Class 3B and Class 4 Laser Laboratory Design Requirements

Purpose

This document is intended to provide general design and engineering guidance for the development and installation of safety controls in laboratories where Class 4 and/or Class 3B laser systems are used. The Principal Investigator and Project Design Engineering Construction (PDEC) team should incorporate as many of these design features as appropriate/applicable into their laboratories or discuss with HSE to achieve the same level of protection with alternate measures.

Scope

This document applies to all laboratories on the KAUST campus, including the KAUST Research and Technology Park and the Innovation Cluster.

Definitions

ANSI	American National Standards Institute
PDEC	Project, Development, Engineering and Construction
LCA	Laser Controlled Area
LEM	Lab Equipment Maintenance
LSO	Laser Safety Officer
MPE	Maximum Permissible Emission
PI	Principal Investigator
SOP	Standard Operation Procedures

Contents

1. Roles and Responsibilities

Principal Investigator is responsible for:

- Providing the data sheet and all required information to PDEC and HSE to help with lab design configurations.
- Communicating and meeting with PDEC and HSE to establishing the Scope of Work.

PDEC is responsible for:

- Notifying the LSO or HSE@kaust.edu.sa when preparing cost estimates for laboratory design or laboratory modifications;
- Notifying the LSO or HSE@kaust.edu.sa that a Lab Modification Request for laser laboratory has been raised.
- Implementing the guidelines when writing the Scope of Work for the lab modification.

The LSO is responsible for:

- Advising PDEC on laser safety requirements for the laser laboratory design or laboratory modifications.

LEM is responsible for:

- Advising PDEC regarding laser installation.

2. Laser Controlled Area

Class 3B and/or Class 4 laser systems set-up in open beam configuration must be operated inside a Laser Controlled Area (LCA). The LCA should extend beyond the Nominal Hazard Distance (NHZ), which is the distance beyond which the laser output is below the maximum permissible exposure (MPE) level. The Laser Safety Specialist typically determines these parameters. In practice, the LCA may be defined by:

- The physical boundaries around the area (i.e. solid walls, windows, doors as well as the floor and ceiling);
- A curtained area around the laser system, if the laser system(s) is used in an open-spaced area;
- An enclosure, which fully covers the laser output beam and beam path.

The design of the LCA must be discussed with the responsible Principal Investigator (PI) or Center Director, the PDEC team representative, the laser engineer from LEM, and HSE. HSE will make recommendations based on the ANSI Z136.1 (2014) and best practices. In some cases, laser laboratory design will deviate from the specifications detailed below, but they will aim to achieve the best combination of safety and flexibility/efficiency for the PI/Center Director.

2.1. Curtained Area to define the LCA

Laser curtains are designed to segregate areas of a laboratory; for example, a curtain can be used to define a laser-free zone or define a LCA within a large area. The approved manufacturer for laser curtains at KAUST is Kentek and the typical laser curtains used from Kentek is the SLC-250W-B. However, if the laser used is very high power, metal curtains or partitions may be required such as the Kentek Ever-Guard. **The type of laser curtains to be installed should always be checked with HSE.**

Laser curtains – installation requirements

- Composition: Fabric that is appropriately rated for the laser power and capable of preventing combustion when hit by a laser beam. There are different protection level and the appropriate protection level should be discussed with HSE and the curtain manufacturer.
- Flame retardant: A permanent label must be affixed to the curtain indicating compliance with the fire code requirements.
- The position of the curtains should not interfere with the fire suppression sprinklers and Fire Loss Prevention (see section 4.8) should review the proposed design.
- Valence – The addition of valence must be discussed with HSE and the users. If a valence is required it should be made from the same material as the curtain and should be placed along the ceiling to overlap with the rails from the curtain (i.e. same length as the rails) and drop about 30 cm down (Figure 1).
- The curtains should be connected to each other via zippers, magnets, velcros or curtain overlap to ensure the whole area is laser safe and the required protection level should be discussed with HSE.

Figure 1. Laser curtains and valence at the top of the laser curtain to define a Laser Controlled Area.

2.2. Laser Enclosure Requirements

In some situations, the laser and laser beams will be enclosed. The minimum requirements for the enclosure to satisfy Class 1 requirement is that the entire beam path must be enclosed so that the enclosure limits the laser radiation to level at or below the applicable MPE. In addition, a warning sign must be posted on the enclosure to indicate the hazards if the enclosure is opened/removed. An example of such warning sign is shown in Figure 2.

Figure 2. Warning sign to be displayed on an enclosure.

3. Practical Safety Requirements

3.1. Controlled Access

Class 3B and Class 4 laser systems used in open beam configurations require measures to control the access. At KAUST, there are two approved entryway controls:

- Safety Interlock Systems
- Electronic door locks

The type of access control should be selected based on how effective they are at containing the laser beams but also on other implemented control measures, which will help contain the laser beams.

3.1.1 Safety Interlock Systems

An interlock system is intended to prevent those who are not authorized to enter the LCA and avoid risk of exposure; however, it does not protect the users. If a laser safety interlock is installed, it must be such that the laser can only by switched on when the interlock is armed. It should also be set so that it causes the laser beam to switch into safe mode when triggered. This can be achieved by lowering a shutter at the laser exit port or causing the laser to lose power (least favored approach).
At KAUST, most safety interlocks currently installed are not connected to a shutter or the laser power supply; they are used as door lock system to stop unauthorized person entering the laser lab and indicate to people outside the room that a laser is in use. This is not recommended anymore unless approved by HSE.

There exist different types of safety interlocks:

- ***A defeatable door interlock*** – this type of interlock is equipped with an access device on the exterior side of the room (keypad or proximity card reader) that allows authorized persons from outside the laboratory to enter without deactivating the laser or blocking the beam. Similarly, on the interior side of the room, a bypass switch is available for the person in the room to exit without deactivating the laser or blocking the beam. The bypass devices to enter or exit the room have a predetermined time, if the door is not shut within this predetermined time, the interlock system activates and the laser is disabled or the beam is blocked. In addition, the system must be linked to the Fire Suppression system so if the fire alarm is triggered, the interlock is defeated. The interlock must also be equipped with an emergency entry crash button on the outside of the laboratory (for emergency access) so when it is activated, it unlocks the door and deactivates the laser or block the beam.
- ***A non-defeatable door interlock*** – this system is designed to block the beam or deactivate the laser every time the door to the laboratory is opened. **This should not be used at KAUST**.

The typical laser interlock installation requirements in laboratories at KAUST is described in Appendix A. Figure 3 shows the KAUST approved laser safety interlock to be installed.

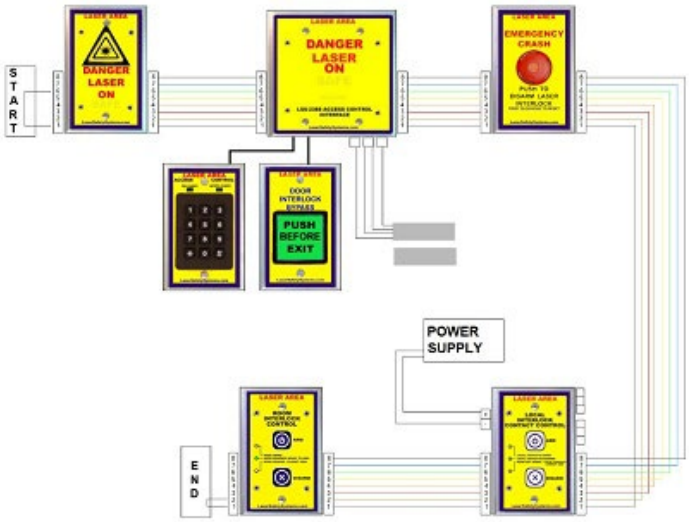


Figure 3. Approved Laser Safety Interlock installed in KAUST laboratories (Manufacturer: Laser Safety Systems).

3.1.2 Electronic door Locks

Another method to control entry to a LCA is to use an electronic door lock. At KAUST, there are two approved electronic lock: keypad and proximity card reader (Figure 4). It is recommended to use a keypad reader for access to the lab as these are easier to maintain than proximity card reader; with card reader it is the responsibility of the lab to update who has the right to access, who should not access the lab and ensure that the emergency responder have the right to access. If electronic door locks are used to access lab, only entry to the lab is controlled (i.e. it does not interfere with laser operation) and therefore additional control measures must be implemented as well. Loss of power to the hardware will also unlock the door (e.g. fire alarm is triggered, etc.). There is the possibility to have an emergency key override, and this should only be used by first responder or other key personnel.

(a) (b)

Figure 4. Example of approved electronic lock used at KAUST. (a) key-pad access, (b) card access.

3.2. Laser free zone

A laser-free zone is an area within the room where laser eye protection is not required and that laser users can use to store protective eyewear and prepare to enter the LCA. It is designed to protect the doorway and incoming personnel from exposure to stray beams.
The laser-free zone is generally set as a curtained entrance or blocked off area (using laser-proof barrier) right at the entrance of the laboratory area. The laser-free zone should be large enough to fit one or two people. If laser curtains are used they should follow the curtain requirements given in section 2.1. Example of laser free entrance are shown in Figure 5

(a) (b) (c)

Figure 5. Curtained entryway examples (a) overlapped curtains, (b) zipped curtains (c) moveable panels at entrance.

3.3. Illuminated Warning Signs

All Class 3B should and Class 4 laser laboratories shall have an illuminated warning sign, except laboratories where Class 3B and Class 4 lasers are embedded (i.e. system is designated as Class 1 laser during normal operation). The illuminated warning signs must have a label or text that informs the person outside the laser room that a laser is switched on. An example of a displayed text is: “Laser In Use”, etc.

Figure 6. Approved illuminated warning sign.

Installation Requirements

- Posted on the exterior side of the door, at about 1500 – 1600 mm above the floor and on the side of the door handle.
- Use a low voltage sign rather than one at 110-220 V powered.
- LED light source should be used rather than standard bulbs.

- The illuminated warning light is required for each doorway that allow access to the lab.
- Automatic light, i.e. light turns ON/OFF based on when the laser is ON/OFF
  - If electrically connected to the laser safety interlock, it should be connected so that the light will only turn on when the interlock is armed.
  - If it is electrically connected to the power supply, it should be ON when the laser is switched ON. The design of the electrical connection will be done by Core Lab Electronic Workshop and PDEC will need to raise a RFS.

The approved illuminated warning light is shown in Figure 6 and the specifications are shown in Appendix B. Other warning lights can be used but they must be reviewed by HSE before they are used in a laboratory. Example of alternative warning lights can be found on Kentek website (warning light 1, warning light 2)

3.4. Posted Signs

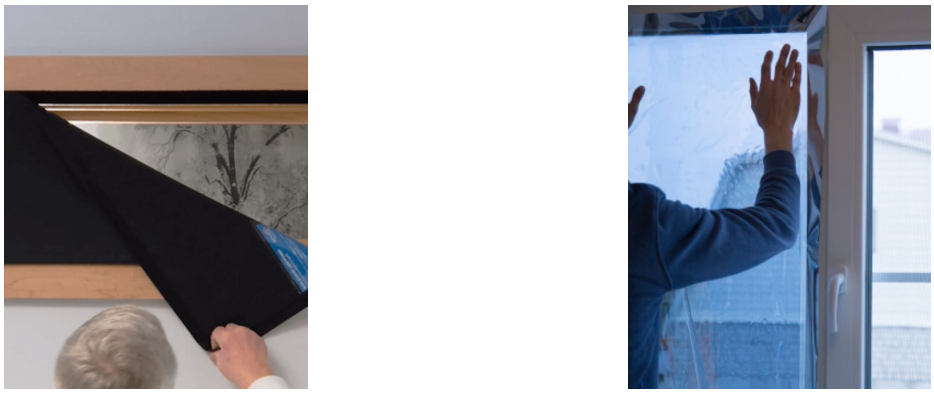
Any laboratories using Class 3B and Class 4 laser systems must have a posted warning sign at all entrances of the laboratory. The template warning sign used at KAUST can be found here. Please note that we do not follow the requirements set in the ANSI Z136.1 (2022).
Class 2, 2M or 3R laser must have a posted warning sign if they are used unattended.

3.5. Window

Ideally, a LCA will not have windows or windows on door. However, at KAUST many of the laboratory doors have windows. If doors are equipped with windows or if there are windows in the LCA, these must be covered using one of the following material:

- Laser-protective films that can be fixed directly on the window. The films will let through some of the visible light but will block some specific range of wavelengths. The films must be placed on the interior side of the windows and will have a specific protection level for specific range of wavelengths. Example of these films are available on Kentek or UVEX websites. The Laser Safety Specialist will determine the type of film to select for the specific application.
- Laser-proof curtains can be fixed on the interior sides of the windows using Velcro, magnet, grommets or snaps. The preferred choice of curtains used at KAUST are the ones from Kentek (SLC-250W-B), please ensure the installation requirements given in section 2.1 are followed. Discussion with HSE must take place if different curtains will be used.

Figure 7 illustrates the various windows covers that can be installed.



(a) (b)

Figure 7. Examples of window covers, (a) laser-proof window curtain fixed with Velcro, (b) laser-protective films installed on the inside of the room.

3.6. Eyewear storage

Laser eye protection should be stored in a proper manner to avoid damages and ensure easy access. The selection of the storage device should protect eyewear from scratches and should kept the eye protection away from dust, dirt and other contaminants. There are several options available as shown in Figure 8.

(a) (b)

Figure 8. Example of eyewear storage. (a) Kentek (Part No. EW-Holder), (b) Hanging shoe organizer from online retailers will be appropriate for eyewear storage.

3.7. Emergency crash-off switch

Emergency shut-off buttons are often red mushroom style buttons placed on the power supply of Class 3B or Class 4 laser system (Figure 9). This is a suggestion of ANSI Z136.1 (2022) standard but not a requirement. In some cases, if a high power laser is not equipped with an emergency-stop button, external ones should be added in more than one location. In addition, they should be labelled so everyone knows what they do.

Alternatively, in some situation, posting the location of the circuit breaker box that controls the lasers or the location of the power supply in the room can be done.

Figure 9. Example of an emergency-stop button.

3.8. Optical Tables

The optical table is where the laser and experimental set-ups are located. Most optical tables are designed to have vibration isolation devices and these requires to have a gas connection. The gas connection can be set by fixing a gas cylinder and gas cylinder bracket in the room or via manifolds. The optical table and ancillary equipment must be placed so that there is enough clearance around the table for good workflow. In addition, the position of the optical tables should be discussed with regard to the position of the HVAC as these may disturb some of the lasers/experiments.

4. Non-Beam Hazards and other Lab Environment Considerations

Non-beam hazard relate to the requirement for electrical cables (e.g. 3-phase, etc.), water lines, gas lines, fire suppression, arrangement for handling toxic chemicals that are associated with some dye lasers, and ventilation. These need to be discussed early on with the relevant team to ensure safety is not compromised and unexpected complications arise from unnecessary infrastructure requirements.

4.1. Electrical

When designing the laser room, the required electric connections and power for the laser power supply and ancillary equipment must be taken into account. Some equipment do not require specific electric connections while others may require a tri-phase type plug. PDEC must consult with the Principal Investigator to determine whether special electrical connections need to be added within the room. If it the case, these must be installed in the appropriate location so as to avoid long cable trail, etc.
Below are some recommendations:

- All equipment, adaptors and extension plug must be UL listed;
- Provide Ground Fault Indicator (GFI) protection to electrical receptacles above counter tops and within 6 inches of sinks, safety showers and other source of water;
- Place electrical outlet at height (i.e. so that leakage of water coolant or other liquids will not lead to risk of electrocution) and away from cooling water pumps, lines, filters, etc.;
- Ground Fault Circuit Interrupter (GFCI) should be installed near sinks, wet areas, water cooling systems, etc.

- Appropriate grounding connections should be implemented for laser power supplies/electrical components;
- Grounding of optical tables and other tables/equipment with energized equipment should be considered.

4.2. Water

Many lasers require water cooling. The type of water cooling required including chiller requirement. Type of water to be used, flow, maintenance, etc. must be taken into consideration as well as the noise level.

4.3. Room Temperature

The typical lab temperature is oscillating between 21 - 25 degree Celcius. Cooling of laser system may require the use of a chiller. Chillers can generate heat, it is therefore important to think about where these will be located. Consider placing the chillers in dedicated rooms or outside the laser area (e.g. in service corridors). Additionally, the laser selected should ideally be known before the facility readiness is assessed, and with such, the required cooling load to protect users and laser from overheating.

If specific room temperature is required, a request for temperature control in line with the laser requirement needs must be submitted to PDE&C (Planning, Design, Engineering & Construction) to scope the requirements. The lab will fund the cost of the modifications.

4.4. Room Humidity

Most labs in KAUST do not have the provision to control humidity within a certain parameters, meaning, that the relative humidity of the air provided in labs cannot be set at a specific setting or percentage (it can be up or higher than 60% during the summer months). This is not a deficiency in the lab, and represents the design requirement when KAUST was built. If a lab requires control over the relative humidity, a humidifier/dehumidifier must be installed, which will need to be funded by the lab. **A request for such modification must be submitted to PDE&C (Planning, Design, Engineering & Construction) to scope the requirements.**

4.5. Room Ventilation

Room ventilation needs to be considered as with any other lab spaces.
The following standard building codes relate to ventilation:

- Provision should be made for local exhaust of instruments, gas cabinets, vented storage cabinets or other operation requiring local ventilation (se section 4.8)
- Laboratories must be designed to pull air into the laboratory from the corridor (e.g. negative pressure in relation to the rest of the building, via an air duct system).
- Placements of “air supply” and “exhaust air” vents must be installed to avoid short-circuited air movement patterns.
- The ventilation system must operate continuously.
- Typical lab environment require 6-8 air changes per hour. If necessary this can be adjusted by facility management; however, before actions are taken the proposed changes must be reviewed by HSE.

In addition, the PI must be asked if the lab and equipment that will be installed will be sensitive to dust.

Only a small number of labs in KAUST were design to have "clean" conditions. There is a high chance that the lab under review is not part of these.
If the lab will need a dust free environment, there are few free of charge mitigation actions that can be implemented, such as:

- Changing the lab pressure to positive (if the surrounding labs/spaces allow this for safety purposes)
- Increasing the air change per hour (providing the air valves have enough physical capacity)
- Keeping lab doors closed
- Gowning before entering the lab
- Adding a sticky pad at the lab entrance
- Making sure that no unnecessary equipment and boxes are present in the lab space (e.g. cardboard boxes, wooden boxes, etc.)

If, after implementing these mitigation actions, the dust control is still not satisfactory, a request for clean environment in line with the laser requirement needs must be submitted to PDE&C (Planning, Design, Engineering & Construction) to scope the requirements. The lab will fund the cost of the modifications.

4.6. Compressed gases

If compressed gas cylinders are required for the laser operation (e.g. excimer laser) or as part of the experiment, these must always be properly labelled with the content and appropriately secured.
If hazardous gases (toxic, flammable, etc.) are used there are additional requirements for the storage and safe use that must be implemented. These are detailed in the Compressed Gas Safety Standard. For example, gas cylinders may need to be placed in gas cabinets with adequate exhaust, sensors may need to de added in the gas cabinet and in the room, etc.

4.7. Cryogen use

In some labs, cryogen may be required and their use must follow the Guidelines for Working with Cryogenic Liquids. Temperature Controls/chiller use

4.8. Fire safety

The following must be checked by Fire Loss Prevention:

- Position and number of fire sprinklers are adequate and not impaired by proposed design;
- Fire extinguishers are appropriate and available in the last area. For the laser area, we recommend to use Halotron I or CO_2 fire extinguishers.
- Fire alarm annunciators are operational;
- If hazardous chemicals or gases are used, FLP must review the control measures.

4.9. Dedicated exhaust

Dedicated exhaust needs to be considered if toxic fumes or laser-generated air contaminants (LGAC) need to be extracted (in which case the extraction should be located as close to the source as possible).

The interaction of the high-intensity laser beams with different target materials may create air contaminants, plasma, and ionizing radiation. These by-products could include volatile gases and

particulates, and may contain carcinogens. Inhaling gases and particulates can damage the lungs. As a result, these hazards must be controlled if the laser beam has the potential to reach and exceed the following irradiance levels:

- Air contaminants including fumes, nanoparticles at irradiance $>10^3$ W/cm^2
- Plasma radiation at irradiance $>10^{12}$ W/cm^2 - Non-ionizing plasma radiation can include hazardous levels of UV and blue light.
- Ionizing radiation at irradiance $>10^{16}$ W/cm^2 - Ionizing radiation may also be emitted by plasmas when the laser irradiance on a target exceeds 10^{16} W/cm^2.

When the beam irradiance exceed 1000 W.cm^{-2}, an evaluation must be performed by an industrial hygienist to identify engineering controls for LGAC. Places where irradiance exceed 10,000 W.cm^{-2} must be enclosed to the maximum extent practical, and be properly ventilated. **Exposure to LGAC must not be managed with the use of PPE only**.

Organic materials, including polymers and tissue, produce plumes containing potentially carcinogenic materials when struck by laser radiation. Polymers pyrolyze to form toxic gases. Metals and inorganic materials form fumes clouds. These can be treated as common hot-gas air contaminants sources in accordance with American Conference of Governmental Industrial Hygienist (ACGIH) and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) criteria. The interiors of the enclosures should be easy to clean and decontaminate. The usefulness of high efficiency particulate air (HEPA) filtration of the effluent must also be evaluated when beam irradiance exceed 10,000 W.cm^{-2}.
Contact HSE for assistance with fumes and nanoparticles, plasma and ionizing radiation.

Excimer Lasers

Considerations when installing and using excimer lasers (i.e. laser using toxic gases to generate the laser beam):

- Ventilation systems should be capable of maintaining an average face velocity of 200-300 feet per minute at the cabinet's window opening when the window is fully opened.
- An airflow meter alarm should be used to monitor and indicate low-flow conditions.

5. References

[1] American National Standard for Safe Use of Lasers, ANSI Z136.1 (2014)
[2] How to Set-Up a Laser Lab, Ken Barat, SPIE Press, 2015
[3]

Document History

REV	DATE	PREPARED BY	DESCRIPTION
01	Mar. 2020	D. Darios	Initial Document
02	May 2023	D. Darios	Review the whole document and include requirements for PDEC Scope of Work in Appendix

Appendix A – Laser Safety System Interlock Specifications

At KAUST, interlock system from *Laser Safety System*[1,2] may be used to control entry to the lab. The following part of the *Laser Safety System* interlock must be installed in the laser laboratory:

- LSS 2380 – Laser Warning Module.
- LSS 2381 – Interlock Control Module.
- LSS 2383 – Emergency Crash Module.
- LSS 2384 – Laser/Shutter Interface Module.
- LSS 2388 – Defeatable Access Control Kit.

LSS 2380 – Laser Warning Module

This module provides a clear visual indication of the present interlock state (Figure 1a). It must be located next to the outer entrance of the LCA at eye level height (i.e. no higher than 65" or 165 cm from the floor) and, if possible, on the side of the door handle.

(a) (b) (c)

Figure 1. (a) LSS 2380 – Laser Warning Module, (b) LSS 2381 – Interlock Control Module, (c) LSS 2383 – Emergency Crash Module.

LSS 2381 – Interlock Control Module

This module is used to arm and disarm the laser interlock system (Figure 1b); in our implementation scheme it will lock/unlock the entrance door. It shall be located inside the laser area and located near the laser power supply at waist height and not higher than 60" or 150 cm.

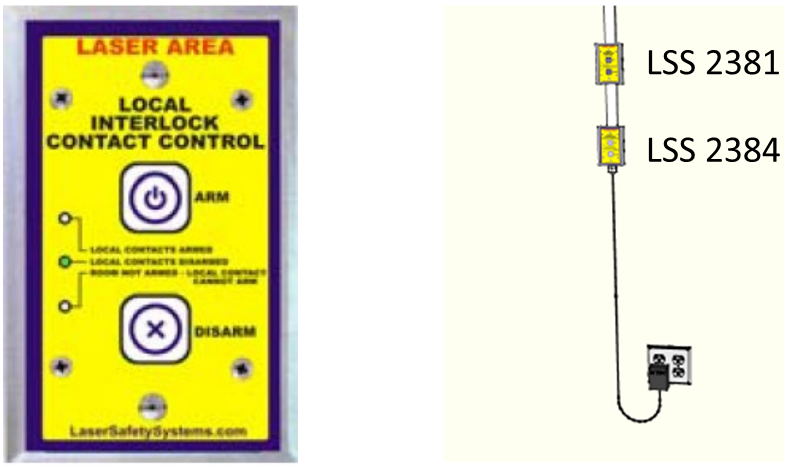
LSS 2383 – Emergency Crash Module

This module overrides all other modules and disarms the interlock, in our implementation scheme it will unlock the entrance door (Figure 1c). It must be located outside the LCA entrance, if possible, on the side of the door handle and at the height of the door handle and not higher than 60" or 150 cm from the floor.

LSS 2384 – Laser/Shutter Interface Module

This module is required since it is the only module that can be connected to the power via an electrical socket (Figure 2). This module contains the final safety relay contacts for interface to the laser and/or

safety shutter mechanism. When the room interlock is armed (i.e. LSS 2381 arm button is on), the arm and disarm button on this module will cycle the internal safety relay when pressed. However, it is possible to have the module LSS 2384 automatically armed when the LSS 2381 module is armed. Finally, it is possible to have the module LSS 2384 so that it is not connected to the laser power supply or shutter (i.e. in that case it is not used).



(a) (b)

Figure 2. (a) LSS 2384 - Laser/Shutter Interface Module, (b) Connect to the power/electrical socket.

LSS 2388 – Defeatable Access Control Kit

The kit is composed of four modules (Figure 3):

- Keypad: The keypad must be located outside the laser area, if possible, on the side of the door handle, at the height of the door handle and not higher than 60" or 150 cm from the floor, and next to the emergency crash module;
- Door interlock bypass: The door interlock bypass module (or exit push button) must be located inside the protected entryway next to the entrance door and, if possible, on the side of the door handle;
- Access Control Interface: This should be mounted near the top of the door frame inside the LCA and connected to the magnetic switch and door interlock bypass;
- Dual magnetic door sensors (LSS 2306-12): The portion with the armored cable contains two independent magnetic reed switches. This portion mounts to the door frame inside the LCA. The portion without the cable contains a magnet and mounts to the swing door. A mounting bracket is also provided to adjust the gap for this switch.

An example of a LCA using this interlock system is shown in Figure 4.

Figure 3. Defeatable Access Control Kit.

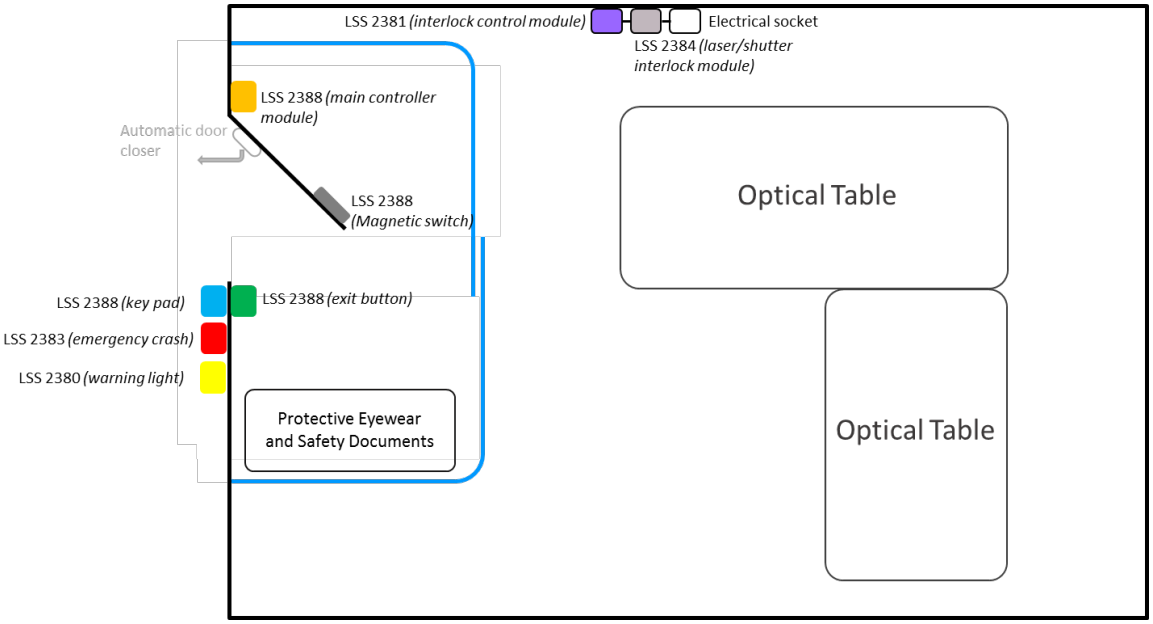


Figure 4. Example of a Laser Controlled Area design using defeatable interlocks from Laser Safety System.

References:

[1] Laser Safety System User Manual, revision 4.1, July 2015.

[2] LSS-2388 Installation and User Manual, revision 2, July 2015.

Appendix B – Illuminated Warning Sign Specifications

PRODUCT ID: 38832
Indoor LED Backlit Sign

MODEL
SBLF718W-193R/120-277VAC

DIMENSIONS
7" H x 18" W x 2.25" D (est. 4.134 lbs)

CLASS
Class: SBLF Series
Control Method: Switch (not included) or external relay.

CONSTRUCTION
Cabinet: 1-piece, corrosion resistant, extruded all-weather frame, 2.25" deep.
Face Material: 1/8" thick, clear polycarbonate (0000)
Faces: Single Faced Sign
Finish: Duranodic Bronze
Graphic: Printed graphic applied to surface

ELECTRICAL
Flashing: Not Included
Input Voltage: 120-277 VAC
UL/cUL Listed: Listed

MESSAGE
Color: Red translucent
Font: Swiss 721 Bold BT
Illumination: Backlit with white LEDs. Message always visible.
Sign Messages: See message table below

MESSAGE	LED/COLOR	HEIGHT	AMPS
LASER IN USE	Red Translucent	2.0"	0.088-0.038

NOTE: Above messages are independently controlled.

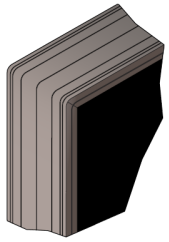
Signal-Tech
4985 Pittsburgh Ave.
Erie, PA 16509
Phone: (877) 547-9900
Fax: (814) 835-2300
Email: sales@signal-tech.com
Website: www.signal-tech.com

Proudly Made in the USA

Product View

NOTE: Sign image may not exactly represent the finished product. For illustration purposes only.

Frame Detail



07142020 | DP

Appendix D – Scope of Work – Laser Safety Requirements

Installation of Laser Safety Interlock

- Supply and install new Laser Warning Module LSS-2380 to be mounted at 1600mm from the floor on exterior side of the door and next to the "Laser In Use" sign, if possible on door handle side.
- Supply and install new interlock control module LSS-2381 to be mounted at 1300 – 1600 mm from the floor inside the laser room (i.e. to be within the curtained entrance or define the location in the room on the drawing).
- Supply and install new Interlock Relay module LSS-2384 to be mounted at 1300 – 1600 mm from the floor inside the laser room next to module LSS-2381 (i.e. to be within the curtained entrance or define the location in the room on the drawing).
- Supply and install new Emergency Crash module LSS-2383 to be mounted on the exterior side of the door at 1300mm from the floor, below the LSS-2380.
- Supply and install new Defeatable Room Access control system with Door sensor, keypad and push-to-exit LSS-2388.
    - Exit request module, laser safety systems LSS-2388 Kit to be mounted on the interior side of the door at 1300mm from the floor and inside the curtained entrance, next to the exit door and on the side of the door handle (if possible).
    - Magnetic lock interface module, laser safety systems LSS-2388 to be mounted on the interior side of the door at 2000mm from the floor, i.e. above the door.
    - Keypad module, laser safety systems LSS-2388 kit to be mounted on the exterior side of the door at 1300mm from the floor next to the exit request module on the side of the door handle (if possible).
- Supply and Install Magnetic lock and Mounting Hardware and magnetic switch – to be mounted on the door.
- Laser safety systems # UL24V UL listed 24VDC power limited supply 220V, single phase, 20A circuit. Plug-in to matching receptacle. This needs to be connected to the LSS-2384 module.
- Laser interlock system shall be connected to the fire alarm system. Connect LSS-2388 to the normally closed contacts on the fire alarm system. Upon activation of fire alarm system doors shall unlock and laser system shut down.
- Testing and Commissioning as per KAUST standards

Installation of a Curtained Laser Controlled Area

Install new Class 4 laser safety curtains (Kentek SLC-250W-B) ceiling tracks, Velcro and valence as required. The curtains and tracks will be supplied by KAUST. The various curtains sizes are:

- Curtains on ceiling tacks: AAxA mm etc
- Curtains on Velcro, to be placed to cover the windows: (3) BBxBB mm, (8) CCxCC mm

Installation of a curtained Laser-Free Zone

Install new Class 4 laser safety curtains (Kentek SLC-250W-B) ceiling tracks, Velcro and valence on the interior side of the lab as shown in drawing. The curtains and tracks will be supplied by KAUST. The various curtains sizes are:

- Curtains on ceiling tacks: AAxA mm etc

Connection of the Illuminated Warning Sign with the Interlock System

- Supply and install new “Laser In Use” warning light (Signal-tech, model: SBLF718W-193R/120-277VAC) at each entrances. The warning light must be mounted on the wall and positioned at 1600mm above the floor, if possible on the side of the door handle.
- Install the connection between the interlock module as per instruction in Appendix C.

Connection of the Illuminated Warning Sign with the Laser Power Supply

- Supply and install new “Laser In Use” warning light (Signal-tech, model: SBLF718W-193R/120-277VAC) at each entrances. The warning light must be mounted on the wall and positioned at 1600mm above the floor, if possible on the side of the door handle.
- The design connection between the warning light and the laser power supply will be done by the Core Lab Electronic Workshop. PDEC to raise a RFS with Core Labs Electronic Workshop.
- Install the connection between the warning light and the lasers as per instructions given by Core Lab Electronic Workshop.