

Standard Operating Procedures for laboratory work with the UV laser at CTIO

Scope

This document covers the Standard Operating Procedures (SOP) to be observed during experiments with the UV laser at CTIO, in the framework of the SAM project. These experiments will be conducted during a limited period of time at the CTIO main facility in La Serena. This procedure shall be posted in the CTIO Optical Lab room #202.

Laser Characteristics

The UV laser is a Class 4 laser product, High Powered Q-Switched Diode Pumped Nd:YAG with a frequency doubler and tripling crystals to make it an Ultraviolet (UV) Laser model Q301-HD from JDSU. It has the following characteristics:

Wavelength: 355nm
Average nominal power: 10W
Pulse duration: 34 ns
Nominal pulse frequency: 10 kHz
Pulse energy: 1 mJ

The output beam has 1/e² waist diameter of 0.9mm. The energy density in this beam is 3.1E7 W/m². The laser body is hermetically sealed and shall not be opened by any users. The laser has an internal shutter which can be connected to the interlock circuit and a removable power on/off key.

The laser beam is invisible. It can cause severe injuries to the skin (treatable) or to the cornea of the eye (permanent, e.g. cataract). The maximum permissible exposure for both skin and eyes at 355 nm is 1000 W/m² for a maximum duration of 10s, higher for shorter duration. Thus, protective eye-wear with an optical density of 4.5 or higher at 355 nm is required.

The laser does not present high-voltage hazards. The UV laser is fully contained in its OEM housing and later will be contained in a SOAR built laser box with other devices.

The UV laser beam itself can provoke inflammation and thus presents a mild fire hazard

(as a soldering iron) if the beam is not properly managed. Combustible and flammable materials and liquids shall be removed from the bench before the UV laser is turned on.

The laser can be operated at reduced optical power when necessary. The preferred power reduction method is the operation in continuous wave (CW) mode (optical power 10-20 mW). Other methods to reduce the power of the UV laser are decreasing pulse frequency or increasing the pulse frequency to 100 kHz. The Authorized Laser Operators shall use a low power optical laser for initial alignment and operating in power reduction mode when performing secondary alignment procedures with the UV laser.

Control Measures for Laser Safety

This section details the precautions, work practices, and general procedures for the safety management of the UV laser during its use in the laboratory. This section can be used as an audit to determine compliance.

Laser Controlled Area

The UV laser will be located in the optical laboratory at the basement of the main CTIO building in the enclosed black painted room, sub-room #203 of the Optical Lab room #202. For the duration of the experiments, this laboratory will be declared a Laser Controlled Area when the key to the UV laser is physically this room. The laboratory has a single entrance door and the physical control measures will consist of:

Warning signs on the door in compliance with regulations.

Warning lights on the door: green light with a sign that states entry is authorized, red light with a sign "Do not enter!" means that the entry is prohibited. The red light will be interlocked with the laser on switch which will denote to the persons outside of the Laser Control Lab the UV Laser is on.

There will be an interlock switch on the door that is activated as soon as the door starts to open. This circuit will be wired to an audible alarm in the Laser Controlled Area to alert the Authorized Laser Operators.

There shall be two handles (door knobs) that must be used to enter during laser use experiments. The first is the normal door handle and the second handle is one that will be engaged by the Authorized Laser Operator during laser use. Both handles must be turned in order to access the Laser Controlled Area during laser operation, minimizing accidental entry. Engaging the second handle will activate the Red light and the alarm signal when door is opened.

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There shall be no admittance into the Laser Controlled with out the Approval of the Authorized Laser Operators.

Eye Protection

Occupants of the Laser Controlled Area shall wear UV laser protective glasses (OD >4.5 at 355nm) at all times while in the laser controlled area, even if the laser is off. All eyewear shall be labeled with the wavelength and optical density. UV protective glasses shall be made available at the door to the Laser Controlled Area.

Beam Control

A large "Stop" button connected to the UV Laser interlock circuit will be installed on the optical table to prevent laser emission in the case of emergency, an unexpected event, or an accident. This button will turn off the lasers electrical power.

Accidental activation of the UV laser by un-authorized persons (cleaners or others) will be prevented by keeping the key of the laser power supply in a separate location under the custody of R.Tighe. The key will be used only by the Authorized Laser Operators and removed each time these persons leave the Laser Controlled Area.

Any reflective personal items such as watches, rings, necklaces, other jewelry, reflective buttons, or belt buckles are prohibited in the controlled area. Lab coats will be provided if necessary.

The optical table shall be kept clear of all reflective objects before any procedure requiring any laser to be used. Reflective objects are items such as tools, handheld mirrors, and other ancillary equipment used for set up.

Computers and laptops shall be positioned so the computer screen field of view is opposite of the beam and higher or lower than the expected beam path.

The beam path of any laser shall be well below eye level.

All un-necessary equipment shall be removed from the optical table before a laser procedure is conducted.

All combustible and flammable (inflammable - Spanish) objects and liquids (including those for optics cleaning) shall be removed from the optical table before propagating the high-power UV laser beam.

Other Hazards

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Electrical Connection shall be NEC complaint and intact.

Administrative and Procedural Controls

A log-book will be maintained to register the work with the UV laser. Each time the Authorized Laser Operator(s) enters the Laser Controlled Area with the laser key, a record will be started and shall be completed before exiting the Laser Controlled Area. Each record will contain the following:

Date and start time, names of the experimenters, hazard evaluation check list (interlock checked, optical setup safe), procedure being conducted, use of the UV laser and its power, end time, and signatures.

The Authorized Laser Operators shall follow any recommended use and safety precautions as noted in the owner's manuals of the OEM equipment.

There will be only one key for the UV laser.

Education and Training

Established Authorized Laser Operators include those persons who are directly working on the project and who have been taken the laser safety course.

Visitors - Entry of the controlled area is not permitted unless it has been approved by the attending Authorized Laser Operator and the visitor(s) have been briefed about the hazards of lasers, laser safety control measures, are wearing Laser protective eyewear before entering the Laser Controlled Area.

Safe System of Work during Operation and Alignment

The Authorized Laser Operators working with the UV laser shall have taken the laser safety course. They shall adopt the following work practices:

Exclude unnecessary personnel from the Laser Controlled Area during experiments with the UV Laser.

Wear protective glasses (OD >4.5 at 355nm) at all times while in the Laser Controlled Area when the UV Laser key is in the room, even if the laser is off.

Visually examine the optical setup before turning on the UV laser. Ensure that the beam is intercepted by the beam dump and that no stray reflections are possible.

Replace the UV laser beam by a low-power visible laser for most of the alignment steps. The visible and UV lasers will be initially co-aligned.

Each alignment operation or experiment will proceed in three stages: 1) use visible laser for pre-alignment and for ensuring the lack of stray reflections, 2) propagate the UV beam with reduced power, and 3) propagate the UV beam at full power only when necessary and for as short of time as necessary.

Shall never look into UV and visible laser beams and never place eyes at the level of the beam.

Shall never use optical setups where the UV laser beam is reflected upwards.

Shall prevent the propagation of the UV beam beyond the optical table with suitably located beam dumps and shields.

When aligning invisible beams, use beam display devices such as image converter viewers or phosphor cards to locate beams.

Authorized Persons

The only persons authorized (Authorized Laser Operators) to work in the UV Laser Controlled Area are:

Roberto Tighe

Andrey Tokovinin

These persons are fully responsible for the laser safety in the controlled area.

Access of other persons to the laser controlled area is permitted at times when the experiments are not conducted. During these periods, the laser power key to the UV laser is physically removed from the laboratory and the light on the entrance door is green.

Emergency Procedures

In case of an emergency or accident, the UV laser and its power supply will be immediately turned off and the key will be removed from the controlled area. Adequate

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measures will be taken to help the injured persons and medical treatment will be sought. A report on the accident with corrective actions will be submitted no later than the following day to the LSO and CTIO Director by one of the authorized persons.

I am the Laser Safety Officer and I approve this Standard Operating Procedures for laboratory work with the UV laser at CTIO.

Signature of the CTIO/SOAR Laser Safety Officer

Date