



Solstice™ User Manual

Compact, high power, multi-position LED photoreactor



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1. SAFETY:

1.1 General Safety Considerations



PLEASE READ THE USER MANUAL BEFORE USING THIS INSTRUMENT



The Asynt **Solstice™** is designed to work with the **Borealis™** LED lamp unit under ambient temperature conditions in a properly ventilated environment and requires a flowing cold water supply or other suitable heat exchanger/recirculator to dissipate the heat generated at the back plates of the high powered LED arrays.

The unit is fitted with a safety interlock switch which immediately disables the LEDs should any attempt be made to remove the light hood from its reactor base when operating.

The **Solstice/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 **Solstice/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 low current, high voltage product which uses up to 200V DC; sufficient to cause cardiac arrest. Any maintenance issues MUST be referred to Asynt Ltd in the first instance.



CAUTION! High intensity light source. **Borealis** LED lamp units are 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 lamp units** 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

2.1 Solstice™ Multi-tube Photoreactor:

The Asynt [Solstice](#) is a jacketed, multi-position tube holder for 13mm OD, septum-sealed reactor tubes. It is designed to fit onto a standard (135mm diameter top plate) laboratory magnetic stirrer such that when equipped with suitable (8mm rare earth) PTFE stirbars, the contents of each tube may be efficiently stirred. The reactor tubes are held in close contact with the external cooling/heating jacket by a series of spring-clips.

Reaction solutions may be maintained at a fixed temperature by connecting the [Solstice](#) to a recirculating liquid coolant. Although a piped water supply can be utilised, more precise temperature control can be achieved by connection to a recirculating heat exchanger. The temperature range achieved is ultimately determined by the power of the recirculator. However, for photochemical reactions in the range 10°C – 60°C, Asynt recommends the use of the Huber Piccolo OLÉ 280. This is a compact and portable solid-state unit that employs a stacked Peltier heat exchanger.

By inserting a [Borealis](#) LED lamp of an appropriate wavelength into the centre of the [Solstice](#), the magnetic stirrer is adapted for use as a temperature controlled, multi-position photoreactor. As such, Borealis lamp units can be used for both batch and continuous flow applications ([Borealis Flow™](#) - please refer to the separate product brochure).

A wide range of [Borealis](#) lamp units are available as standard. Moreover, LED lamp units with customised wavelengths or combinations of wavelengths can be manufactured on request.

Available wavelengths are 365nm, 385nm, 425nm, 440nm, 460nm and 525nm.

2.2 Borealis™ LED Lamps:

These 180W [Borealis](#) LED lamp units have an embedded temperature sensor that measures the back-plate temperature of the LEDs and a memory chip that, when connected to the matching 'smart' power supply, ensures that the LED wavelength and electrical parameters are automatically detected and configured correctly.



Moreover, the power supply allows the LED intensity to be varied from 10-100% in 5% stages. The constant current supplied is shown on the integrated display. It is also able to read and display both the LED and reactor temperatures. The latter is achieved using a stainless steel temperature probe that is inserted directly into one of the reaction solutions.

Generally, Asynt recommend that one tube should be 'sacrificed' and filled with an inert liquid (e.g. 10% isopropanol water), however, a PTFE coated temperature probe can be provided where insertion into a corrosive reaction mixture is desirable.

The power supply has RS232, USB and ethernet connectivity that can be used to monitor or control the system remotely (command protocols are available, on request)..

2.3 Borealis™ Scholar LED Lamps:

A more cost-effective alternative to the 180W Borealis LED lamps is also available. The **Borealis Scholar™** LED lamps operate at 60W and have a simple standalone power supply. Again, 'standard' available wavelengths are 365nm, 385nm, 425nm, 440nm, 460nm and 525nm.

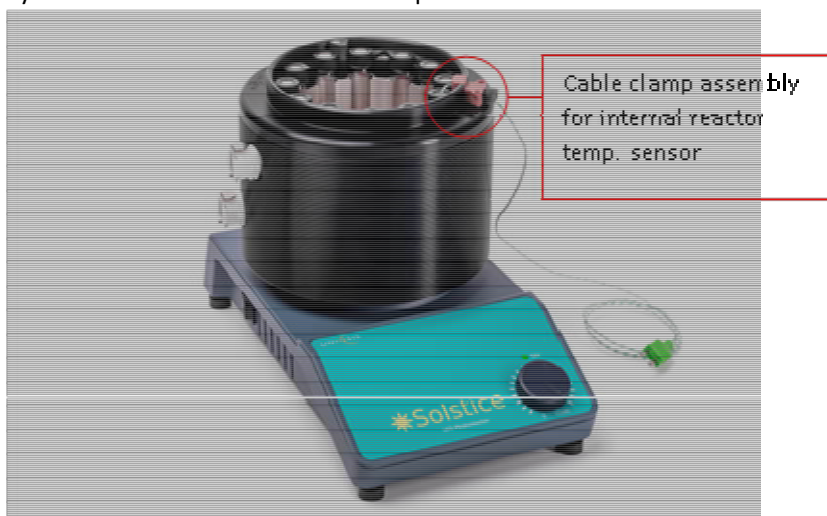
The **Scholar** is fitted with two sets of LEDs which are operated independently and are mounted in different positions on the lamp unit.

A lower set of LEDs provides optimal illumination when using the Solstice tube reactors. A central set of LEDs provides optimal illumination when fitted to the **Borealis Flow** continuous flow reactor system. A switch enables the most appropriate sets of LEDs to be selected.

Borealis Scholar LED lamps can be manufactured with two different LED colours, on request.

3. ASSEMBLING THE SOLSTICE PHOTOREACTOR SYSTEM:

1. Position the **Solstice** tube holder onto a suitable magnetic stirrer (the stirrer should have a top plate diameter of 135mm, e.g. IKA). Asynt offer a cost-effective **magnetic stirrer that has been modified to improve stirring efficiency**. The **Solstice** may be freely rotated into the most convenient position.



2. Insert the temperature probe assembly into a reactor tube filled with a sufficient quantity of an inert solution such that the tip of the stainless steel probe is immersed by at least 1cm (10-15% isopropanol-water is recommended) . The threaded glass reactor tubes are 13mm OD x 100mm high. Additional tubes and septa are available from Asynt.



A PTFE coated temperature probe is also available for applications that require the temperature probe to be inserted into a reaction solution. Locate the tube/ probe assembly into the **Solstice** and secure the cable with the clamp (the cable clamp both prevents light leakage and locates the Borealis lamp unit reproducibly in a fixed position).

3. The **Solstice** can either be loaded with septum-sealed tubes pre-filled with reagent solutions. Alternatively, the tubes can be filled *in situ*. The tubes are held securely in close contact with the external temperature controlled jacket surface with spring 'butterfly' clips.
4. Select a **Borealis** LED lamp with the desired wavelength and insert this into the Solstice. The lamp has a notch that locates with the temperature probe cable clamp. When correctly positioned the interlock safety switch on the underside of the lamp will 'click'.



5. Connect the **Borealis** multi-pin connector to the back of the power supply. Plug the temperature probe connector into to rear of the power supply. (When using the **Borealis Scholar** LED lamps, the temperature probe should be plugged into the external meter supplied to obtain a reactor temperature read-out) .



6. **Temperature Control:** In order to ensure that the LED lamp doesn't overheat (attributable to the high back-plate temperature of the LEDs), and to enable control of the reaction temperature, both the **Solstice** tube holder and the **Borealis** LED lamp **must** be connected to a circulating liquid coolant. When the required reaction temperature is close to room temperature, it is most convenient to connect the **Solstice** and the **Borealis** together in series to the same heat exchanger.

Reactions 15°C – 30°C: For reaction temperatures below 30°C, it is recommended that the coolant flows through **Solstice** first and then through the **Borealis** LED lamp prior to return to the recirculator.

Reactions 30°C – 40°C: Flow the coolant through the **Borealis** LED lamp first.

Typically, there will be a 2–3°C temperature difference between the reaction temperature and the LEDs at steady state. The recirculator will usually need to be set 5–10°C colder than the reaction temperature.

Ultimately, the range of reaction temperatures that may be achieved depends upon the power of the recirculator or heat exchanger employed.

In testing, Asynt have found that the Huber Piccolo works well for reactor temperatures in the range 15–50°C. This is a compact, portable (16kg) heat exchanger that uses solid-state stacked Peltier technology as opposed to much heavier traditional compressor-based refrigeration systems.



For reaction temperatures below 15°C or above 40°C, a conventional recirculator such as the Huber MiniStat or MiniChiller is suitable. However, in these cases, the Borealis LED lamp should be *independently* cooled; by connection to a piped cold water supply, for example.

For low temperature reactions, to prevent possible condensation inside the lamp unit, the a *dry gas* supply should be connected to the inlet barb fitted to the Borealis lamp.

LED degradation increases with temperature. For this reason, the **Borealis** power supply monitors the LED back-plate temperature and cuts off the power if this temperature exceeds 55°C. This facility is **not** available with the **Scholar** LED lamps.



7. **Borealis** LED lamp units and hoses are supplied with Quick-connect fittings. These are valved to prevent coolant spillage when the hoses are disconnected. Please note the labelled *inlet* and *outlet* positions on top of the lamp units. For reaction temperatures 15-30°C, please connect the coolant inlet to the lower position on the Solstice, as shown in the setup image below:

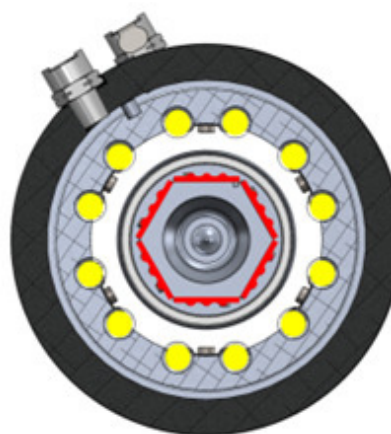


8. Start the coolant supply to the light hood flowing before powering 'On' the **Borealis** LED lamp. Check for any leaks! The power supply has a mains rocker switch located to the rear of the unit.
9. When the **Solstice** and **Borealis** units are connected in series and the lamp is operating at full power, the measured LED temperatures will typically be 2-3°C higher than the reaction temperature. This is normal and attributable to the heat from the LEDs. Accordingly, the recirculator temperature should be set lower than the desired reaction temperature. This requires some trial and error.

In practise, it is better to *equilibrate* the **Solstice** to the desired reaction temperature without the filled reactor tubes inserted, before removing the lamp (the interlock will safely switch it off) and loading the tubes.

Borealis LED lamp units have a hexagonal central core. Each face of which is fitted with identical LEDs (shown in red) that are symmetrically spaced.

This, in conjunction with the geometrical arrangement of the individual tube reactors (shown in yellow) ensures that all tubes are irradiated equally; thereby ensuring meaningful comparison between different reactions when the **Solstice** is used for the optimisation of reaction conditions and catalyst screening.



3.1 Thin-film Tube Inserts:

Thin-film tube inserts are available for the **Solstice**. These are manufactured from chemically inert PTFE and have a central hole to allow both the introduction of reagent solutions and the withdrawal of samples for analysis.

They do not interfere with stirring and are most suitable for use with reaction volumes of between 1.0 – 2.5ml.

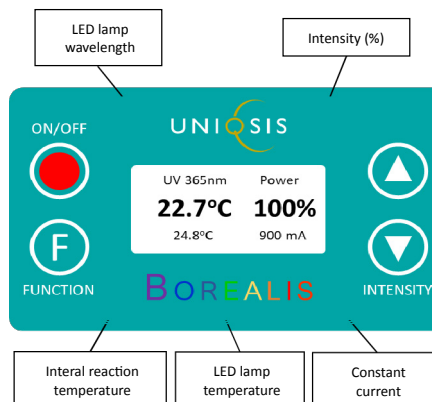
As can be seen in the image opposite, the insert significantly increases the thin-film surface area presented to the lamp (solution volume is 1.5ml in each case). Light absorption is improved and the rate of reaction increased.



4. OPERATING THE BOREALIS LED LAMP

The screen on the control panel of the power supply displays the following parameters:

- The selected wavelength (automatically detected)
- The *internal* reaction temperature
- The LED backplate temperature
- The power level selected (INTENSITY)
- The current being supplied to the Solstice LED lamp module.

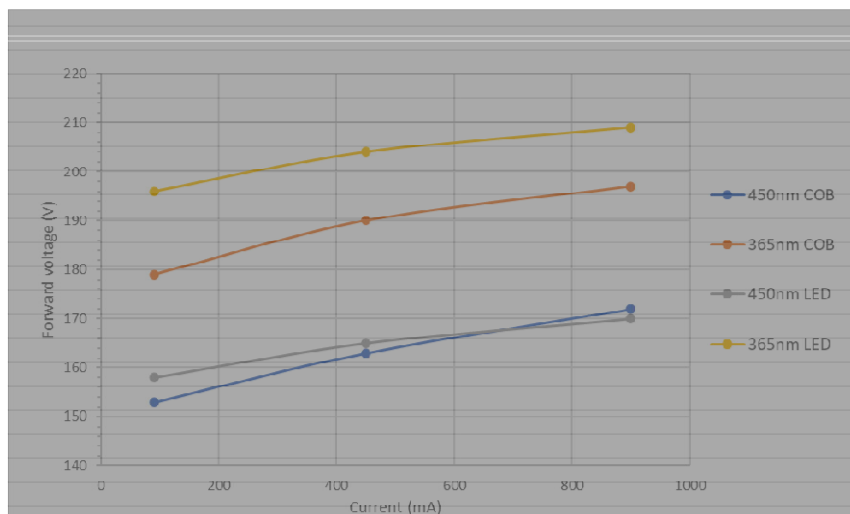


The internal reaction temperature is measured passively and not set or directly controlled by the internal PID of the recirculator.

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

- 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.
- 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.
- Press the \uparrow or \downarrow arrows to adjust the power level.

Borealis LED LAMPS are operated using a 'smart' constant current power supply. The forward current ('intensity') may be set by the user in 5% increments. The current in mA may be converted to Watts by multiplying by the forward voltage. There is no direct readout of forward voltage, however, given that it varies between 160V up to 200V dependent upon the lamp intensity, an approximate value for operating power in Watts can be calculated by multiplying the current in amps by 180(V).

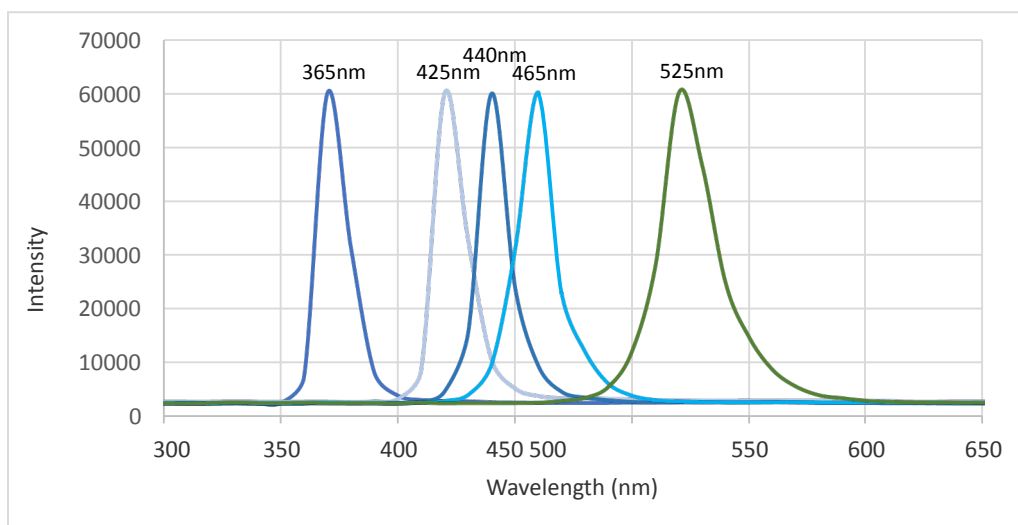


Depending upon the wavelength and intensity setting of the **Borealis** light unit, in practise the reactor temperature is typically 5-15°C higher than the internal setpoint temperature of the recirculator. The LED (back junction) temperature will be approximately 2-3°C higher than the reactor temperature, when included in the fluidic cooling circuit.

5. ERROR CONDITIONS & SAFETY FEATURES

1. 'Missing Thermocouple' Thermocouple is either missing or faulty (open circuit).
2. 'Performing Internal Test' When the **Borealis** 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 light hood from the reactor base when in operation, or the lamp unit is not located correctly inside the coil reactor, the interlock microswitches will immediately disable the power supply to the LEDs before any light can escape from the unit. Only 1-2 mm of movement is sufficient to trigger this safety response.
5. If the light hood 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 light hood 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 60°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. This is to preserve the diodes, which will degradate more rapidly as the temperature increases. An error message will be displayed, accordingly.

6. SPECIFICATION



SOLSTICE™ PhotoReactor Components & Accessories

UQ8214-B	SOLSTICE™ 12-position tube adaptor (bare)
UQ8214	SOLSTICE™ Parallel Photochemical Batch Reactor Tube Adaptor, complete (including stirrer, 12 tubes, 12 stir bars, temp. sensor)
UQ8204	Borealis™ LED Lamp Unit, UV (365nm)
UQ8205	Borealis™ LED Lamp Unit, UV (385nm)
UQ8203	Borealis™ LED Lamp Unit, PURPLE (425nm)
UQ8202	Borealis™ LED Lamp Unit, ROYAL BLUE (440nm)
UQ8201	Borealis™ LED Lamp Unit, BLUE (460nm)
UQ8200	Borealis™ LED Lamp Unit, GREEN (525nm)
UQ8206	Borealis Programmable ‘Smart’ Power Supply, 300W; 230/110V
UQ8207	Piccolo™ Solid State Temperature Control Module, 4-70C; 230/110V
UQ8217	Reactor Tubes, pack of 25 (for Solstice)
UQ8218	Septum Sealed Reactor Tube Caps, pack of 100 (for Solstice)
UQ8219	Magnetic Stir Bars, rare earth, pack of 12 (for Solstice)
UQ8221	Solstice, Thin Film Tube Insert, PTFE (each)
UQ8215	Solstice, Temp. Probe Assembly, complete

6.1 Borealis 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 $\pm 10\%$ 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
Maximum LED temperature	60°C

The unit should be protected from exposure to direct sunlight.

7. WARRANTY

The [Solstice](#) Photoreactor System 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
- Use outside of the parameters of the conditions of use (see conditions of use e.g. allowing LEDs to overheat)
- Damage to the LEDs attributable to operating the lamp with inadequate liquid cooling.

Warranty includes:

- Protection against faulty materials or workmanship
- Return-to-customer shipment costs if unit is required to go back to base for repair (customer is required to arrange and cover the cost of outward shipment to Uniqsis).

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 Asynt via the details below.

