STANDARD OPERATING PROCEDURE (SOP) FOR THE SAFE USE OF CLASS 3B / 4 LASER PRODUCTS

This SOP is not an exhaustive 'list' of requirements nor is it an instruction on how lasers should be used. Its purpose is to draw the attention to matters that should be considered when designing experiments employing the use of Class 3B and 4 lasers.

Resources	Standard for the management of class 3B / 4 lasers Web resources Training videos on YouTube
VIRGIL	If you want to use a Class 3B / 4 laser, or need to access a Class 3B / 4 laser fixed inside a Class 1 laser product (e.g. for alignment, servicing, maintenance) you must register for a laser permit and be 'associated' with a risk assessment for that activity. You need to do is apply on VIRGIL, the agile database that manages all aspects of laser safety. You should also read (at least) the bullet points in the standard for the 'Management of Class 3B / 4 Lasers'. Don't worry, the standard is short, sensible and written to be helpful.
Laser Safety Officers	The LSOs are your departmental contacts, who will assist in arranging local lab inductions and authorise your VIRGIL application. Biology – Dave McCarroll Chemistry – Mark Blitz Earth & Environment – Gareth Keevil Electronic & Electrical Engineering – Paul Dean Mechanical Engineering – Brian Leach Physics – Ben Woodman SPEME – Mo Javed
Building laser experiments	Understand your laser's capabilities and operational parameters (power, wavelength, pulse repetition rate, size, weight - you may need to move it around), and also the services it needs (power supply, coolant, gases, corrosive gases, ventilation) when designing your experimental layout. Consider any modifications to supplied equipment or established experiments with care. New laserists should receive peer-led training on how to build experiments. Your LSO will help you to make contact with a suitable mentor.

Optical components (lenses, diffraction gratings, splitters, etc.)	Must be firmly secured to the optical bench prior to an experiment going live. Some flexibility will be required when performing beam alignment, but care should be taken to ensure that optical components will not get knocked and cause misalignment or beams to become directed off the optical bench. A video showing a simple alignment can be watched here (9 minutes long).
Beam path	Laser beams should be fully enclosed wherever possible. One advantage of this is that it can allow non-laserists (including undergraduates) to operate the system and carry out experiments without having to go through the formality of registering. Where it is not possible to create a fortress around a hazardous laser beams should be enclosed wherever possible using flight tubes or barriers. The purpose of this is to prevent inadvertent hand exposure and also to make it impossible for a person to lean into and look at a laser beam. Where beams paths cannot be enclosed you need to understand why this is so. Usually total enclosure is impractical because of the need to make regular adjustments of the optics: watch this discussion (11 minutes long).
Beam stop / dump	Beam stops are temporary intercepts that are used when aligning optics, training / leading laser beams etc. so that the end point of a beam is known and controlled at all times. Whilst performing alignments the laserist may choose to use a simple piece of card for the 'beam stop' (seen near the beginning of this video). However, thought should be given to what the beam might strike should a mistake be made...a sheet of blackened aluminium held in a stable holder? Laser beams must be 'dumped' at the end of their useful path. The dump may be a camera, measuring device, power meter, a feathered heat absorbed, right angled piece of copper tube, etc.
Enclose optics	Covering optics not only provides control over the beam paths, but may also help to keep the optics free from dust thus optimising beam transfer.
Securing optical components	Wherever possible, all components forming the experiment (laser, optics, cameras, beam dumps, etc) should be firmly secured so they cannot move with respect to one another. This is to stop optics in particular from moving and misdirecting beams, but also to prevent misalignment should the bench be knocked or suffer from vibration. This incident relates to misalignment.
Prisms	Prisms can rotate beams through unexpected angles. Ensure the plane of rotation is known and use intercepts (metal shields, light absorbing Perspex, beam stops) to prevent beams leaving the optical bench.
Reflections	Specular reflections arise from smooth shiny surfaces and diffuse matte reflections from roughened surfaces. • specular reflections from Class 3B lasers may be harmful to the eye • specular and diffuse reflections from Class 4 beams may be harmful to both the skin and eye. Wherever possible, optical components and other equipment used on optical benches should be supported in blackened holders / supports. Unintentional reflections must be prevented. Specular reflections must never be allowed to become directed towards doorways or windows. Where appropriate side screens should be fixed around the edges of optical benches or around the experimental area. Screens can be made in house from 3mm thick aluminium sheets, spray painted black, and typically 300 mm high. As an alternative coloured Perspex / acrylic may be used, depending on the wavelength(s) of the laser radiation. The Radiation Protection Service can give further assistance.

Intrabeam viewing	Never design an experiment such that it could be possible for a person to directly view a laser beam. Take care when siting PC workstations and ensure that, wherever possible a user's eye level is not in the same plane as the laser beam, or use screens as discussed above.
Periscoped beams	If possible avoid periscoping laser beams from one plane to another. If this has to be done ensure that shields are placed to cut out intrabeam viewing in the vertical plane. Clearly label periscopes. One UK university researcher was blinded by accidentally looking down onto a periscoped beam.
Laser goggles	Laser eye wear should be used where identified by a risk assessment. Goggles are the last line of protection and should be used in accordance with the alignment flow chart. One pair of goggles will not protect from all wavelengths, they are very specific, and therefore should be clearly labelled as to what wavelengths they are suitable for. Wearing in appropriate goggles can result in serious injury or eye loss (read this incident). When purchasing goggles for a laser go directly to a reputable manufacturer and discuss your needs with them: products are being continually improved. You will be looking for a wrap around goggle that carries a CE quality mark, and the wavelengths and level of protection will be stamped on the lens. Depending on the type expect to pay £150 to £300 per pair.
Laser curtains, window / door blinds	Window / door blinds should be used when open beam laser work is in progress. Curtains installed to divide rooms into laser bays should be used where appropriate.
Warning lights	Annunciators should be installed that indicate when a laser is (a) in a state of readiness and (b) the shutter is open and a beam is being emitted.
Warning signs	Laser warning signs should only be used to indicate when Class 3B or 4 lasers are in a laboratory. Other laser uses should **not** be signed.
Jewellery and shiny surfaces	Shiny surfaces reflect laser beams, and uneven polished surfaces can reflect beams in unexpected directions. Keep clutter and tools (on optical benches) to the minimum. Watches, rings, bracelets, dangling chains should also be removed before working on open beam laser systems, or opening the covers on enclosed systems, because these can scatter beams or reflections in unexpected directions.
Ties, baggy clothing, lab coats	Ties, no! Lab coats are best avoided unless there are genuine risk-related reasons for wearing them that have been identified in a risk assessment.
House keeping	Space around laser benches is often at a premium and it is sometimes difficult to prevent 'clutter' from building up. Use storage areas and keep the laser bay tidy. Keep laser labs free from combustible materials.
Security	Laser laboratories should be secured such that only authorised laser users can enter. Where areas are secure local key-control arrangements can be made, otherwise laser keys should be held by persons authorised by the LSO.
Servicing & maintenance	Servicing and maintenance should be carried out by a reputable engineer who will be able to present evidence of indemnity insurance cover. Alternative arrangements can be discussed with your LSO and the Radiation Protection Service.