Example of an Approved Scheme of Work for Undergraduates

This document has been drawn up to give an indication of the kind of information that should be incorporated into a written procedure for undergraduate work. It should be highlighted that group undergraduate practicals should, wherever possible, be carried out using laser systems below Class 3R (A).

Approved Scheme of Work - undergraduate projects October (Year)

<u>YAG pumped dye laser system</u>

students - XXXXXXX

YYYYYYYY

No undergraduate may work in this laboratory unless she/he has read and understood these notes.

Introduction
The apparatus is used for the study of the laser spectroscopy of vdW complexes.

The principal hazards are from laser radiation and high electrical voltages.

Students working on this apparatus should not only be aware of the hazards associated with this particular apparatus but should be acquainted with the principal hazards associated with the other experiments in the laboratory, and to have performed M. P. E calculations for all lasers found in the laboratory and to understand well the necessity for wearing the correct protective eyewear for working in that laboratory.

A number of general principles apply to working in this laboratory and are described in the General Safety Guidelines.

In this laboratory particular attention should be paid to the following;

(a) Laser Radiation
This equipment on which the students will work includes a YAG (class IV) laser producing light at 1064nm, 532 nm used to pump a dye (class IV) laser which emits tuneable light in the visible and near-UV regions. This is often frequency doubled into the far ultra violet region, typically between 215 nm and 320 nm. Class 4 lasers are the highest power category and can cause damage to the eye including blindness when the radiation is viewed directly or from specular reflection. Serious skin and flesh burns may also result from direct exposure to the beam.

The use of these lasers requires extreme care. Undergraduates must wear laser goggles at all times in the laboratory when a laser is in operation, whether this is part of the system on which they are working or another system.

Students must be aware of the dangers of other systems in the laboratory and when safety screens are in place around another experiment students are not allowed to look around these screens.

Note that the UVB light is invisible to the naked eye. Even low levels of scattered light can harm the cornea. The experimental apparatus has been designed and constructed so as to minimise reflections and scattered light. Screens should be used to prevent any possibility of accidental exposure to UV light. Students should not attempt to move these screens in order to obtain better access to equipment.

If the **LASER ON - NO ENTRY** warning light is illuminated then any undergraduate project student wishing to enter the lab must knock and wait to be admitted regardless of whether or not this is during one of their designated project work times. Laser safety goggles must be worn immediately on entry to the lab and at all times when any laser in the lab. is in operation. If these goggles are removed at any time because no laser is in operation then normal laboratory safety glasses **must** be worn.

The undergraduate students are not allowed to switch on any laser or to undertake any alignment work on a laser, either to the laser itself or to steering optics. Alignment work should be done by the supervisor and the student should not be present in the work area during this procedure.

b) Electrical hazards

Keys are in required for the operation of the laser power supplies. Prospectively lethal voltages of 30kV are used in the laser discharge circuitry. Therefore all grounding procedures must be followed rigorously whenever the protective covers are removed. The high voltage capacitor banks have a tendency to recharge even after careful discharging. These power supplies should never be switched on or off by any undergraduate student - nor should any undergraduate student be in the laboratory with a power supply in operation unless a member of staff (designated as project supervisor) is present.

High voltages are also used in the operation of photomultiplier tubes/TOF apparatus. Particular care should be taken to ensure that the H.V supply to any photomultiplier tube/TOF is correctly connected and that the value of the voltage supplied does not exceed that recommended in the product specification. To this end the students should have familiarised themselves with the relevant specification sheet and know both the photomultiplier model number and the correct operational voltage before commencing the experimental procedure. The photomultiplier tube should never be exposed to daylight when the H.V. supply is switched on.

d) The preparation of dye solutions

The toxicity of laser dyes are not very well determined and so they should be treated as potentially toxic and carcinogenic/mutagenic chemicals. When requested to do so by the supervisor a student is allowed to prepare the laser dye mixture. **These solutions should be prepared in a fume cupboard and the wearing of gloves, a laboratory coat and safety spectacles is essential.** Any spillage’s should be cleaned up immediately and should the dye or dye solution come into contact with any part of the body a very thorough washing is required.

Students should also be aware that the methanol used to prepare dye solutions is itself a hazard. Methanol has a flash point of 10 degrees C and an autoignition temperature of 464 degrees C. It is therefore a fire hazard. It is also toxic by inhalation and absorption through the skin, the principal effect being on the central nervous system. When not in use ALL solvents should be stored in the metal cabinet provided in the laboratory, including clearly labelled Winchesters of waste solvent which are awaiting disposal. Care should always be taken to avoid getting solvents on the skin and gloves should be used.

The experiment to be carried out by the project students in the laboratory concerns the laser xxxxxxxxxxxxx

The general procedure of the experiment is as follows.

A YAG laser will be used to pump a tuneable dye laser which is then frequency doubled using a KDP crystal. Students will not be involved in the alignment of these lasers.

The students will familiarise themselves with the computer controlled scanning programs for the grating and intracavity etalon and are allowed to set up the scanning programs when required.

The sample will be vaporised in a small oven mixed with helium carrier gas at stagnation pressures of 2 to 3 atm and expanded into a vacuum chamber through a pulsed nozzle valve. The solvent molecule is coexpanded with the sample. Continuous monitoring of the temperature is provided by chromel-alumel thermocouples located close to the nozzle orifice and oven.

The vacuum chambers are evacuated with a diff/rotary combination. A delayed pulsed generator is used to trigger both the pulsed valve and the YAG pumped dye laser, allowing synchronisation of the pulsed supersonic jet and the intersecting laser beam 7 - 10 mm downstream from the skimmer. The laser-induced fluorescence light is collected by a lens and detected by an unfiltered photomultiplier/boxcar combination.

Students should be aware of the sequence of valves openings that is required in order to pump out the chamber and to isolate the oil diffusion pump when opening the chamber up.