.168.0.222

9.8.8 Others

EMO circuit	optional
Remote interlock circuit	yes
Handheld terminal	yes

9.9 Physical Dimensions and Weight

COMPex 50/100 Series

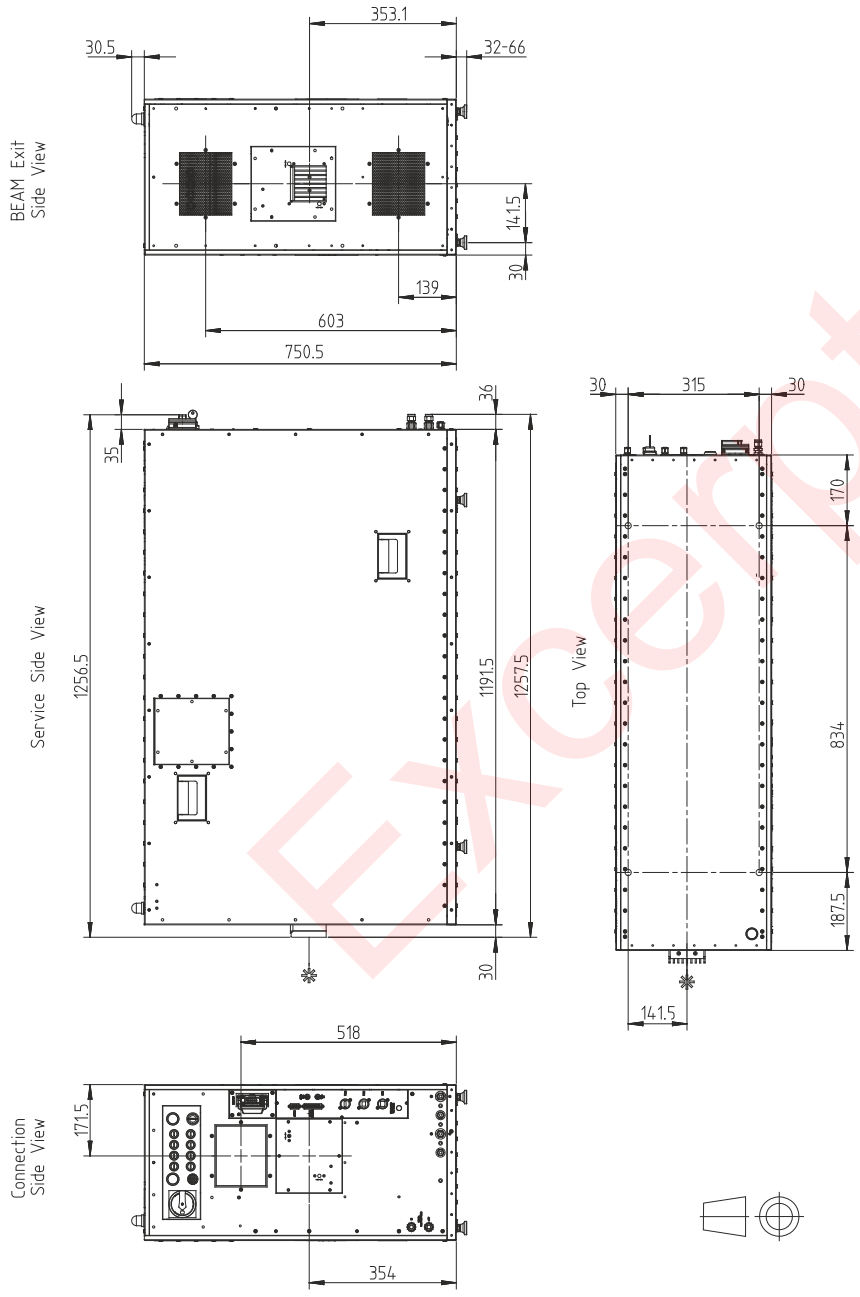

Figure 193: *Dimensions: COMPex50/100 Series*

Length x width x height of laser device (without electrical connectors)	approx.1258 mm × 375 mm × (813 to 847) mm
Weight of laser device	280 kg
Beam exit height	386 to 419 mm
Max. length of service panel	1.2 m

COMPex 200 Series, COMPex F2

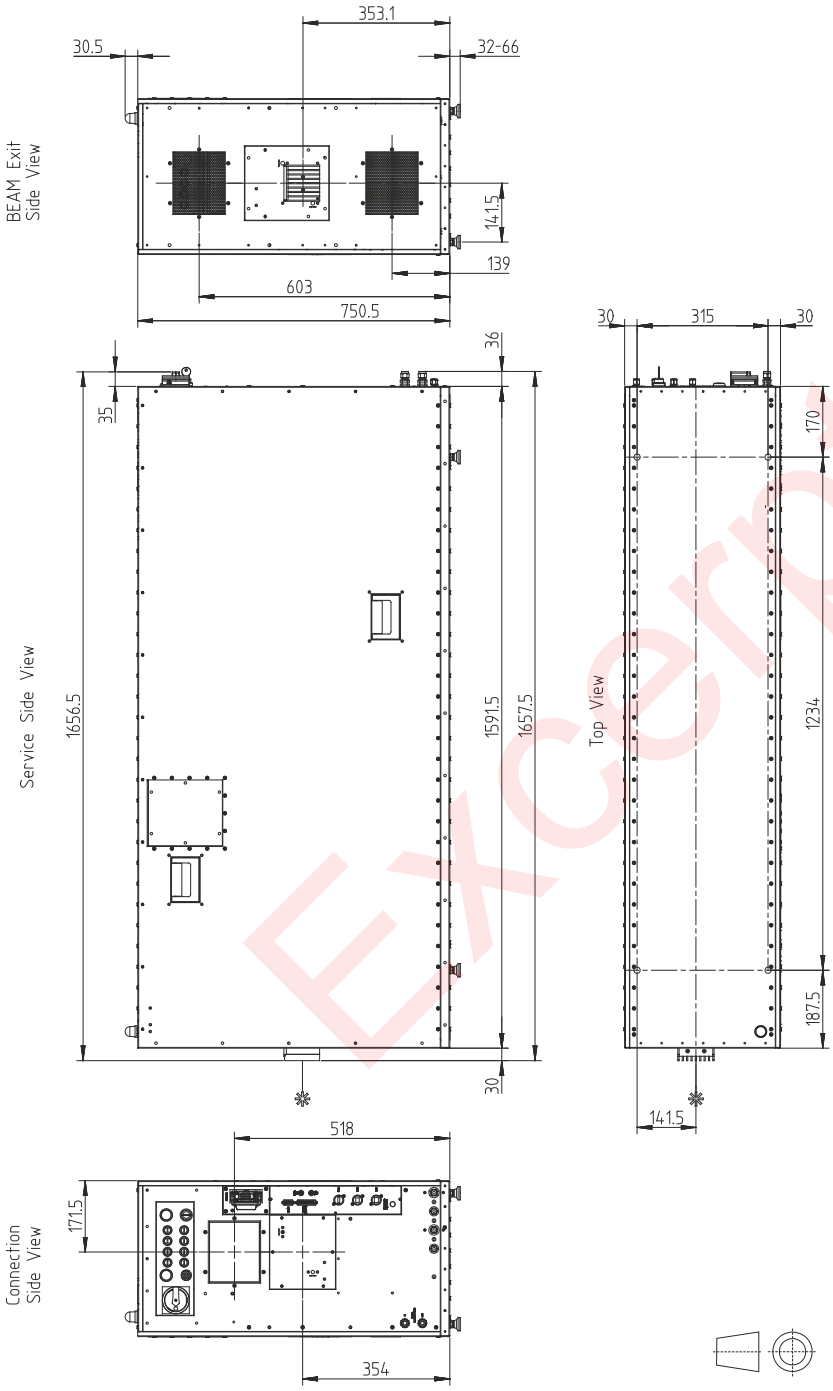

Figure 194: *Dimensions: COMPex 200 Series, COMPex F2*

Length x width x height of laser device (without electrical connectors)	approx.1658 mm × 375 mm × (813 to 847) mm
Weight of laser device	325 kg
Beam exit height	386 to 419 mm
Max. length of service panel	1.6 m

9.9.1 Center of Gravity

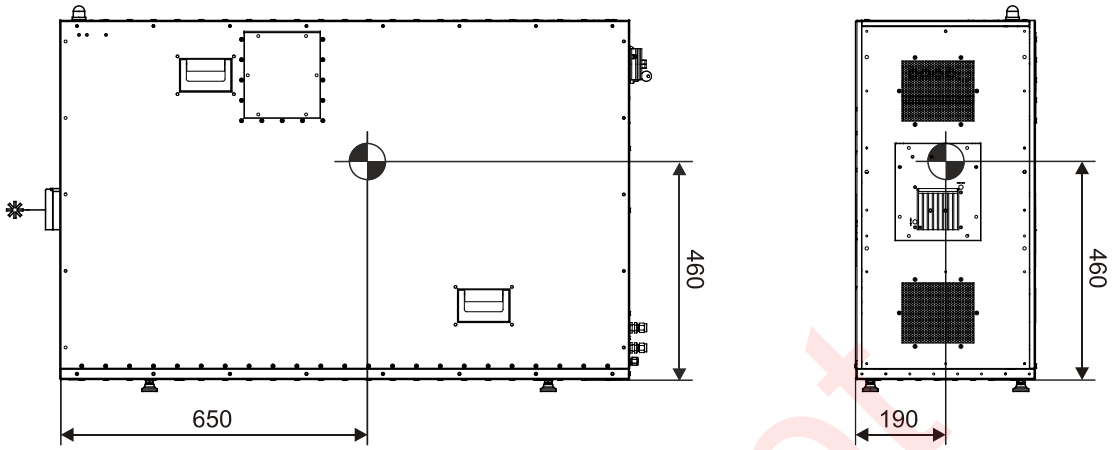

Figure 195: *Position of center of gravity: COMPex 50/100 Series*

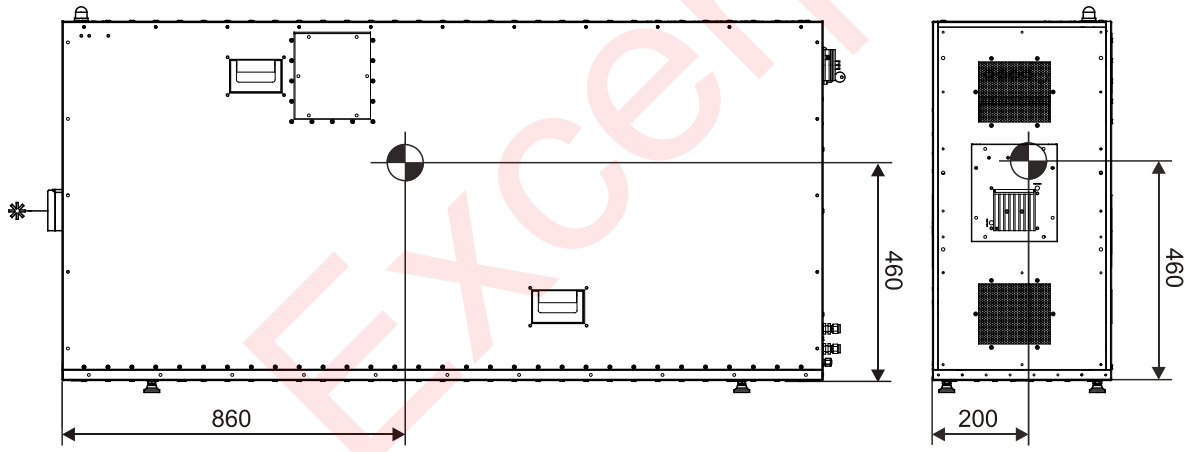

Figure 196: *Position of center of gravity: COMPex 200 Series, COMPex F2*

9.9.2 Transport Packaging

Laser device in container

Length x width x height of laser device in container	1811 mm × 885 mm × 1022 mm
Weight of laser device in container	
- COMPex 50/100 Series (with accessories)	376 kg
- COMPex 200 Series, COMPex F2 (without accessories)	401 kg

Accessory package (COMPex 200 Series, COMPex F2)

Length x width x height of accessories package	550 mm × 530 mm × 300 mm
Weight of accessories package	20 kg

9.10 Noise Level

Noise level during operation (max duty, closed laser cover, 1 m distance)	< 76 dB(A)
Noise level during service (max duty, opened laser cover, 1 m distance)	< 100 dB(A)
Noise level during service (max duty, opened laser cover, 10 cm distance)	< 105 dB(A)

COHERENT

INNOVATIONS THAT RESONATE

COMPex 4.0

Document Number: D165188 Revision: AJ