⋆LISER™ & LED/LD 光源

用户手册

Version 1.0.1

Contents

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Important Safety Information

1.1 General Safety Information

The ⋆*LISER*™ & *LED/LD Light Source* is a new type of optical source which, in addition to the laser-pumped Ce:YAG crystal fluorescence output, can also include standard LED or laser diode outputs. This type of hybrid light source is not specifically considered by international safety committees such as the IEC[1] and the FDA[2]. Consequently, the user should follow all safety procedures related to the worst case scenario, either in working or failure condition. Considering the power level of the fluorescence output of the ⋆*LISER*™ & *LED/LD Light Source*, this means following Class 3B laser product safety rules even though the output does not necessarily contain laser radiation, depending on the exact model and output filter. The next section on laser safety information should thus be **read and carefully followed**.

1.2 Laser Safety Information

If you are not familiar with laser light sources, ask for advice to qualified personnel **BEFORE FIRST USE** and **READ CAREFULLY** the application note ***Important Laser Safety Information*** that can be found on the USB key. You can also contact directly Doric Lenses by email (sales@doriclenses.com) to obtain a copy of this application note.

DANGER!

The ⋆*LISER*™ & *LED/LD Light Source* is a Class 3B laser product.
Read the application note *Important Laser Safety Information*
BEFORE FIRST USE.

The ⋆*LISER*™ & *LED/LD Light Source* is a Class 3B laser product emitting visible light at sufficiently high power levels to **PERMANENTLY DAMAGE THE EYES. NEVER LOOK** directly into the optical beam exiting from the output FC connector or from any optical fiber connected to the output FC connector. **NEVER LOOK** directly at specular or diffuse reflections of the output beam. It is important to **WEAR LASER SAFETY GLASSES** (goggles) certified for the wavelength and power level of the light source. Also follow all safety procedures to protect anyone working in the area. Even when wearing laser safety glasses, **NEVER LOOK** directly into the beam or any specular reflection of the optical beam exiting from the ⋆*LISER*™ & *LED/LD Light Source* or from any optical fiber connected to its output FC connector. The ⋆*LISER*™ & *LED/LD Light Source* is provided with a safety interlock connector on the rear panel. When the interlock circuit is shorted and the power key is inserted, the driver is enabled (see Section 1.4). For a safe use of the ⋆*LISER*™ & *LED/LD Light Source*, the safety interlock connector should be connected to the laser safety interlock circuit of the laboratory. You should contact the laser safety officer (LSO) of your institution or company to set a proper laser safety interlock circuit for your application and laboratory installation. The ⋆*LISER*™ & *LED/LD Light Source* emits light spanning over a large bandwidth in the visible light spectrum. Since the output spectrum depends on the exact model and optional output filter, the output power level and the according safety procedures are specific to each application.

[1] International Electrotechnical Commission
[2] Food and Drug Administration

1.3 Safety Labels

The laser class labels are provided with the system and the laser aperture is clearly identified by laser warning label and/or the text *LASER APERTURE*.

(a) *Laser Classification Label Example*

(b) *Laser Warning Label*

LASER APERTURE

(c) *Laser Aperture Identification*

Figure 1.1: *Safety Labels*

1.4 Activation Safety Features

The drivers for all Doric Lenses light sources come with a number of safety features. These are built into the driver circuits, as shown in the block diagram (Fig. 1.2).

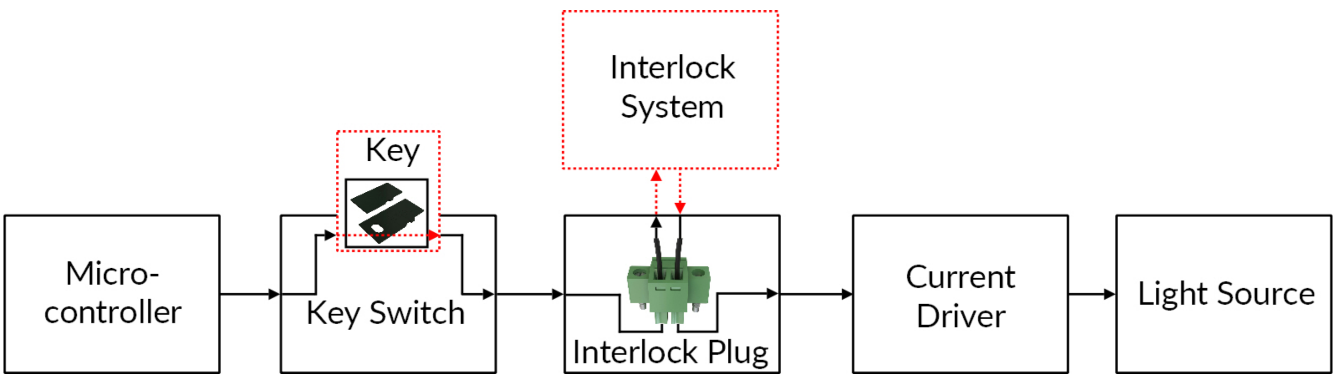
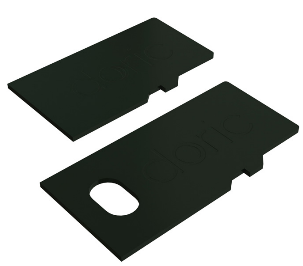
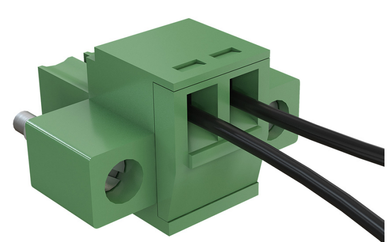


Figure 1.2: *Safety feature block diagram*

- The **Micro-controller**, **Key Switch**, **Interlock Plug** and **Current Driver** are connected in series. This means that if any single safety feature is not properly in place, the light source cannot be activated.
- The **Micro-controller** is used to control the light source driver.



(a) *Key Switch*



(b) *Interlock Plug*

Figure 1.3: *Safety Feature Elements*

- The **Key Switch** (Safety feature 1) (Fig. 1.3a), located on the left side of the driver, is required to activate any light source. If removed, no data can be sent from the micro-controller to the **Current Driver**.
- The **Interlock plug** (Safety feature 2) (Fig. 1.3b) is used to integrate the driver into an **Interlock Circuit**.
  - The **Interlock Plug** comes with a small wire short-circuiting it. This wire must be removed before integrating it into an **Interlock Circuit**.

  - Connect the **Interlock Circuit** in series with the **Interlock Plug** so the circuit may function properly.

- The **Current Driver** sends current to any connected light source. If the **Key** is absent or the **Interlock Plug** has an open circuit, it cannot receive signals from the micro-controller, preventing it from sending out current.

1.5 Emission Indicator

For light sources emitting invisible laser radiation, a dedicated LED indicator is ON when the driver is outputting an electrical current. When the driver is outputting current, the light source will emit light from the aperture.

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Overview

2.1 Operating Principle

The Doric ⋆*LISER*^{TM} light source is inspired by the “white” LED concept. LEDs (Light Emitting Diodes) are solid state light sources emitting light by the direct conversion of an electric current passing through a semiconductor junction. LEDs are now available at many central wavelengths and bandwidths. Properly speaking, no LEDs can emit over the entire visible spectrum to produce white light. Many so-called “white” LEDs are in fact a combination of a blue LED and a fluorescent crystal. A part of the blue LED light is absorbed by a Cerium doped Yttrium Aluminum Garnet crystal (shortly: Ce:YAG crystal) which, after absorption of blue light, spontaneously re-emits over a significant part of the visible spectrum, mostly green, yellow and red light. The combination of the green-yellow-red fluorescence and the unabsorbed blue light from the pumping LED results in white light.

“White” LEDs are designed for energy efficient white lighting applications. For scientific applications involving optical fiber coupling, high spectral brightness (W/mm^2/sr/nm) sources are required. In order to increase the spectral brightness, the “white” LED operating principle must be scaled in term of pump power. The power scaling first requires a higher brightness pump source emitting blue light. In the Doric ⋆*LISER*^{TM} light source, high power blue laser diodes (LDs) emitting at 450 nm are used to provide a much smaller pumped volume of the Ce:YAG crystal. Such a direct power scaling of the pumping source leads to thermal failures. Indeed, a high brightness pumping leads to a local heating of the Ce:YAG crystal. When the crystal temperature locally reach about 400°C, a phenomenon called “temperature quenching” leads to a significant drop of the fluorescent emission due to non radiative relaxation of blue-light excited Ce^{3+} ions. The temperature increase ultimately leads to a catastrophic failure of the crystal. Heat generated by high brightness pumping thus have to be managed properly using passive/active cooling and crystal geometry.

The ⋆*LISER*^{TM} light source emits over a broad and continuous visible light spectrum. A typical fluorescence spectrum of a Ce:YAG crystal is shown in Fig. 2.1. The source thus provides a speckle-free light beam at the output of multimode optical fibers. Also, direct modulation of the emitted light intensity is easily achieved through the modulation of the injection current of all pump laser diodes, and this, without any detrimental spiking like with diode-pumped solid-state (DPSS) laser systems.

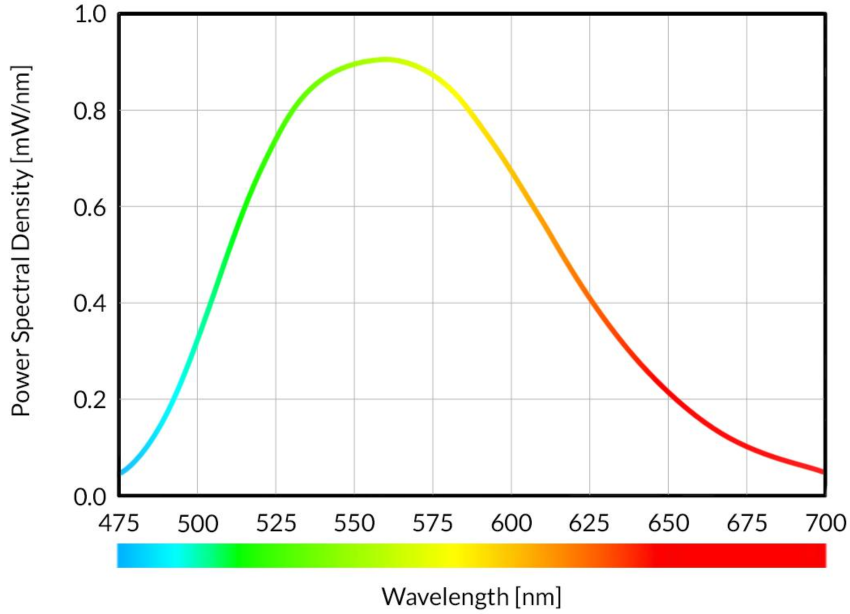

Figure 2.1: *Output Power Spectral Density of a ⋆LISER™ Fiber Light Source using 200 µm, 0.53 NA Fiber*

2.2 Overview of the ⋆LISER^{TM} & LED/LD Light Source

The Doric ⋆*LISER*^{TM} & *LED Light Source* includes a LED light source combined with the ⋆LISER^{TM} source (Fig. 2.2). The light from both sources are mixed using an optical combiner. The ⋆*LISER*^{TM} & *LED/LD Light Source* is considered as a Class 3B laser product. It is critical to follow the safety instructions stated in this manual. The device has the following elements.

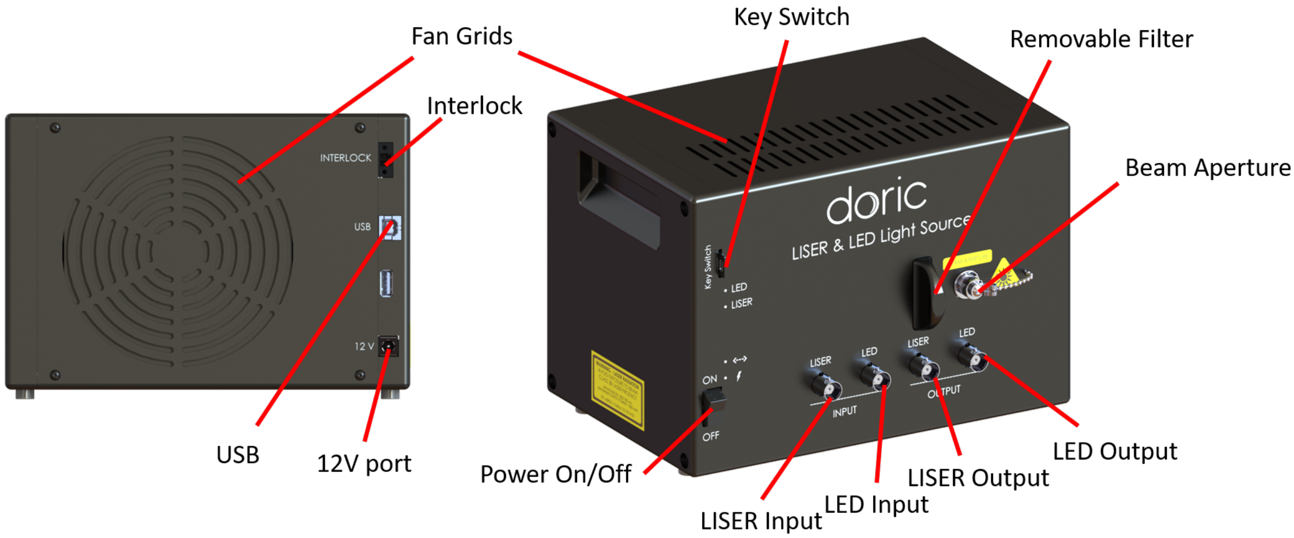

Figure 2.2: ⋆*LISER*^{TM} *& LED/LD Fiber Light Source*

- The **Beam Aperture** is where the light exits the light source. The aperture is composed of a fiber coupling assembly that injects the emitted light into an optical fiber. The standard model uses an FC fiber connector. A safety FC metal cap is attached to the optical head to block the output light beam in absence of optical fiber.
- The **Fan Grids** are found on the top, rear and side of the light source. They must be kept clear at all times to avoid overheating the system.
- The **Removable Filter Holder** is used to insert an optical bandpass filter in the system, allowing the selection of a narrow part of the broad Ce:YAG spectrum of emission. The filter holder can accept any filter up to a 25.4 mm diameter and a maximum 5 mm thickness.
- The BNC **LISER Input** Port is used to command the ⋆LISER^{TM} source.
- The BNC **LED Input** Port is used to command the LED/LD source.
- The BNC **LISER Output** Port is used to monitor the ⋆LISER^{TM} source.
- The BNC **LED Output** Port is used to monitor the LED/LD source.
- The **Power On/Off** switch turns on/off the driver.
- The **Key Switch** must be in place to enable light emission. Note that, despite its similar form factor, the power key **is not a standard micro SD card** such as those used in some digital cameras. Do not attach the **Key** to a key fob or similar holder; this may prevent proper insertion of the **Key Switch**.
- The **12 V** port connects the ⋆*LISER*^{TM} to its 12 VDC power supply.
- The **USB** port allows the user to connect the ⋆*LISER*^{TM} to a computer using a USB-A/USB-B cable. This allows the driver to be controlled using *Doric Neuroscience Studio*.
- The **Interlock** connector plug allows the user to connect the ⋆*LISER*^{TM} to a safety interlock system. It is recommended to connect the interlock plug to a laboratory interlock system (See chapter 1).

2.3 Overview of the Bandpass Filter for ⋆LISER^{TM}

Considering the very broad spectrum of the ⋆*LISER*^{TM} fluorescence, it is often required to select a specific part of the output spectrum using an optical bandpass filter. The light source contains a **Removable Filter Holder** that can accept filters with an outside diameter of 25.4 mm and maximum thickness of 5 mm. The filter is placed between the ⋆LISER^{TM} light source and the combiner, and is held in place magnetically. A wide variety of filters are available in our Website.

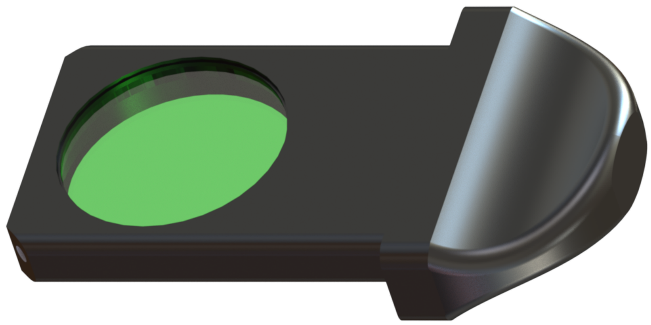

Figure 2.3: *Bandpass Filter for the ⋆LISER^{TM} in its holder*

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Operations Guide

3.1 Getting Started

The procedure below should be followed carefully. There are several safety measures to take into account to ensure safe and proper use of the ⋆*LISER*^{TM} *& LED/LD Light Source*.

1. Connect the **Interlock plug** to the driver. The system CANNOT be operational if the safety interlock circuit is open.
    - When unpacking, a temporarily shorted interlock plug is already secured in place. It is highly recommended to remove the shorting electrical wire and connect the interlock plug to a proper interlock circuit of the laboratory.
    - See the Important Safety Information section (Chapter 1) for more information.

WARNING!
Be aware that a shorted interlock plug DISABLES this safety feature AT YOUR OWN RISKS. A proper safety interlock circuit is highly recommended.

2. Ensure that the **ON/OFF switch** of the driver is set to OFF.
3. Connect the ⋆*LISER*^{TM} *& LED/LD Light Source* to the power outlet with the included 12 V AC-DC adapter.

WARNING!
DO NOT OPEN the enclosure of the driver. Electrical hazards may result. The driver does not contain any user-serviceable components.

4. The optical head is sensitive to electrostatic discharges, use proper grounding techniques.
5. Unscrew the metal safety cap from the **Beam aperture**.
6. Connect the *Optical fiber patch-cord* to the ⋆*LISER*^{TM} *& LED/LD Light Source* (see the section 3.2).
7. Ensure that a proper laser beam block is ready at the output of the optical fiber.

DANGER!
The light beam exiting the ⋆*LISER*^{TM} *& LED/LD Light Source* or any connected optical fiber should be confined properly BEFORE turning ON the device. Use a proper beam block. Read the application note *Important Laser Safety Information* BEFORE FIRST USE.

8. Ensure that all laser safety procedures are followed.
9. Insert the power key into its receptacle.

10. Set the power switch to ON.

11. Connect the **USB-A/USB-B cable** between the *⋆LISER™ & LED/LD Light Source* and the computer.

12. Install the Doric Neuroscience Studio on the computer. To install the software, double-click on the DoricNeuroscienceStudioSetup_vX.X.exe file located on the Doric USB memory stick supplied with the *⋆LISER™ & LED/LD Light Source* and follow the on-screen instructions (help is also available in the **Doric Neuroscience Studio User Manual**, which can be downloaded on our Website, section **SUPPORT**).

13. If needed, connect an external device to the *⋆LISER™ & LED/LD Light Source* by using one of the input BNC port. In this configuration, the driver will wait the signal from another device, consequently the light source will be triggered. To follow an external device, select the external TTL or the external analog mode for the desired channel (see section 4.1.2).

14. If needed, connect a data acquisition system or an external device to the *⋆LISER™ & LED/LD Light Source* by using the output BNC port of the desired channel. A data acquisition system enables the viewing and the recording of the signal generated by an external device connected to the light source. The output BNC can also be used to connect an external device that will be triggered by the light source.

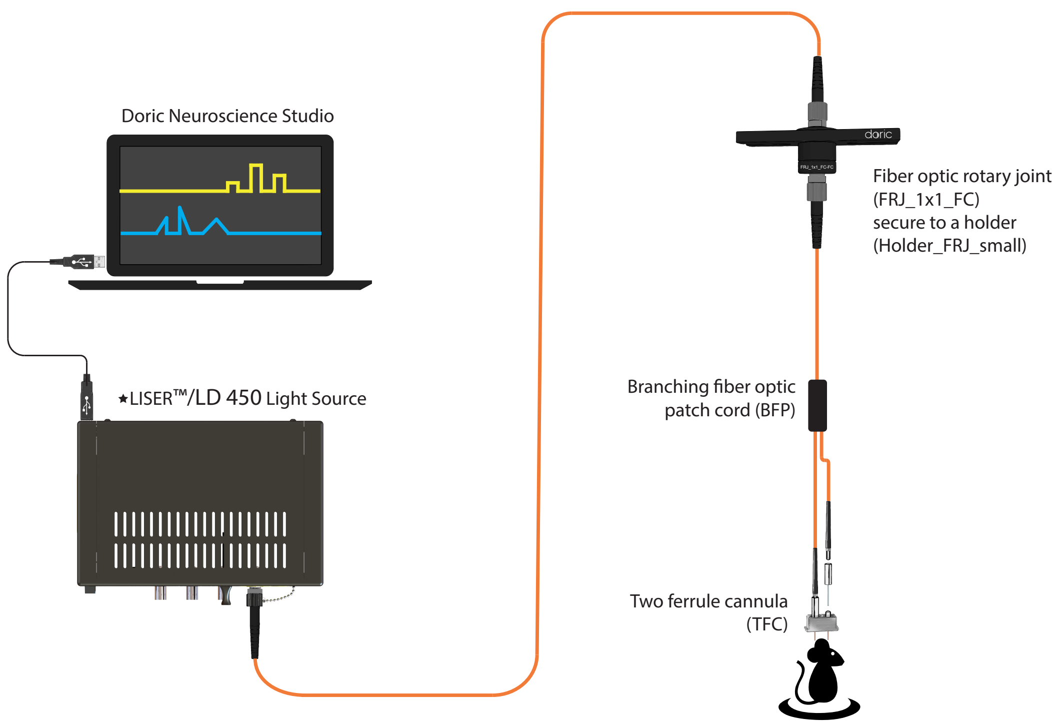


Figure 3.1: *System using a ⋆LISER™ & LED/LD Light Source*

3.2 FC Connector Installation

1. Clean the optical fiber connector before insertion. Use isopropanol and a lint-free wipe.
2. With an FC connector, the connector key must be oriented to enter within the receptacle slot to ensure proper connection (Fig. 3.2).

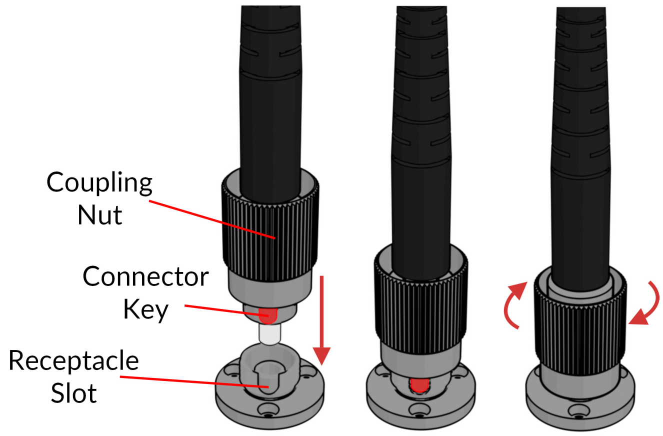


Figure 3.2: *FC connector, Fiber Installation*

To reduce the risk of eye injury, it is sound practice to NOT CONNECT/DISCONNECT OPTICAL FIBERS when the light source is turned on

4

Doric Neuroscience Studio

Doric Light Sources can be controlled by the Doric Neuroscience Studio. These include *LED Modules*, *Laser Diode Modules* and *⋆LISER^{TM} Light Source*[1]. The interface is separated into two main sections, **Control & settings** and the **Acquisition View**. Each light source driver has a number of **Channels**, each one controlling a light source of its given type. These channels, accessible using the **Add Channel** button, will be the first detailed.

4.1 Channel Configuration

4.1.1 Channel Configuration Window Overview

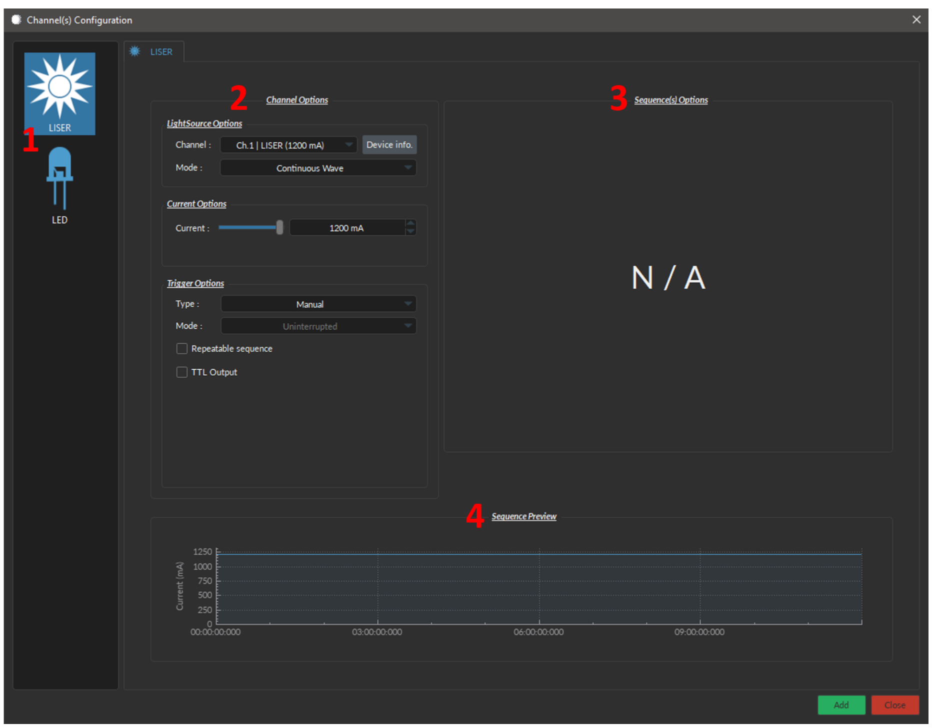


Figure 4.1: *Channels Configuration Main Interface*

The **Channels configuration** window is used to configure each channel. The window can be accessed by using either the **Add Channel** or **Edit** buttons. This window is separated into multiple sections shown in Figure 4.1 that are defined below.

[1] The ⋆LISER^{TM} Light Source are also known in older models as Ce:YAG Fiber Light Source.

1. The **Channel Types** are displayed on the left side of the window. These include the ⋆**LISER**^{TM} light sources, the **LED** light sources and the **Laser Diode** light sources.

2. The **Channel Options** section allows you to define the Light Source Option, the Current options and the Triggering Options. The different fields of this section are explained in more detail in section 4.1.2.

3. The **Sequence Options** defines the parameters of each pulse sequence for the channel. These parameters are different for each Channel Mode. The different fields for the different Channel Mode are explained in more detail in section 4.1.3.

4. The **Sequence Preview** section shows a visualization of the output sequence that will be generated by the current configuration.

5. The **Add** button will save the current channel configuration and enables a new channel to be configured. The **Close** button will close the window without saving the current channel configuration.

4.1.2 Channel Options Section

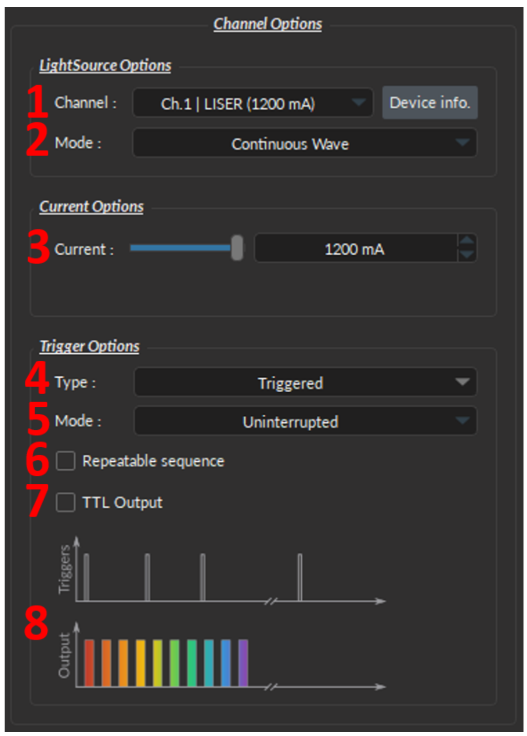


Figure 4.2: *Channel Options of the Channel Configuration Window*

The Channel Option section (Fig. 4.2) is separated in 3 sub-sections, the **LightSource Options** section that defines the channel and its mode, the **Current Options** and the **Trigger Options** section that control the trigger method of the selected channel.

LightSource Options

1. The **Channel** field identifies which of the available channels is currently being modified. The Light Source can be changed by selecting a new one from the drop-down list.

2. The **Mode** field identifies the mode used to generate the light. Five modes are available, **Continuous Wave** (fix current), **External TTL** (external digital command), **External Analog** (external analog command), **Square Sequence(s)** (internal digital command), and **Complex Sequences(s)** mode (internal analog command). Each mode enables different options of the Sequence Option section that are explained in more detail in section 4.1.3.

Current Options

3. The **Current Options** includes the slider used to control the current sent to the light source.

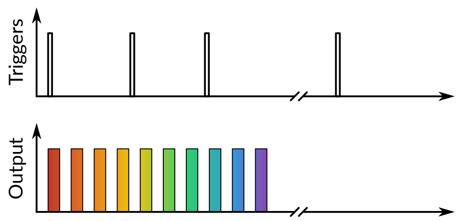
   - When using some *LED* module, the **Overdrive** checkbox will appear. When selected, this allows the system to exceed the normal safe current limit of the light source. **THIS SHOULD ONLY BE USED WITH PULSED SIGNALS, AS IT CAN OTHERWISE DAMAGE THE LIGHT SOURCE.**
   - When using a *CLED* module, the **Low-Power** checkbox will appear. When selected, this allows reduced-power signaling for the same voltage. This mode is only available for *CLED* modules. This allows low-power signals to be more stable in time. The maximal current is reduced to one tenth of light source's normal maximal current. If the **BNC Output** is used to monitor the LED power, its output voltage is proportional to the current passing through the light source, and not the voltage sent to it. For example, a driver with a normal maximum current of 2000 mA for a 5 V signal (400 mA/V) will have a maximum current of 200 mA for a 5 V signal (40 mA/V) in low power mode. The **BNC output** of the driver will still relate LED current with a 400 mA/V conversion factor.

Trigger Options

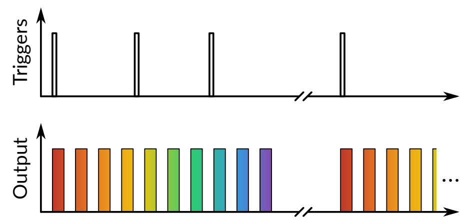
4. The **Type** defines the type of trigger that is used to start/stop a sequence. The **Triggered** type can starts and stops a sequence at a rising edge while the **Gated** type can starts the sequence at a rising edge and stops it at a falling edge. A more refined interaction of the trigger with the defined sequence can be set up using the **Mode** field. Not all Trigger Type are available for each combination of Trigger Mode and Repeatability. The different combinations are shown in Figure 4.7.

5. The **Mode** field defines how the trigger activates a sequence. Each mode are not compatible with each combination of trigger type and repeatability. Figure 4.7 shows the different available combinations for the different Trigger Modes. Four Modes are available and are the following:

   - **Uninterrupted**: This mode activates the channel sequence when an input greater than 3.3 V is detected by the BNC input. Following input pulses will be ignored while the sequence is running (Fig. 4.3). When the **Repeatable sequence** checkbox is checked, the sequence will restart with the arrival of the first input pulse after the sequence has finished (Fig. 4.3b). This mode is available for *Triggered* pulse only.
   - **Pause**: This mode activates the channel sequence when a rising edge greater than 3.3 V is detected on the BNC input (Fig. 4.4). Following input pulses (when *Triggered*, Fig. 4.4a) or falling edge (when *Gated*, Fig. 4.4c) will pause the sequence and the sequence will continue when the next rising edge is received. When the **Repeatable sequence** checkbox is checked, the sequence will restart with the arrival of the first input pulse after the sequence has finished (Figs. 4.4b and 4.4d).
   - **Continue**: This mode activates the channel sequence when a rising edge greater than 3.3 V is detected on the BNC input (Fig. 4.5). The following input pulse (when *Triggered*, Fig. 4.5a) or a falling edge (when *Gated*, Fig. 4.5c) will turn off the output, but the sequence will continue. The output will be turned back on at the reception of the following rising edge. Triggers only affect the output voltage value. When the **Repeatable sequence** checkbox is checked, the sequence will restart with the arrival of the first input pulse after the sequence has finished (Figs. 4.5b and 4.5d).
   - **Restart**: This mode activates the channel sequence when a rising edge higher than 3.3 V is detected on the BNC input. The following input pulse (when *Triggered*, Fig. 4.6a) or falling edge (when *Gated*, Fig. 4.6b) will stop the sequence and the sequence will restart from the beginning when the next rising edge is received. When the sequence is completed, it will restart with the next input pulse.

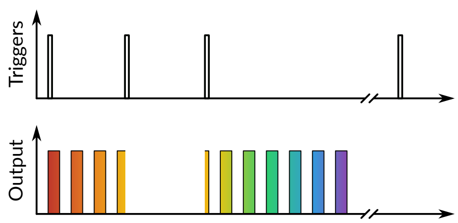


(a) *Triggered Non-Repeatable Sequence*

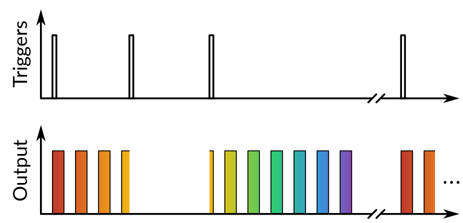


(b) *Triggered Repeatable Sequence*

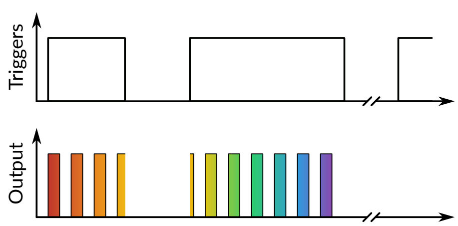
Figure 4.3: *Uninterrupted Sequence Mode*



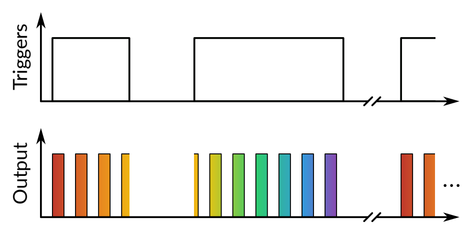
(a) *Triggered Non-Repeatable Sequence*



(b) *Triggered Repeatable Sequence*

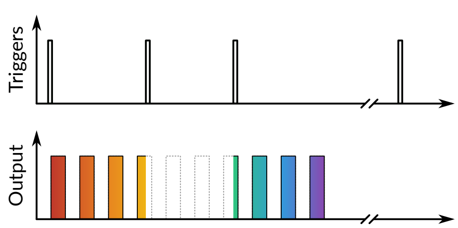


(c) *Gated Non-Repeatable Sequence*

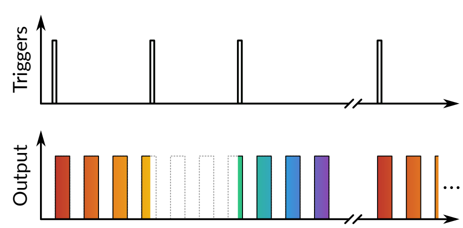


(d) *Gated Repeatable Sequence*

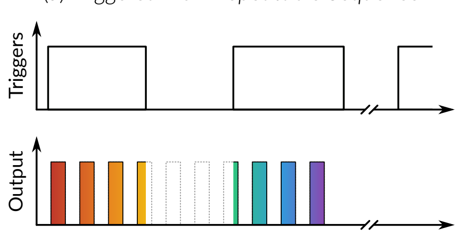
Figure 4.4: *Pause Sequence Mode*



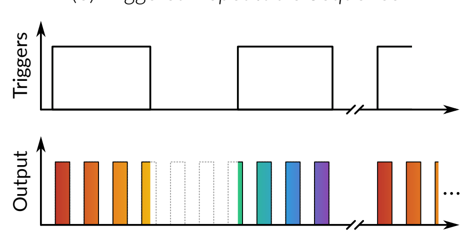
(a) *Triggered Non-Repeatable Sequence*



(b) *Triggered Repeatable Sequence*

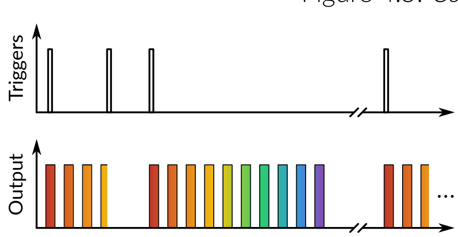


(c) *Gated Non-Repeatable Sequence*

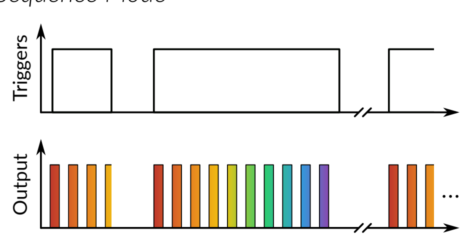


(d) *Gated Repeatable Sequence*

Figure 4.5: *Continue Sequence Mode*



(a) *Triggered Repeatable Sequence*



(b) *Triggered Gated Sequence*

Figure 4.6: *Restart Sequence Mode*

6. The **Repeatable sequence** checkbox, when selected, allows a sequence to be repeated. Not all modes and trigger types can be repeated. Please refer to the Figure 4.7 to know the repeatable sequence combinations.
7. The **TTL Output** checkbox, when selected, allows the output BNC channel to be used as a TTL generator. The monitoring signal will provide a TTL signal instead of an analog voltage output proportional to the LED current. The output will send out a 5 V signal whenever the input current is >0 mA. This can be used even if a light source is not connected.
8. The **Sequence Visualisation** shows a graphical representation of the behavior of the selected Trigger Option Type, Mode and Repeatability.

	Triggered		Gated	
	Non-repeatable sequence	Repeatable sequence	Non-repeatable sequence	Repeatable sequence
Uninterrupted	✓	✓		
Pause	✓	✓	✓	✓
Continue	✓	✓	✓	✓
Restart		✓		✓

Figure 4.7: *Trigger options possibilities*

4.1.3 Sequence(s) Options Section

Continuous Wave

The **Continuous Wave** mode is used to set the Light Source to a chosen intensity without variations during experiments.

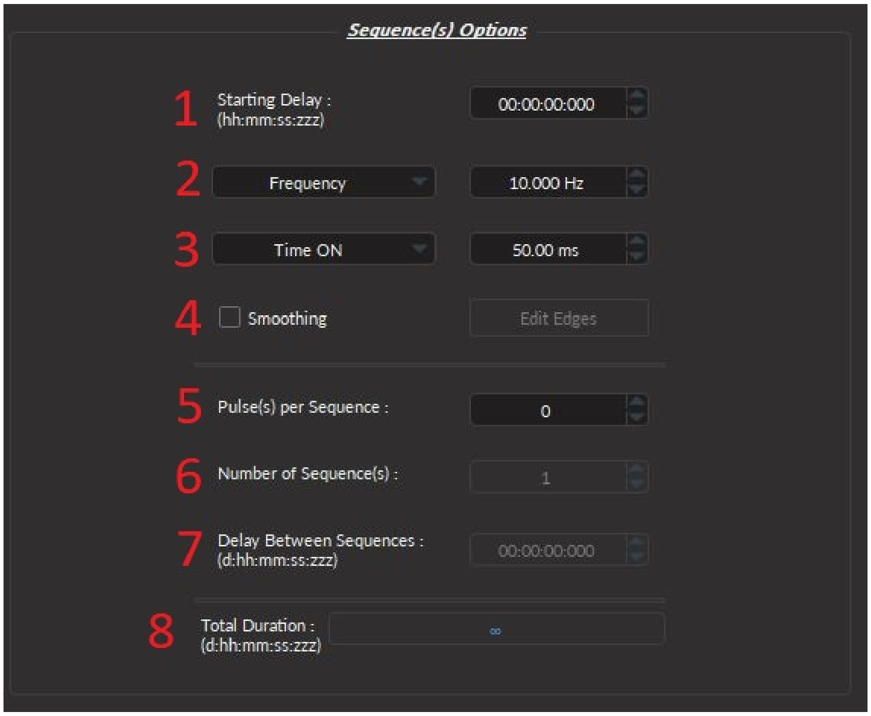
External TTL

The **External TTL** mode is used to drive the Light Source to a chosen intensity when the External TTL signal is high. When the External TTL signal is low, the Light Source is turned OFF.

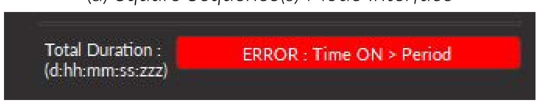
External analog

The **External Analog** mode is used to drive the Light Source in function of the analog voltage used as input. The input voltage may varies between 0 V and 5 V and the intensity will follow the variations between 0 mA and the maximum current.

Square Sequence(s)



(a) *Square Sequence(s) Mode Interface*



(b) *Exemple of Error*

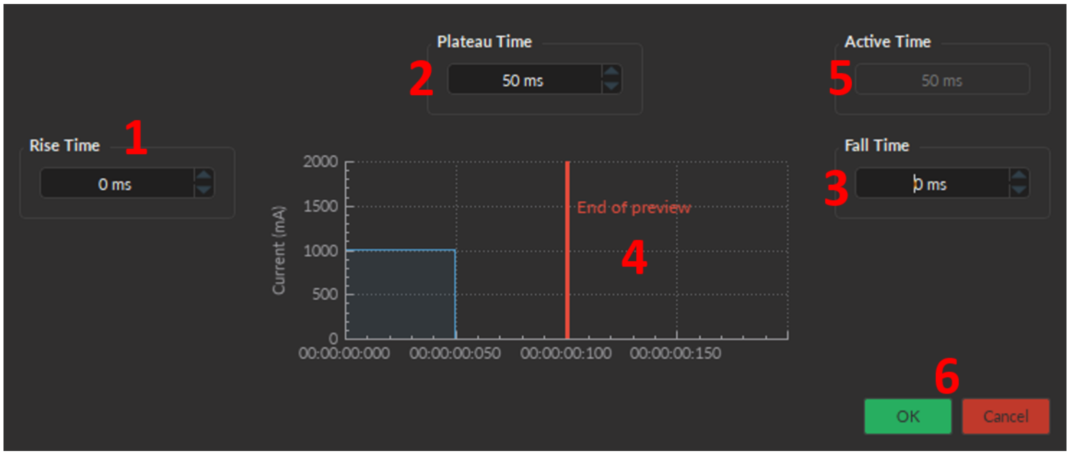
Figure 4.8: *Sequence Options of the Square Sequence(s) Mode.*

The **Square Sequence(s)** mode allows the creation of a square TTL pulse sequence. The Sequence(s) Options of this mode are shown in Figure 4.8a and are explained below.

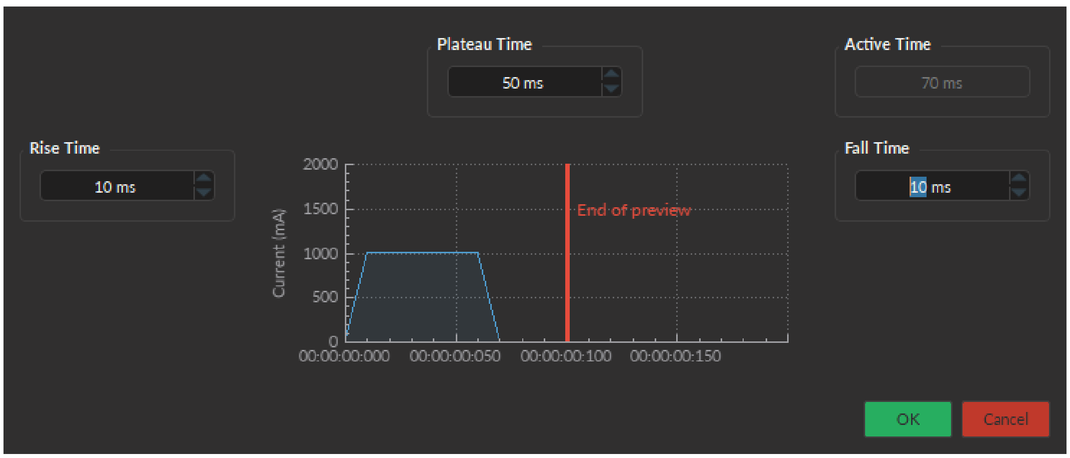
1. The **Starting Delay** defines the time between the activation of the pulse sequence and the beginning of the first light illumination.
2. The **Frequency** sets the frequency (in Hz), which is the number of pulses per second. The frequency can also be changed to the **Period**. For example, a light illumination at 10 Hz (frequency) will output one pulse every 100 ms (period), whereas a light illumination at 0.5 Hz (frequency) will output one pulse every 2 seconds (period).
3. The **Time ON** defines the length of a single pulse. This time can also be converted to a **Duty Cycle**, which represents the % of the period the pulse duration corresponds to.
4. The **Smoothing** check box allows to change the pulse slope in square pulse sequences. The **Edit Edges** button opens the **Smoothing Edge(s)** window. An overview of the window opened by **Edit Edges** will be done in the next subsection.
5. The **Pulse(s) per sequence** set the number of pulses per sequence. If it is set to 0, the number of pulses will be infinite.
6. The **Number of sequence(s)** sets the number of times that the sequence will be repeated.
7. The **Delay between sequences** sets the delay between each sequence.
8. The **Total Duration** shows the total expected duration of the pulse sequence. Should the duration be infinite, the box will display ∞. If there is an error in parameter selection, this box will turn red and display what is the error (see Figure 4.8b).

Smoothing Edge(s)

The Smoothing Edge(s) window (Fig. 4.9) allows to change the pulse slopes of the square pulse sequences.



(a) *Overview of the Smoothing Edge(s) window*



(b) *Exemple of smoothing edges (10ms for rise and fall time)*

Figure 4.9: *Smoothing Edge(s) window*

1. The **Rise Time** box is used to define the duration to rise from 0 mA to the pulse maximum value.
2. The **Plateau Time** box is used to define the duration the pulse at its maximum value.
3. The **Fall Time** box is used to define the duration to descend from the pulse maximum value to 0 mA.
4. The **Pulse Graph** displays the pulse shape.
5. The **Active Time** box displays the total duration of the pulse. While the **Smoothing** option is active, the **Time ON** is fixed at this value.
6. The **OK** button save the changes of the shape of the pulses. The **Cancel** button discard the changes. Both buttons close the window.

Complex Sequence(s)

If needed, it is possible to define a complex sequence to trigger the light source in the **Complex Sequence(s) Options** (Fig. 4.10).

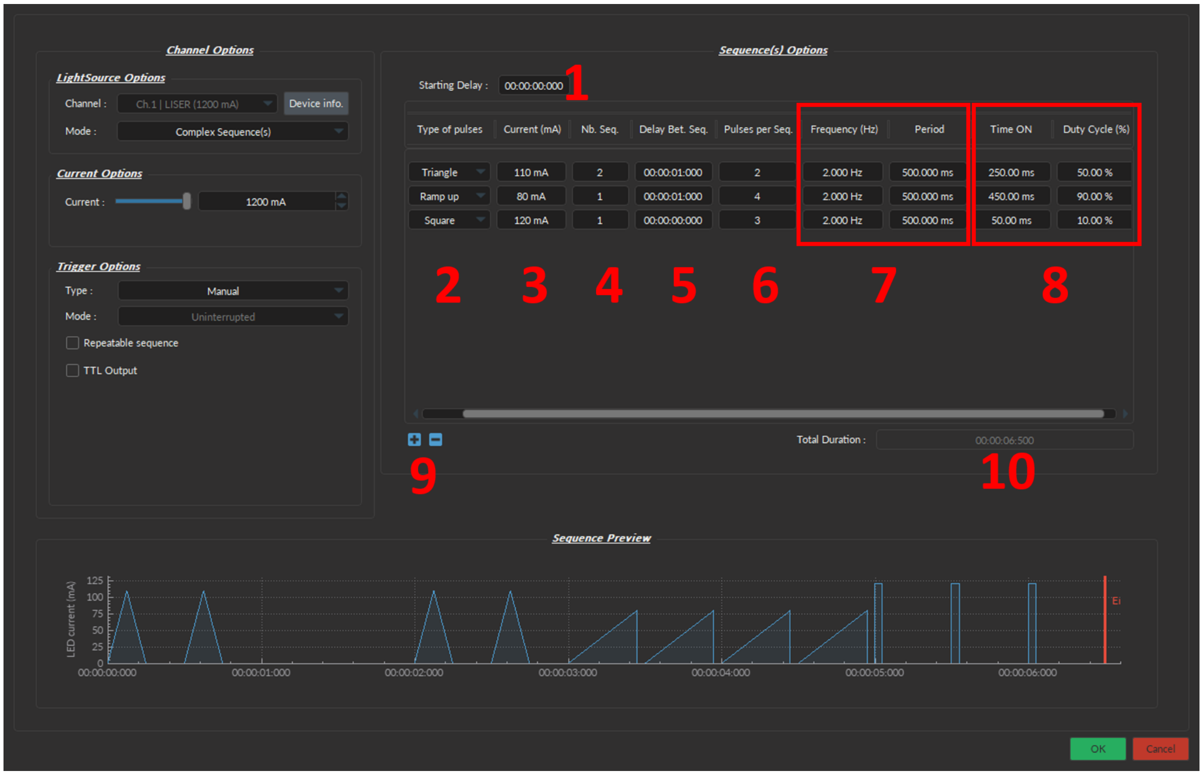


Figure 4.10: *Complex Sequences Window*

1. The **Starting Delay** sets the delay (in hh:mm:ss:zzz format) before the first light illumination.
2. The **Types of pulses** sets the pulse type. Pulses can be **Square**, triangular (**Triangle**), **Ramp up**, **Ramp down** or **Delay**. The **Delay** pulse type is used to create a delay between different sequence.
3. The **Current** sets the maximum current (in mA) for the given sequence.
4. The **Nb. Seq.** sets the number of times that the sequence will be repeated, with a minimum of 1.
5. The **Delay between sequences** sets the delay (in hh:mm:ss:zzz format) between each sequence if **Nb.Seq.** is greater than 1.
6. The **Pulses per Seq.** sets the number of pulses per sequence, with a minimum of 1.
7. The **Frequency**/**Period** sets the frequency (in Hz) or period (in ms) for the pulse sequence. These two values are linked, and when one is changed the other will adjust automatically. For example, a signal at 10 Hz (frequency) will output one pulse every 100 ms (period), whereas a pulse sequence at 0.5 Hz (frequency) will output one pulse every 2000 ms (period).
8. The **Time ON**/**Duty Cycle** sets the time (in ms) or the duty cycle (in %) for each pulse. These two values are linked, and when one is changed the other will adjust automatically. The **Time ON** must be lower than **Period**+0.005 ms, while the **Duty cycle** must be below 100 %.
9. The **Sequence controls** allow the addition (**+**) or removal (**-**) of sequences to the spreadsheet.
10. The **Total Duration** displays the total time of the experiment. The different values can be *Inf* for infinite, a valid time value or *Err* if the **Time ON** value is greater than the **Period**.

4.2 Control ans Settings

The **Control and Settings** box is used to manage the different parts of the software. It contains three tabs, the **Acquisition**, **Configuration**, and **View** Tabs.

4.2.1 Acquisition Tab

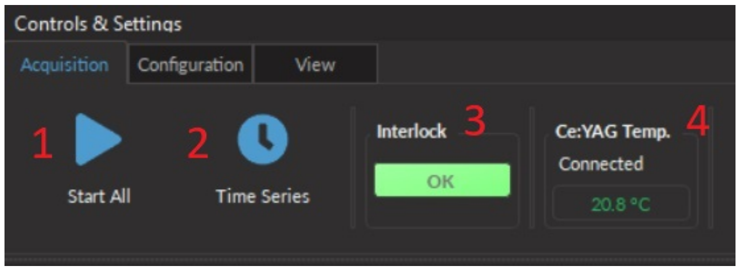


Figure 4.11: *Acquisition Tab*

The different buttons of the **Acquisition Tab** are shown in Figure 4.11 and their functions are explained below.

1. The **Start All** button starts all currently configured channels.
2. The **Time Series** button opens the Time Series window (Fig. 4.12). This tool allows all channels to share the same timing.
3. The **Interlock** indicator displays  when the interlock is correctly connected, and  when disconnected (more details in the section 1.4).
4. The **Ce:YAG Temp.** indicator displays the temperature of the Ce:YAG crystal base in real time. This indicator will only appear when a *LISER driver* is connected to the computer. Should the temperature be too high, the temperature will appear in red. Should the temperature be too low, the temperature will appear in blue.

Time Series

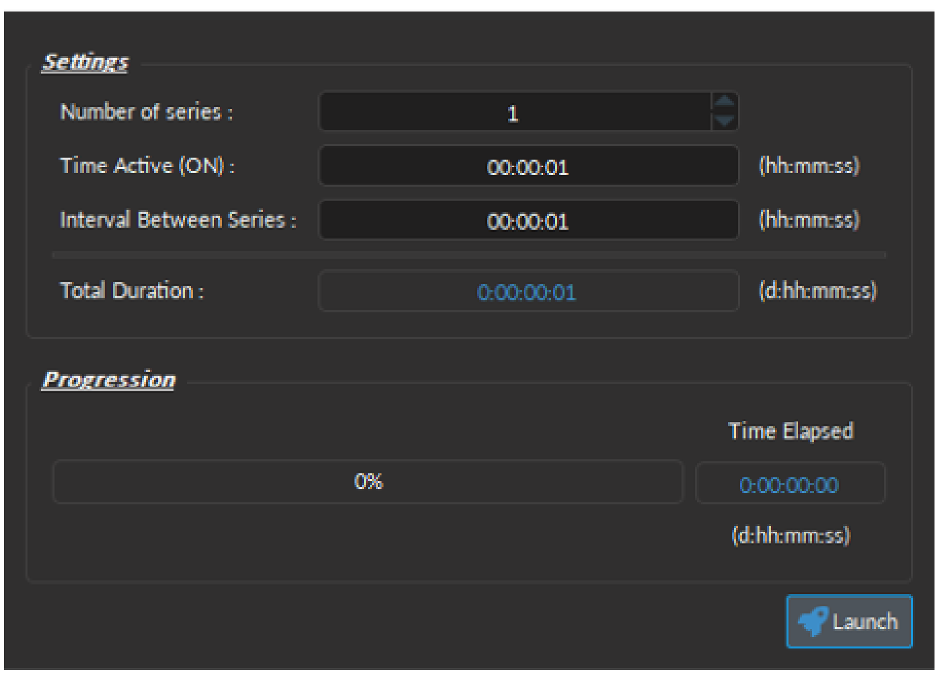


Figure 4.12: *Time Series Window*

- The **Number of series** sets the number of times that the sequence will be repeated, with a minimum of 1.
- The **Time Active** sets the duration of each series in hh:mm:ss:zzz format. The **Time series** can be used in combination with a sequence such as the Square Sequence(s) or the Complex Sequence(s) Mode. If the **Time Active** duration is shorter than the sequence time length, the sequence will stop at the end of the **Time Active** time length.
- The **Interval between series** sets the duration between each series in hh:mm:ss:zzz format.
- The **Total Duration** displays the total duration of the sequence in d:hh:mm:ss:zzz format.
- The **Progression** bar displays the progression of the sequence in %, while the **Time Elapsed** counter displays the progression in hh:mm:ss:zzz format.
- The **Launch** button starts the sequence.

4.2.2 Configuration Tab

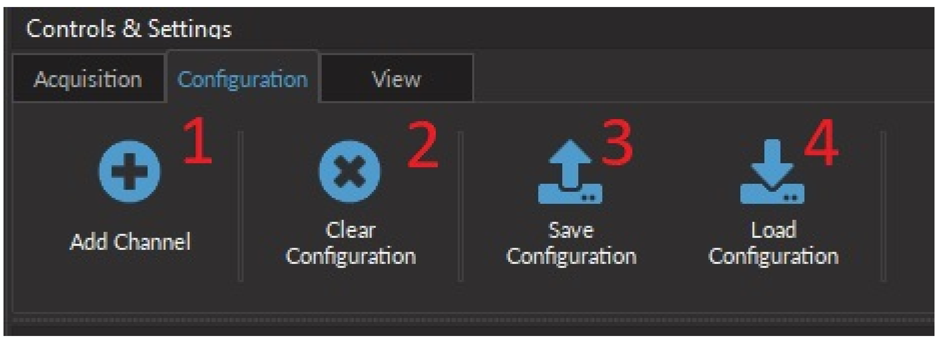


Figure 4.13: *Configuration Tab*

The different buttons of the **Configuration Tab** are shown in Figure 4.13 and their functions are explained below.

1. The **Add Channel** button opens the **Channels Configuration** window to setup the channels. This window is detailed in section 4.1.
2. The **Clear Configuration** button resets the acquisition view and all other parameters set. Any configurations already set will be lost.
3. The **Save Configuration** button is used to save the Light Source configuration in a **.doric** format.
4. The **Load Configuration** button allows a Light Source configuration in **.doric** format to be loaded. Recorded data files also contains the configuration used during the experiment and this configuration can be loaded using this button.

4.2.3 View Tab

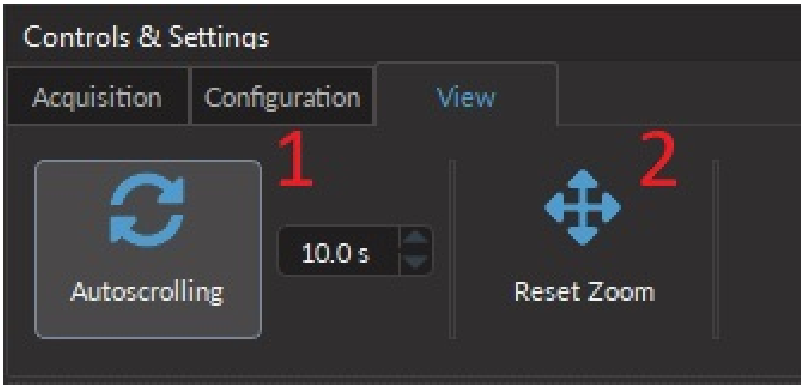


Figure 4.14: *View Tab*

The different buttons and fields of the **View Tab** are shown in Figure 4.14.

1. The **Autoscrolling** button, when clicked, makes the graphs scroll as new data appears. The duration (in seconds) kept on display is controlled by the field beside the button.

2. The **Reset Zoom** button resets the horizontal axis of all graphs displayed in the **Acquisition View** to the duration chosen in the **Autoscrolling** field.

4.3 Acquisition View

4.3.1 Acquisition View Overview

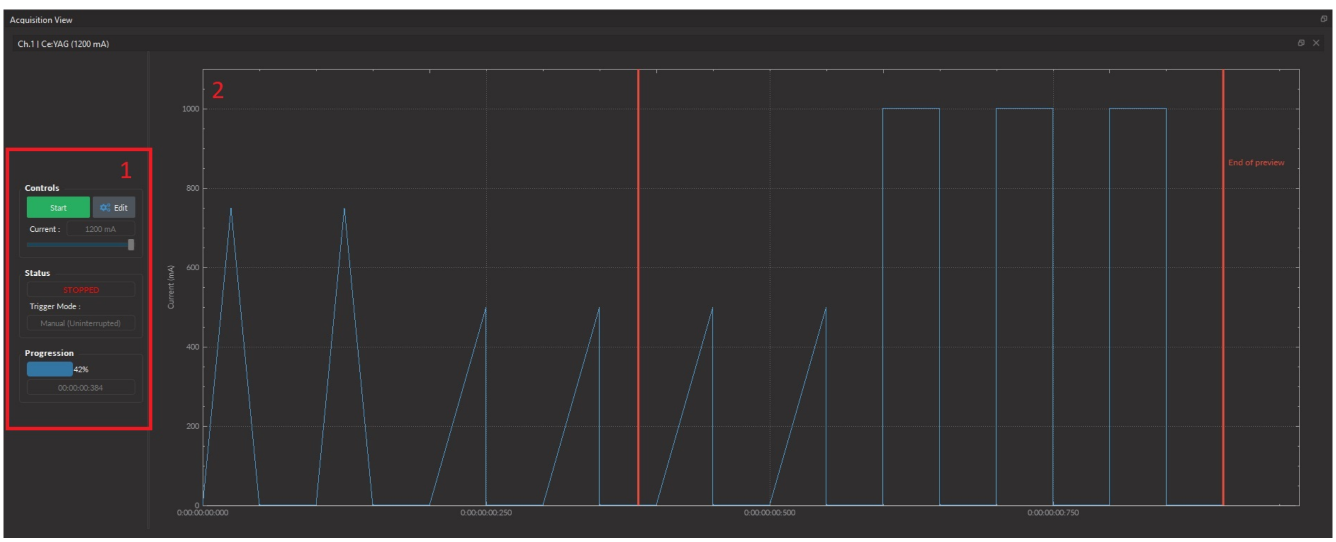


Figure 4.15: *Experiment View*

The Acquisition View (fig: 4.15) is composed of two sections:

1. The **Controls View** displays all elements to control/configure the channel. An overview this part will be done in section 4.3.2.

2. The **Graph View** displays a preview of the pulse sequence for Light Source Channels.

4.3.2 Acquisition View Control

Figure 4.16: *Control of the Acquisition View*

The different buttons of the **Control of the Acquisition View** are shown in Figure 4.16 and their functions are explained below.

1. The **Start/Stop** button activates/deactivates the light source connected to the **Light Source Channel**.
2. The **Edit** button opens the **Channel configuration** window to edit the pulse sequence. This button is only accessible when the channel is deactivated and an overview of the **Channel Configuration** window is done in section 4.1.
3. The **Current Box** allows the current to be changed exactly (in mA).
4. The **Current Slider** allows the light source current to be adjusted.
5. The **Status** box displays the status **Light source**. The **Status** will display RUNNING... when active and STOPPED when deactivated.
6. The **Trigger Mode** of the light source is displayed in this box. For more information on the different Trigger options, see section 4.1.2.
7. The **Progression** box displays the progression of the pulse sequence. The advancement of the sequence is displayed in % on the **Progression Bar**, and in hh:mm:ss:zzz format on the **Time Elapsed** box.

5

Specifications

Table 5.1: *Specifications of the ⋆LISER™ & LED/LD Light Source*

Specification	**Value**	**Note**
Power supply	110 - 240 VAC, 50 - 60 Hz	
DC Power supply	12 VDC, 150 W	
Mass	2.6 kg	
Dimensions		
Width	20 cm	Including connectors
Depth	15 cm	Including connectors
Height	14 cm	Including connectors
TTL input voltage	0 to +5 V	
Display current accuracy	<5% @ maximum rated current	Error increases at lower current.
⋆LISER™ Analog input voltage	240 mA/V (typical)	See data sheet
⋆LISER™ Monitor output voltage	4.17 V/A (typical)	See data sheet
⋆LISER™ Maximum output current range	1200 mA	See data sheet
⋆LISER™ Maximum forward voltage	6 V typical	See data sheet
⋆LISER™ Rise/Fall time	<10 µs	
LED Analog input voltage	400 mA/V light source current 40 mA/V light source current	Standard 1 A LED Driver Low power mode enabled
LED BNC output voltage	2.5 V/A	
LED Maximum output current range	200, 2000 mA	
LED Maximum forward voltage	7 V	
LED Minimum output current	2.5 mA	Low power mode enabled
LED Rise/Fall time	<10 µs Typical	
LD Analog input voltage	80 mA/V light source current	If applicable: see datasheet
LD BNC output voltage	12.5 V/A	
LD Maximum output current range	LD Model dependent	
LD Maximum forward voltage	10 V	
LD Minimum output current	25 mA	Low power mode enabled
LD Display current accuracy	2% at maximum rated current	Error increases at lower current
LD Rise/Fall time	<10 µs Typical	
Output NA	0.63	
Output Optical Fiber Core Size	<600 µm	Power scales up to this core size

Table 5.2: *Software Specifications of the ⋆LISER^{TM} & LED/LD Light Source*

Specification	Value	Note
Current adjustment steps	1 mA	
Modulation minimum frequency	0.01 Hz[1]	Internal complex mode : 0.000054 Hz
Modulation maximum frequency	90 kHz	-3 dB attenuation
Minimum ON or OFF time	0.005 ms[1]	Internal complex mode : 2 ms
Maximum ON or OFF time	100 s[1]	Internal complex mode : 5 h
Maximum number of pulses per sequence	16.68 millions[1]	Internal complex mode : 65 535
Maximum number of sequences	4.2 billions[1]	Internal complex mode : 65 535
Minimum step increments	39 µsec[1]	Internal complex mode only
Number of steps per period	128[1]	Internal complex mode only

Table 5.3: *Recommended Environmental Specifications*

Specification	Operation	Storage
Use	Indoor	Indoor
Temperature	20 °C to 30 °C	-20 °C to 60 °C
Humidity	40 - 60 % R.H., non condensing	40 - 60 % R.H., non condensing

[1] For all operation modes, except the internal complex mode

6

Support

6.1 Maintenance

The product does not require any maintenance. Do not open the enclosure. Contact Doric Lenses for return instructions if the unit does not work properly and needs to be repaired.

6.2 Warranty

This product is under warranty for a period of 12 months. Contact Doric Lenses for return instructions. This warranty will not be applicable if the unit is damaged or needs to be repaired as a result of improper use or operation outside the conditions stated in this manual. For more information, see our Website.

6.3 Disposition

Figure 6.1: *WEEE directive logo*

According with the directive 2012/19/EU of the European Parliament and the Council of the European Union regarding Waste Electrical and Electronic Equipment (WEEE), when the product will reach its end-of-life phase, it must not be disposed with regular waste. Make sure to dispose of it with regards of your local regulations. For more information about how and where to dispose of the product, please contact Doric Lenses.

6.4 Contact us

For any questions or comments, do not hesitate to contact us by:

Phone 1-418-877-5600

Email sales@doriclenses.com

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