EDINBURGH INSTRUMENTS

AGILE Picosecond Pulsed Light Source

User Guide

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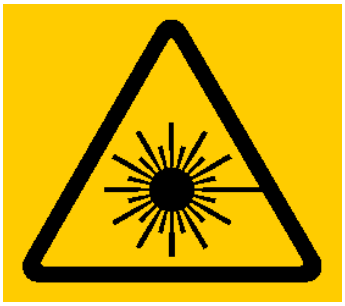
The product described in this manual is subject to continuous development and, while every effort has been taken to make sure that the information given is correct, Edinburgh Instruments Limited cannot accept any liability for errors and omissions or their consequences.

1. Laser Safety

The laser radiation emitted by AGILE picosecond pulsed light source is hazardous. The user must obey the following safety instructions:

Warning !
Never look directly into the laser beam, avoid direct exposure and exposure through reflections.



1. This product is classified as a Class 4 Laser product (IEC 60825-1:2014)

2. The radiation emitted by this laser can be either collimated (laser beam) or focussed, and is both visible and invisible. The maximum average optical power is 500 mW.

3. Laser radiation is emitted whenever the red **EMISSION** LED indicator is lit. The laser output aperture is indicated by the **Laser Aperture** label.

4. Mount the laser into an optical setup in such a way that the laser radiation emitted can not cause any hazard. Provide appropriate beam stops.

5. The laser can be remote interlocked. Follow the instructions given in section 3, Installation, for connections.

2. Introduction

AGILE is a wavelength-tuneable, high brightness light source providing picosecond pulses with variable kHz to MHz repetition rates.

The technology behind AGILE is based on supercontinuum generation with Edinburgh Instruments' proprietary high power picosecond pump laser at its core.

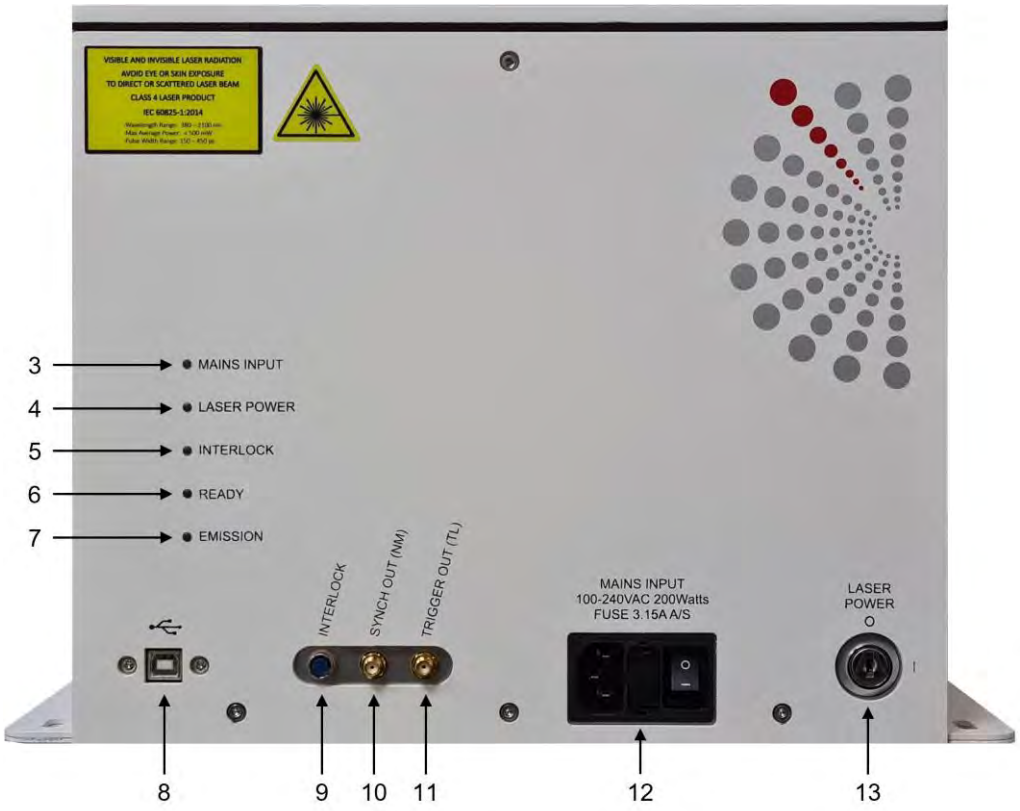
AGILE features a broadband spectral output from < 400 nm to > 2000 nm and pulse repetition rates from 10 kHz to 1 MHz, making it the ideal light source for the majority of fluorescence lifetime applications. Using the Time-Correlated Single Photon Counting (TCSPC) technique, fluorescence lifetimes from a few picoseconds to microseconds can be accurately resolved.

Coupling AGILE to a monochromator provides continuous wavelength tuning across the visible and near-infrared spectrum with output power and temporal profile comparable to individual, single wavelength, picosecond pulsed diode lasers.

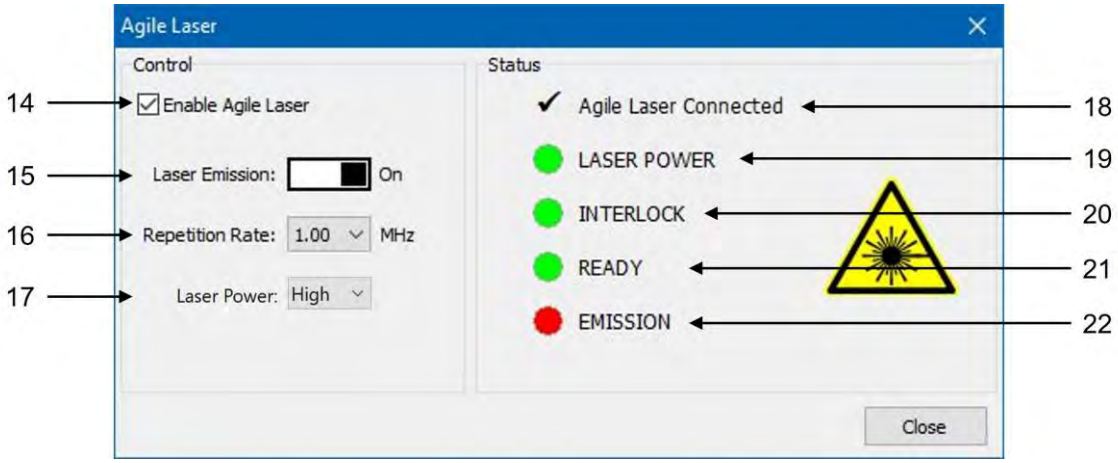
The output of AGILE can be configured as a collimated beam for free-space applications or focused with F-number matching to the Edinburgh Instruments FLS1000 Photoluminescence Spectrometer. When operated as part of the FLS1000, AGILE is fully computer controlled by the spectrometer operating software Fluoracle.

Laser aperture and Adjustment Hatch cover

Real panel of AGILE



Software control panel of AGILE



Indicators: Rear Panel

MAINS INPUT (3)
Indicator that illuminates GREEN when a mains voltage is connected to the unit and the mains input switch is turned on.

LASER POWER (4)
Indicator that illuminates GREEN when the laser power key switch is turned to the **ON** position and the **MAINS INPUT** condition is active.

INTERLOCK (5)
Indicator that illuminates GREEN when all interlock loops are closed and the **MAINS INPUT** condition is active.

READY (6)
Indicator that illuminates GREEN when the laser temperature control is stable and the laser is ready to operate in measurement conditions via the software control programme.

EMISSION (7)
Indicator that illuminates RED when the laser is operational and laser radiation is being emitted. Laser radiation is emitted when **MAINS INPUT**, **LASER POWER**, **INTERLOCK**, and **READY** are active and the laser has been turned on using the 'Laser Emission' button via the operating software.

Indicators: Software Control Panel

Agile Laser Connected (18)
A check/tick will indicate that the AGILE laser unit is connected to the PC via a USB cable and that the unit is **Enabled** within the software control.

LASER POWER (19)
Indicator that illuminates GREEN when the laser power key switch is turned to the **ON** position, the **MAINS INPUT** condition is active, and the unit is **Enabled** within the software control.

INTERLOCK (20)
Indicator that illuminates GREEN when all interlock loops are closed, the **MAINS INPUT** condition is active, and the unit is **Enabled** within the software control.

READY (21)
Indicator that illuminates GREEN when the laser temperature control is stable and the laser is ready to operate in measurement conditions.

The laser temperature control will activate when the laser power key switch is turned to the **ON** position and the unit is **Enabled** within the software control.

EMISSION (22)
Indicator that illuminates RED when the laser is operational and laser radiation is being emitted. Laser radiation is emitted when **LASER POWER**, **INTERLOCK**, and **READY** are active and the laser has been turned on using the 'Laser Emission' button via the operating software.

Controls and Connectors: Rear Panel

USB (8)

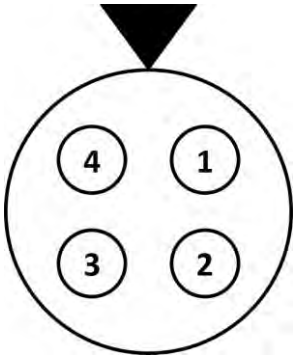
A USB type 2.0 connector is required to link the AGILE unit with the operating software via a suitable PC.

INTERLOCK (9)

Hirose connector that can be used to externally interlock the laser. There are two interlock operations, **Unlatched interlock** (Hirose connector pin 1) and also **Latched interlock** (Hirose connector pin 2). Both interlocks are deemed OK or active when their respective pins are connected to ground (Hirose connector pin 3). The **Unlatched interlock** (pin 1) can be connected to a system or monochromator sample chamber. The **Latched interlock** (pin 2) is for room door access. The laser will switch off if either interlock line is broken and will not switch on again once reconnected. To resume emission switch on the laser via the LASER ON/OFF button within the operating software.

Connector Hirose
HR10-7P-4P(73)

Pin 1:- INTERLOCK Unlatched
Pin 2:- INTERLOCK Latched
Pin 3:- Ground
Pin 4:- *not in use*



Back of HR10-7P-4P(73) connector

SYNCH OUTPUT (10)

Low jitter trigger output (NIM standard). The trigger is active when the laser is **ON**. Connection is via an SMA connector.

TRIGGER OUTPUT (11)

Low jitter trigger output (TTL standard). The trigger is active when the laser is **ON**. Connection is via an SMA connector.

The TTL of the **TRIGGER OUTOUT** occurs ~300 ns before the NIM of the **SYNCH OUTPUT** for use with MCS measurements.

MAINS INPUT (12)

Universal mains plug cable to connect power to the laser. The input voltage requirement is 100-240 V AC, 200 Watts.

LASER POWER (13)

Key switch that controls the laser supply voltage. The key can only be removed when the switch is in the **OFF** position.

Controls and Connectors: Software Control Panel

Enable AGILE Laser (14)

Check box to enable the laser to be controlled via the software control panel.

Laser Emission (15)

Button which activates and deactivates the laser emission when the unit is ready to operate in measurement conditions.

Repetition Rate (16)

Drop down menu to select the required repetition rate of the emitted optical pulses. The units for the repetition rate are in MHz.

Laser Power (17)

Drop Down menu to select the required power of the emitted laser. See section 4, Operation, for the laser power at each setting.

3. Installation

Install AGILE in a place suitable for operation of lasers. AGILE is intended for laboratory use. See **Appendix A** for AGILE dimensions. If the unit has been stored in an environment outside of the operational temperature, please allow one hour for the unit to reach laboratory temperature before powering the unit. This is especially important when unpacking AGILE after shipping by Air Freight.

AGILE, when fitted to an Edinburgh Instruments FLS1000 spectrometer, should be secured to the system using the through holes at the **Laser Aperture (1)** of the unit and the M3 tapped holes at Port A of the excitation monochromator.

The through holes of AGILE can be accessed by removing the **Adjustment Hatch (2)**.

To meet the laser safety regulations AGILE needs to be remote interlocked, e.g. by a door switch or to a suitable cover to the radiation path. Use a cable that is connected to the **INTERLOCK** input connector of AGILE. The interlock is healthy if both pin 1 and pin 2 of the connector are shortened to ground (pin 3). A breakage of these links will cause an interlock failure.

Connect the 240 V supply to the **POWER** input of the laser, a USB 2 to USB 1 cable between the operating PC and the USB port of AGILE, and, depending on the required measurements to be made, an SMA cable from the **SYNCH OUTPUT**, for TCSPC measurements, or the **TRIGER OUTPUT**, for MSC measurements, to the corresponding input connector on the TTC2.

4. Alignment

WARNING: ALIGNMENT OF THE AGILE OUTPUT BEAM SHOULD ONLY BE PERFORMED WHEN THE POWER LEVEL IS SET TO 'ALIGNMENT MODE' (SEE SECTION 4, OPERATION, FOR DETAILS ON HOW TO CHANGE THE OUTPUT POWER LEVEL).

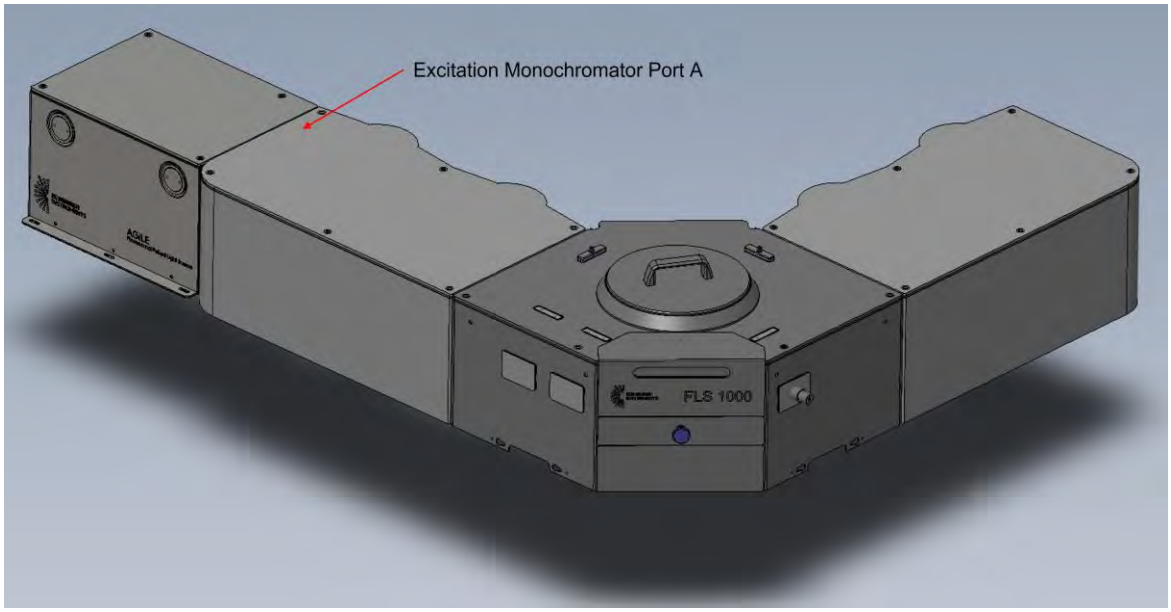
FULL LASER SAFETY PRECUSIONS MUST BE TAKEN AT ALL TIMES WHILE ALIGNNMENT OCCURS AND WHEN THE BEAM IS EXPOSED.

ALIGNMENT OF THE AGILE OUTPUT BEAM THROUGH AN FLS MONOCHROMATOR SHOULD ONLY BE PERFORMED BY AN EDINBURGH INSTRUMENTS ENGINEER.

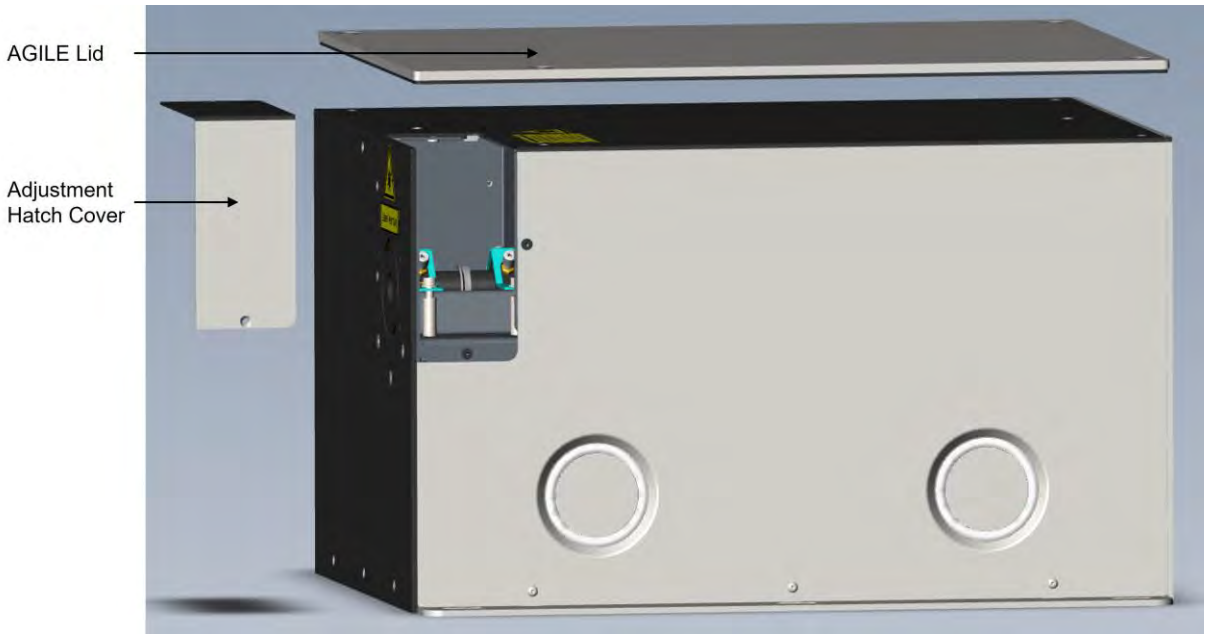
BEFORE APPLYING FULL POWER ENSURE THAT THE ALIGNMENT HATCH IS FULLY COVERED AND THE LASER BEAM PRESENTS NO HAZARD, E.G. BY DIRECT EXPOSURE, REFLECTION, OR STRONG SCATTERING.

For alignment into an Edinburgh Instruments FLS1000 spectrometer, follow the procedure below:

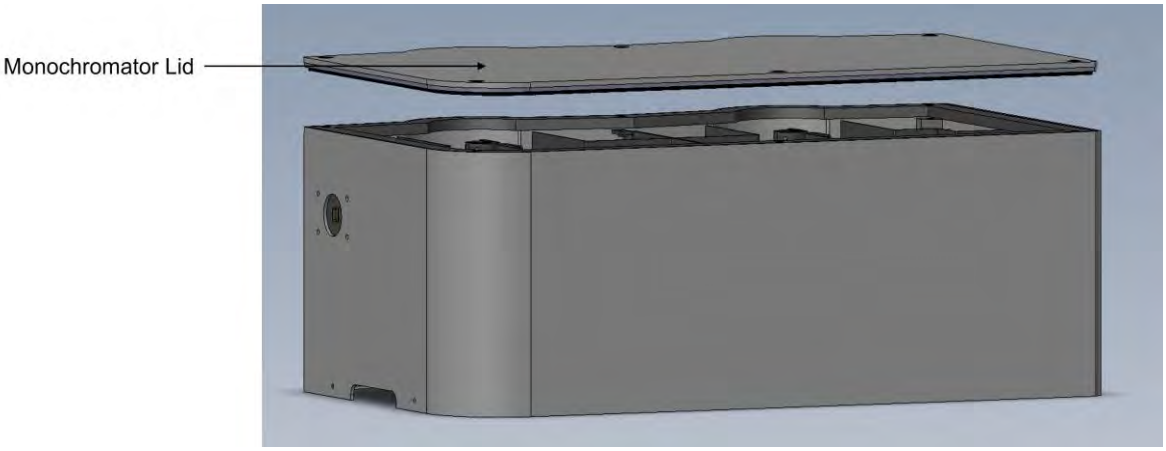
- Position AGILE at Port A of the excitation monochromator



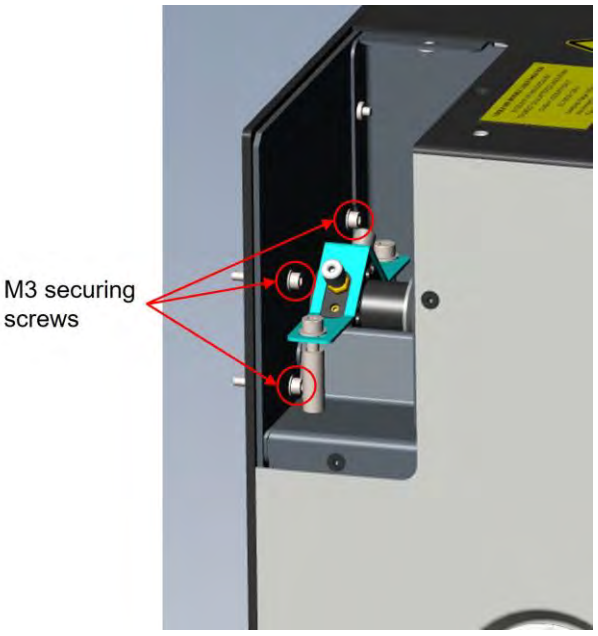
- Remove AGILE lid and Adjustment Hatch cover



- Remove the lid of the excitation monochromator

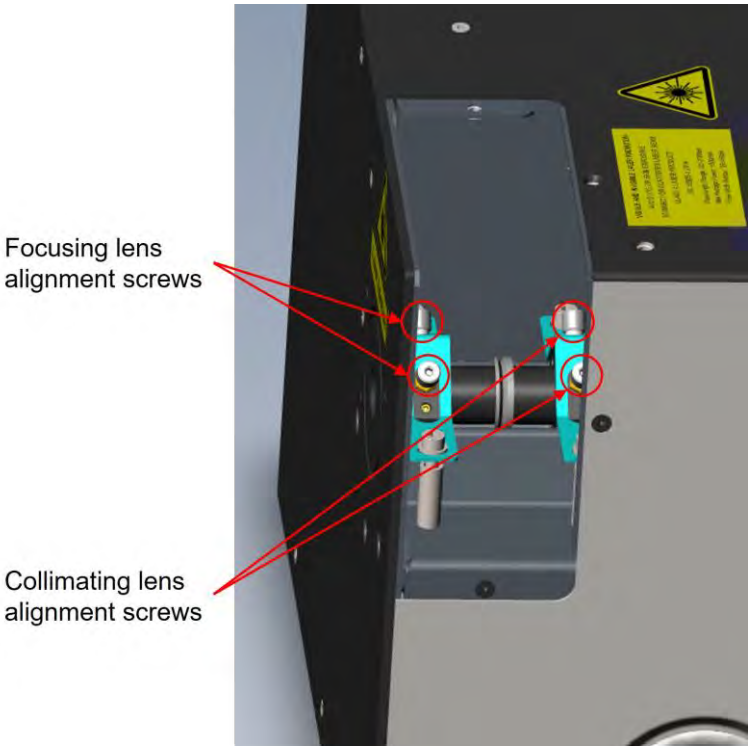


- Open the slits of the excitation monochromator to a narrow width
- Roughly position AGILE such that the output light, when in alignment mode, propagates through the centre of the slit opening
- Secure the system to the monochromator using M3 screws when in this position



- Open the slits of the excitation monochromator to a wide width

- Using the alignment screws of the collimating and focusing lenses, located within the adjustment hatch, finely alter the position of AGILE output beam to align this with the centre of the focussing mirror within the excitation monochromator



- Once the beam is aligned, secure the adjustment hatch cover and the AGILE lid back into position, as well as the excitation monochromator lid

5. Operation

1. Supply mains voltage to AGILE

Connect a universal mains cable to the mains supply and turn the **MAINS INPUT** switch **ON.**

2. Use the key to power up the laser

When the key is switched to the **ON** position, the **LASER POWER** indicator will illuminate green and the **INTERLOCK** indicator will also illuminate provided the interlocks are not interrupted.

3. Open the software control programme

If the intended use of AGILE is in conjunction with an Edinburgh Instruments FLS1000 system, open the Fluoracle software programme.

If the intended use of AGILE is independent of an Edinburgh Instruments system, open the AGILE stand-alone software programme.

If using the Fluoracle software programme, within the **Setup** menu, select the **AGILE Supercontinuum** in order to open the software control panel.

For both the Fluoracle and stand-alone software, if it is not already, ensure the **Enable Agile Laser** check box is ticked.

At this point the status indicator on the software control panel will show the Agile Laser as being Connected. Additionally, if the key switch is **ON** and the interlocks are not interrupted, the **LASER POWER** and **INTERLOCK** indicators will illuminate green.

Also at this point, if the **LASER POWER** is **ON**, the TEC control within the laser will start operating to bring the internal components to operating temperature. During this time a loading icon will appear on the screen. Once the laser has reached optimal temperature the **READY** indicator will illuminate green on both the software control panel and on the back panel of the unit.

AGILE is then ready for full operation under measurement conditions.

4. Set the desired repetition rate and power level

Using the drop down menu select the desired repetition rate (in MHz) required for the measurement being carried out; 1.00, 0.50, 0.20, 0.10, 0.05, 0.02, 0.01.

Using the drop down menu select the desired power level, depending on the required energy. There are three power levels which can be selected;

Full	100% laser power
Low	<60% laser power
Align	<30% laser power

5. Start the laser operation

Turn on the laser using the **Laser Emission** button on the software control panel. The laser is now operating, indicated by the red **EMISSION** indicator light and laser warning symbol.

Trigger pulses are sent to the Synch and trigger output connectors only for the duration of the lasing operation.

6. Change the repetition rate and/or power level

The repetition rate and laser power of AGILE can be changed during operation without the need to switch off and restart operation of the laser. Simply select the desired repetition rate or laser power from the drop down menus.

7. End the laser operation

The laser operation will stop by either pressing the **Laser Emission** button on the software control panel again, or by an interlock failure.

If the laser operation was stopped by an interlock failure, the cause for the failure needs to be rectified before the laser can be restarted. To begin laser emission again the **Laser Emission** button will have to be pressed.

Note: The useful operational life of AGILE can be extended by not leaving the laser in the **EMISSION** state unnecessarily for long periods. This is especially important at high repetition rates.

6. Maintenance

AGILE does not require any special maintenance as long as the unit is operated and stored under specified laboratory conditions.

There are no user serviceable parts on AGILE. Any attempt to open the unit will void warranty and will most likely result either in destruction of the laser or will cause detrimental effects to the laser.

Edinburgh instruments offers a laser refurbishment service, please contact EI laser service for details.

7. Technical Specification

Wavelength Range	**[nm]**	< 400 … > 2000
Repetition Rate		MHz: 1 kHz: 500, 200, 100, 50, 20, 10

Wavelength Range	**[nm]**	400-500	500-600	600-700	700-800	800-900	900-1000
Average Output Power @ 1MHz / 10 nm Bandpass *	**[mW]**	0.51	0.39	0.30	0.27	0.17	0.11
Typical Pulse Width	**[ps]**	350	250	200	200	200	200

Total Power Stability	< 2%**
Polarisation	Unpolarised
Beam Output	Focussed for application with FLS1000 Collimated for free space application
Computer Interface	USB 2.0
Synch Output	NIM
Trigger Output	TTL
Interlock Input	Hirose HR10-7R-4S (73)
Key Switch	Yes
Cooling	Yes, actively controlled
Operating Temperature	+15°C to +30°C
Software Control	Fluoracle Stand-alone
Power	90 – 240 VAC, 1A, 50 / 60 Hz
Dimensions	410 mm (L) x 305 mm (W) x 245 mm(H)
Weight	14 kg (approx)

8. Warranty

1 a) The Company guarantees the equipment forming the subject of the contract/quotation against defective materials and workmanship for a period of one year from the date of delivery to the Purchaser.
   b) In the case of sub-assemblies of equipment not manufactured by the Company, but incorporated in the equipment ordered, the Purchaser will be entitled only to the benefit and/or limitations of any guarantee given by the makers of such assemblies.
   c) In no event shall the Company be liable for any consequential loss or damage arising from failure of the equipment under warranty.
   d) At the end of the one year period referred to herein, all claims upon all liability of the Company shall be absolutely at an end.

2 a) The Company also warrants that the equipment conforms to specifications contained in current brochures or to extra specifications confirmed in writing at the time of order acknowledgement.
   b) No warranty is made or implied as to the suitability of any equipment for the Purchaser's intended use beyond such performance specifications as form part of the contract.

3. The purchaser warrants:
   a) That he will carefully examine and list all parts of the equipment supplied by the Company and notify the Company in writing of any shortage, defect or failure to comply with the contract, which is or ought to be apparent upon such examination and test, within 48 hours of the equipment being delivered to or collected by the Purchaser.
   b) The equipment will be operated in accordance with the instructions and advice detailed in the appropriate operating instructions manual, or any other instructions which may be provided by the Company. The Company shall not be held responsible for any defect arising from the Purchaser's failure to comply with these recommendations and instructions or from damage arising from negligence or exposure to adverse environmental conditions.

4. The warranty is effective when:
   a) Any defects in the equipment supplied are notified immediately by the Purchaser to the Company.
   b) The equipment is returned to the Company at its Edinburgh premises, transportation and insurance prepaid, and undamaged by the failure to provide sufficient packaging.
   c) The Purchaser has made payment in full for the contract in accordance with the Company's normal trading terms, i.e. 30 days from date of invoice.

5. The warranty covers:
   a) Engineer's time costs during inspection and repair.
   b) Any materials or components, which require to be replaced.
   c) Return carriage costs to the Purchaser

6. However, if the Purchaser requests a service engineer to carry out the necessary inspection and repair of the equipment covered by the warranty on site, the Purchaser will be liable, at the Company's discretion, for:
   a) Engineer's travelling time costs.
   b) Engineer's travelling and accommodation expenses.

The timing of the inspection and repair of the equipment will be determined entirely at the discretion of the Company.

9. Declaration of Conformity

CE

Manufactured by: Edinburgh Instruments Ltd.
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Livingston
EH54 7DQ
Tel.: + 44 1506 425 300
Fax.: + 44 1506 425 320

AGILE picosecond pulsed light source units have been CE marked to indicate compliance with all essential requirements of the Directives referenced.

AGILE picosecond pulsed light source units are intended for use in commercial and light industrial environments and the following standards have therefore been applied:

BS EN 61000-6-1:2007	EMC immunity for residential, commercial and light-industrial environments
BS EN 61000-6-3+A1:2011	EMC emission standard for residential, commercial and light-industrial environments
BS EN 61010-1:2010	Safety requirements for electrical equipment for measurement, control and laboratory use
BS EN 60825-1:2014	Safety of laser products. Equipment classification and requirements

10. Document History

ISSUE	DATE	ECN
1.0	August 2021	Original
1.1	August 2022	Addition of section 4. Alignment

11. Appendix A

AGILE dimensional drawing. All units are in mm.