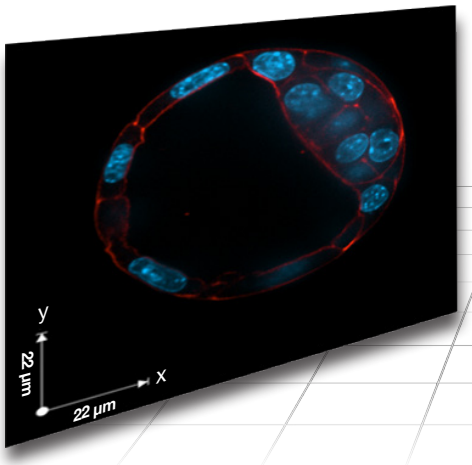
Borealis

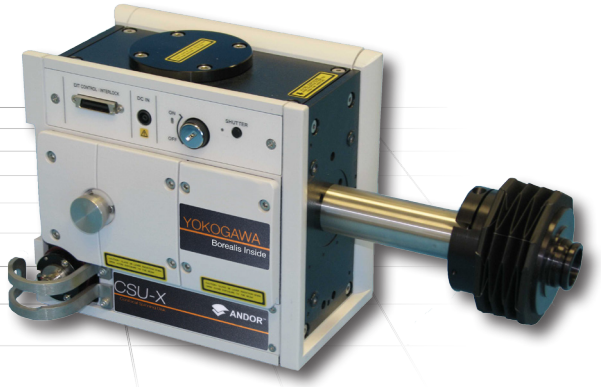
Enhanced illumination and imaging upgrade for CSU spinning disks

ANDOR
an Oxford Instruments company

SPECTRAL

- ☑ *Up to 10x improvement in uniformity*
- ☑ *Up to 3x higher throughput*
- ☑ *Extended wavelength range*





Enhanced Laser Illumination

Features and Benefits

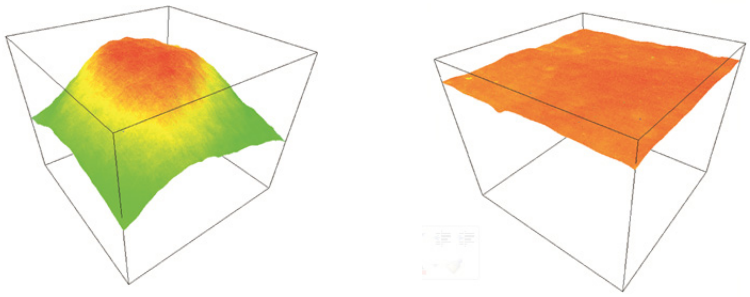
- **Uniformity improvements of up to 10x**, Resulting in 3-5% deviation (5% guaranteed)
- **Throughput improvements up to 3x** For some CSU models
- **Extended wavelength range** (400-750 nm excitation) for deeper imaging
- **Improved optical sectioning** Optical pinhole adaptation allows CSU to be used with lower magnification objectives
- **Enhanced laser coupling stability** Resulting from large diameter multi-mode fibres
- **Flexible bellows coupling** For optimal, strain-free alignment with your microscope
- **Improve Analysis** Directly compare image intensities with high precision in single frame or montage
- **Fast Imaging** Borealis supports imaging up to 1 kHz

Patented Homogeneous Laser Illumination and more Enhancements for Yokogawa CSU

With the acquisition of Spectral Applied Research Inc., Andor now offers further enhancement in the optical performance of Revolution XD and 3rd party systems using Yokogawa's CSU-10, 21, 22 and X1•[1, 2]. Spectral has raised laser illumination of spinning disk confocal to new levels with Borealis, delivering unparalleled uniformity and throughput for the CSU confocal scan heads, whilst extending the excitation range into the near-infra red for broader choice of fluorescent probes. Borealis also offers additional enhancements including: bellows attachment to the microscope, used with Andor's XD tilt stage for optimal alignment; switchable field lens tubes to enhance imaging performance and adjusting the effective pinhole size. Adaptation of the pinhole allows CSU to be used with lower magnification objectives, taking advantage of longer working distances.

Comparison of illumination uniformity

Standard CSU | **Borealis enhanced CSU**



Standard CSU (left) and Borealis enhanced CSU (right)- more light of greater uniformity is delivered by the Borealis enhanced CSU.

Key Specifications

Wavelength range (excitation)	**400-750 nm**
Uniformity	**5% rms - for single dichroic systems**
Maximum frame rate (fps)	**1000**

Specifications

Borealis Enhanced CSU

Wavelength range (excitation)	400-750 nm
Uniformity	5% rms - for single dichroic systems
Maximum frame rate (fps)	1000

Beam Conditioning Unit

Weight	7 kg
Dimensions (L x W x H)	400 x 200 x 95 mm
Laser source fibre coupler	FC/APC
Fibre length from laser source	2 m
Fibre length to CSU	2 m
Power adaptor	100-240v, 50-60Hz, 0.8A
Interlock cable	BNC-BNC Coax cable 3 meters

Field Lens Tubes

Magnification options Short (S) and Long (L) tubes	1.0x (S), 1.5x (S), 0.9x (L), 1.5x (L), 2.0x (L)
Tube lengths (mm)	37.6, 109.3, 187, 206.1, 290

Bellows Adaptor

Length range (mm)	47.9 to 59.9
Tubes and bellows diameter (mm)	66, 85

Camera Matching

Andor Camera Type	Sensor Format	Pixel Size	Camera magnification required to fill sensor (when fitted to Borealis enhanced CSU-X)
Clara	1392 x 1040	6.45	1x subarray
iXon 860	128 x 128	24	1x
iXon 888	1024 x 1024	13	2x (or 1x + subarray)
iXon 897	512 x 512	16	1x
Neo 5.5/Zyla 5.5	2560 x 2160	6.5	2x (or 1x + subarray)
Zyla 4.2	2048 x 2048	6.5	2x (or 1x + subarray)

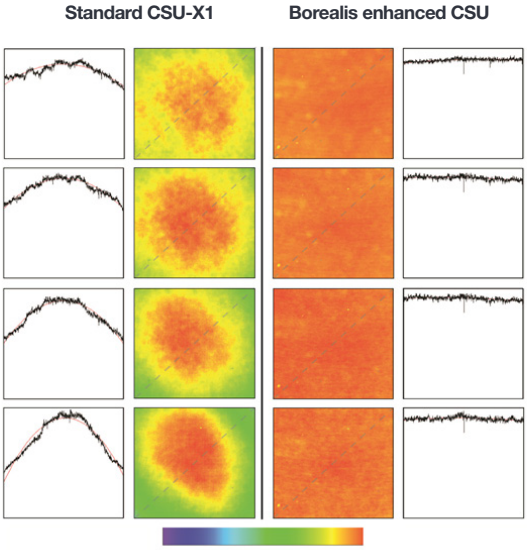
Principle of Operation

At the heart of Borealis is the realization that standard CSU illumination with a single mode fibre does not fill the microlens-pinhole etendue. This means that more light can be squeezed through the device with the right optical design. Exploiting this fact and utilizing multi-mode fibres with high performance beam conditioning, it is possible to deliver, simultaneously, more light with greater uniformity. Multi-mode fibres bring the additional benefits of: enhanced stability of laser coupling (because the core is > 10x diameter of a single mode fibre) and increased wavelength range – NIR lasers can be coupled efficiently through the CSUX up to ~750 nm, leading to the possibility of imaging deeper into thick or scattering specimens.

Reduced Sensitivity to Laser Wavelength and Illumination Artefacts

Figure 1 (right) shows the effect of laser wavelength on illumination profile in the CSU-X1 contrasting Borealis with the standard Yokogawa method. Standard CSU-X1 uniformity, measured by diagonal profile variation, can be > 40%, and throughput is typically 12-15%, while its excitation wavelength range is 400-650 nm. The standard CSU-X1 has been improved above earlier models such as 10 and 22 and uses beam shaping with a single mode fibre.

In contrast, Borealis (using multi-mode fibres and beam conditioning achieves uniformity of ≤5% and 20-25% throughput. Moreover, wavelength sensitivity is greatly reduced and laser coupling stability improved due to the larger core diameter of the fibre and its excitation wavelength range is extended to 400-750 nm.



Borealis enhanced CSU | Standard CSU

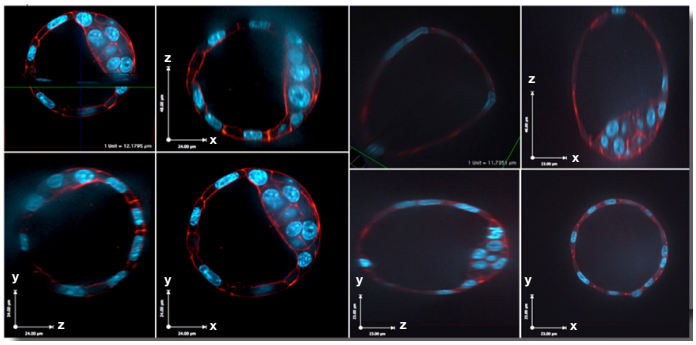


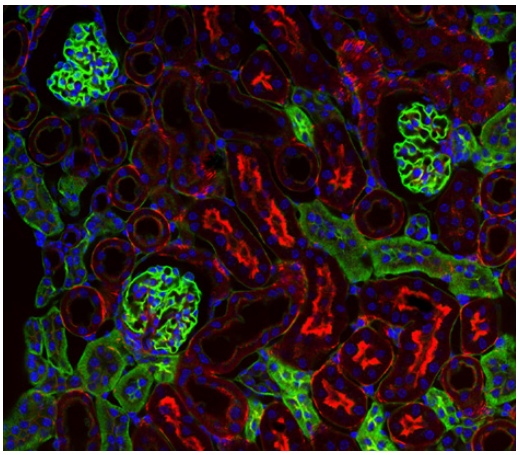
Figure 2 Comparing contrast and optical aberrations between Borealis (left) and standard CSU-X1. The specimens are mouse embryos day 4.5 prepared by Drs. Masahiro Narimatsu and Jeff Wrana at the Samuel Lunenfeld Research institute, Mount Sinai Hospital, Toronto. Captured with a 40x 1.25NA oil immersion objective, 512x512 BT EMCCD camera, 50 mW 561 nm laser anti-phospho-Smad2-DyLight 549 (Blue), 40 mW 647 nm laser mouse-b-catenin-DyLight 649 (Red). Images acquired using equipment integrated by Quorum Technologies Inc.

Figure 3 (right) shows * FluoCells® prepared slide #3, mouse kidney section with Alexa Fluor® 488 WGA, Alexa Fluor® 568 phalloidin, DAPI . Captured with a 60x 1.4NA oil immersion objective on a Spectral Borealis system using a 512x512 BT EMCCD camera with MetaMorph Slide scan configured for butt stitching with no overlap. More than 9w x 7h fields.

Even careful observation does not reveal joining boundaries. Please visit http://www.andor.com/microscopy-systems/revolution/borealis for detailed comparison to standard CSU unit

Minimizing Imaging Artefacts

Figure 2 (left) shows how Borealis enhancements improve image quality in 3D imaging, compared with the standard CSU-X setup. Not only is XY uniformity and contrast improved, but also fidelity in the Z-axis by use of the field lens. The improvements provide deeper imaging and reduce geometric errors in resulting data sets - important results for quantitative analysis.



Borealis upgrades include the following components:

Beam Conditioning Unit (BCU)

The BCU provides laser beam homogenization and includes input fibre for laser source coupling (FC/APC connection) and output fibre for CSU coupling (FC/APC connection). The output fibres have a square core cross section. Square core is ideal for use with square format cameras, e.g. Andor's iXon range of EMCCD cameras and supports high speed sub-array imaging with scientific CMOS cameras, e.g. Andor's Neo or Zyla cameras (see Camera Matching table on page 2).

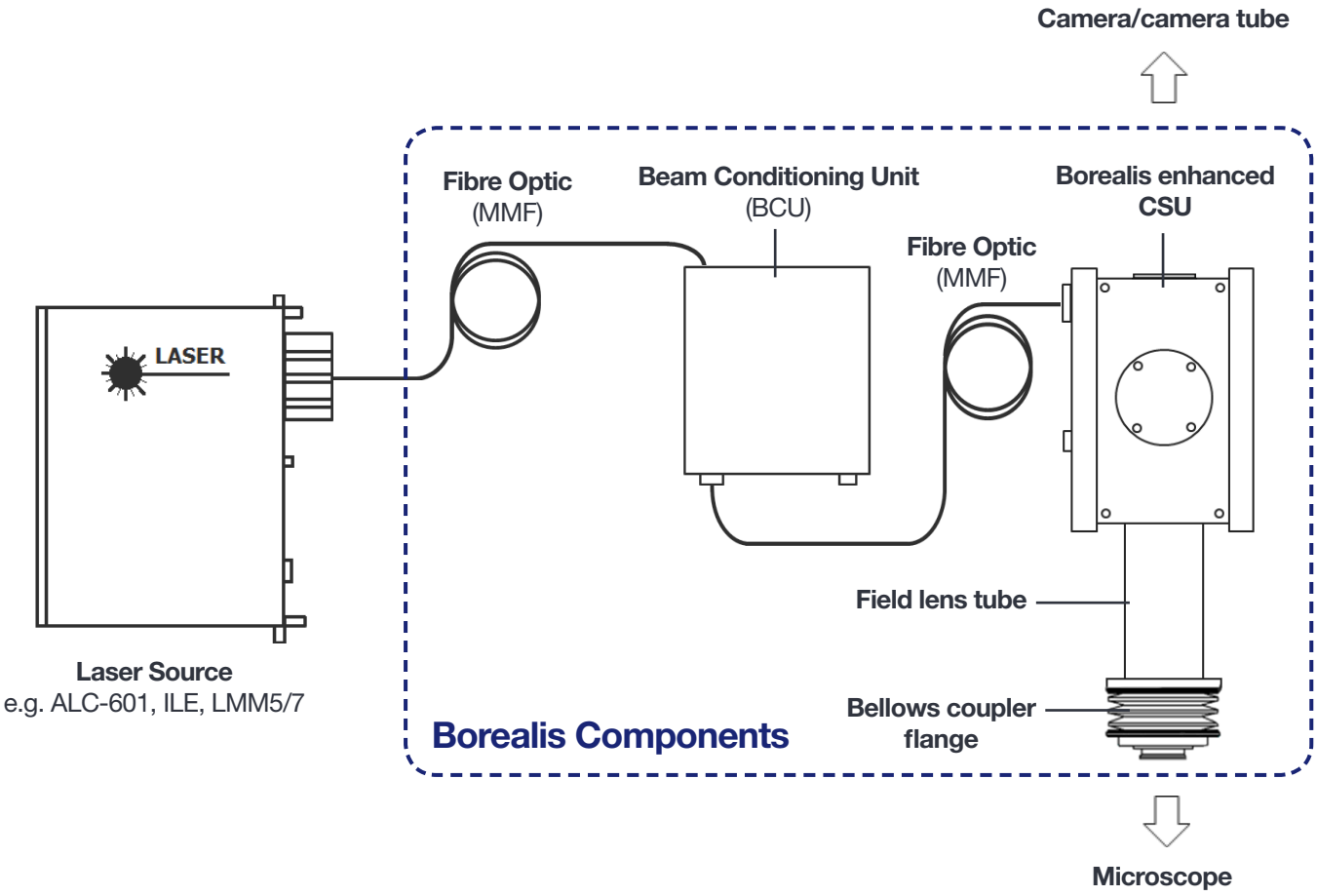
CSU head enhancements

Borealis CSU enhancements are factory installed and include Borealis fibre coupler for the BCU square output and Borealis illumination optics. Original illumination optics from the CSU are removed and no longer usable.

Microscope coupling

The C-mount tube of the microscope is replaced by one or more field lens tubes, each coupling to the flexible bellows which replaces the rigid C-mount of the microscope.

System Overview



Have you found what you are looking for?

We offer a wide range of other components to enhance your imaging system. Consider state of the art laser engines, EMCCD and scientific CMOS cameras and many others. Please contact your local specialist or visit our website for more information: http://www.andor.com/microscopy-systems

Creating the Optimum Product for You

Prior to commencing the order process please advise your customer representative of your application requirements[•4].

Step 1.
Choose the model of CSU you want to enhance.

Step 2.
For CSU-X1-M (manual) models you can choose a 3 position dichroic slider.

Step 3.
Choose the microscope make/model.

Step 4.
Choose the field lens tube(s) (see page 2)[•5].

Step 5.
An optional field installation service is available, ask your representative[•6].

Example 1:
Upgrade a CSU-22 with Olympus IX81 working with 60x water or oil immersion objective: choose the following parts:
CR-BORS-22
CR-BORB-OLY
CR-BORF-09LY

Example 2:
Upgrade a CSUX-M1L with 3 position dichroic slider, for a Zeiss Axio-Observer with 25x multi-immersion objective:
CR-BORS-X1
CR-BORD-3PS
CR-BORB-ZEI
CR-BORF-20LL

CR-BORS - X1
example shown

Step 1.
Choose the model of CSU you want to upgrade

X1	CSU model CSU-X1
10	CSU model CSU-10
21	CSU model CSU-21
22	CSU model CSU-22

Step 2.
CSU-X1-M (manual) models have a single dichroic holder so that exchange dichroics must be stored and handled. Choose our 3 position dichroic slider for easy exchange and no risk of damage.
CR-BORD-3PS

Step 3.
Choose the Bellows flange for your microscope system
CR-BORB-XXX
The part # **XXX** is replaced by:

LEI	Leica Microscope models
NIK	Nikon Microscope models
OLY	Olympus Microscope models
ZEI	Zeiss Microscope models

For example, for Leica microscope models bellows part # is **CR-BORB-LEI.**

Step 4.
Choose the tube lens options you would like[•5]

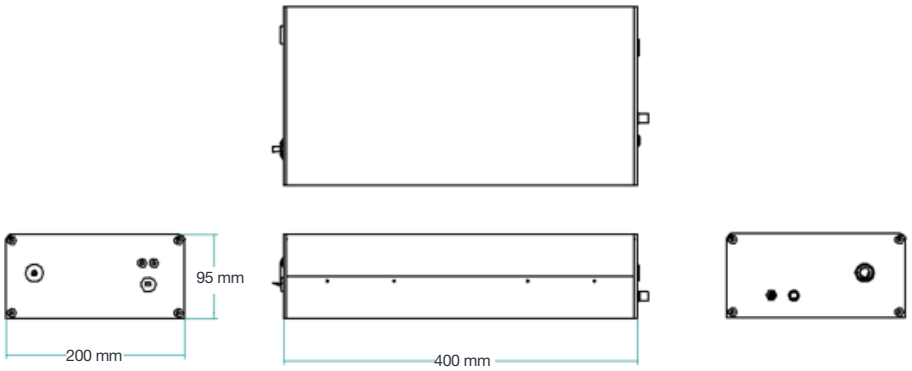
Magnification	Part # Olympus	Part # other Microscopes
1.0x (Short)*	CR-BORF-10SY	CR-BORF-10SL
1.5x (Short)	CR-BORF-15SY	CR-BORF-15SL
0.9x (Long)	CR-BORF-09LY	CR-BORF-09LL
1.5x (Long)	CR-BORF-15LY	CR-BORF-15LL
2.0x (Long)	CR-BORF-20LY	CR-BORF-20LL

*Default

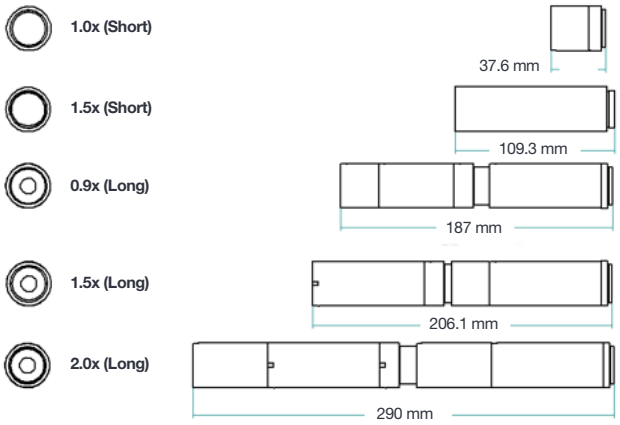
Notes:
1.0X (S): Use for compact assembly; CSU optimized for 100x and 60x objectives.
1.5X (S): Choose for use with 40X or 60X objectives and improved optical sectioning.
0.9X (L): Use to extend CSUX space (e.g. incubator) and enhanced imaging 100x and 60x.
1.5X (L): Use with 40x or 60x objectives, improved optical sectioning, space for incubator.
2.0X (L): Reduce effective pinhole to 25 µm; extend mag to 20-30x and longer working distance.

Product Drawings

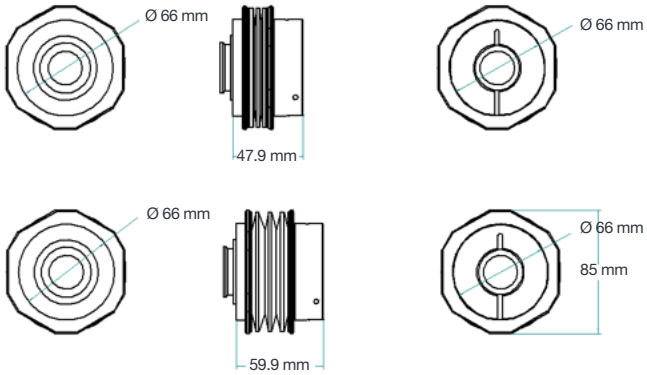
Beam Conditioning Unit (BCU)



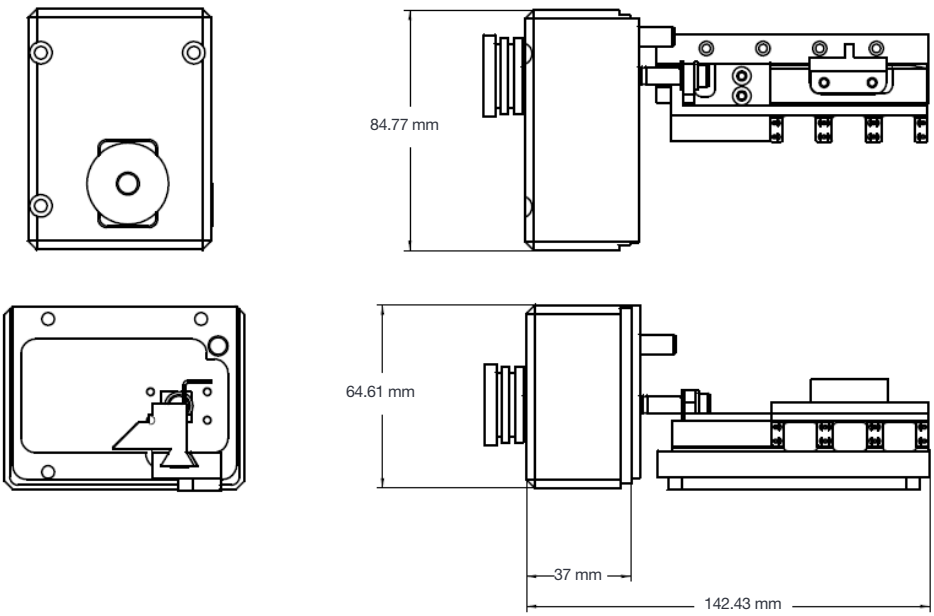
Field lens tubes

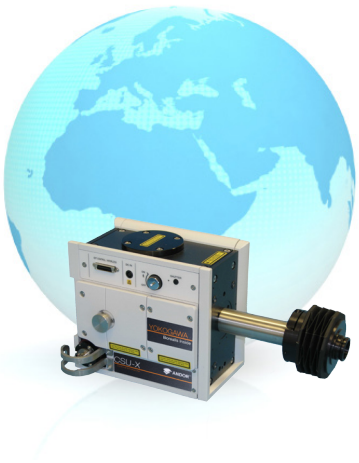


Bellows coupling adaptor



3-position Dichroic Slider for manual CSU models





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Items shipped with your system:

1x Beam Conditioning Unit and power supply (includes MM Fibre optics)
1x Borealis enhanced CSU (see Footnote 4 for CSU upgrade policy)
1 or more Field Lens tube(s) as ordered
1x Microscope specific Bellows adapter

Footnotes: Specifications are subject to change without notice

1. Borealis can be supplied with your new Revolution XD systems or as a factory-installed upgrade to existing CSU-10, 21, 22 and X1 models.
2. Andor Revolution XD owners with extended warranty will have the Borealis upgrade warranty included- as a benefit of their extended warranty terms.
3. Warranty on Borealis upgrades to existing scan heads covers parts and labour of the parts supplied for a period of 12 months.
4. When purchasing an upgrade we will contact you to arrange a suitable date for return of your CSU scan head to our factory in Toronto. Please note: You must ensure rugged packaging. We cannot accept goods damaged in transit. Existing damage on CSU units will be reported to the customer before any changes are made to the CSU. A charge will be levied for this report if you choose not to proceed with the upgrade.
5. Choose long field tubes if you require space between the scope and CSU for incubator or other devices. Additional field lens tubes can be purchased separately.
6. We strongly recommend an on-site installation service to ensure optimum performance of your new Borealis enhanced CSU. A skilled service specialist will be happy to install, configure and quality assure your device.

CSU-X Laser Safety label*

SPECTRAL

Minimum Computer Requirements:
- Borealis upgrade is independent of PC, operating system or any other hardware requirements. It simply enhances the existing CSU scan head.

Laser Safety Requirements*
- Dependent on system configuration- contact your representative for further information.

Operating & Storage Conditions
- Operating Temperature: 18°C to 28°C ambient
- Storage Temperature: 0°C to 50°C
- Relative Humidity: < 70% (non-condensing)

Power Requirements
- Beam Conditioning Unit: 100-240 V, 50-60 Hz, 0.8 A
- Borealis enhanced CSU: as per existing CSU model