|  |  |
| --- | --- |
| **Location (e.g. B5-1234)** |  |
|  |  |
| **Laser Class** | **Choose an item.** |

|  |  |  |  |
| --- | --- | --- | --- |
| **Manufacturer** | **Model** | **S/N** | **Asset No.** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**IMPORTANT Contact Details**

|  |  |  |  |
| --- | --- | --- | --- |
| **Laser Safety Contact** | XXXX | Phone | 012 808 XXXX05X XXX XXXX |
|  |  |  |  |
| **Laser Safety Officer** | Delphine Darios | Phone | 012 808 2206054 470 0564 |
|  |  |  |  |
| **Maintenance/Repair** | Ralph A. Timmermeester  | Phone | 012 808 7582054 470 0523 |
|  |  |  |  |
| **Principal Investigator** | XXXX | Phone | 012 808 XXXX054 470 XXXX |

**Emergency** **911 (KAUST Landline) 012 808 0911 (Mobile Phone)**

**Document History**

|  |  |  |  |
| --- | --- | --- | --- |
| **Version** | **Date (dd/mm/yyyy)** | **Written by** | **Comments** |
| 01 | 5-Dec-2019 | Ralph Timmermeester | New Document |
|  |  |  |  |
|  |  |  |  |

# Technical Specifications

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Laser 1** | **Laser 2** | **Laser 3** |
| **Model** |  |  |  |
| **Class** | Choose an item. | Choose an item. | Choose an item. |
| **Wavelength (nm)** |  |  |  |
| **Beam Dimensions (mm)** |  |  |  |
| **Beam Divergence *(full angle)*** |  |  |  |
| **Operation Mode** | Choose an item. | Choose an item. | Choose an item. |
| **Avg. Power (W)** |  |  |  |
| **Max. Power (W)** |  |  |  |
| **Max. Energy/pulse (mJ)** |  |  |  |
| **Max. Repetition Rate (Hz)** |  |  |  |
| **Pulse duration (FWHM)** |  |  |  |
| **Beam Delivery** | Choose an item. | Choose an item. | Choose an item. |
| **Beam Path** | Choose an item. | Choose an item. | Choose an item. |

Add a Photo

**Figure 1.** Picture of the XXX laser system.

# Lab layout and area Designation

Attach a layout of the laser lab, indicate Laser Controlled Areas, nominal hazard zones, entryway interlocks, protective barriers (curtains, beam blocks, enclosures), emergency controls, etc.



This is an example. Please add the plan of your lab.

**Figure 2.** Layout of the laboratory and experimental table.

This laboratory is designated as a Laser Controlled Area when the laser is switched on. The area is defined by the structure of the room, including doors and windows/curtains. A warning sign and warning light must be placed at the entrance to the Laser Controlled Area and the laser(s) shall only be used by authorized users, who have obtained permission through training.

# Related Hazards and Control Measures

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Hazard** | **Description & Task Associated** | **Hazard Present** | **Control Measures** | **Person at Risk** | **Authorized Users** |
| **Unauthorized access to the laser room** | *Only authorized users are allowed to access Laser Controlled Areas. They must have received training and understood the risks involved.* | Choose an item. | * Entryway controls (interlocks, key/card pad access, administrative access) for authorized users only;
* Laser Hazard Evaluation completed;
* Control area designated and appropriately posted (i.e. warning sign and warning light displayed);
* Protective barriers utilized (i.e. curtains/partitions);
 | * Visitors
* Cleaners
* Site services
 | NoNoNo |
| **Unauthorized use of the laser** | *Only authorized users are allowed to use a Class 3B or 4 laser as they must have received training and understood the risks.* | Choose an item. | * Laser master-switch (key or code). Key removed from laser system when not in use;
* Entryway controls (interlocks, key/card pad access, administrative access) for authorized users only;
* Training completed for all authorized users;
* Buddy system in place;
* SOP is in place;
 | * Visitors
 | No |
| **Open/Accessible laser beam** | *Laser beams that are accessible to the user can lead to laser injuries (eye or skin).* | Choose an item. | * Entryway controls (interlocks, key/card pad access, administrative access) for authorized users only;
* Laser Hazard Evaluation completed;
* **Beam partially enclosed – i.e. optical fiber;**
* **Beam is enclosed (enclosure is not interlocked);**
* Diffuse and specular reflection assessed and terminated via beam blocks/dumps;
* Training completed for all authorized users;
* Appropriate eyewear is available (i.e. OD and good condition);
* Protective barriers utilized (i.e. curtains/partitions);
 | * Student
* Staff/PI
* Visitors
 | YesYesNo |
| **Laser eye injury** | *All Class 3B and 4 lasers have a potential to cause laser eye injury due to direct, diffuse or indirect beam. These hazards include:** *Unintentional viewing of the direct beam;*
* *Beam is at eye level of person sitting or standing;*
* *Reflective materials is in the beam path;*
* *Stray beams;*
* *Collecting optics/*
 | Choose an item. | * Laser is secured to the base;
* Laser associated equipment secured to base;
* Training completed for all authorized users;
* Appropriate eyewear is available (i.e. OD and good condition);
* Laser emission indicator on the system (visual or audible);
* Barriers/enclosures used to stop specular and diffuse reflections;
* Beam stops/attenuators are available and used to block the laser beam;
* **Alignment procedure is available;**
* During alignment procedure – use only low power OR use secondary laser that emits low power;
* Emergency STOP/Panic button identified;
* User must remove/cover jewelry and reflective objects (ID badges, access card, etc.);
* Regular maintenance of the system;
 | * Student
* Staff/PI
* Visitors
 | YesYesNo |
| **Beam Reflections** | *Exposure to laser beam via reflective surface (e.g. PC monitor, etc.) in vicinity of the laser.* | Choose an item. | * Appropriate eyewear is available (i.e. OD and good condition);
* Minimum use of reflective surface near the laser beam;
* Laser beam enclosure utilized;
 | * Student
* Staff/PI
* LEM
* Visitors
 | YesYesNoNo |
| **Collateral radiation exposure** | *Exposure to:** *UV;*
* *Blue light;*
* *Infrared light;*
* *Microwave;*
* *Radiofrequency.*
 | Choose an item. | * Training completed for all authorized users;
* Appropriate eyewear is available (i.e. OD and good condition);
* Appropriate PPE available;
* Protective barriers/enclosure utilized;
* Regular maintenance of the system;
 | * Student
* Staff/PI
* LEM
* Visitors
 | YesYesNoNo |
| **Plasma radiation** | *Exposure to plasma radiation induced by laser-matter interactions process.* | Choose an item. | * Appropriate PPE available;
* Plasma radiation enclosed;
 | * Student
* Staff/PI
* LEM
* Visitors
 | YesYesNoNo |
| **Electrical Hazards** | *Most lasers contain high-voltage power supplies and often large capacitors/capacitor banks that store lethal amounts of electrical energy.* | Choose an item. | * Electrical cords are checked regularly to ensure that they are in good condition;
* Power supply is grounded;
* Housing of the power supply must not be removed;
* Work on the power supply can only be done by service engineer or LEM engineer;
* Power supply is elevated from the floor;
 | * Student
* Staff/PI
* LEM
* Visitors
 | YesYesNoNo |
| **Hazardous materials/waste (dyes, solvents, etc.)** | *Exposure to chemicals used in lasers such as dyes and solvents can cause harm.* | Choose an item. | * Follow manufacturer instructions for handling;
* Lab users trained;
* Appropriate PPE available;
* Hazardous solutions prepared in Fume Hood;
* Safety Data Sheets available;
* Follow Hazardous Waste Manual for disposal of these materials;
* Hazardous materials stored appropriately;
 | * Student
* Staff/PI
* LEM
* Visitors
 | YesYesNoNo |
| **Laser Generated Air Contaminants (LGAC)** | *Potentially-toxic substances generated when high power laser beams strike target materials (plastic, tissue, etc.).* | Choose an item. | * Enclose the process generating fumes/vapors and link it to local; exhaust to evacuate LGACs;
* Ensure laboratory ventilation is adequate;
* Appropriate PPE available and required training completed;
 | * Student
* Staff/PI
* LEM
* Visitors
 | YesYesNoNo |
| **Compressed gases** | *Use of compressed gases as part of the laser system (i.e. laser medium) or experiment. Risk of explosion, fire, toxic gas exposure etc.* |  | * Authorized users have taken the required training;
* Keep compressed gases in upright position and secured;
* Use correct regulator;
* Familiar with the [KAUST Compressed Gas Safety Program](https://hse.kaust.edu.sa/docs/default-source/research-safety/compressed_gas_safety_program_mar_2022.pdf?sfvrsn=93ce6ae9_6);
* Toxic gases stored in ventilated gas cabinets;
* Install Toxic Gas Monitors if required;
* Check regularly the tubing for damage and leaks (if toxic/corrosive gases are used);
 | * Student
* Staff/PI
* LEM
* Visitors
 | YesYesNoNo |
| **Trip Hazards** | *Hazard related to poor housekeeping.* | Choose an item. | * Cables are kept off the floor or in cable runner;
 | * Student
* Staff/PI
* LEM
* Visitors
 | YesYesNoNo |
| **Fire Hazard** | *Class 4 lasers may ignite combustible materials, and thus may represent a*fire*risk.* | Choose an item. | * A CO2 fire extinguisher is available in the room;
* Lab Safety Plan includes the emergency exit route;
* Rapid egress and emergency access satisfactory;
 | * Student
* Staff/PI
* LEM
* Visitors
 | YesYesNoNo |

# Personnel and Required Training

## Authorized users

The laser(s) detailed in section 2 can only be operated by authorized users who are adequately trained in the safe use of the laser(s) prior to the commencement of work. To become an authorized user, one must:

* Complete the training ***Laser Safety Training*** (available via Salute Portal);
* Read and fully understand the Standard Operating Procedures (SOP);
* Receive equipment specific safety training;
* Users have been added to the list of authorized users;

## Unauthorized users

Visitors or other staff members who are not authorized to work with the laser system(s) are not allowed in the area while the laser is in operation unless they are accompanied by an authorized user. All visitors must be briefed on proper safety protocol and must wear appropriate laser safety eyewear before entering the area.

# Personal Protective Equipment

All standard PPE must be worn when entering lab spaces: lab coat, close fitting clothes, closed-toe shoes, etc. In addition, when working with open beams appropriate laser safety eyewear must be worn (instead of standard safety glasses).

|  |  |
| --- | --- |
| **Eyewear Protection Level required for this Laser is:** | **≥ OD # for #### nm** |

The appropriate laser safety eyewear available at the entrance of the laboratory are as follows:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Which laser** | **Eyewear Model** | **Protection Range** | **VLT** | **Nb. of pairs** | **Storage Location** | **When to use them** |
| Asterella | ThorlabsLG 10 | 720 – 1090 nm | OD 5 | 25% | ## | In the table at the entrance of the Lab  |  |
|  |  |  |  |  |  |  |  |

# Operating Procedures

Sequential events that describe the complete operation including when to implement hazard control measures.

## Initial Safety Checks

1. Remove jewelry/objects that might reflect beams.
2. Obtain appropriate eyewear. Be certain it is of appropriate OD for the wavelength(s) in use.
3. Only authorized personnel can operate the laser(s).
4. Unauthorized or untrained personnel are STRICTLY NOT ALLOWED to enter the laboratory on their own; they must be accompanied by an authorized user.
5. Laser warning light should be activated and doors closed.
6. The laser safety curtain/barrier at the entrance of the laboratory must always be in-place.
7. A [warning sign](https://hse.kaust.edu.sa/services/laser-safety) must be posted at the entrance to the Laser Controlled Area.
8. Before starting the Class 3B/4 lasers, beam paths should be inspected for any objects that should not be there.

## Target area preparation or Experiment preparation

## Turn on the laser

1. Press the button #### to turn the laser on.
2. Wait for at least 5 min for the laser to warm up.
3. Communicate your intentions to others present in the room/area at all times (e.g. before opening/closing shutters, removing beam blocks, or actions that might put others unintentionally at risk).
4. Consider the use of remote viewing (e.g. cameras, safety glasses combined with the use of IR viewer, etc.).

## Beam Alignment Procedures

|  |
| --- |
| *Alignment Tips:** Allow only trained personnel to be present during alignment. Minimize the number of personnel present during the alignment. All present must wear appropriate eyewear.
* If possible, avoid using beam paths that are at sitting or standing eye level.
* Where feasible, use low power (class 2 or 3R) visible lasers to simulate the path of high power or invisible lasers.
* Where feasible, terminate laser beams and specular reflections on diffuse reflecting beam blocks.
* Use phosphor cards, IR viewers, video cameras or other display devices to locate invisible beams.
* Locate any specular reflections of the beam and block them as close to the source as possible.
* Whenever possible, reduce all high power laser beams to the minimum possible power.
* Use beam shutters to block high power beams any time they are not actually needed.
 |

***Note: It is sometimes necessary to align, clean or otherwise maintain the internal components of a laser. If this is so for this laser, please attach a procedure for this process as an addendum. Describe how you will perform this work in a safe manner. If this is performed by a vendor, please indicate so.***

### Internal Alignment of the laser system

1. Internal laser alignment must be performed according to the manufacturer’s specifications and with the lowest power available.
2. Internal alignment of the laser must only be performed by LEM or the manufacturer.
3. Or describe what the steps are.

### External Alignment of the laser beam

1. Select a low output power (e.g. 10 mW) by pressing #### on the front panel menu - describe how to select low output power.
2. If the beam path needs to be changed significantly by relocating the laser or optics, all users of the laser must be notified of the change.
3. Carry out the alignment using an infrared card etc.
4. Use beam blocks to stop any reflections coming from the optical table.

Etc…..

## Shutdown Procedure

1. Press switch off button on the touch screen on the front panel of the laser.
2. Turn the key switch to the OFF position.

# Maintenance

**Maintenance and internal alignment of the system** are not described in this procedure and shall be performed only by a qualified technician, LEM or the manufacturer. For optics cleaning or replacing the halogen filter or flash lamps, etc., please consult the laser manual.

# Emergency Procedures

Authorized laser users must be familiar with the Building Emergency Plan, location of emergency equipment, and emergency procedures for fires and evacuations. The red Emergency shut-off button is located at the front panel of the laser system; once you have pressed the button you should turn the key to the OFF position.

## Suspected Laser Injury

Accidental laser beam exposure is a serious event. In the case of suspected laser eye injury, operations must be ceased and the laser setup must remain unchanged to allow for analysis of the cause of the accident.

In case of injury, the other users in the laboratory must:

* Stay with the injured person (if it is safe to do so);
* Call **911** (KAUST landline) or **012-808-0911** (mobile phones), indicate the location of the incident and if an ambulance is needed;
* Immediately contact the PI/Center Director or LSC, and LSO;
* The injured person must go the KAUST Health Emergency Room as soon as possible and in any case within 24 hours. KAUST Health ER will follow the established procedure for laser eye/skin injury;
* If accidental exposure to the eye has occurred, complete the [*Laser Eye Injury Description Form*](https://hse.kaust.edu.sa/docs/default-source/research-safety/laser_eye_injury_description_form.docx) and take to KAUST ER (if possible);
* Log the incident in the [reporting system](https://hse.kaust.edu.sa/SALUTE/reportit);
* Collaborate with the LSO/RST to investigate the cause of the incident. The LSO will investigate any suspected exposure to excessive levels of laser radiation.

## Damage and malfunction of the laser

If the laser is damaged or malfunctioning, please follow the steps below:

* Stop the laser equipment using the normal procedure and if necessary press the Red Emergency Stop button, or any other method to interrupt the laser emission;
* If the equipment is equipped with a key, remove the key;
* Place a warning notice on the equipment “DO NOT USE – EQUIPMENT FAULT”;
* Contact your LSR, PI/Center Director, LEM and/or LSO and let them know about the issue so the laser equipment can be fixed.
* Report: After the incident has been dealt with to ensure the area is safe, you will need to report the incident using the University’s accident [reporting system](https://hse.kaust.edu.sa/SALUTE/reportit).

## Fire or Explosion

In the event of a fire or explosion, local area fire drill procedures should be followed as well the steps below:

1. In an emergency, interrupt the laser emission by hitting the Red Emergency Stop button, or turning the key switch off;
2. Call the Fire Department (**911** from a campus phone or **012 808 0911** from a mobile phone) and follow your lab emergency response procedures for Fires and Explosions;
3. Inform the PI/Center Director, Laser Safety Contact and Research Safety Team;
4. Prevent Access: Ensure that no one is able to restart the laser (e.g. by removing the key);
5. Evacuate the laboratory according to the local area fire drills (see Lab Safety Plan);
6. Report: After the incident has been dealt with to ensure the area is safe, you will need to report the incident using the University’s accident [reporting system](https://hse.kaust.edu.sa/SALUTE/reportit).

**Authorized Users Signatures**

I have read and understood this procedure, its content, and attached addendum. I agree to follow this procedure each time I use the laser/laser system. **Please be certain to read any addendums to this SOP prior to signing!**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **KAUST ID** | **Signature** | **Date (dd/mm/yyyy)** |
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