Asynt
By chemists, for chemists

Borealis Flow™ User Manual

High power LED Photoreactor for Continuous Flow Chemistry

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1. SAFETY:

1.1 General Safety Considerations

PLEASE READ THE USER MANUAL BEFORE USING THIS INSTRUMENT

The Asynt Borealis™ is designed to work under ambient temperature conditions in a properly ventilated environment only. The high intensity LEDS must be connected to a flowing cold water supply (or similar) to dissipate the heat generated at the back plates of the high powered LED arrays.
Failure to do so will INVALIDATE the product warranty.
The unit is fitted with safety interlock switches which immediately disable the LEDs should any attempt be made to remove the light hood from its reactor base when operating.
The Borealis has been designed to prevent light leakage when in operation and therefore does not need to be used within a light-tight or tinted glass enclosure.

The Borealis should only be operated by technically competent users wearing suitable personal protective equipment.

CAUTION! Risk of electric shock and death. The power supply casework and the LED lamp units within the light hood should NOT be opened under any circumstances. This is a high voltage product which uses 180V DC; sufficient to cause cardiac arrest. Any maintenance issues MUST be referred to Asynt Ltd in the first instance.

CAUTION! High intensity light source. The Borealis is fitted with high intensity LEDs and NO attempt should be made to look at the light source when in operation.

CAUTION! High intensity UV light. Some versions of the Borealis are fitted with high intensity UV LEDs. Any attempt to view high intensity UV LEDs in operation, even for short exposure periods, can lead to skin and tissue damage which may be irreversible.

2. INTRODUCTION

The Asynt Borealis has been designed to provide scientists with a high power LED light source for continuous flow applications.
LED lamp units may be specified fitted with either with warm white (3000K), 525nm (green), 465nm (blue), 440nm (royal blue), 425nm (purple), 385nm (UV) and 365nm (UVA) as standard (please enquire if you specifically require an alternative wavelength). The LED lamp modules are fitted with a safety interlock to ensure that the LEDs can only be powered when the lamp unit is correctly inserted inside the matching coil reactor module.

The LED array is fitted with an internal temperature sensor that is monitored b the Borealis power supply module. T prolong the life of the LEDs, the power unit will automatically switch the LEDs off if the back junction temperature exceeds 50°C. In addition, the LED modules are automatically identified when connected to the power unit and the available wavelength is displayed on the control screen. The high power rating of th Borealis LED lamp modules requires *liqui cooling* to prevent the LEDs from overheating.

Fig. Borealis X-ray View

Borealis LED lamp modules are designed to be inserted into Borealis Coil Reactors. The lamp units have locating lugs to ensure that they are always installed in the same way. Once the locating lugs are engaged, the interlock is deactivated.
The coil reactors are wound *internally* with FEP tubing (for optimal transparency down to low wavelengths). An internal temperature sensor is fitted to the coil reactor, close to the reactor tubing. This connects to the rear of the power supply and provides a direct readout of the *reactor* temperature on the control display.

Fig. Borealis Coil Reactor

Borealis Coil Reactors are designed to locate within the Cold Coil MkII. Again, a locating pin ensures that they are always positioned in the same way. The clamping mechanism on the Cold Coil MkII allows the mandrel to be expanded in order to easily fit the coil reactor. It can then be tightened to clamp the coil reactor, thus ensuring optimal thermal contact.

The temperature of the Cold Coil – and thereby that of the coil reactor – is controlled by connection to a suitable external recirculator. The Borealis LED lamp unit can be cooled independently by connection to a cold water supply or alternatively, if the desired reactor temperature is within the range 15° – 40°C, by connection in series with the Cold Coil. The

ability to control the reactor temperature independently from the temperature of the LED lamp unit means that the reactor temperature limits are dictated by the power of the recirculator.

Whereas, the Huber Piccolo (solid state) heat exchanger is a compact affordable and convenient choice for temperatures in the range 10° – 70°C, a MiniStat or MiniChiller would be required for lower reaction temperatures.

Since the reactor temperature is controlled by a recirculator, ideally using an external temperature probe inserted through the base of the Cold Coil, then any recirculator can in fact be used with the Borealis Flow photoreactor system.

Note: The reactor temperature displayed on the power supply control screen is the observed temperature i.e. the power supply does not control the reactor temperature.

Fig. 2: Huber Piccolo Peltier Heat Exchanger

3. ASSEMBLING THE BOREALIS PHOTOREACTOR SYSTEM:

1. Insert a suitable Borealis Coil Reactor into the Cold Coil Mk2. Ensure that the locating pin engages with the corresponding hole (located at the hinge) in the top of the Cold Coil.
2. Fit the desired Borealis LED lamp module inside the coil reactor and rotate it until both locating studs engage into the corresponding recesses ontop of the coil reactor. (Take care not the trap the inlet/outlet tubing and the wire for the temperature sensor.) When correctly in position you may hear the interlock 'click' to signify that it is deactivated.
3. Connect the recirculator to the Cold Coil MkII and either connect the Borealis LED lamp unit to a cold water supply, or connect it in series with the recirculator (for desired reactor temperatures in the range 15°-40°C only). (Although not essential, an external process probe may be used to control the recirculator. This should be inserted through the hole in the underside of the Cold Coil MkII.
4. Connect the Borealis multi-pin connector to the Borealis power supply (twist the connector

Fig. 3: Borealis Assembly Schematic

plug until the pins align with the socket in the back of the power supply, then push in and twist the outer retaining ring to lock the connector in place).

5. Connect the Borealis temperature sensor (yellow plug) to the rear of the Borealis power supply.
6. Connect the Borealis coil reactor inlet /outlet to a suitable pump/reagent delivery system and back pressure regulator, if required. Asynt recommend the use of the following pumps:

Part No.	Description
UQ1022T	Binary Pump Module™ (BPM), PTFE flow path, 2 x 10ml/min, Pmax=40bar
UQ1062	HPLC Pump 4.1S (CPG20EB50) with pressure transducer, 0.05-10 ml/min
UQ-1068	Dosing Pump, PTFE, diaphragm, 0.05-30ml/min
UQ-1069	Dosing Pump, PTFE, diaphragm, 0.05-30ml/min, RS232

7. Connect the power supply to the mains (110V or 220V AC; 50/60Hz) and switch the mains supply 'on'.
8. Remember to start the coolant supply to the light hood flowing before powering 'On' the Borealis LED lamp. Check for any leaks! The power supply has a mains ON/ OFF rocker switch located to the rear of the unit.

An example 120W system configuration suitable for performing reactions at ambient temperature is shown below.

Fig. 4: Example Borealis Continuous Flow Photoreactor System

4. OPERATING THE BOREALIS LED LAMP

Borealis LED lamps are available in either 120W or 180W versions. The former have 120x individual high-power LEDs and are compatible with the 120W Borealis Scholar variable analogue power supply unit (PSU). 180W versions have 180x LEDs and are only compatible with the larger Borealis Digitial PSU.
The lamps are not interchangeable and have connecting plugs that are compatible only with the correct PSU.
Both power supplies are constant current devices.

Fig. 120x LED Borealis SCHOLAR LED lamp

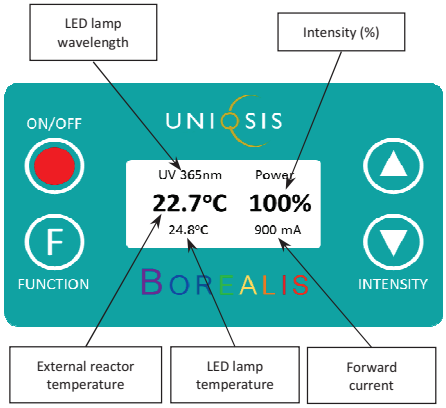
Fig. 180x LED Borealis LED lamp

4.1 DIGITAL PSU FOR 180W HP BOREALIS LED LAMPS

The LED display on the control panel of the power supply shows the following information:

a. The wavelength of the selected LED lamp.
b. The coil reactor temperature.
c. The power level selected (INTENSITY)
d. The current being supplied to the Borealis LED lamp module (mA).
e. LED lamp temperature (back-plate).

Note: in addition, operating information and error descriptions are inserted as text. The display will change colour to red if the interlock is disengaged.



1. The 'FUNCTION' button can be used to view and/or change the IP address of the module. Alternatively, set the IP address to 0.0.0.0 to switch to DHCP.
2. Press the RED on/off button to switch the LED array 'ON' or 'OFF'. The LED array will be powered at 10% intensity by default.
3. Press the <↑> or <↓> arrows to adjust the power level.

The coil reactor temperature is measured by a thermocouple embedded in the coil reactor positioned as close as possible to the FEP tubing. This should be plugged into the rear of the PSU.
The forward current is adjusted automatically to maintain constant output current.

There are ethernet (RJ45), Serial (RS232) and USB ports fitted to the back of the power supply that can be used for remote control or system integration (command protocols are available from Uniqsis on request

Fig. 180W Borealis LED lamp with DIGITAL PSU

4.2 SCHOLAR VARIO PSU FOR 120W BOREALIS LED LAMPS

The 120W Scholar Vario PSU is more compact than the 180W digital PSU. Intensity can be varied manually in 20% increments using a rotary control knob. The Scholar Vario PSU is designed for standalone use and does not have external communication ports. It is simpler and more cost-effective than the larger digital PSU. It is fitted with over-current protection.

Fig. 120W Borealis LED lamp with SCHOLAR PSU

Depending upon the wavelength and intensity setting of the Borealis light unit, in practise the reactor temperature is typically 5°-8°C higher than the internal setpoint temperature of the recirculator. The LED (back junction) temperature will be approximately 5°-10°C higher than the reactor temperature.

5. ERROR CONDITIONS & SAFETY FEATURES

5.1 DIGITAL PSU

1. ‘Missing Thermocouple’ Thermocouple is either missing or faulty (open circuit).

2. ‘Performing Internal Test’ When the Borealis digital power supply is switched ‘on’, an internal safety test is performed to check the operation of the relays that control the power supply to the two LED arrays.
3. ‘Safety Test Passed’ A message will appear briefly at the bottom of the screen if this is completed successfully.
4. ‘Interlock’ RED screen. If an attempt is made to remove the LED lamp from the reactor when operating, or the lamp unit is not located correctly inside the coil reactor, the interlock microswitches will immediately disable the power supply to the LEDs to prevent light leakage. Only 0.5-1.0 mm of movement is sufficient to trigger this safety response.
5. If the LED lamp is replaced within 1 second, then the lamps will remain ‘off’ for 5 seconds but then restart at the last defined power level.
6. If the LED lamp is removed for more than approx 5 seconds, then the display screen will turn red and an error message will be displayed. This will then reset after 5 seconds but the lamps will remain ‘off’ until the <ON/OFF> button is depressed. The lamps will then be powered at the last defined power level.
7. If insufficient cooling is applied to the LED arrays and their temperature exceeds 50°C, the LEDS will automatically be switched ‘off’ by the power supply and cannot be restarted until the PCB temperatures have fallen below the permitted maximum level. An error message will be displayed, accordingly.
8. Large fluctuations or unstable forward current readings may indicate a fault with the Borealis LED lamp unit

5.2 SCHOLAR VARIO PSU

1. If an attempt is made to remove the LED lamp from the reactor when operating, or the lamp unit is not located correctly inside the coil reactor, the interlock microswitches will immediately disable the power supply to the LEDs to prevent light leakage. Only 0.5-1.0 mm of movement is sufficient to trigger this safety response.
2. If the LEDs become too, a thermal cutout in the Borealis LED lamp will cut power to the LEDs until the lamp unit has cooled to below approximately 35°C.

Please Note: The green LED on the front of the PSU indicates that the PSU is powered and not that the LEDs are necessarily illuminated.

6. SPECIFICATION

Part No.	Description
UQ8209	Borealis™ LED Lamp Unit, WARM WHITE (3000K)
UQ8200	Borealis™ LED Lamp Unit, GREEN (525nm)
UQ8201	Borealis™ LED Lamp Unit, BLUE (465nm)
UQ8202	Borealis™ LED Lamp Unit, ROYAL BLUE (440nm)
UQ8203	Borealis™ LED Lamp Unit, PURPLE (425nm)
UQ8204	Borealis™ LED Lamp Unit, UV (365nm)
UQ8205	Borealis™ Coil Reactor, 1/16" OD FEP, 15ml, complete with temperature sensor
UQ8206	Borealis™ Programmable Power Supply, 300W; 230/110V

UQ1050-M2 Cold Coil™ MkII standalone coil reactor module (requires separate recirculating chiller)

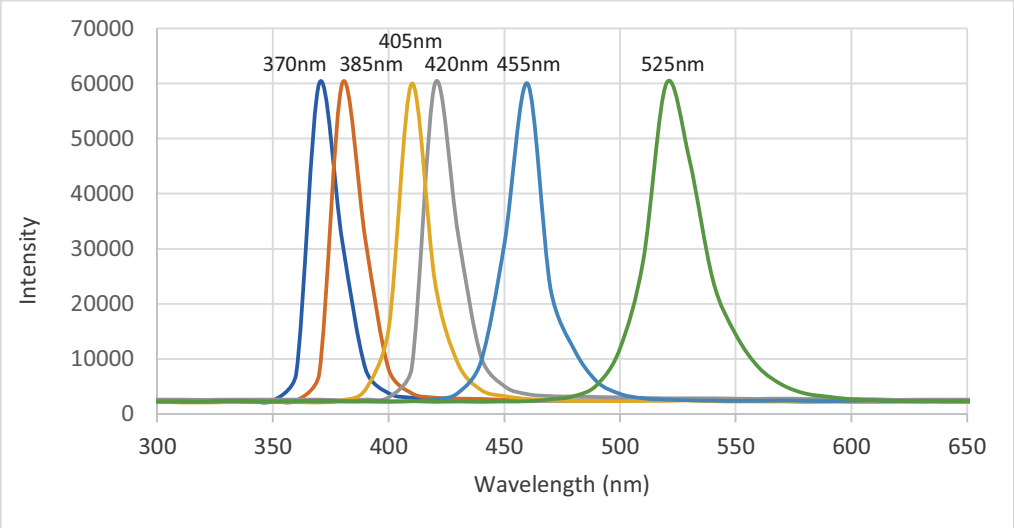
UQ8207 Piccolo™ Solid State Temperature Control Module, 4-70C; 230/110V

6.1 Power Supply

Width x Depth x Height	190 mm x 460 mm x 140 mm
Weight	7.3 kg

6.2 Borealis LED Lamp Assembly

Diameter x Height	150 mm x 190 mm
Weight	1.5 kg



6.3 Borealis Power Supply Specification

100-240V, 50-60Hz, <2.0A

Mains supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage.

6.4 Electrical Supply

The device is intended for use with AC power networks of 110–230 VAC and 50-60Hz.

Check that the supply voltage marked on the serial number label, and the type of mains plug, are correct for your mains supply outlet, which must have a ground connector.

6.5 Conditions of Use

Operating environment:	Indoor use only
Pollution degree:	2
Installation category:	II
Temperature	5 to 40°C
Maximum relative humidity	80 % r.h. in room temperatures up to 31°C decreasing linearly to 50 % r.h. at 40 °C
Altitude	Up to 6,500 feet (2,000 m) above sea level
Operating Environment:	Indoor use only

The unit should be protected from exposure to direct sunlight.

7. WARRANTY

The Borealis photoreactor is covered by a warranty for 12 months from the date of

delivery. **The warranty does not include:**

Accidental or wilful damage
Fair wear and tear
Damage caused by incompatible solvents or substrates
Damage specifically caused inadequate cooling of the LEDs
Blockages caused by precipitation in the reactor tubing
Blockages attributable to build up of residue in the cooling channels associated with a contaminated coolant liquid or water supply
Use outside of the parameters of the conditions of use (see conditions of use e.g. allowing LEDs to overheat)

Warranty includes:

Protection against faulty materials or workmanship
Shipment costs if unit is required to return to base for repair

All warranty claims shall be invalid if any unauthorised changes are made to the unit or any attempt is made to open the power supply or LED lamp array casework.

8. CLEANING & CARE

Risk of electrical shock or short circuit if cleaning solutions enter the inside of the Borealis power supply. Do not over-moisten the cleaning cloth.All external surfaces of the instrument can be cleaned using a cloth moistened either with a dilute aqueous soap solution or isopropanol.

Corrosive reagents and solvents should not be left in contact with any painted or anodised external surfaces for extended periods of time.

9. SERVICE & SUPPORT

For service and support please contact us via the details below:

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+44 (0)1638 781709