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| **Date:** (1)  **X/Y/ZZZZ** | **Assessed by:** (2)  **A. S. Postdoc** | **Validated by:** (3)  PI/manager  Laser safety advisor | **Location:** (4)  **Lab 1A, Building A** | **Assessment ref no** (5)  **V1** | **Review date:** (6)  Annually, or at change of use |
| **Approval of open beam work by Head of Department/ Director of Institute:** (7)  **Name: ………..……………………………….Signature:……………………** | | | | | |
| **Task and Environment :** (8)  Materials processing using Vlase UV laser.  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.  The Vlase UV laser system is located within Room 1A, as such it can only be accessed via the standard laboratory entry procedure on key access to the room. | | | | | |
| **Justification for open beam work:** (9)  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. | | | | | |
| **Details of Laser(s) used, including ELV/MPE calculations:** (10)  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.  Operating modes: Pulsed ~5 ns pulse duration, 80kHz repetition rate ; Average Power: 3 W ; Active Lasing Medium: Nd:YO4  Beam diameter: 3 mm, Gaussian profile ; Divergence of focussed beam (Average Hor/Ver) = 1.5 mrad  Aperture Diameter for eye irradiance = 1 mm ; Blink response = 30000s  The hazards posed by the lasers in this system have been assessed by calculating the maximum permissible exposure (MPE) according to PD IEC TR 60825-14:2022, the exposure limit values (ELV) according to Directive 2006/25/EC, which produce the same values for this system.  Tabulated ELV/MPE Values:  Ocular, 10-9 to 10-7 s: Hsingle =C1 = 5.6x103 t0.25 Jm-2  Ocular, 30000s: HBlink=104 Jm-2  Skin, 10-9 to 10-7 s: Hsingle =C1 = 5.6x103 t0.25 Jm-2  Skin, 100 s: Eskin= 104 Jm-2  Ocular:  Single Pulse with pulse-width of 5 ns:  Hsingle = C1 = 5.6×103 t0.25 = 47.09 Jm-2  Pulse Train MPE:  Htrain=Hsingle×N-0.25=47.09×(30000×80000)-0.25=0.21 Jm-2  Average output MPE at 80kHz (worst case), use t=30000s:  HBlink=104 Jm-2  Htrain=Hblink/N = 104⁄(30000×80000)= 4×10-6 Jm-2  Most Restrictive Occular ELV/MPE= 4×10-6 Jm-2  Eye limiting aperture, DL = 3.5 mm (ELV) or 1 mm (MPE). 1/e beam diameter is 1 mm, Use the largest (3.5 mm) to calculate beam area = 9.62x10-6 m2  Laser energy density = Pulse energy/ area = 37.5 µJ / 9.62x10-6 m2 = 3.90 J m-2  **Laser output exceeds eye ELV/MPE by a factor of 974418**  Cutaneous (100s):  Single Pulse with pulse-width of 5 ns:  Hsingle =C1 Jm-2 = 5.6×103 t0.25 = 47.09 Jm-2  Pulse Train MPE:  Htrain=Hsingle×N-0.25=47.09×(100×80000)-0.25=0.88 Jm-2  Average MPE at 80 kHz (worst case):  Hskin=104 Jm-2  Htrain=Hskin/N = 104⁄((100×80000)=) 1.25×10-3 Jm-2  **Most Restrictive Skin ELV/MPE = 1.25×10-3 Jm-2**  Skin limiting aperture, DL = 3.5 mm, 1/e beam diameter is 1 mm, Use the largest (3.5 mm) to calculate beam area = 9.62x10-6 m2  Laser energy density = Pulse energy/ area = 37.5 µJ / 9.62x10-6 m2 = 3.90 J m-2  **Laser output at 355 nm exceeds skin ELV/MPE by a factor of 3118** | | | | | |
| **Provided PPE, including calculated eyewear requirements:** (11)  Using rep. rate 80kHz, pulse duration 5ns, beam diameter 3 mm, 3W, 37.5uJ  Calculated requirement (EN: 207): D LB6 R LB4  Eyewear available: Thorlabs LG3, rating >315 to 532 nm (DIRM LB6)  Appropriate broadband goggles are available for the wavelengths emitted from this laser system. Nitrile gloves are also provided to protect the users hands from exposure to scattered ultraviolet radiation. | | | | | |

| **Activity** (12) | **Hazard** (13) | **Who might be harmed** (14) | **Existing measures to control risk** (15) | **Risk rating** (16) | **Result** (17) |
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| General use of Class 4 Laser system following UoM chapter 27 | Non-ionising radiation, Heat radiation, hot work pieces, harmful particulates, fume, Burns to skin and eyes, fire | Users, staff, visitors, contractors | Only trained and competent users can use the Laser systems:   * All users to have completed courses- THS42e Laser Safety training and follow the General Local Rules * Access to Laser laboratories is to authorised/trained/supervised persons only. * LS3 form must be filled in by all users that are trained on the laser system * All users must sign the logbook with located on every laser computer. * Laser keys must be stored in a key box or equivalent storage. Keys must be returned after every use. * All high-powered lasers are CE marked, from a reputable supplier, and logged on LabCup | Low | A |
| Using Vlase UV Laser | The Class 4 laser beam is extremely hazardous to the eyes and skin. and its specular and diffuse reflections must not be viewed at any time as they may cause permanent loss of sight. | Users, staff, visitors, contractors | * Laser Head and beam delivery fully enclosed within the metal enclosure. Interlocks are fitted, used, and working correctly (regularly checked by Technical staff) * Optical modification only takes place when laser is disabled. Enclosure Interlocked for everyday use. * Interlock override is available for servicing. All Laser alignment to be carried out by Technical staff who have undergone additional training and completed Advance Laser Safety Course (THS43e). * During open beam work only specified procedures followed, and only during standard working hours. * Safety eyewear and nitrile gloves are available to protect user during alignment (see above for details). | Med | A |
| Using Vlase UV Laser | High and Normal Voltage. (Computer CNC Laser Power Unit, etc.) | Users, staff, visitors, contractors | User Training, Annual inspection, and maintenance (PAT) performed on the system. No users to access to PSU internals except LPRC support staff. Short cabling and avoidance of user access to cabling where possible. Emergency off switch (PSU) should be installed when possible. | Low | A |
| The Laser Process | Use of Local Exhaust Ventilation systems  Harmful particulates and fume. | Users, staff, visitors, contractors | All Laser processes are required to use Local Exhaust Ventilation systems  Pre-user checks to be carried out on LEV system:   * Air flow is audible * Power light is on * Air flow is reading above 0.4 m/s on digital display (when applicable) * Ducting/hoses not blocked with debris * All ducting is connected in place to enclosure and unit * Power cables free from damage and not strained from socket.   Systems inspected by Allianz within every 14 months (check label)  Any faults reported to Technical staff and processes not attempted until repair is carried out  Any adjustments to LEV must be approved by Supervisor/Technician/EO before attempting. | Low | A |
| The Laser Process | Chemicals used for process, pre- and post-treatment | Operators and the Environment | COSHH Data and Procedures should be in place by the operator. The operator before use should perform RA for the process. | Low | A |
| The Laser Process | Burning Hazard (human damage) | Operators and the Environment | Samples must be allowed to cool to reasonable temperature before handling, protective gloves are provided. | Low | A |
| Use of Compressed inert gases | Accidental release of asphyxiant gas, cold burns, incorrect use, or handling | -Users, staff, visitors, contractors  - Cold burns from accidental discharge, Asphyxiation, Musculosketal injuries from handling/operation of cylinders | Users to have completed training course: TLCA105 Compressed Gases Workshop  Technical staff only to move cylinders within Laboratory  Use of Carbon Dioxide is banned  Pre-user checks of:  Cylinder and regulator free from defects  Cylinder and regulator in date (5-year use by limit)  Close the regulator before fitting to ensure against accidental release  Open valves slowly  Do not:   * Attempt to modify or repair the regulator * Interchange regulators between different gas types * Force connections or use adapters * Use any out of date cylinders or regulators | Medium | A |
| Use of Cooling systems | Electrical faults, damage to equipment, system not working correctly,  leaks | -Users, staff, visitors, contractors  -Electric shocks, slips on spillages, | * User is trained and supervised until fully competent. * Check PAT up to date * Fixed electrical equipment annually checked by qualified engineers * Visual checks before use to make sure equipment, cables, and hoses free from defects. * If fault or leak occurs stop use and report it as soon as possible to Supervisor and Technical staff. Make sure equipment is switched off and made safe after use | Low | A |
| Moving around Laboratory | Slips and falls, wet floors, uneven surfaces, obstacles | User / Visitors - Strains and impact injuries | * Care should be exercised whilst in laboratories at all time to prevent any general personal injuries * Good working practice adopted e.g. regular tidying of cables and furniture * Ensure floor remains dry and mop up any spilt liquids * Follow designated pathways/routes-No cables to be used across walkways. | Low | A |
| General working in workshop, cleaning, maintenance, and visitors | **Slips and Trips, wet floors, obstacles, uneven surfaces** | **All Lab users** | * Reasonable standards of housekeeping maintained * Trailing cables positioned neatly away from walkways * Any damage to floor coverings and other repairs and maintenance reported immediately to estates-helpdesk@manchester.ac.uk for repair/replacement as necessary * Floors kept clear of items, e.g. debris, litter, equipment & tools, bags. * All cabinet drawers and doors kept closed when not in use * Floor cleaned regularly by sweeping area of derby * Adequate lighting provided during any work. * Appropriate clothes and shoes must worn when in the laboratory. | **Low** | **A** |
| Use of additional electrical equipment | Can cause fire, burns or electric shock | User and others in the area | * User is trained and supervised until fully competent. * Check PAT up to date * Fixed electrical equipment annually checked by qualified engineers * Visual checks before use to make sure equipment, cables and free from defects. * If fault occurs stop use and report it as soon as possible * Make sure equipment is switched off and made safe after use. | Medium | A |
| Use of Hazardous materials: Powders | Flammables, Oxidisers, CMRS, Nanoparticles, chemical reaction with other substances. | **-All Lab users**  -Effects of harmful powders: inhalation, burns, health damage | * All substances used must have a Chemical Risk Assessment before work commences and substances purchased * Check with Supervisor/Technical staff for permission of powder use * CMRs cannot be used within these systems * LEV systems should be used for decanting powders (e.g. Fume cupboard) and new containers must be labelled with substance details, date, quantity, and name of Student. * Particle size is limited to 20µm. If you wish to use powders below this size, then they must be incorporated in a slurry. Slurries must be produced in a sealed glove box, or similar control system * All Users of the SLM A28b have personal PPE * All Powders are disposed of via Powders bin provided in labelled, sealed bags. | Medium | A |
| Use of hazardous materials: Metals | Flammables, Oxidisers, chemical reaction with other substances | **-All Lab users**  **-Effects of chemical reaction, Burns, Fume** | * All substances used must have a Chemical Risk Assessment before work commences and substances purchased * Aluminium, Magnesium and Titanium require additional assessment from members of staff before any use can be permitted. * Check SDS for specific PPE information and storage details | Medium | A |
| Using glassware | Sharps hazard | User  Risk of cuts | * Check that glassware is suitable for procedure before use. * Make sure it is in good condition, free from chips and cracks. * Handle with care and do not apply excessive force. * If broken use dustpan & brush or forceps to pick up broken pieces, do not use hands. Dispose of in designated sharps bins. * Wear cut-resistance protective gloves. | Low | A |
| Hand Tools, Sharp instruments | Sharp edges, impact injuries | -User, anyone in proximity  -Cuts from use, misuse, inappropriate disposal | * User is trained and supervised until fully competent. * Visual inspection of equipment for obvious defects * Tools free from grease, oils, paints, chemicals, and adhesives. * Use equipment as per manufactures guide. * Use correct tool for the task (e.g. Use hand scraper instead of knife for adhesive removal). * Never apply excessive force * If faulty stop use immediately and report it to a lab technician. * Dispose of blades in a Sharps bin.   Return to correct storage area | Low | A |

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| **Action plan** (18) | | | | |
| **Ref No** | **Further action required** | **Action by whom** | **Action by when** | **Done** |
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**User Declaration**

*I have read and understood this document and agree to abide by its requirements at all times. I accept that we are all jointly responsible for one another’s safety and undertake not to knowingly permit the infringement of these requirements by others.*

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| **Name** | **Signature** | **Date** |
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**Notes to accompany Laser Risk Assessment Form**

This form is adapted from the one recommended by Safety Services, and used on the University’s risk assessment training courses. It is strongly suggested that you use it for all new assessments, and when existing assessments are being substantially revised. However, its use is not compulsory. Providing the assessor addresses the same issues, alternative layouts may be used.

1. **Date** : Insert date that assessment form is completed. The assessment must be valid on that day, and subsequent days, unless circumstances change and amendments are necessary.
2. **Assessed by** : Insert the name and signature of the assessor. The assessor should have completed the Laser Safety Awareness course THS42e and Advanced Laser Safety Awareness course THS43e. General guidance on completing risk assessments can be found on the safety services website: https://www.healthandsafety.manchester.ac.uk/toolkits/ra/
3. **Checked/Validated by** :

**Checked by** : Insert the name and signature of someone in a position to check that the assessment has been carried out by a competent person who can identify hazards and assess risk, and that the control measures are reasonable and in place. The checker will normally be a line manager, supervisor, principal investigator, etc.

**Validated by** : Insert the name and signature of your Local Laser Safety Advisor (or their designated deputy), they will need to check that your safety calculations and control measures are adequate.

1. **Location** : insert details of the exact location, ie building, floor, room or laboratory etc. If off-campus, provide information about expected location(s) or attach itinerary.
2. **Assessment ref no** : use this to insert any local tracking references used by the school or administrative directorate.
3. **Review date** : insert details of when the assessment will be reviewed as a matter of routine. Usually this is for 1 years’ time, but might be less for a short programme of work. Note that any assessment must be reviewed if there are any significant changes – to the work activity etc.
4. **Approval of open beam work :** Where open beam work with class 3B and 4 lasers is essential, it must be signed off by the Head of School/ Department/ Institute.
5. **Task**: insert a brief summary of the task, eg research project [title] involving the use of X equipment.
6. **Justification for open beam work:** where open beam work with class 3B and 4 lasers is essential, it must be robustly justified
7. **Details of Laser(s) used, including ELV/MPE calculations:** include make, model and other details of the laser system(s) in use, including wavelength, power, energy, pulse duration and beam size where known. This is also the place to include details of ELV/MPE calculations. If the calculations are extensive (covering multiple wavelengths etc.) then the results can be summarised here and given in full in a separate referenced document.
8. **Provided PPE, including calculated eyewear requirements:** list what PPE is available, and summarise what eyewear your calculations have specified. If the eyewear available does not match that specified then clearly state what wavelength/energy rages are covered. Also include here plan for how eyewear condition will be checked regularly and monitored/recorded.
9. **Activity** : use the column to describe each separate activity covered by the assessment. The number of rows is unlimited. For example activities might include: in one particular lab or for one particular project might include: Use of Lasers, Open beam work, Experimental process, Lone Working, General lab use, Use of substances hazardous to health, etc
10. **Hazard** : for each activity, list the hazards. Remember to look at hazards that are not immediately obvious. The same activity might well have several hazards associated with it. For example ‘Use of lasers’ would include personnel exposure to beam (from the laser output), fire (from high power beams) , electrical (from power supplies), water leaks (from cooling systems), trip hazards (from cables), irritants (from laser cutting). The ‘Open beam work’ hazard would personnel exposure to beam during alignment.

Assessment of simple chemical risks (eg use of cleaning chemicals in accordance with the instructions on the bottle) may be recorded here. More complex COSHH assessments eg for laboratory processes, should be recorded on the specific COSHH forms.

Describe how harm might come about, eg an obstruction or wet patch on an exit route is a hazard that might cause a trip and fall; use of electrical equipment might give rise to a risk of electric shock; use of a ultraviolet light source could burn eyes or skin.

1. **Who might be harmed**: insert everyone who might be affected by the activity and specify groups particularly at risk. Remember those who are not immediately involved in the work, including cleaners, young persons on work experience, maintenance contractors, Estates personnel carrying out routine maintenance and other work. Remember also that the risks for different groups will vary. Eg someone who needs to repair a laser may need to expose the beam path more than users of the laser would do. Vulnerable groups could include children on organised visits, someone who is pregnant, or employees and students with known disabilities or health conditions (this is not a definitive list).
2. **Existing measures to control the risk** : list all measures that already mitigate the risk. For example, in normal operation the risk of exposure to beam has been mitigated by fully enclosing the system, and interlocking to the laser output any access panels. For exposure to beam during alignment extra precautions would be needed, access controls, further training, appropriate PPE etc.
3. **Risk Rating** : the simplest form of risk assessment is to rate the remaining risk as high, medium or low, depending on how likely the activity is to cause harm and how serious that harm might be.

The risk is **LOW** - if it is most unlikely that harm would arise under the controlled conditions listed, and even if exposure occurred, the injury would be relatively slight.

The risk is **MEDIUM** - if it is more likely that harm might actually occur and the outcome could be more serious (eg some time off work, or a minor physical injury.

The risk is **HIGH** - if injury is likely to arise (eg there have been previous incidents, the situation “looks like an accident waiting to happen”) and that injury might be serious (broken bones, trip to the hospital, loss of consciousness), or even a fatality.

1. **Result** : this stage of assessment is often overlooked, but is probably the most important. Assigning a number or rating to a risk does not mean that the risk is necessarily adequately controlled. The options for this column are:

**T = trivial risk**. Use for very low risk activities to show that you have correctly identified a hazard, but that in the particular circumstances, the risk is insignificant.

**A = adequately controlled, no further action necessary.** If your control measures lead you to conclude that the risk is low, and that all legislative requirements have been met (and University policies complied with), then insert A in this column.

**N = not adequately controlled, actions required**. Sometimes, particularly when setting up new procedures or adapting existing processes, the risk assessment might identify that the risk is high or medium when it is capable of being reduced by methods that are reasonably practicable. In these cases, an action plan is required. The plan should list the actions necessary, who they are to be carried out by, a date for completing the actions, and a signature box for the assessor to sign off that the action(s) has been satisfactorily completed. Some action plans will be complex documents; others may be one or two actions that can be completed with a short timescale.

**U = unable to decide. Further information required.** Use this designation if the assessor is unable to complete any of the boxes, for any reason. Sometimes, additional information can be obtained readily (eg from equipment or chemicals suppliers, specialist University advisors) but sometimes detailed and prolonged enquiries might be required. Eg is someone is moving a research programme from a research establishment overseas where health and safety legislation is very different from that in the UK.

**For T and A results**, the assessment is complete.

**For N or U results**, more work is required before the assessment can be signed off.

(18) **Action Plan**. Include details of any actions necessary in order to meet the requirements of the information in Section 11 ‘Existing measures to control the risk’. Identify someone who will be responsible for ensuring the action is taken and the date by which this should be completed. Put the date when the action has been completed in the final column.