

# Dragonfly

## High-speed Confocal Imaging Platform

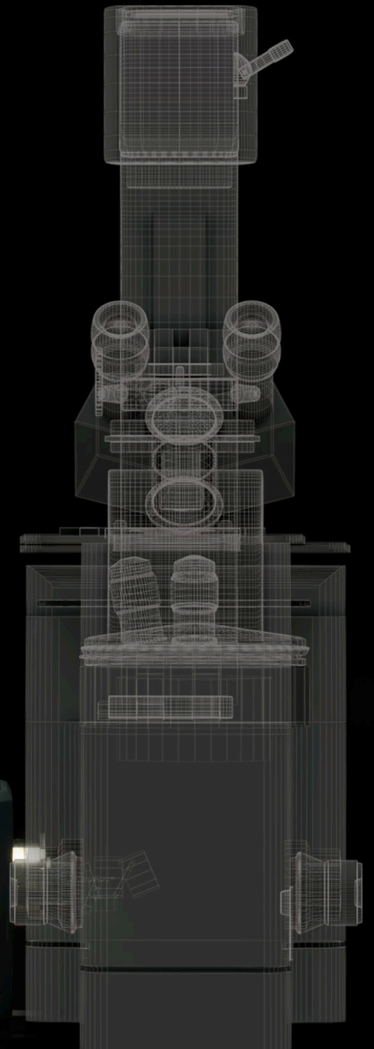
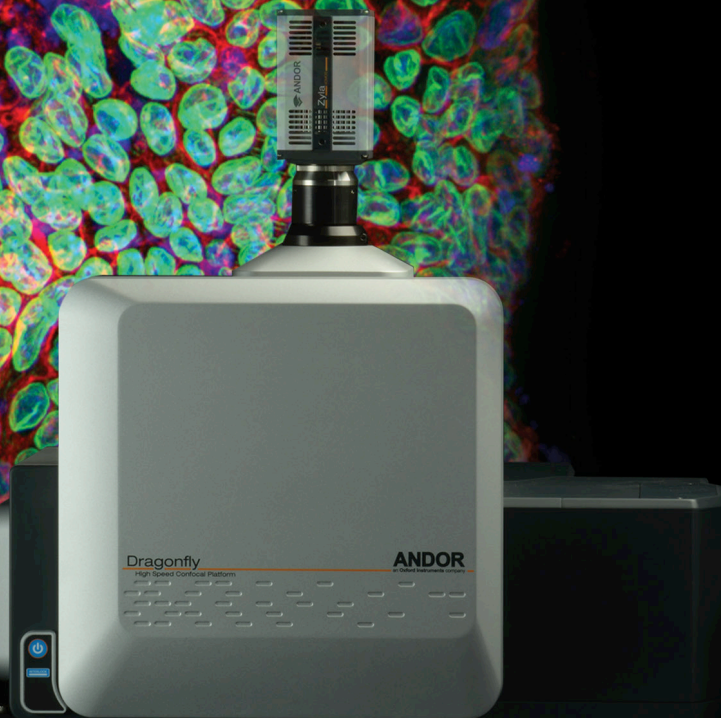
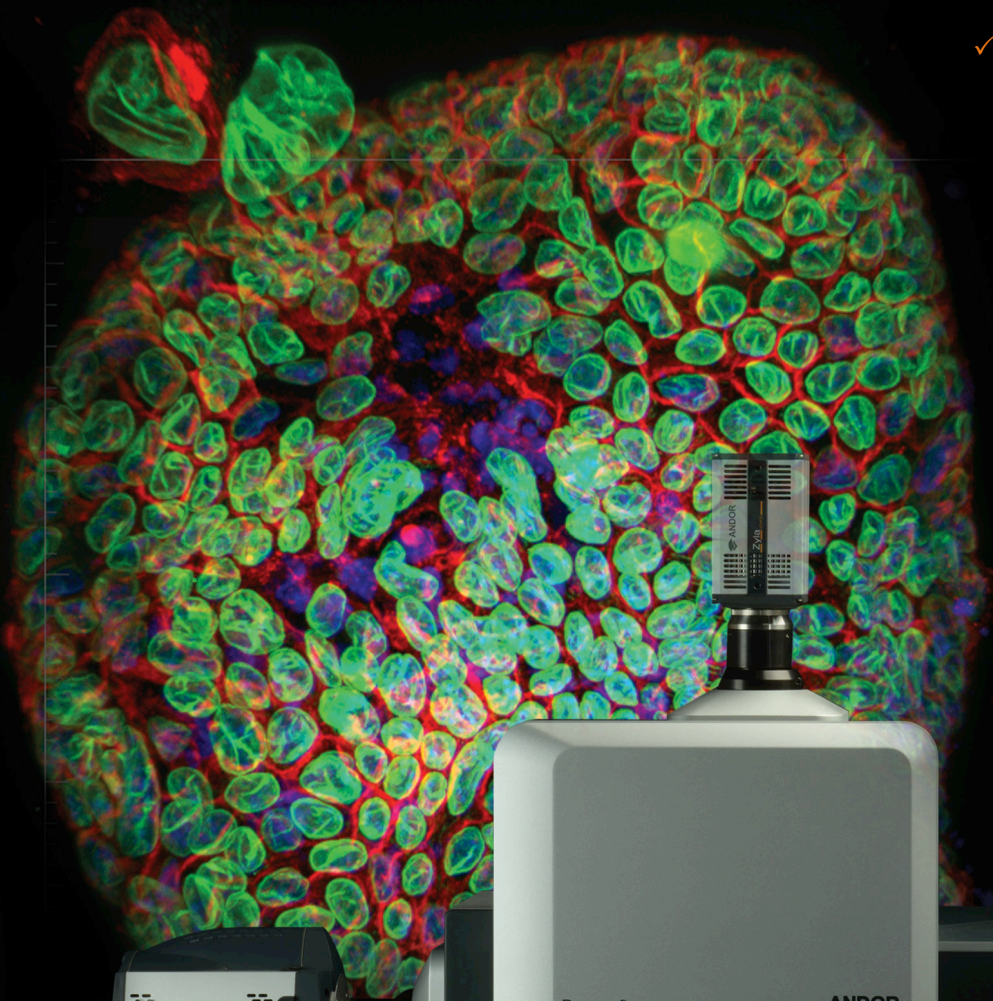


Controlled by Fusion

Acquire | Visualize | Analyze

**NEW**

- ✓ Instant Confocal
- ✓ Simultaneous multi-colour TIRF
- ✓ Laser widefield imaging
- ✓ Single molecule imaging
- ✓ VIS-NIR wavelengths
- ✓ Borealis Illumination
- ✓ GPU accelerated deconvolution



# Introducing Dragonfly

It's more than confocal...

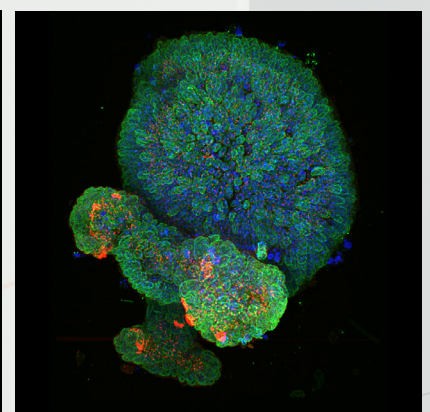
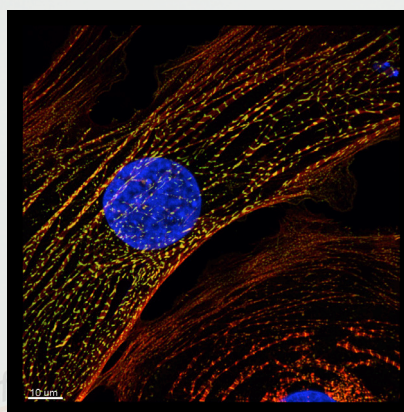
Dragonfly is a **high-contrast multi-dimensional imaging platform** capable of three key imaging modalities.

At its core is a **multi-point confocal** for **high-speed and high-sensitivity** image capture. Capturing at speeds **at least 10x faster than conventional confocal technology**, this confocal mode is the optimal solution for live cell imaging, avoiding the sensitivities to phototoxicity and photobleaching, or perfect for **fast volume acquisition** of fixed samples for high-throughput imaging.

A second available imaging mode is **laser-illuminated widefield epifluorescence**. This mode is ideal for applications that do not benefit from confocal imaging, such as yeast and other very thin samples, or applications that require high laser power density, like single molecule localisation. Imaging in widefield using Dragonfly, you can share the same cameras and lasers with the other modes and do not have to switch ports and turrets in the microscope, resulting in more efficient hardware control. This mode benefits from Borealis illumination and is complemented by **GPU accelerated deconvolution**.

The third high-contrast technique **TIRF (total internal reflectance) microscopy** is available as a factory-installed option. This is the tool of choice for imaging protein dynamics at or proximal to the cell membrane and single molecule imaging. Dragonfly TIRF is capable of **simultaneous multi-colour TIRF**, which means we correct for optical chromatic shifts. The result is that the excitation penetration depth of any two simultaneous wavelengths are perfectly matched for accurate interpretation of 3D localization.

Finally, Dragonfly utilises a range of additional integrated functions to enhance image quality and provide more tools for additional applications. **Camera zoom optics** optimize sampling and resolution according to the objective required by your application. **Illumination zoom** increases excitation power density for light-hungry applications like single molecule localization. **Self-adjusting path alignment** corrects for small but significant variations in optic tolerances between elements, thus ensuring optimal image quality.



**Above** - Left: Human iPS cardiomyocyte labelled with actinin488 and phalloidin560. Courtesy of Dr Travis Hinton, The Pat and Jim Calhoun Cardiology Center, University of Connecticut Health Center & The Jackson Laboratory for Genomic Medicine. Right: Mouse Colonic Epithelial Organoid. DNA (blue), LaminB1 (Green, nuclear envelope) and GM130 (Red, cis-golgi). Courtesy of Ronan Mellin & Dr. Luke Boulter MRC Human Genetics Unit, University of Edinburgh.

| Spectral range | Confocal speed | Aperture | Camera zoom  | Illumination zoom | Pinhole Sizes |
|----------------|----------------|----------|--------------|-------------------|---------------|
| 400-800 nm     | 400 fps        | 22 mm    | 1x, 1.5x, 2x | 1x, 2x, 4x, 6x    | 40, 25 µm     |

# Features & Benefits

| Hardware Feature  | Benefits   |
|---|--|
| Large field of view (16.6 x 14.4mm)                       | <ul style="list-style-type: none"> <li>• Capture more in a single image</li> <li>• Matches large sCMOS sensors</li> </ul>  |
| 2 pinhole diameters (25µm and 40µm)                       | <ul style="list-style-type: none"> <li>• High contrast imaging at low and high magnification for large samples to subcellular imaging</li> <li>• Optimally matched axial resolution at 60 to 100x magnification</li> </ul> |
| High speed confocal                                       | <ul style="list-style-type: none"> <li>• Up to 400fps for fast cell dynamics</li> <li>• Up to 20x faster than conventional confocal</li> </ul>   |
| Simultaneous multi-color TIRF (option)                    | <ul style="list-style-type: none"> <li>• Match the penetration depth of two labelled targets</li> </ul>  |
| Laser-illuminated widefield mode                          | <ul style="list-style-type: none"> <li>• For imaging thin specimens and single molecules</li> <li>• High power for single molecule localization</li> </ul>   |
| 16-bit dynamic range                                      | <ul style="list-style-type: none"> <li>• Capture both weak and bright signals without saturation</li> </ul>  |
| Illumination Zoom <sup>*1</sup>                           | <ul style="list-style-type: none"> <li>• Delivers higher illumination power density for applications such as localization microscopy</li> </ul>  |
| Astigmatic lens (option) <sup>*1</sup>                    | <ul style="list-style-type: none"> <li>• For 3D single molecule localization imaging in a volume</li> </ul>  |
| Motorized 3 position camera magnification (1x, 1.5x & 2x) | <ul style="list-style-type: none"> <li>• For higher resolution imaging and pixel scaling to achieve Nyquist sampling over a wide range of objectives and pixel sizes</li> </ul>  |
| Motorized 4 position emission-splitting dichroic cassette | <ul style="list-style-type: none"> <li>• Optimal flexibility for simultaneous dual colour imaging (e.g. single camera bypass + 3 chromatic splitters)</li> </ul>   |
| Self adjusting light-path                                 | <ul style="list-style-type: none"> <li>• Maintains optimal image quality</li> </ul>  |
| Exchangeable emission filter wheels                       | <ul style="list-style-type: none"> <li>• To comprehensively image multiple fluorophores when using up to 8 laser lines for excitation (UV to NIR)</li> </ul>   |
| Active Blanking   | <ul style="list-style-type: none"> <li>• Laser illumination timed with camera exposure to minimize phototoxicity and photobleaching.</li> </ul>  |

| Software Feature   | Benefits   |
|--|--|
| Real-time 3D rendering   | <ul style="list-style-type: none"> <li>• Immediate visual feedback on experimental progress to evaluate data and make appropriate decisions in real-time</li> </ul>  |
| GPU accelerated deconvolution<br>Deconvolution within a protocol<br>Three algorithms available | <ul style="list-style-type: none"> <li>• 10x faster processing than non-GPU based deconvolution solutions</li> <li>• Run deconvolution during an experiment to save time</li> <li>• Choose an algorithm to balance speed and quality according to your image properties</li> </ul> |
| Imaris file format   | <ul style="list-style-type: none"> <li>• Easy transfer of data to Imaris for comprehensive downstream multi-dimensional analysis</li> </ul>  |

# Technical Data

## General Specifications<sup>\*2</sup>

|  |  |
|--|--|
| <b>Confocal/Widefield Wavelength Range</b> | <b>Excitation range:</b> 400-800nm<br><b>Emission range:</b> 420-850nm   |
| <b>TIRF Input Wavelength Range</b>         | 400-640nm  |
| <b>Confocal/Widefield Input Power</b>      | 2W maximum for combined wavelengths  |
| <b>Confocal Pinhole Diameter</b>           | 25 µm and 40 µm  |
| <b>Active Blanking</b>                     | Laser illumination timed with camera exposure to minimize phototoxicity and photobleaching   |
| <b>Output Power</b>                        | As classified under IEC 60825-1 or the regional equivalent: 500mW maximum Class 3B (typical). May be Class 4 with 1W maximum With some laser combinations – refer to Laser Safety and Classification sections in the preface of the hardware manual. |
| <b>Lateral Resolution</b>                  | Diffraction limited in 19 mm diagonal  |

## Mechanical Specifications

|                                       |  |
|---------------------------------------|--|
| <b>Weight</b>                         | 65 kg approx. without cameras/accessories  |
| <b>Dimensions (WxDxH) inches [mm]</b> | 31.2 x 30.7 x 19.3 [792 x 780 x 489] (with installation handles)<br>31.2 x 26.5 x 19.3 [792 x 674 x 489] (without handles) |

## Frame Rates<sup>\*2</sup>

### Maximum Confocal Frame Rate (FPS)

#### Zyla 4.2 USB 3.0

| Array Size               | Frame Rate (Overlap on) <sup>*5</sup> |
|--------------------------|---------------------------------------|
| 2048x2048                | 81 (103)                              |
| 1024x1024 (2x2 binning*) | 81 (103)                              |
| 2048x1024                | 134 (205)                             |
| 2048x512                 | 201 (400)                             |
| 2048x128                 | 317 (400)                             |

\*matches iXon dimensions for dual camera capture

#### iXon Ultra 888<sup>\*4</sup>

| Binning | Array Size |         |         |         |
|---------|------------|---------|---------|---------|
|         | 1024x1024  | 512x512 | 256x256 | 128x128 |
| 1x1     | 24         | 48      | 94      | 123     |
| 2x2     | 48         | 94      | 123     | 178     |
| 4x4     | 76         | 123     | 178     | 320     |

### Maximum Widefield/TIRF Frame Rate (FPS)

| Array Size | Zyla 4.2 USB 3.0 | iXon Ultra 888 |
|------------|------------------|----------------|
| 2048x2048  | 92               | NA             |
| 1920x1080  | 160              | NA             |
| 1024x1024  | -                | 25             |
| 512x512    | 285              | 48             |
| 128x128    | 598              | 150            |

# Technical Features Explained

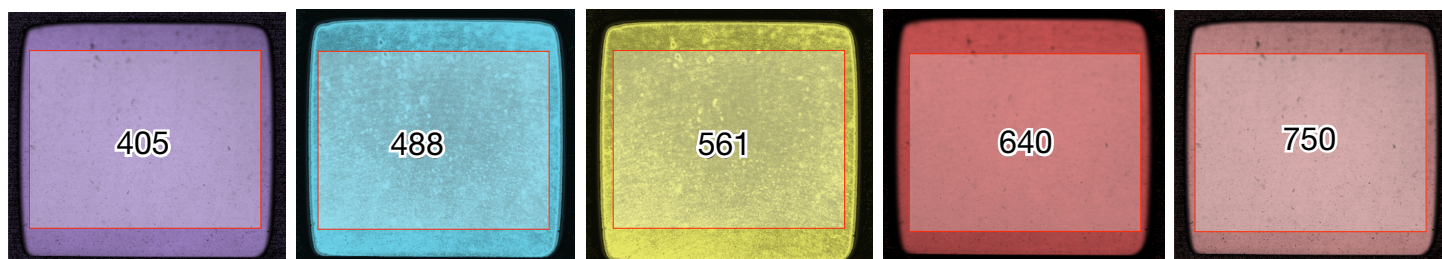


## 1 Borealis- Patented Perfect Illumination Delivery™

Integral to the illumination pathway for confocal and widefield modes is **Borealis**. Borealis utilizes a multimode fiber and microscope correction optics to provide exceptional illumination optimizing the following parameters: coupling stability and efficiency, excitation throughput, imaging uniformity and spectral range.

| Feature   | Benefits  |
|---|---|
| Uniformity improvements of up to 10x            | <ul style="list-style-type: none"> <li>Accurate cross-field analysis</li> <li>Seamless tiled/montage imaging</li> </ul>   |
| Throughput improvements up to 3x                | <ul style="list-style-type: none"> <li>Lower laser powers required = lower cost</li> <li>More light for high power applications (e.g. single molecule localisation microscope)</li> </ul> |
| Extended spectral range (400-800 nm excitation) | <ul style="list-style-type: none"> <li>Greater choice of fluorescent probes</li> <li>NIR imaging to avoid autofluorescence or for deeper imaging</li> </ul>                               |
| Better axial geometry                           | <ul style="list-style-type: none"> <li>More accurate three dimensional image reconstruction</li> </ul>  |
| Enhanced laser coupling stability               | <ul style="list-style-type: none"> <li>Longer term illumination stability</li> <li>Reduced risk of alignment drift and correction</li> </ul>  |

### Broad Spectrum Delivery

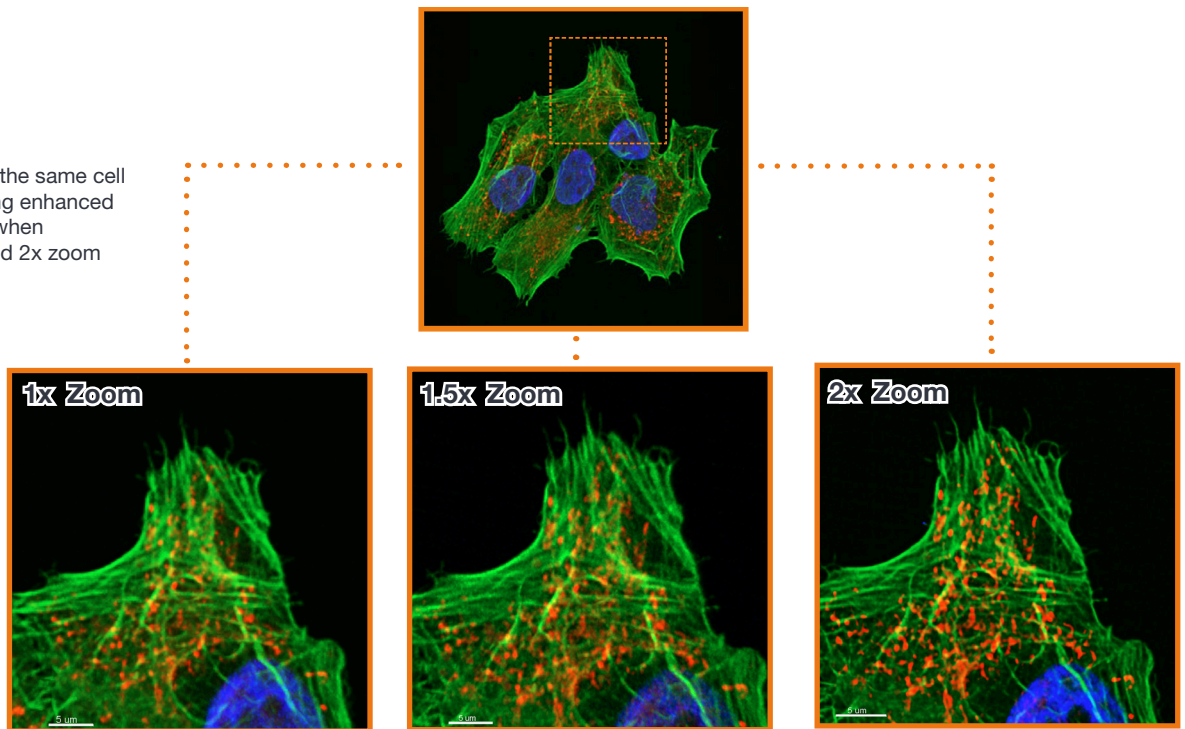


A series of intensity maps captured at the exit window of Dragonfly across all major wavelengths from 405nm to 750nm. An extremely high degree of uniformity is visible. This uniformity then translates to the sample with high quality chromatically corrected objectives in the microscope.

## 2 Camera Zoom

As part of each camera port there is a motorized 3 position magnification changer holding 1x, 1.5x and 2x zoom optics. If you are using a sensitive camera with a larger pixel, such as on the iXon Ultra 888 (13µm), moving to a 2x zoom allows you to reach Nyquist sampling to ensure all the finest details from your sample are captured. The level of detail is then only limited by the objective you use.

**Right:** A comparison of the same cell with sub-images showing enhanced resolution of fine detail when moving from 1x, 1.5x and 2x zoom respectively.

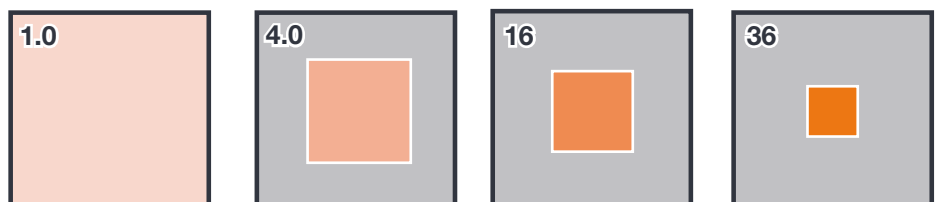
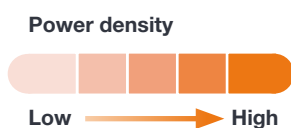


| Relative Zoom | 1x   | 1.5x   | 2x   |
|---------------|--|--|--|
| Description   | Imaging Field xy dimensions = 1x Specimen Illumination xy dimensions | Imaging Field xy dimensions = 1.5x Specimen Illumination xy dimensions | Imaging Field xy dimensions = 2x Specimen Illumination xy dimensions |

## 3 Illumination Zoom

The illumination path for widefield and confocal modes has a motorized 4 position zoom mechanism. This enables the illumination light to be focused into a smaller area and deliver a higher power density of light to the sample when an application requires more light from the laser source.

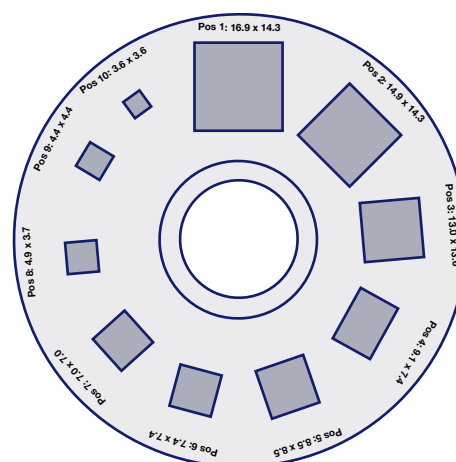
|                           | Mode      | 1x Zoom | 2x Zoom | 4x Zoom  | 6x Zoom  |
|---------------------------|-----------|---------|---------|----------|----------|
| Increase in power density | Confocal  | 1x      | 2x      | not used | not used |
|                           | Widefield | 1x      | 4x      | 16x      | 36x      |



**Right:** Using the Illumination Zoom to increase the power density of illumination.

## 4 Selectable Illumination Field Aperture Size

Dragonfly includes a variable aperture to best match the area of illumination to the camera sensor format, the zoom illumination size, or the field size covered with the camera zoom. The purpose of controlling the field aperture is to ensure the sample is not over-illuminated ensuring minimal phototoxicity and photobleaching. Stray light is also reduced, providing higher contrast images.



| Relative illum. Power Density | Camera Magnification (nominal) | Field of view (mm) | Comments   | Min Disk Area Illum. Dimensions (mm) |
|-------------------------------|--------------------------------|--------------------|--|--------------------------------------|
| 1x                            | 1x                             | 16.64x14.04        | Neo&Zyla 5.5 (2560x2160 sCMOS) - Full frame  | 16.64x14.04                          |
| 1x                            | 1x                             | 14.04x14.04        | Neo&Zyla 5.5 (2160x2160 sCMOS) – Scope Quality Area Field Number Limit                                 | 14.04x14.04                          |
| 1x                            | 1x                             | 13.3x13.3          | Zyla 4.2 (2048x2048) and Ixon 888  | 13.3x13.3                            |
| 2x                            | 1x                             | 8.8x7.1            | sCMOS 1392x1080 optically centred window (200 fps)   | 8.8x7.1                              |
| 2x                            | 1x                             | 8.2x8.2            | iXon 897   | 8.2x8.2                              |
| 2x                            | 2x                             | 14.04x14.04        | Neo&Zyla 5.5 (2160x2160 sCMOS) – effective pixel size = 3.25µm   | 7.1x7.1                              |
| 2x                            | 1x                             | 6.7x6.7            | iXon 888:<br>512x512 ROI Optically Centred Crop  | 6.7x6.7                              |
| 2x                            | 2x                             | 13.3x13.3          | iXon 888:<br>256x256 ROI Optically Centred Crop  |                                      |
| 2x                            | 2x                             | 13.3x13.3          | Zyla 4.2 (2048x2048) – effective pixel size = 3.25 µm  |                                      |
| 2x                            | 2x                             | 9.1x6.8            | sCMOS 1392x1080 optically centred window (200 fps): 3.25 or 6.5 µm (binned 2x2 with higher frame rate) | 4.6x3.4                              |
| 2x                            | 1x                             | 4.1x4.1            | Ixon 897:<br>256x256 ROI Optically Centred Crop  | 4.1x4.1                              |
| 2x                            | 2x                             | 8.2x8.2            | Works for iXon 897 – effective pixel size = pixel 8 µm   |                                      |
| 2x                            | 2x                             | 6.5x6.5            | iXon 888 quadrant crop mode<br>effective pixel size = 6.5 µm   | 3.25x3.25                            |



### Excitation Illumination Options

The **Andor ILE** can support up to 8 laser lines and up to 3 output ports for multi-modal imaging and additional applications (please refer to the [ILE specification sheet](#) for more details).

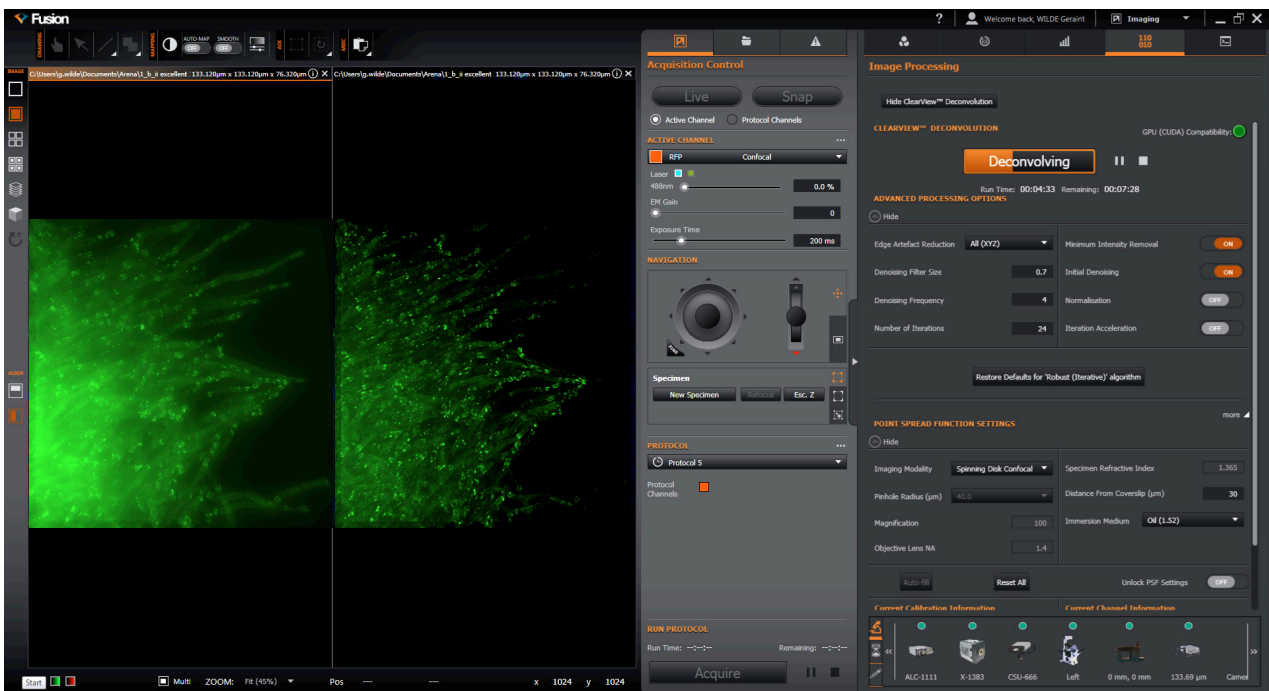
# Integrated Software Solutions

## Fusion

**Fusion** is a brand new solution designed to meet the requirements of today's expectations for ease of use and immediate visual feedback for data review, whilst fulfilling tomorrow's aspirations for handling multi-modal imaging.

Fusion simplifies the control of the Dragonfly system, with its multiple imaging modes, to fluorophore and imaging mode selection in just three mouse clicks. Once the sample is on the microscope you can control all hardware, including the x,y stage with its unique software joystick. Real-time 3D visualization provides a powerful insight to your experiment, and GPU accelerated deconvolution delivers enhanced clarity in all modes of imaging.

To find out more about Fusion please see: [andor.com/microscopy-systems/dragonfly](http://andor.com/microscopy-systems/dragonfly)

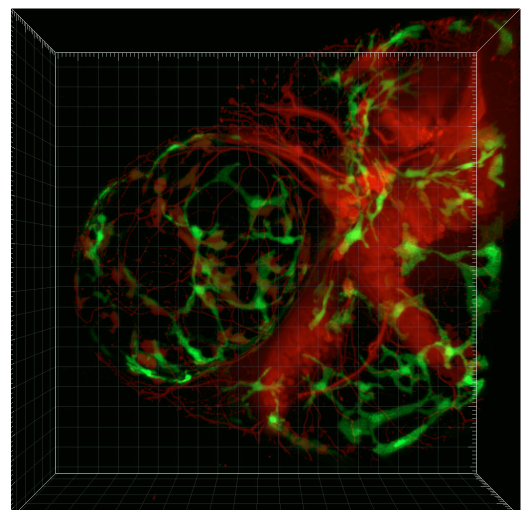


## Imaris®

Saving files in Imaris format, Fusion permits easy transfer of the data into Imaris software. **Imaris Core** is a standard part of the Dragonfly package, and required for downstream editing, annotating, surface rendering, and creating sophisticated multi-dimensional movies.

Additional application-specific modules are available on request, such as measurement packages for cell biology, cell lineage, neuroscience and much more.

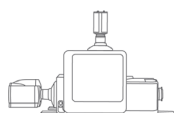
To find out more about Imaris please see: [bitplane.com](http://bitplane.com)





# Creating the Optimum Product for You

## Step 1 Select the Dragonfly model you require



### Dragonfly

| Description   | Model Number |
|---|--------------|
| Single pinhole pattern, camera port zoom, single camera port (not upgradeable)      | CR-DFLY-301  |
| Single pinhole pattern, camera port zoom, second camera port ready                  | CR-DFLY-302  |
| Dual pinhole pattern, illumination zoom, camera port zoom, second camera port ready | CR-DFLY-502  |
| Dual pinhole pattern, illumination zoom, camera port zoom, dual camera port         | CR-DFLY-503  |
| Full feature set: Dual pinhole pattern, dual port, Zoom, TIRF, AST                  | CR-DFLY-505  |

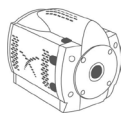
All models include workstation with Fusion and Imaris Core software.\* If 505 models is selected, skip step 2.

## Step 2 Choose additional options

### Dragonfly Model Options

| Description            | Option on models: | Part Code       |
|------------------------|-------------------|-----------------|
| TIRF                   | 301/302/502/503   | CR-DFLY-TIRF    |
| 3D Localisation optics | 502/503           | CR-DFLY-AST     |
| Second camera port     | 302/502           | CR-DFLY-CAM-UPG |

## Step 3 Select the cameras you require (refer to the camera specification sheets for details)



### Cameras

#### Neo 5.5 and Zyla 4.2 and 5.5 sCMOS Cameras

- < 1 e<sup>-</sup> read noise, > 80% QE, Industry fastest speeds, 4.2 and 5.5 Megapixel options

#### iXon EMCCD Camera Series

- Single photon sensitive, Fastest frame rates, TE cooled to -100°C

## Step 4 Select splitter and filter options

Alternatives may be considered through discussions with your Sales Engineer and subject to technical compatibility with the Dragonfly (maximum of 4 installed per unit – user-exchangeable per cassette system)



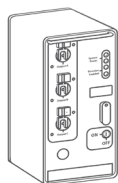
### Splitters & filters

| Description               |                              | Part Code         |
|---------------------------|------------------------------|-------------------|
| 100% first surface mirror | Switch between camera ports  | TR-DFLY-CMSP-MIRR |
| 500nm long-pass           | CFP/YFP simultaneous imaging | TR-DFLY-CMSP-500  |
| 565nm long-pass           | GFP/RFP simultaneous imaging | TR-DFLY-CMSP-565  |
| 605nm long-pass           | GFP/Cy5 simultaneous imaging | TR-DFLY-CMSP-605  |
| 640nm long-pass           | Cy3/Cy5 simultaneous imaging | TR-DFLY-CMSP-640  |
| 750nm long-pass           | Visible/NIR dye imaging      | TR-DFLY-CMSP-750  |

| Laser Wavelength | Emission Filter | Typical Fluorophore         |
|------------------|-----------------|-----------------------------|
| 405              | 450/50          | DAPI                        |
| 445              | 480/40          | CFP                         |
| 488              | 525/50          | GFP, FITC, Alexa488, Fluo-4 |
| 515              | 540/30          | YFP                         |
| 561              | 600/50          | RFP                         |
| 561, 594         | 620/60          | mCherry                     |
| 640              | 700/75          | Cy5                         |

**Step 5** Select the required ILE Model (refer to the ILE Specification sheet for details)

Many combinations of the following can be supported. For specific laser wavelength configurations please speak to your Sales Engineer and refer also to the ILE specification sheet.



**ILE & Laser options**

| Available Wavelengths | Power (mW) | Application Recommendation    |
|-----------------------|------------|-------------------------------|
| 405                   | 100, 200*  | Confocal, TIRF, *Localization |
| 445                   | 75         | Confocal, TIRF                |
| 488                   | 50, 150*   | Confocal, TIRF, *Localization |
| 514                   | 45         | Confocal, TIRF                |
| 532                   | 100        | Confocal, TIRF                |
| 552                   | 100        | Confocal, TIRF                |

| Available Wavelengths | Power (mW)    | Application Recommendation    |
|-----------------------|---------------|-------------------------------|
| 561                   | 50, 100, 150* | Confocal, TIRF, *Localization |
| 594                   | 50, 100       | Confocal, TIRF                |
| 640                   | 140           | Confocal, TIRF, Localization  |
| 685                   | 40            | Confocal, TIRF                |
| 730                   | 30            | Confocal, TIRF                |
| 785                   | 50            | Confocal, TIRF                |

**Step 6** Select the required accessories (please discuss with your sales engineer)

**Accessories**

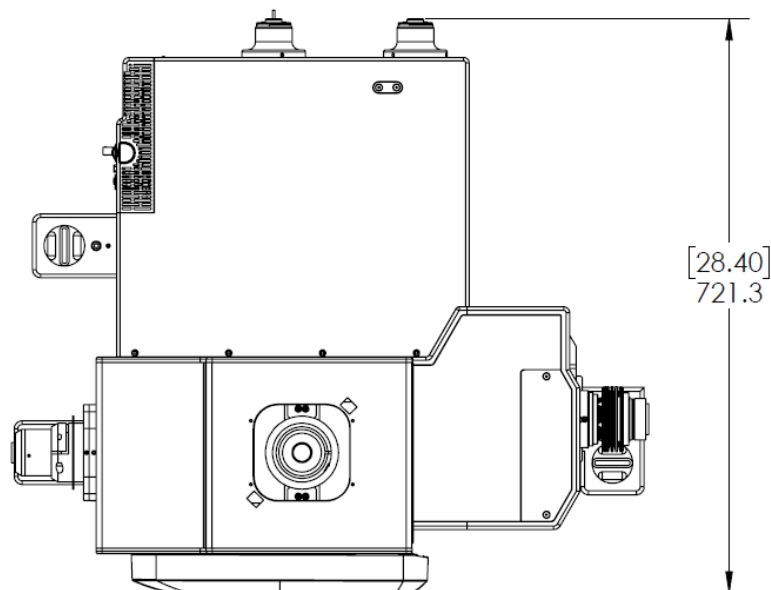
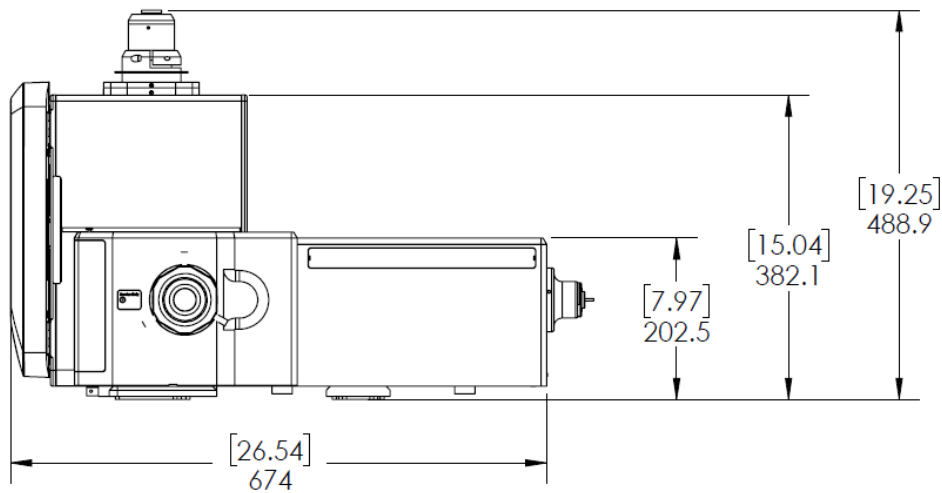
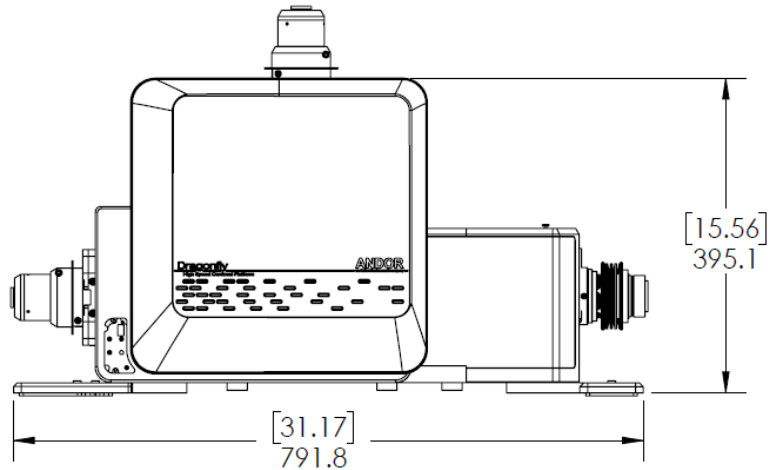
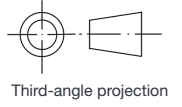
Please discuss any additional requirements, such as motorised x,y,z stage control, incubation and accessories for your specific application needs with your Andor sales engineer.

## Recommended Microscopes

| Model                                       |
|---|
| Leica DMI8 including AFC                    |
| Nikon Ti-E (single/dual deck) including PFS |

# Mechanical Drawings

Dimensions in inches [mm]



Note: Shown without installation handles, depth is 30.7 [780] with handles. For dimensions of the ILE, please refer to the [ILE specifications sheet](#).



# ORDER TODAY

Need more information? At Andor we are committed to finding the correct solution for you. With a dedicated team of technical advisors, we are able to offer you one-to-one guidance and technical support on all Andor products. For a full listing of our regional sales offices, please see: [andor.com/contact](http://andor.com/contact)

Our regional headquarters are:

**Europe**

Belfast, Northern Ireland  
Phone +44 (28) 9023 7126  
Fax +44 (28) 9031 0792

**Japan**

Tokyo  
Phone +81 (3) 6732 8968  
Fax +81 (3) 6732 8939

**North America**

Concord, MA, USA  
Phone +1 (860) 290 9211  
Fax +1 (860) 290 9566

**China**

Beijing  
Phone +86 (10) 8271 9066  
Fax +86 (10) 8271 9055

**Items shipped with your Dragonfly**

- Dragonfly base unit, cables and accessories (model as ordered)
- ILE Laser combiner (with laser options and accessories as ordered)
- Borealis BCU
- PC Workstation and accessories
- Fusion and Imaris Core Software
- User Guides in electronic format

**Footnotes**

1. Available on the Dragonfly 500 series.
2. All specifications are typical.
3. Frame rate data shown for two typical camera options.
4. All measurements are made at 30 MHz pixel readout speed with 0.6  $\mu$ s vertical clock speed. It also assumes internal trigger mode of operation. Frame rates shown are for Optically Centred ROIs.
5. Figures shown in brackets are the maximal frame rate with Overlap on, this slightly increases the specimen exposure.



The Dragonfly system may be classified under IEC 60825-1 and CDRH 21 CFR 1040.10 as either Class 3B or 4 depending on the system configuration.



**Minimum Computer Requirements:**

- 3.0 GHz single core or 2.4 GHz dual or quad core processor
- 2 GB RAM
- 100 MB free hard disc to install software (at least 1 GB recommended for data spooling)
- USB 3.0 High Speed host Controller capable of sustained rate of 60 MB/s
- Windows (7 and 8)

**Operating & Storage Conditions:**

- Operating Temperature: 18°C to +28°C ambient
- Indoor use only
- Operating Altitude: up to 2000m
- Relative Humidity: <70% (non-condensing)
- Storage Temperature: 0°C to 50°C

**Power Requirements:**

- External supply: 100 - 240 VAC, 50 - 60 Hz
- Power consumption: 60 W/100 W (typ./ max.)



Windows is a registered trademark of Microsoft Corporation.