Standard Operating Procedure: Ultrafast Equipment MAS 2.11

Before commencing work with Class 3B/4 lasers, you must read this document, and sign the sheet at the end to confirm that you have understood the content and that you agree to abide by the protocols contained herein.

Purpose and Structure of this document

The principal aim of this document is to outline the elements of good laser practice as they apply specifically to experiments currently being undertaken in the above laboratory. General aspects of laser safety are covered in sections of the manuals accompanying the lasers.

The document is structured as follows: at the top level (this sheet) an overall description is made of laser research activity in this laboratory. The user is then referred to a number of accompanying documents under two headings: Laser types in use and Safety Protocols.

Description of Activity:

The facility contains two lasers the first provides four main beamlines served from a single 40 fs, 1 kHz, 800 nm 13 W beam. This pumps visible, UV and IR optical parametric amplifiers as well as white-light continuum and THz generation. The second is a variable output ND:YVO^4 (1064, 532, 355, and 266 nm) producing < 800 ps pulses at a variable repetition rate between 1-5KHz.

The lasers are enclosed tables which are **only to be opened by fully trained WCUS personnel**. A laser safety curtain separates the ultrafast laser system from the A/C and analytical instruments. This curtain should **only be passed by user approved by the supervisors or facility manager** (see below).

For a description of the Hazards in this room, please see the Risk Assessment Forms.

The lab is protected by a magnetic interlock system on the door. This stops access without the appropriate code being entered. At all times when the laser is in operation a laser warning light will be displayed and when the beam is in use on specific experiments, an indicator will be lit outside the laboratory. Finally, a notice board, updated regularly throughout the day, displays what wavelengths of light are being generated and used on each table.

In the event of harmful exposure to laser radiation, please see the Emergency Procedures

Four types of situation have been identified which require separate safety protocols, where appropriate:

- Setting up
- Adding new elements
- Day-to-day operation
- Maintenance

Laser in use

Please see Risk Assessment for further details.
As a general rule all Class 3B/4 laser emissions are capable of causing severe eye damage if viewed directly, or as a specular (i.e. mirror-like) reflection. Control measures (careful planning, beam pipes, blocking of reflections, safety eyewear) must be taken to avoid this!
Authorised users of the above lasers are:
Supervisors: James Lloyd-Hughes
Facility Manager: Jack Woolley
Students and others: Please see approved user list

Laser safety protocol: Setting up

Definition

Setting up applies to the initial installation of a new experiment, and to major changes such as the addition of a new type of laser system, or, for example, a complete change of beam paths.

Protocol/Scheme of Work

Planning:

• The installation or changes should be discussed with a supervisor/facility manager prior to operation of Class 3B/4 laser systems.
• In the case of a completely new experiment, the School Laser Safety Officer and/or the Institution Laser Safety Adviser must be consulted and invited to visit the lab.
• The laser beam paths and associated optics should be planned to minimise the possibility of stray reflections.
• Termination of each main laser beam should be planned.
• Consideration should be made on how alignment is to be carried out. Where practicable, the use of cameras for viewing and remote adjustment should be promoted.
• Provision of suitable laser safety eyewear should be addressed at this stage.

Initial Safety Checks:

• Initial laser beam alignment should be performed with a Class 1 or 2 alignment laser (e.g., He-Ne or small cw diode laser) or with the new laser at lowest power (see below). Remember that the final beam path may differ slightly due to dispersion (i.e., the beam path may be slightly wavelength-dependent)
• At this stage, each and every optic element in the beam path must be analysed for stray reflections. Initially this can be done by predicting the likely path of specular (i.e., non-diffuse) reflections and the actual reflections of the Class 1/2 alignment laser may also be used to help identify stray reflections.
• Suitable beam blocks, opaque at the appropriate wavelengths, must then be installed to block all these stray reflections.
• ‘Beam pipes’ should be installed at this stage to cover any beams that leave the confines of the laser table. It is recognised that there may be some places where beam pipes are inappropriate, e.g. when the distance between optics is very short. Beam pipes should be designed to allow limited access to the beam for alignment checking without removal.

Alignment using Class 3B/4 lasers at low power:

• The next stage of alignment using the Class 3B/4 lasers may be carried out only after obtaining the verbal permission of a supervisor.
• Alignment may be carried out by one or at most two authorised laser operators. No one else may be present in the room during this procedure and watches, bracelets and other reflective jewellery should be removed.
• Under no circumstances must direct viewing of the laser beam be attempted even if the beam has been attenuated.
• All optics should be checked for damage, and the stability of optics mounts verified prior to operation of laser.
• This next stage in alignment should be carried out using the lowest possible laser energy (e.g. operating a Nd:YAG laser on fixed-Q) at which it is possible to visualise the laser beam in an appropriate fashion. The method of visualisation is dependent on the wavelength: for UV or visible light, the beam can be viewed on a fluorescent card. An invisible infrared beam may be visualised using LCD heat sensitive paper or possibly using burn paper or a laser power meter.
• In the case of UV or IR beams, appropriate laser safety eyewear should be worn during the alignment procedure at all times when the laser pulse energy exceeds the MPE: note that it should not block the wavelength-shifted visible fluorescence (UV) or the heat effect on LCD paper or burn paper (IR), which can then be used to visualise the beam.
• Alignment of each laser beam to variable diameter apertures (iris diaphragms) should be employed where possible to minimise the necessity for multi-wavelength alignment.
• Further alignment at full power may be carried out in accordance with the protocol outlined under ‘day-to-day operation’.

Laser Safety Protocol: Adding New Elements

Definition

Adding new elements applies to the introduction of any new optic into the beam path of a Class 4 laser such as a lens or filter.

Protocol/Scheme of Work

Planning:

• The placement of additional optics should be planned to minimise the possibility of stray reflections.
• Beam blocks should be devised to terminate any unavoidable stray reflections

Initial Safety Checks:

• Before starting the Class 3B/4 lasers, beam paths should be inspected for any objects that should not be there and beam pipes should be replaced if necessary.
• Laser warning signs should be activated, unauthorised persons excluded and laboratory doors closed.
• Alignment may be carried out by one or at most two authorised laser operators. No one else may be present in the room during this procedure and watches, bracelets

and other reflective jewellery should be removed.
• Appropriate laser safety eyewear should be worn.
• All optics should be checked for damage, and stability of optics mounts verified.

Initial Alignment and Suppression of Stray Reflections:

• Once a new optic is in place, initial alignment should be performed with a Class 1 or 2 alignment laser (e.g., He-Ne or small cw diode laser) or the main laser at low power (See below). For simple optics it may be judged sufficient to proceed to the next step without using a Class 1/2 alignment laser.
• The new optic element in the beam path must be analysed for stray reflections. This can be done by predicting the likely path of specular (i.e., non-diffuse) reflections. The actual reflections of the Class 1/2 alignment laser may also be used to help identify stray reflections.
• Suitable beam blocks, opaque at the appropriate wavelengths, must then be installed to block all these stray reflections.
• Any effect 'downstream' of the new optic should be checked. 'Beam pipes' should be re-installed at this stage.

Alignment using Class 3B/4 lasers at low power:

• This may now be carried out in accordance with the procedure outlined under 'setting up' with the exception that explicit permission of a supervisor is not deemed necessary for addition of a simple optical element. (Anything more complex should be taken as 'setting up' and the protocol followed accordingly.)

Laser Safety Protocol: Day-to-day Running

Definition

Day-to-day running applies to the operation of Class 3B/4 lasers under all circumstances except setting up or addition of a new optic element. It includes initial, minor realignment of laser beams at the beginning of an experimental run and 'tweaking' of alignments during an actual experiment.

Protocols/Scheme of Work

Initial Safety Checks:

• Before starting the Class 3B/4 lasers, beam paths should be inspected for any objects that should not be there, and beam pipes should be replaced if necessary.
• Laser warning signs should be activated, unauthorised persons excluded, and laboratory doors closed.
• Alignment may be carried out by one or at the most two authorised laser operators. No one else may be present in the room during this procedure and watches, bracelets and other reflective jewellery should be removed.
• Appropriate laser safety eyewear should be worn if practicable. Visible or multi-wavelength alignment may have to be carried out without laser safety eyewear, as it would otherwise be impossible to visualise the laser beam on a card. In this case extra caution must be exercised by the operator(s).
• All optics should be checked for damage, and stability of optics mounts verified.

Minor Realignment ('tweaking') with Lasers Running at Full Power:

• During an experimental run, it will sometimes be necessary to re-optimise the alignment to recover lost signal. Of necessity, this can only be carried out at full power, with all lasers on. Extra caution should therefore be exercised.
• All beam guards/pipes and blocks for stray reflections should remain in place during this procedure. Beam pipes should be designed to allow limited access to the beam for alignment checking without removal.
• It is especially important to wear appropriate laser safety eyewear when visualising laser beams at full power.
• It may be possible (and indeed, preferable) to apply minor ‘tweaks’ to the alignment using the experimental signal as a guide. In this case it is not necessary to visualise the laser beams.
• Cameras for remote viewing and the incorporation of remote adjustment aids should be promoted and used where reasonably practicable.
• Under no circumstances must direct viewing of the laser beam be attempted even if the beam has been attenuated. There must be no exceptions to this rule.

Laser Safety Protocol: Servicing

Definition

Servicing is the performance of those procedures or adjustments described in the manufacturer’s service instructions which may affect any aspect of the product’s performance. It can include activities such as the removal and reinstallation of optics for cleaning, the changing of laser dyes, the changing of flash lamps, and the installation of new optics inside the laser cavity. Entry into the laser enclosure potentially exposes the laser worker to additional non-optical hazards, for instance those associated with high voltages, and toxic chemicals, in addition to accessing high energy laser beams which are normally enclosed. See Risk Assessment in this pack for more details.

Protocol/Scheme of Work

Planning:

• Before commencing the work, the manual for the laser system should be consulted, to identify the recommended procedure.
• In the case of anything other than routine maintenance, and/or when the laser manual does not give a procedure, the advice of a laser technician should be sought. Some procedures should only be conducted by an experienced laser technician.
• The hazards associated with the procedure should be assessed, the control measures reviewed, and the conclusions recorded. In the case of some regular maintenance procedures, reference to an existing protocol may well suffice.
• Work involving the alignment of a laser beam inside a laser enclosure, can lead to an increased laser radiation exposure risk, since part of the beam path of a normally enclosed, and potentially very high power beam is likely to be open. The protocol for Setting Up should be consulted.

Safety protocol: Out of hours and lone working – All spectrometers

Definition
Lone and out of hours working applies only to routine work. No extraordinary work should take place under lone or out of hours working.

Protocol/Scheme of Work
Planning:

- Lone working during normal works hours must be avoided where possible.
  • Where not possible, only routine measurements should be carried out alone. Extraordinary work or work requiring a separate risk assessment must not be undertaken alone at any time.
- Where lone working must take place, regular communication should be maintained with another worker on campus or close enough to campus to respond in an emergency.
- All users must sign in when working out of hours, both in the department log book and on the WCUS website.
- Lone working on experiments should never take place outside of normal working hours. All out of hours work must be partnered with someone who is sufficiently responsible to respond to an emergency.
- Lone working on anything other than running experiments may happen out of normal working hours, but regular contact with someone close enough to respond in an emergency must be maintained.