Università degli Studi di Cagliari
CeSAR
Centro Servizi di Ateneo per la Ricerca
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CS10 - Laboratory of Ultrafast Optical Spectroscopy
Laser safety and procedures

M. Marceddu, Rev. 1.0 - 26/01/2022

Introduction

This guide provides basic usefull informations about laser safety and related procedures for working in the Laboratory of Ultrafast Optical Spectroscopy.

The Laboratory of Ultrafast Optical Spectroscopy laboratory is located at CeSAR ground floor, room CS10. The lab specialist is Dr. Marco Marceddu (mail: marco.marceddu@unica.it /phone +390706756584/ ground floor, room CS3).

Ordinary opening hours are 8:00 am – 5:30 pm, Mon-Fri.
Special needs must be authorized by the CeSAR Director. Each lab session must be recorded in the lab register.

When you leave the lab and the end of your day, or have to leave the lab for some minutes, always inform the lab specialist or other CeSAR personnel.
We need to know who is in the buildind and, in particular, do not leave unattended lasers running.

The lab employes class 4 lasers, with potentially dangerous UV-VIS-NIR radiation. Refer to section 1 for a short review of laser safety guidelines.

The standard opical layouts of both time resolved fluorescence and pump-probe absortion experiments are intended for general pourposes. **Changes of this standard configuration are not allowed**. Specifically taylored configurations must be previously authorized by the lab specialist.
Experiments involving instruments or components from other UniCa Departments must be authorized.
Users are not allowed to change computer settings nor to plug external memories or other devices to lab computers. Data transfer will be performed by CeSAR staff.

Any failure and anomaly must be immediatly communicated to the lab specialist.
It is raccomened not to listen to music nor use hearphone: noises are often good indicators of something going wrong.

The lab employes UPS systems. In case of black out UPS will supply power to the lab and beep-sound alarm will be emitted. UPS are intented to protect instruments and lasers from voltage/current spikes and to ensure the completness of the systems shotdown in case of emergency. The lab lasers employed particular crystals that are kept at 160 °C. In case of black out these crystals must thermalise slowly at room temperature in order to prevent demages. Therefore, UPS are not intended to continue the experiments for hours in case of back out. **In case of prolungated main power failure (say 5 min.), immediatly stop the experment and call the lab specialist who will start the shotdown precedures if needed.**

As a general rule of the lab: if some procedure is not clear, if you don't feel fine in performing allowed allignment operations, even if you're scared by laser power, if you notice something strange in the lab (noises, smells…), always refer to the lab specialist. Do not worry about disturbing or boring: this is his job.

1. Laser safety guidelines

General Informations

This section provides safety informations for working in room CS10. You will also find sintetic advices in the lab.
The laser employed in the lab are class 4 classified. This means that visible and invisible radiation extremally dangerous is present, even if reflected or scattered. Lasers employ high voltage power supplies and water cooling systems: pay attention to noises, smells and water fugues. In any case **if you notice anything strange or out of your ordinary experience, immediatly call the lab specialist.**
The lab has three different lasers sources: Libra, Topas and Chameleon.
Libra is a titanium-sapphire regenerative amplifier (emission 800 nm, 1 KHz repetion rate, 4.5 W mean power). Topas is an optical parametric amplifier (OPA – emission 350-1200 nm, rep rate 1 KHz, power up to 500 mW depending on wavelength). Chameleon is a titanium sapphire tunable oscillator (emission 650-1010 nm, rep rate 80 MHz, max mean power at 800 nm 4.3 W), equipped with a frequency doupler device that further extend the Chameleon emission down to the blue. All these lasers may cause severe injuries to skin and eyes and demage or burn objects. **In particular when working with Chameleon be extremally carefull: due to its high repetion rate and tiny spot dimensions, tissues, dresses, allingnment cards or other oblects may easily burn. This holds also for Libra and Topas, when focusing the beams in small spots.**

Safety Rules

The following *golden* rules must be always strictly observed:

1. **The laser lab is a restricted acces room: only authorized personnel**
2. **When lasers are running the red ligth bulb on the entrance doors must be kept on**
3. **Evoid skin and eye exposure to direct or scattered laser ligth**
4. **Wear laser protective eyewear**
5. **In order to avoid uncrontrolled laser reflections take off watches and reflective jewelry**
6. **Long hairs must be tied and loose clothing must be secured**
7. **Always be aware of laser beam path**
8. **Never look at laser beam path eigth (namely within 15-20 cm from table top)**
9. **Unused laser beam path-arms must be secured with black panels (low power beam) or beam stop (high power)**
10. **Avoid uncontrolled reflection from filters, neutral densities or mountings; use black panels.**

PPE – Personal Protective Equipment

When working with laser in lab CS10, you must always wear laser safety spectacles. Two different types of laser protective spectacles are avaible for specific pourposes: memorize the difference and be very carefull when choosing the proper glasses.
The first spectacles are shown in figure 1(for simplicity called *White Mask*). These spectacles offer the best protection at 490-550 nm (OD>8), **but does not protect your eyes at all for wavelength larger than 600 nm**. White Mask must be used when working with Evolution green laser (only authorized personnel) and are suitable also for short-wavelength radiation of moderate intensity. The optical density vs wavelength curve is shown in figure 1.

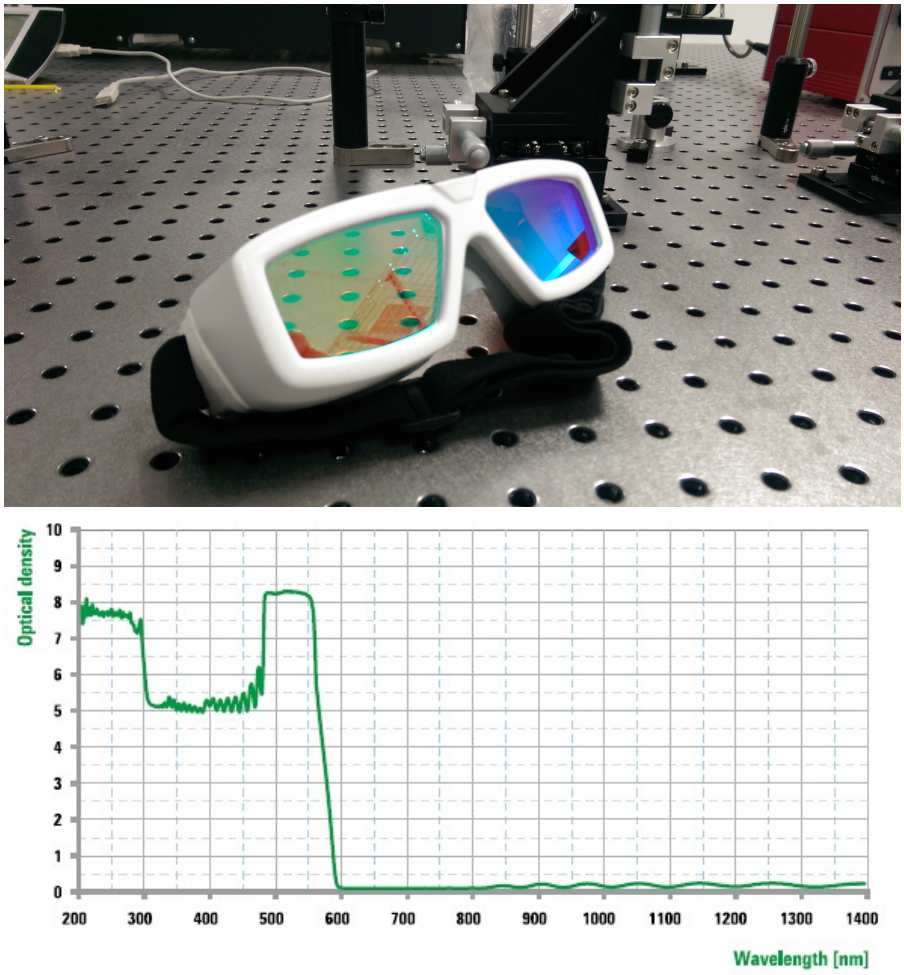

Figura 1: White Mask spectacles are suitable for UV-GREEN high intensity laser radiation

(up: the spectacles; down: OD attenuation curve)

The second spectacles (for simplicity here called *Star Trek,* see figure 2) uses general pourposes, broad band, medium attenuation filters. Star Trek are suitable for the foundamental emissions of both Libra and Chameleon (OD>8 at 800 nm) and for TOPAS UV-BLUE and RED-NIR emissions. **Pay attention: Star Trek offers only moderate protection in the green; for high power green beam White Mask is the best solution**.

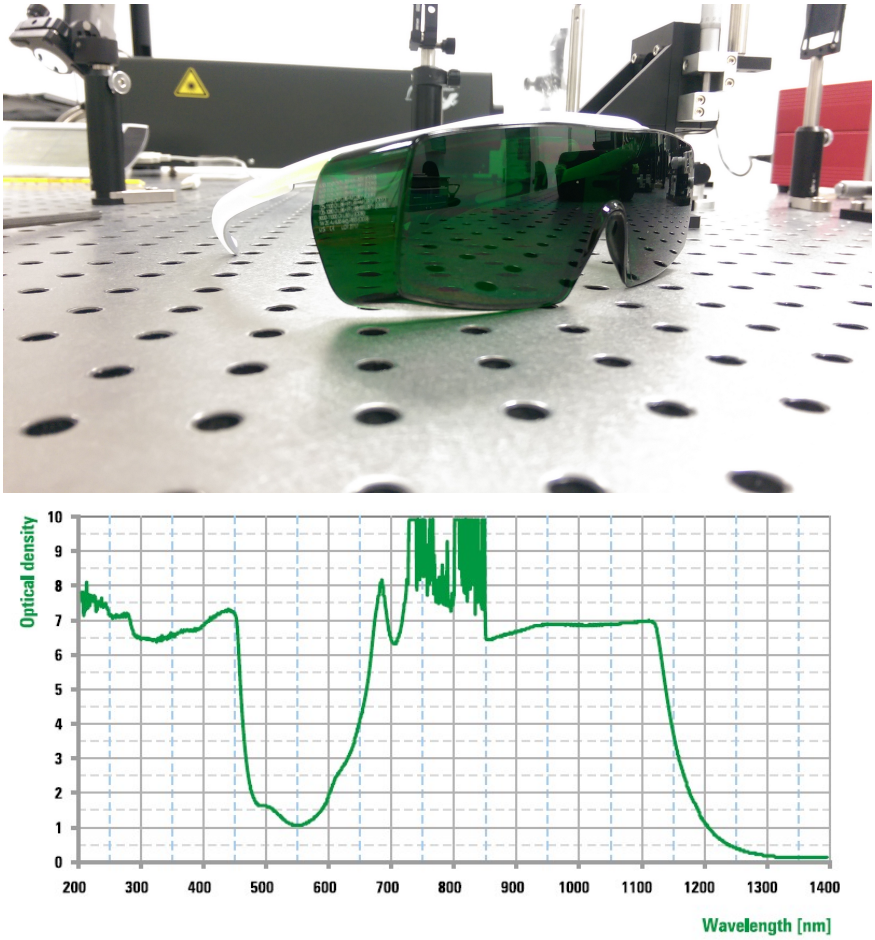

Figura 2: Star Trek spectacles are suitable for UV-NIR laser radiation

(up: the spectacles; down: OD attenuation curve)

2. The lab rules

General Informations

Being a service facility available to different users, the lab is organised with a general porposes layout. For the same reason **some basic rules must be observed**. Please observe the lab rules and leave the lab neat and tidy as you found it. Avoid the rat-pack mentality: hurry, disorder, drab, inaccuracy are our worst enemy. We will very appratiate your collaboration to make the lab a nice and reliable workplace for as many users as possible, but alway remember that in case of problems, **the staff is authorized to deny further acces to the lab** (see CeSAR general regulation).

In the lab foods, drinks and smoking are not allowed.

For safety reason alway wear appropriate dresses: no open shoes and shorts are allowed in the lab; long hairs must be tied and loose clothing must be secured.

When lasers are running always keep in mind the 10 goldens rules (see previous section).

Any failure and anomaly must be immediatly communicated to the lab specialist.

It is raccomened not to listen to music nor use hearphones: noises often are good indicators of something going wrong.

Mechanical tools, optical accessories, manuals and so on are available in the lab cabinets: feel free to use what you need, **but at the end of the day keep everything in place**. In particular filter and other optics must be placed in their storage boxes. If, for any reason, you need to leave the lab for sometimes (coffe brek, courses, exams, seminars…): **place beam stop at laser main exit and inform the lab specialist.**

As a general rule of the lab: if some procedure is not clear, if you don't feel fine in performing allowed allignment operations, even if you're scared by laser power, if you notice something strange in the lab (noises, smells…), always refer to the lab specialist. Do not worry about disturbing or boring: this is his job.

Air conditioning

The lab temperature is kept at 24°C to optimise laser performances: don't change this value for any reason and keep the doors closed.

Electric power plant

The lab has two elettric power plants. With minor exeption (see section 3) **you are not allowed to open and operate on electrical cabinets**.
The first power plant is for general pourposes and is controlled by electrical cabinet n° 8. It is devoted to ligthning, ordinary socket (located on the walls at 1.2 m from floor) and other technical facilities (water, ventilation, laser adivise sign). Feel free to use this section to plug you laptop or other minor devices. **The second one is reserved to lasers and measurements instruments**. This section is controlled by the electrical cabinet with the plastic green transparent cover and supplies power to the industrial-type sockets on the walls, and to the normal sockets located the roof-shelter. Industrial-type socket are reserved to lasers, chillers and measurments systems. They employ two UPS with power loads distributed as follows: chillers alone on UPS n° 2 (to prevent earth-loops); lasers, Streak camera, Helios and lab computers on UPS n°1. **Do not change loads distribution**.
In case of black out UPS will supply power to the lab and beep-sound alarm will be emitted. UPS are intented to protect instruments and lasers from voltage/current spikes and to ensure the completness of the systems shotdown in case of emergency. The lab lasers employed particular crystals that are kept at 160 °C. In case of black out these crystals must thermalise slowly at room

temperature in order to prevend demages. Therefore UPS are not intended to continue the experiments for hours in case of back out.

In case of prolungated main power failure (say 5 min.), save UPS battery charge. Immediatly stop the experment and call the lab specialist who will decide to shotdown the lab if needed.

Special pourposes electronics should be pluged to roof shelter sockets, but it is important to avoid phases unbalance: please ask to the lab specialist.

Figura 3: power plant reserved to lasers and instruments. From left to rigth: electrical cabinet, industrial-type socket, roof shelter sockets.

Technical facilities

The lab is equipped with a closed cycle water-cooling plant. The main valve is located in the gray electrical cabinet (cabinet n° 8), while several secondary valves are located along the room perimeter. This plant is intended as a security in case of laser chiller fault or for special experiments. Users interested will be trained on demand. The lab is also equipped with a gas delivery pipe plant (He, N2, O2, CO2, compressed air, vacuum): please ask for specific authorisation and training. **The usage of water-cooling and gas plants is forbidden to unauthorized personnels.**

3. Lasers procedures

When working with class 4 lasers specific ligth sign located on the entrance door are mandatory. **This ligth must alway be ON when lasers are running**. Rember to turn off this ligth, when you turn off the lasers. The "laser on lamp" switch is located in the upper section of electrical cabined n° 8 (see figure 3). **This is the only switch you are allowed to touch in the electrical cabinets.**

Figura 4: laser running red ligth sign

The lab lasers have two different start up and shot down procedures, named long term and short terms. Tipically you will not be asked to perform long term procedures. In the following you wil find

detailed descriptions of short term procedures, usefull for daily operation. Copy of these checklists are available in the lab nearby the lasers.

3.1 Power Meter

The lab optical power meter comes with three different heads: memorize the difference and always employ the best suited one. **The main beam from both Libra and Chameleon must be measured only with the massive head with cooling feens** (see. Figure 5) since it has the largest damage threshold. It can aso be employed with most intense TOPAS wavelentghs. The second one is a silicon photodiode (PD300-1W, see figure 5) with a removable attenuation filter. With filter out the working range is 350-1100 nm / 500 pW -30 mW, while with filter in the working range is 430-1100 nm / 200µ W -1 W. The last one is an UV-enhance silicon photodiode (PD300R-UV, see fig. 5) with removable attenuation filter. With filter in the working range is 220-1100 nm / 2 µW – 300mW, while with filter out the working range is 200-1100 nm / 200 µW-3W. **Never use the silicon photodiodes to measure Libra and Chameleon main output: they will be destroyed; pay attention also with certain TOPAS wavelentghs** (see TOPAS tuning curves). Silicon photodiode can be safely employed only with attenuated radiations.

Figura 5: power meter heads. From left to rigth: high power head for Libra and Chameleon; Silicon Photodiode; UV-enhanced Silicon photodiode

3.2 Libra Procedures

Always compile the Libra Logbook and measure the laser power at start, at regime and the end of your session. **Your are not allowed to change the laser settings** (diode currents, LBO temperature, Pockels cell timing and so on) **nor to perform internal optics allignment**. These issues are reserved only to authorized personell. If you notice power decrease or instability, poor mode quality, bad pulse build-up on the oscilloscope, or anything else strange, **immediatly call the lab specialist**. Rember that Libra output is splitted in 3 different arms: one is used to pump Topas, one to generate the probe beam in the Helios spectrometer, and one eventually to generate the second harmonics. **Always block unused arms with proper schilds**.

START UP

TURN ON "LASER ON" WARNING LIGTH ⚠

PLACE POWER METER HEAD OR PROPER BEAM STOP IN FRONT OF LIBRA EXIT ⚠

1. **Chiller**: ⚠
a. check fluid level
b. check that is operating at 24 °C
2. **Vitesse laser** (Ti:Saff oscillator seed)
a. turn key to ON
b. wait 2 min
c. open shutter
3. **Evolution laser** (Nd:YLF – amplifier pump)
a. Flick switch to ON
b. Turn key to ON
4. **Evolution Software** (on Dell laptop)
a. Press RUN until it beeps
5. **SDG Elite** (amplifier Pockels cell controller)
a. Reset Error
b. Enable Pockels cells: 3, 2, 1 IN ORDER ⚠

SHOTDOWN

PLACE POWER METER HEAD OR PROPER BEAM STOP IN FRONT OF LIBRA EXIT ⚠

1. **SDG Elite:**
a. Disable Pockels cells: 1, 2, 3 IN ORDER ⚠
2. **Evolution software**
a. Press STOP
b. verify that diode currents goes to zero
c. press exit, close the app
3. **Evolution laser**
a. Turn key to OFF

b. Flick switch to OFF
4. **Vitesse laser**
a. Close shutter
b. Turn key to stand-by

TURN OFF "LASER ON" WARNING LIGTH

3.3 Topas Procedures

Topas is the lab optical parametric amplifier pumped by the Libra output. Only few percent of Libra out is delivered into Topas by means of a beam splitter, a mirror telescope and a diverter mirror (see figure 6). **During day to day operation it could be necessary to perform fine adjustment of input optics**. Specific training will be given on demand, but **if for any reason you will not feel fine with this, even if you have been trained, always call the lab specialist**.
To avoid optics demages: Topas must always work with the first entrace iris fully opened, always close the shutter before change wavelength, do not touch beam splitter and telecope mirror 1 (BS1, BS2, TM1).
The first step is to turn on Libra laser and **wait untill stable output is obtained**. In case of problems call the lab specialist. Once Libra output is stable, remove the power meter head and leave the beam to propagate thowards the telescope. **Block unused beam arms**. Place the power meter head in front of Topas exit. Launch Topas software on Dell laptop, open Topas shutter and check power and stability at the selected wavelength**.** With minor adjustment on telescope mirror 2 (TM2, see figure 6) and diverter mirror (DM), stable and full power output should be obtained**, otherwise call the lab specialist. In any case never touch the beam splitter (BS1 and BS2) and telescope mirror 1 (TS1). Alway close the Topas shutter before change the wavelength.** To change the emission wavelength: close the shutter, enter the desired value in the Topas software, follow the displayed instructions to orientate the final stage non linear crystals; a filter suitable for the selected wavelength has to be mounted on the 2nd crystal.
When you have finished your experiments, close Topas shutter, exit Topas software.

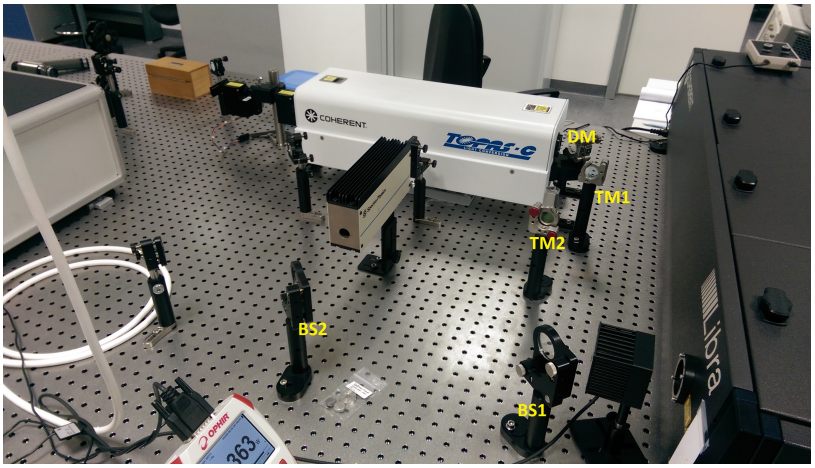

Figura 6: TOPAS input optics

3.4 Chameleon Procedures

In order to have detailed recordings of laser performances always compile the Chameleon logbook. In particular always turn on the laser at 800 nm and record power reading. If you change wavelength, record the power and, before shot down, set again 800 nm and record the power.
Chameleon is a black, sealed box and related procedures are very easy, but alway comply the fallowing steps:

START UP

TURN ON "LASER ON" WARNING LIGTH ⚠
PLACE POWER METER HEAD OR PROPER BEAM STOP IN FRONT OF CHAMELEON EXIT ⚠

1. Verify chiller is runnig at 20°C ⚠
2. Turn key to ON
3. Waint power ramping (see laser display)
4. Open the shutter
5. to change wavelength rotate the knob until the desired value is shown on the display and press

SHOTDOWN
PLACE POWER METER HEAD OR PROPER BEAM STOP IN FRONT OF CHAMELEON EXIT ⚠

1. set 800 nm and record the power
2. close shutter
3. Turn key OFF

TURN OFF "LASER ON" WARNING LIGTH

4. In case of emergency

Please refer to the official University safety and emergency rules:

General procedures:
https://www.unica.it/static/resources/cms/documents/37862445b945116b96dcfb7d4b864e7c.pdf

Emergency plan:
https://www.unica.it/static/resources/cms/documents/37862445b945116b96dcfb7d4b864e7c.pdf

As general rule, always keep in mind that in case of emergency, people's safety comes first.