**Task/ Work:** VLase UV marking

**Location (Room/ Building):** Lab 1A, Building A

**Date :** X/Y/ZZZZ

**Reference / Version :** V1

**Review Date :** Annually, or at change of use

**University Laser Safety Officer :** Dr Ian Haslam, ian.haslam@manchester.ac.uk

**Local Laser Safety Advisor :** laser safety advisor’s name

**Issued under the authority of :** PI/Lab manager’s name

**Purpose & Scope**

This document describes safe working procedures, the use of controls identified in the risk assessment, and plans for any reasonably foreseeable incidents. These rules should be seen as part of the official laser safety standards set out in BS EN 60825-1:2014+A11:2021 and the University Laser Safety Policy as stated in University Health & Safety Arrangements: Chapter 27. These rules implement the University’s laser safety policy at a practical level and form part of the University’s duties under Section 2(3) of the Health and Safety at Work etc Act 1974.

**Introduction & Description of Lasers**

This laboratory utilises high power (up to the kW range) lasers classified as class 4. Equipment of this type can cause instantaneous, massive and non-reversible damage to human eyes not only from direct viewing and from specular reflections but also from diffuse reflections (e.g., from the work piece). The energy levels of these lasers are high enough to cut and weld metals. They can also vaporise any known materials in a fraction of second at the focal point of the laser beam. Most of these lasers are invisible to the human eye. They can generate direct damage (burning) to skin and can ignite clothes and any flammable materials. These lasers can also generate fumes and hazardous materials during laser processing experiments. Therefore, strict safety measures must be employed whilst using this equipment. These include enclosed beam paths and work area, laser shutter interlocks, laser operation indicators at doors and on lasers, protective goggles, gloves and clothing, labels at various places, fume extraction systems, air circulation systems, separated laser work rooms for different lasers, protective screens and curtains, mouth masks, first aid boxes and fire extinguishers etc.

The Datalogic Vlase UV is a diode-pumped, Q-switched, air-cooled OEM laser, with a 3 W nominal output power, in the single transverse mode (TEM00). The laser emits at the wavelength of 355 nm. The beam is characterised by a high pulse-to-pulse stability (<1.9% at 3W in the Q-switched regime) and high spatial resolution (<50μm with a 160 mm focal). The laser in fully enclosed and is class 1 within the enclosure, class 4 with the interlock overwritten. The laser processes undertaken on this system cover a variety of methods, including: Laser engraving, Laser marking, Laser surface processing. Typical materials processed are: Steel (mild, stainless) and other metals (e.g. Ti), Polymers, Insulators.

This Class 4 laser generates a 355 nm blue (UV) beam with a minimum spot size of 25 microns when processed through a laser beam steering/focussing head. Even a fraction of these powers can damage the eyes and skin. A visible red diode laser pilot beam of 3 mW (Class 2M) is installed coaxial to the main laser beam to indicate the beam position. This pilot laser will not cause thermal damage to the skin, but direct viewing of this aiming beam can still damage the eyes. The beams are guided from the laser generator to the workpiece via a beam expander and a scanning head, which allows the marking of arbitrary shapes onto the target by a set of mirrors and is focused by a lens system. The beam path after the scanning head is not enclosed. The entire assembly (laser head, scan head, z-axis motion system and target) however, is in a purpose-built enclosure, protecting against diffuse and specular reflected laser radiation. The doors to this enclosure are interlocked to the control line of the laser. A forced air circulation cooling system cools the laser cavity. Intrinsically, the laser system is powered from a laser diode stack which pumps a frequency doubled Nd:YAG laser system. The fibre, connection the input diode into the YAG system is not a user serviceable part and must not be disturbed by the operator.

**Justification for Open Beam Work**

Under normal operation there are no open beams, but very occasional (<3 times/year) maintenance is required which involves open beam work. It is not practical to eliminate this open beam work due to the complex multi-axis adjustments required. Only fully trained and experienced staff are permitted to carry out this work, and only procedures specified in the scheme of work may be carried out, and only during standard working hours.

**Authorised Users / Responsibilities**

XXXXX(Lab Manager)\*, XXXXX(technical staff)

An asterisk (\*) after the name indicates modification competence for open beam work. An ampersand (&) indicates servicing competence for the laser head. Names in italics indicate non-LPRC members who have not gone through the induction process, but are considered competent, due to their profession.

This document is applicable to all staff and students as well as visiting members to the facility. It is to be noted that these rules do not replace any other safety rules already in existence but are to be used in conjunction with the general safety rules in effect throughout The University of Manchester, the Department, and the School. Although the Head of Department is broadly responsible for ensuring a safe working environment, the following bear specific responsibilities that affect laboratory safety. The University Safety Officer provides advice and guidance about the legal duties and safety standards to be applied. The Department Safety Advisors distributes this information contained in this document within departments. On a regular basis, invite the University Safety Officer to comment on our policies and procedures. Responsibility for ensuring the workplace is safe lies primarily with the academic responsible for the work undertaken (“Academic-in-Charge”) and with everyone carrying out work or observing work. Safety Advisers, etc. do have a supporting role to this, but may interrupt work if they consider it to be carried out in an unsafe manner. Persons found in repeated violations of safety regulations may find themselves banned from entering the laboratory. These local rules are in accordance with the rules set by the University of Manchester health and safety services as stated in Chapter 27 arrangements.

All laser users must attend the appropriate Laser Safety Training Course, which will be provided by the University laser safety officer (ULSO). Details can be found on the webpages below:

http://www.radiationsafety.manchester.ac.uk/lasers/

In addition to this, a basic safety induction must be performed by the laboratory manager, within which the laser user is advised of (amongst others):

a) The local rules/scheme of work (this document)

b) The laboratory rules sign off form

c) The induction checklist (LS3 Form)

Access to the laboratory and booking rights will only be granted after you have attended a training session for one of the pieces of equipment.

Visitors to the labs must be always supervised. Access to the laboratories is only permitted for academic purposes or during guided tours, etc. Before any work on equipment can take place, a visitor must be cleared with the Laboratory Supervisor of the equipment involved, to ensure dissemination of H&S information as well as suitable understanding of the equipment used. Regular visitors who intend to utilise analytical equipment must receive a safety induction and be supplied with the risk assessments for the equipment and areas they are likely to arrive at. Regular visitors who intend to utilise laser systems are required to undergo standard laser user procedures. During promotional events, such as Open Days, UCAS days, WP Events, etc. at least one trained member of staff must be available to supervise the proceedings. A risk assessment must be available for such events, but the possibility of the use of the general area risk assessments may be considered.

**Laser Controlled Area**

The Vlase UV laser system is located within Room 1A, as such it can only be accessed via the standard laboratory entry procedure after undergoing training. There are “laser on” lights outside each of the laboratories, these need to be switched on when the laser is in use. During open beam work and additional barrier and warning signs are placed outside the doorway.

**Protection Measures / PPE**

The laser system keys are kept inside a box in the lab. Staff/ Students will be provided with a number code upon completion of the Health and Safety training. Please note the use of the keys in the logbook provided. Laser keys must be returned to the box after use.

Under normal operating conditions the laser is fully contained in an interlocked enclosure. During open beam work the interlocks may be overridden, but only when the other safety measures are in place (see procedures below).

**PPE**

PPE is required for certain tasks performed on open beams or on specific systems. For this purpose, appropriate PPE is available in the laboratory. Appropriate broadband goggles are available for the wavelengths emitted from this laser system.

Calculated requirement (EN: 207): D LB6 R LB4

Eyewear available: Thorlabs LG3, rating >315 to 532 nm (DIRM LB6)

Nitrile gloves are also provided to protect the users hands from exposure to scattered ultraviolet radiation.

**Procedures**

The operation of the Vlase UV laser system has to be carried out in accordance with the operating instructions of the systems manual. Every user must have passed through the Laser Worker Induction Process. Every use of the system, together with a brief summary of the procedure (1 line or less, in legible handwriting, please) must be logged in the laser system logbook provided and logbook on the computer. Also note down any modifications performed to laser or beam path. Every fault, problem or unusual occurrence must be noted in this logbook, and the member of staff responsible for the system must be informed.

Normal use of this laser system is assessed for generic ablation process arrangements. Processes that differ from this setup must be assessed separately. Other arrangements/ modifications must be assessed separately.

Several laser power meters, beam profiling equipment and energy meters are available for use. These units are intended for use under direct laser radiation, and their use is therefore connected with certain hazards. This is mainly since some units are hand-held. Some of these units may reflect laser radiation to a small percentage. They are designed to be used in a de-focused beam, to avoid damage to their coated surfaces. Their use is therefore only permitted to persons trained in their use. Please contact the instrument supervisor to get access to these pieces of equipment.

Maintenance and Service must be carried out only by qualified persons (Note: A registered laser worker is usually NOT a qualified person). During the course of such procedures, the system will often be operated without covers and opened enclosure and with exposed electrical systems. As a result, no person must approach the system, except when expressly requested/permitted by the service engineer.

During any open beam work the following measures must be observed:

• In addition to the Laser light above the door the ‘open beam work’ barrier and sign must be placed outside the doorway.

• The laser should not be left unattended in an open-beam state or when turned on and enclosure interlocks defeated.

• The operator must ensure that no other persons are present in the laser area other than those strictly required for the purpose in hand.

• Anybody in the area must wear laser protective eyewear conforming to BS EN207, as defined in the risk assessment, unless the operator has confirmed that all protective beam covers are correctly installed.

• Reflective items such as rings and watches must be removed before any optic manipulation takes place.

• The operator must at all times be aware of the location of all beam paths.

• The lowest practical laser power must be used at all times.

• Optics should be checked for damage and stability before open beam work is carried out

• The operator must ensure that after open beam work takes place all safety covers and interlocks are restored.

• When adjusting optical paths a beam block should be placed at the output of the laser to be aligned before the laser is switched on. The laser can then be switched on and the position of the beam spot verified. The laser shutter should then be closed, and the beam block moved just beyond the next optical element. The shutter should then be opened again, the beam pointing checked on the next optic, and any necessary adjustments made. It is essential to ensure the beam is fully stopped by the beam block while performing this. This sequence should be repeated with each optical element, making small adjustments to the alignment as necessary.

**Summary of Hazards**

Class 4 beam hazards

High voltages in laser head

Water cooling

Trip hazards.

Electrical hazard from ancillary equipment.

**Contingency Plan**

In case of emergency call your nearest first aider, outside of normal working hours call Security on 0161 306 9966.

If an ambulance is needed, telephone 999 stating clearly the full postal address (XXX), and what is wrong with the casualty, together with your name. Also inform building reception (XXXX) and arrange for somebody to meet and direct the ambulance staff to the casualty.

In the event of an accident involving eye exposure, as soon as possible and within 24 hours of the incident, take this completed card and any relevant risk assessments to:

**Manchester Royal Eye Hospital, Oxford Road, Manchester, M13 9WL**

Emergency Eye Department opening times: 08:00-20:00, 7 days a week

Outside these hours call: 0161 701 0249, or attend general A&E at Manchester Royal Infirmary (address as above)

Do not drive yourself. Get a friend or colleague to take you, or use a taxi.

It is important that the affected person does not rub their eye after exposure as this can lead to corneal abrasions.

All injuries, however small, and any near-misses must be reported to the Local Safety Advisor in order that an accident form or near miss form may be completed.

In the event of any unsafe condition or fault being apparent with the equipment, the experiment must cease immediately, the laser be turned off if it is safe to do so, and the matter reported to local staff supporting the experiment.

**Scheme of Work Approved by:**

Name: ………………………… Signature:………………………… Date:…………

**THIS DOCUMENT SHOULD BE REVIEWED ANNUALLY**

**User Declaration**

*I have read and understood this document and agree to abide by its requirements at all times.*

*I understand that in the event of any malfunction, or suspected malfunction, of any part of the laser system or its security and safety systems that the experiment must be stopped immediately, the laser switched off and the matter reported to local staff supporting the experiment. I accept that we are all jointly responsible for one another’s safety and undertake not to knowingly permit the infringement of these Rules and Procedures by others.*

**Authorised Users**

 **Name Signature PI Signature Date**

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| Laboratory Address: |  |
| Laser classification: |  |
| Type: Pulsed, Continuous Wave |  |
| Wavelength (nm) |  |
| Effects on Eyes of excessive exposure. | Delete as appropriate:180 – 315 nm: Photokeratitis315 – 400 nm: Photochemical cataract400 – 780 nm: Photochemical and thermal retinal injury780 – 1400 nm: Cataract, retinal burn1400 – 3000 nm: Aqueous flare, cataract, corneal burn3000nm – 1 mm: Corneal burn |
| Pulse energy (duration, peak power, repetition frequency) |  |
| Circumstances of accident / injury: |  |
| Time & Date of Injury |  |
| Eye affected: Left / Right / Both |
| Were protective goggles being worn? Yes / No |