USER MANUAL
SML780-191

Version		-1	A	B	C	D
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	Nom :	Stern G.				

INDICE DE REV.	DESCRIPTION DES EVOLUTIONS
-1	1st version
A	
C	

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GLOSSARY

EDFA   :   Erbium Doped Fiber Amplifier

PPLN(-WG)   :   Periodically-Poled Lithium Niobate (Wave Guide)

N/A: Not applicable

Phd :   Photodiode

Seed, Seeder laser: Refers to the seeder laser diodes

Tpm: Phase Matching Temperature

Mphi: Phase modulator

1 WARNINGS

The following information is relative to safety. Before using the laser system, the user has to read the full document, and especially the part concerning the laser and electrical risks.

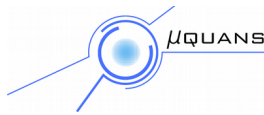## 1.1 General safety instructions, liability and warranty

- All work described in this document may only be carried out by persons who have suitable technical training and the necessary experience or who have been instructed by the end-user of the product.

- Muquans assumes no liability and the warranty becomes null and void if the end-user or third parties:

    - disregard the information in this document.

    - use the product in a non-conforming manner.

    - make any kind of interventions (modifications, alterations etc.) on the product.

    - use the product with accessories and options not listed in the corresponding product documentation.

1.2 Laser risks
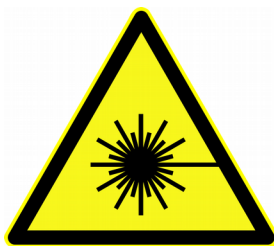
INVISIBLE LASER RADIATION
AVOID EXPOSURE TO BEAM
CLASS 4 LASER PRODUCT

- Laser risks and safety rules are defined according to the norm NF EN 60825-1.

- A Class 4 laser may cause severe, permanent damage to eye or skin without being magnified by optics of eye or instrumentation. Diffuse reflections of the laser beam can be hazardous to skin or eye.

- Laser system should not be operated unless all appropriate safety precautions are taken. These include, but are not limited to:
    - wearing protective safety glasses by all people in the vicinity of the laser system
    - installing warning lights, signs, safety screens and/or curtains
    - implementing a safety interlock so the amplifier shuts down if someone unexpectedly enters an area containing the laser
    - containing the beam to eliminate or minimize the possibility of exposure to the beam

- Use of the laser system other than as specified herein may result in hazardous radiation exposure.

- Use of optical instruments with the system SML780-191 may increase eye hazard.

**INVISIBLE LASER RADIATION
AVOID DIRECT EXPOSURE TO
DIRECT OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT**

Laser risks.

**Power.............................. 2 W
Output............ Continuous (CW)
Wavelength.................. 780 nm**

Laser specifications.

1.3 Electrical risks

- Incorrectly grounded products can be extremely hazardous in the event of a fault. The power connector may only be plugged into a socket with a protective ground. The protection must not be nullified by an extension cable without protective ground.

- Hazardous voltages are present in the system. It should only be open by qualified personnel.

Power supply should respect:

SUPPLY VOLTAGE	100-240Vac
FREQUENCY	50-60Hz
CURRENT	0.75 A

1.4 Other safety considerations

- The device must be located in order to keep free the fan air outlets at the rear panels of the racks.

- Do not close the cabinet containing the system.

- Switching OFF and ON the system with the key switch in a fast way can damage the fuse. Please wait for ten seconds after switching OFF the system before to switch it ON again.
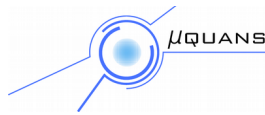
2 GENERAL INFORMATIONS

The SML780-191 laser system provides up to 2 W of frequency stabilized laser light at 780 nm among two fibers. It has been designed in respect to NF/EN 60950-1 and NF/EN 60825-1 norms.

2.1 Normal environmental conditions

The equipment is designed to be safe at least under the following normal conditions:

a) Indoor use
b) Altitude up to 2 000 m
c) Temperature 15 °C to 35 °C;
d) Maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C
e) MAINS supply voltage fluctuations up to ±10 % of the nominal voltage
f) TRANSIENT OVERVOLTAGES up to the levels of OVERVOLTAGE CATEGORY ll
g) TEMPORARY OVERVOLTAGES occurring on the MAINS supply
h) Applicable POLLUTION DEGREE of the intended environment (POLLUTION DEGREE 2 in most cases).

2.2 Technical specifications

2.2.1 Electrical rating

Supply voltage	100-240 Vac
Frequency	50-60 Hz
Power	150 W
Current	0.6 A

2.2.2 Optical rating

| Class	4
Output power	<2 W
Wavelength	780 nm
Regime	CW

2.2.3 Degree of ingress protection

IP	30

3 LASER SYSTEM PRESENTATION
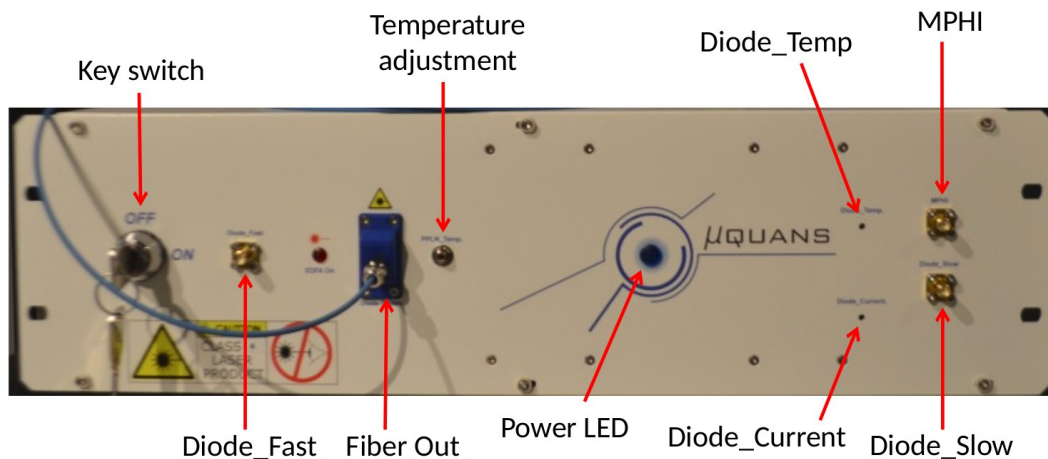
3.1 Laser diagram

The SML-191 laser system is dedicated to Rubidium laser cooling experiments. A seeder at 1560 nm is phase modulated, amplified by an EDFA and frequency doubled by a PPLN. A 2 meters long output fiber finally provides 780 nm light up to 1,1 W. The frequency seeder can be controlled with external signal
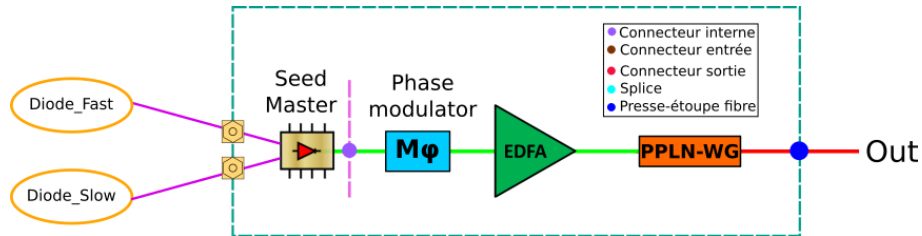
Laser scheme.

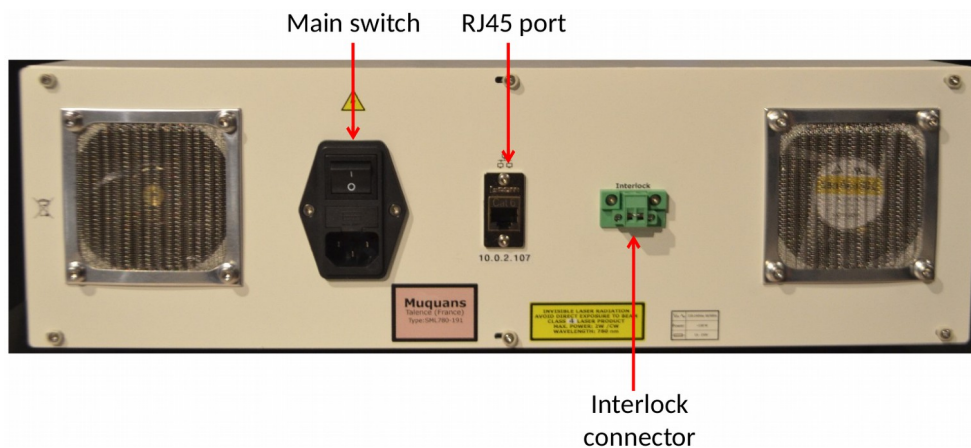## 3.2 Laser description

3.2.1 Front view

Designation	Description
Diode_Fast	Input signal for the fast modulation.
Diode_Slow	Input signal for the slow modulation.
MPHI	Frequency input for the phase modulator.

3.2.2 Rear view

4 OPERATING INSTRUCTIONS

4.1 Connecting fibers

- Ensure that the device is not powered up.

- The system is delivered with a FC/APC connectorized fiber. To connect this system to others devices, please check the connector compatibility.

- Remove protection caps from fiber connectors.

- Clean and connect the optical connectors to the suitable devices.

4.2 Starting procedure

- Check that both the mains switch are on the OFF position.

- Connect the SMA cables providing the signals for the modulations and the MPhi. These signals should stay off until the system is on.

- Plug the power cable to the mains socket located on the back of the system.

- Turn the main switch on the ON position.

- Turn the key on the ON position. The laser system is now ready to use. The blue LED emits.

- Connect the control computer to the laser RJ45 plug with an RJ45 cable and open the required Telnet sessions (see annex). The useful commands are described in annex.
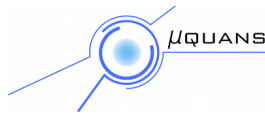
4.3 Power up the diode

- In the *Laser_Ctrl* session, use the command *sml780_tool Enable_Current_Laser_Diode on*[1] to switch on the Master diode.

Command lines to drive the diode and the EDFA.

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[1] The *pink* color refers to software commands/instructions.

- The most relevant parameters for the diodes can be displayed in the *Laser_Mon* session with the command *ils780_tool cplot*. Use the lateral arrows to navigate among the different parameters. *Ctrl+C* allows going back to the commands from the monitoring window.

```
MIRAVAL_MONITORING_ANALOG_IN

Mon_Current_TEC_Laser_Diode : 1.483 V -42 mA
Mon_Temp_NTC_Laser_Diode : 0.730 V 22.5 degC
Mon_Current_TEC_Case_Laser_Diode : 1.537 V 92 mA
Mon_Temp_NTC_Case_Laser_Diode : 0.291 V 24.9 degC
Mon_Current_Laser_Diode : 0.183 V 183 mA
Mon_Optical_Power_Laser_Diode : 1.171 V

Mon_Temp_LM35_Case_Laser_Diode : 0.253 V 25.3 degC
```

```
VCSR_EDFA_ANALOG_IN

EDFA_PhdIn : 2.999188 V
EDFA_Current : 2.691 V 7.688 A
EDFA_PhdOut : 2.500534 V
EDFA_PhdOut_Dpp : 0.289917 %

Mon_Temp_NTC_Freq_Doubler : 1.340 V 56.5 degC
Mon_Current_TEC_Freq_Doubler : 2.419 V 766 mA
```

Laser parameters monitoring. Use the left and right arrows to change the displayed parameters.

4.4 EDFA control

- The *EDFA_Protection* parameter should be OK if the EDFA input power is high enough. If so, the EDFA can be driven. If not, please contact Muquans.

- The EDFA output power is proportional to the voltage given by the *EDFA_PhdOut* parameter visible in the *Laser_Mon* session.

- In the *Laser_Ctrl,* use the command *sml780_tool edfa_set YYY* where *0≤YYY≤2.5* to control the EDFA output power. *YYY* defines the *EDFA_PhdOut* value to which the EDFA output power is set. The *EDFA_PhdOut* parameter is estimated by the output photodiode of the EDFA.

- Once the EDFA is ON, its red laser LED emits. **As soon as the sml*780_tool edfa_set* command is used, power at 780 nm is potentially available at the fibers. Always be sure that the fibers are connected to the right optical device.**

Red LED indicates if the EDFA is running.

4.5 Phase modulator

- The phase modulators allow the generation of sidebands around the optical frequency. The frequency difference between the carrier and the sidebands depends on the frequency applied to the MPHI connector. The sidebands amplitude depends on the RF power applied on the connector. **Do not exceed 25 dBm on the phase modulator connectors otherwise the phase modulators could be damaged.**

| Input	Power on 50Ω (dBm)	Frequency range	Comments
MPHI	[0;25]	[0 GHz; 10 GHz]	

Specifications for the input signals.

4.6 Phase matching temperature adjustment

- The use of SHG through a PPLN with a pump laser at 1560 nm allows the generation of 780 nm light when the phase matching temperature is achieved. For a stable operation, the PPLN temperature must be finely tuned and locked to satisfy the phase-matching condition.

- Connect a device to measure the output power at 780 nm before switching on the EDFA. Switch on the EDFA and set the EDFA output power. Put a screwdriver in the *PPLN_Temp.* potentiometer and tune the crystal temperature by turning it. The phase matching temperature is achieved when the output power at 780 nm is at the highest level[2]. The potentiometer makes some acoustic noise when it reaches one of its limits. The user must then stop turning it.

Tune the crystal temperature with a screwdriver until the Tpm is reached.
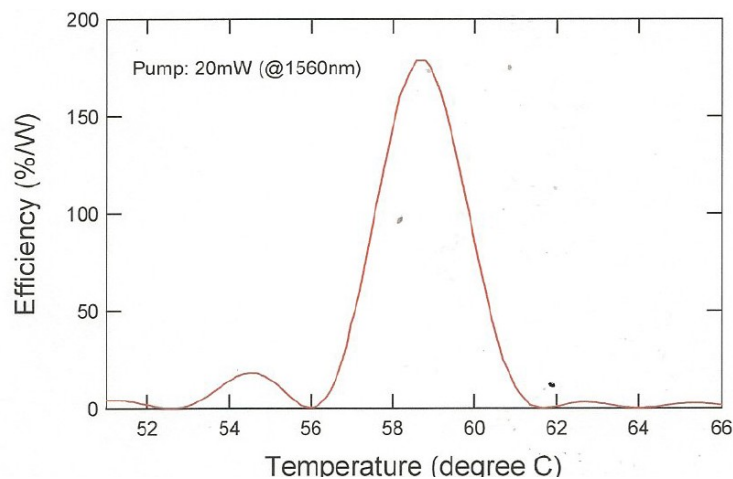
Conversion efficiency evolution for a temperature scan around Tpm (this is an example).

- The Tpm depends on the EDFA output power. Once the Tpm is set for a given EDFA output power, it is required to adjust it each time the EDFA output power is changed.

4.7 Frequency laser control

- The *Diode_Temp* trimmer allows adjusting the temperature of the diode and so its frequency. Before changing the frequency diode, please wait for 30 minutes to make the system thermalize. We strongly recommend not to change it too far (1 or 2 °C typically) from the initial setpoint otherwise mode hops can happen. If so please contact Muquans.

- The *Diode_Current* trimmer allows adjusting the current of the diode and so its frequency. Nevertheless, we recommend not to turn it otherwise mode hops can happen.

[2] We advise the user to begin with a full scan of the temperature range. In this way, the user can detect the maximum power achievable by the system. Once detected, the user will slightly adjust the temperature to get it. Temperature takes some time to stabilize so it shouldn't be changed too fast for the final tuning.
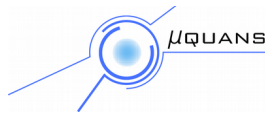
- Two SMA connectors allow an external frequency control of the diode. The user can apply a signal on them to control the seeder frequency through its current.

- The *Diode_Slow* signal is usually used to sweep slowly the current to observe an absorption spectrum for example. The frequency of the applied signal is limited to few tens of Hz.

- The *Diode_Fast* signal is usually the signal used to frequency lock the diode. The frequency of the applied signal can reach few MHz.

- We give below the Absolute Maximum Ratings.

	Voltage
LF Modulation	±5 V
HF Modulation	±5 V

4.8   Interlock

- The system is provided with an interlock safety. The interlock connector is on the rear panel of the system. The two poles of the connector must be shortened to enable the laser. The user can connect it to an external circuit.

Interlock connector.

## 4.9   Putting the system in a cabinet

- The system can be put it in a 19'' cabinet but it has to rely on slide rails. It can't just be hanged by its front panel. The size of the system is 19'' wide x 3U high x 580 mm. Unscrew the four feet to place the laser if needed.

- The feet are required if the system is in a benchtop configuration in order that the cooling can happen.

4.10   Switching off the system

- Stop the EDFA with the commands *sml780_tool edfa_shutdown* in the suitable *Laser_Ctrl* session.

- Switch off the external signals.

- Turn the key switch on the OFF position.

- Turn the main switch on the OFF position.

- Unplug the main cable.
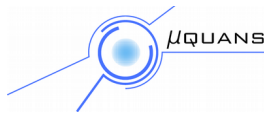
4.11 Assistance

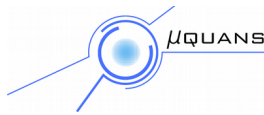Should a problem occur, please contact Muquans before operating the system in a debug mode.

Muquans

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SOFTWARE ANNEX

- *Ctrl+C* allow going back to the commands from the monitoring windows.

- Typing *ils780_tool* or *shutters* in a session gives you the list of the available commands and their syntax.

- With *sml780_tool,* you get:

 # sml780_tool

unknown command

Available commands:

 *sml780_tool Enable_Current_Laser_Diode <on|off>*

  sml780_tool edfa_shutdown

  sml780_tool edfa_set <setpoint>

  sml780_tool cplot

COMMUNICATION SOFTWARES ANNEX

- The laser system have the IP class C static address 10.0.2.107 (netmask 255.255.255.0). No DHCP is provided on the system laser. The laser system can be reached only via the telnet protocol on TCP port 23 (no user, none password needed). The control computer must be set with an IP address on the same network.

- Copy the *mtputty_base_package* folder on the computer and open it.

- Follow the instructions given in the file *README_mtputty_create_titled_tabs.txt* to open Telnet sessions.

- In the manual, we propose to open 2 different sessions for a convenient use of the system. Click several times on the dedicated icons for that. An unique session can also be enough but is a little less convenient.
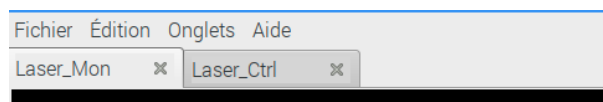
2 sessions can be open to operate the system in an easy way.