



DRAGONFLY 4.1 RELEASE NOTES

The screenshot displays the Dragonfly 4.1 software interface, which is divided into several panels:

- Top Panel:** Contains a menu bar (File, Tools, Developer, Demos, ORL, Help) and a toolbar with various manipulation tools like Move, Rotate, and Scale.
- Left Panel:** Includes 'Window Leveling' and 'Scene's View Properties' with options for 'Show scale bar', 'Orthographic projection', 'Show legends', 'Show text annotations', 'Lower quality in motion', 'Maximize quality', 'Anti-aliasing', and 'Edge detect'. It also features 'View mode' (3D), 'Render mode' (Default), and 'Background color' settings.
- Center Panel:** Shows a 3D rendering of a complex, porous biological structure in a yellowish-brown color against a light gray background.
- Right Panel:** Contains 'Data Properties and Settings' for the selected object, including 'Mesh Nodes dark?' and 'Interfacial Mesh?'. Below this is an 'Information' section with statistics: Name: Interfacial Mesh, Number of vertices: 536653, Number of edges: 1181798, Number of triangles: 10605916, Surface: 1544.97 μm², Volume: 233.99 μm³, X size: 37.92 μm, Y size: 36.64 μm, Z size: 21.04 μm, Min Feret diameter: NA, Mean Feret diameter: NA, Max Feret diameter: NA. There are also checkboxes for 'Surface', 'Volume', and 'Feret diameter', and a 'Refresh' button.
- Bottom Panel:** Shows a 'Graph of Connectivity - Edge length' visualization. The graph consists of numerous nodes (colored in a gradient from blue to red) connected by edges. A color scale on the right indicates edge length from 0.00 to 1.00. Below the graph is another color scale for 'Graph of Connectivity - Equivalent radius (Millimeters)' ranging from 0.00 to 6.82. The 'Properties' panel on the right for the graph shows: Name: Graph of Connectivity, Number of vertices: 1931, Number of edges: 3970, Edges total length: NA, X size: 109.75 mm, Y size: 149.47 mm, Z size: 42.02 mm. It also includes 'Graph settings' for 'Edge radius measurement' (Edge length), 'Edges LUT' (RGB), and 'Vertex radius measurement' (Equivalent radius).

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Release Notes

Version 4.1

This document describes the new features, product enhancements, and other improvements implemented in the Dragonfly and Dragonfly Pro 4.1 software release. You should read these release notes carefully before you install this new version.

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New Features

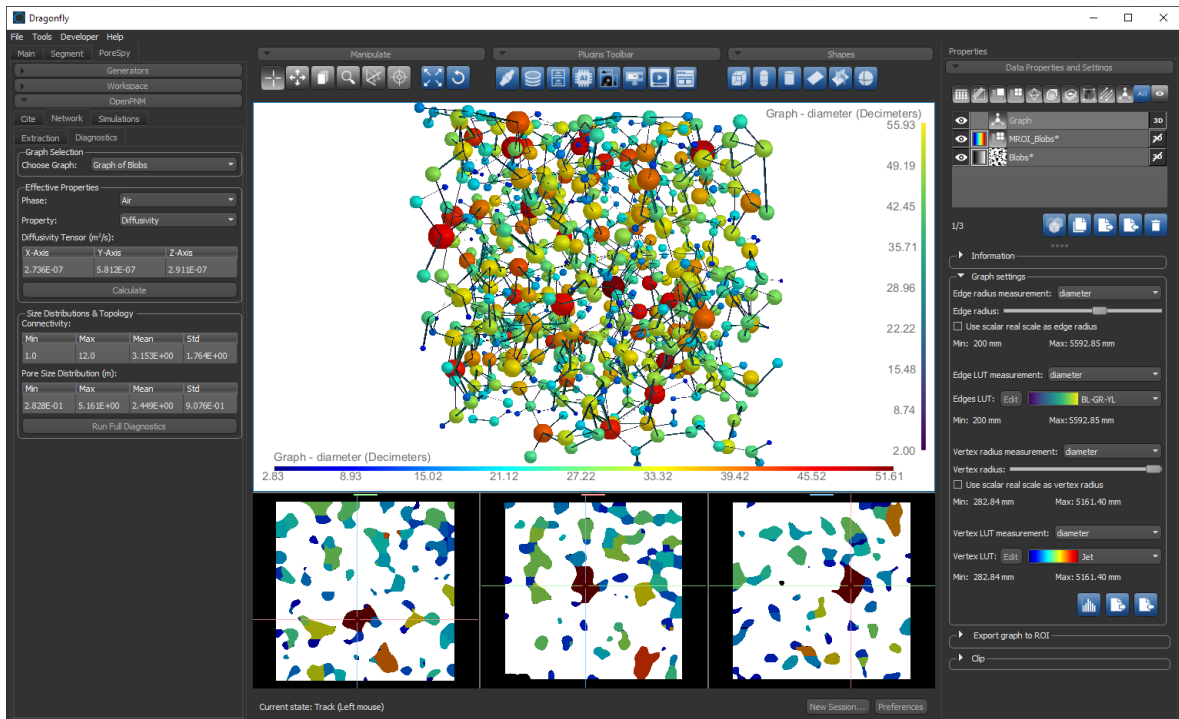
The 4.1 software release for Dragonfly and Dragonfly Pro provides the following new features. For information about enhancements for Deep Learning and Bone Analysis, as well as improvements for window leveling, visual planes, 3D modeling, and other changes, see [Product Enhancements](#) on page 25.

Pore Network Modeling

The 4.1 release includes the full integration of OpenPNM, which provides porous media researchers with a ready-made framework for performing a wide range of pore network simulations. The concept of pore network modeling is to represent a porous material as a network or graph of pores, which form the nodes and throats that form the connections or edges. In a traditional pore network, the pores are the void spaces between solid objects. However, Dragonfly's pore network model can consider connected void space or solid space and even multiple phases within each space.

Choose **Tools > Pore Network Modeling** on the menu bar to open the OpenPNM tab on the left sidebar. The pore network modeling workspace is shown below.

Pore network modeling workspace



Networks are usually “extracted” from images, in which the space is divided into regions, thereby reducing the complexity of the space and degrees of freedom for simulation. Direct numerical simulation techniques typically consider every voxel in the image, whereas pore network models group neighboring voxels together and treat them as larger regions with common properties. This allows for rapid calculations, especially for multiphase flows that are governed by capillary forces. Pore network models are

especially suitable for linear transport and percolation problems, and can also provide estimations of flow at the sub-pore scale.

Fluid flow simulations use the extracted information about the pore regions such as the diameter of an inscribed sphere, cross-sectional area, and volume. The simulations then use analytical solutions for flow in pipes of equivalent dimensions and shapes to build a set of linear algebraic equations of the form $Ax + b = 0$. The 'A's are the conductances of the connecting throats, the 'b's are a combination of the boundary conditions and source terms in the pores, while 'x' is the quantity of interest such as concentration of oxygen in air. The equations are cast into an adjacency matrix and solved using common matrix inversion techniques.

NOTE The theory of pore network modeling and details of the software are presented in: [Gostick et al., OpenPNM: A pore network modeling package, *Computing in Science & Engineering*, 18, 4, \(60-74\), \(2016\).](#)

Pore Network Modeling Plugins

The new plugins included in this Dragonfly release for pore network modeling are:

Generators... The Image Generator plugin can be used when tomography data is not available. This plugin uses PoreSpy generators functions for generating artificial images of porous materials for testing, validation, debugging, and illustration purposes. Go to <https://porespy.readthedocs.io/en/master/modules/generators.html> for more information about PoreSpy generators.

Network Extraction... Although abstract pore network models can be constructed using cubic lattices for the pore positions and other constructions, such as Delaunay tessellations, the most useful type of network model is extracted from an image.

The Network Extraction plugin takes a dataset, ROI, or multi-ROI as an input to extract a network. The extraction uses PoreSpy's SNOW (Sub-Network of an Over-segmented Watershed) network extraction algorithm. Details of the algorithm can be found in: [Jeff T. Gostick, Versatile and efficient pore network extraction method using marker-based watershed segmentation, *Physical Review E* 96, 2, \(2017\).](#)

Importantly, the algorithm accurately captures the size and shape of the pores across a wide range of porosity, which is the fraction of voxels in the image assigned to a particular phase. The above manuscript details how experimental percolation data was matched for a wide variety of materials including sandstone with 20% porosity and highly anisotropic fibrous material with 75% porosity.

Network Diagnostics... This plugin provides a simple way to run diagnostic simulations for the effective properties of the network without specifying boundary conditions.

Boundary Selector... The Boundary Selector plugin lets you select boundaries for performing simulations using the multi-ROI image created during network extraction.

Simulations... The Simulations plugin allows for greater control over the simulation variables, compared with the Network Diagnostics plugin.

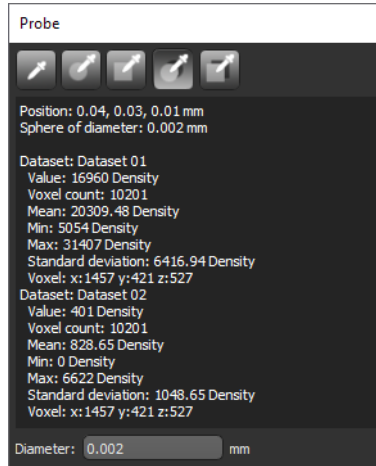
Workspace Manager... This plugin is provided for cases in which OpenPNM, an advanced open source pore network modeling package, is required for very complex simulations. The Workspace Manager lets you save objects generated in Dragonfly and then open them using OpenPNM scripts. Go to <http://openpnm.org/> to learn more about OpenPNM.

Area and Depth Probe Tools

This Dragonfly release provides the option to probe 2D and 3D neighborhoods of image data, multi-ROIs, and meshes and then extract measurements such as voxel counts, mean value, and the standard deviation of probed voxels, as well as the scalar values assigned to multi-ROI labels and to the vertex indexes of scalar meshes. The area and depth probe tools are applicable to 2D views in any oblique, and are also available for probing 3D views.





The new area and depth probe tools are available on the updated Probe panel, shown below.

Probe panel



Refer to the table below for information about the new Probe tools.

Probe tools

	Description
	Disk Probe... Reports the position and values of the selected circular neighborhood that is aligned with the current view.
	Square Probe... Reports the position and values of the selected square neighborhood that is aligned with the current view.
	Sphere Probe... Reports the position and values of the selected spherical neighborhood that is aligned with the current view.
	Cube Probe... Reports the position and values of the selected cubic neighborhood that is aligned with the current view.

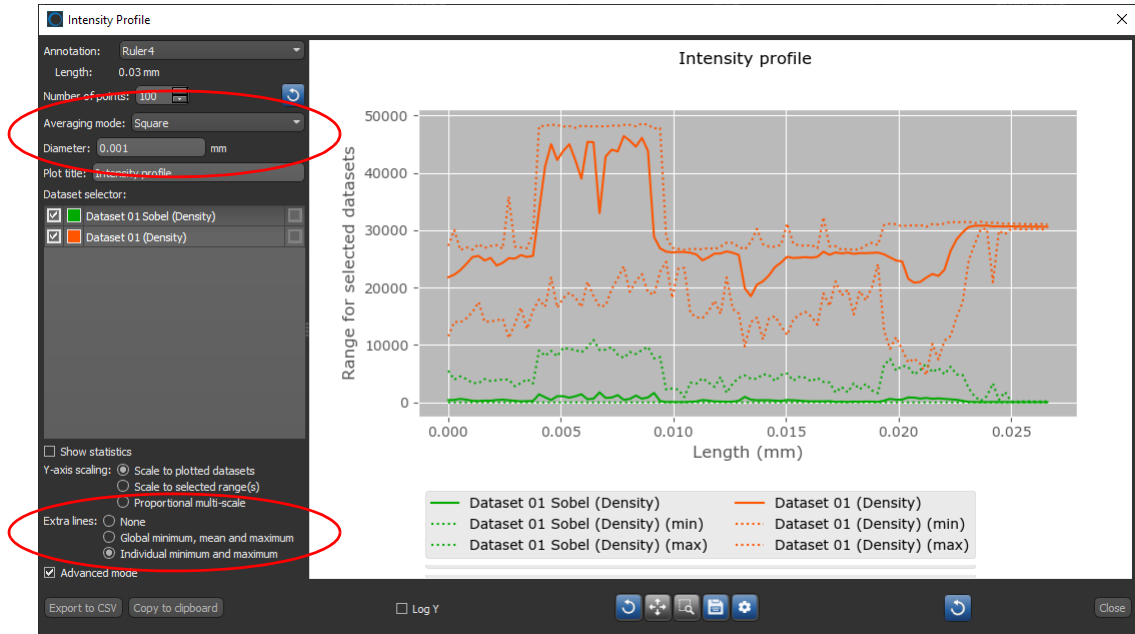
NOTE When probing neighborhoods, the diameter of the Disk or Sphere probe, as well as the side measurement of the Square or Cube probe, is selectable. Refer to the Dragonfly Help system for more information about the Probe measurements and for information about the configured actions for the Probe tools.

Depth Probing with Annotation Tools

In addition to the depth probe tools available on the Probe panel (see [Area and Depth Probe Tools](#) on page 7), this software release provides the option to apply an *Averaging mode* to profile intensity perpendicular to a ruler or path within a disk or square.

The Averaging mode for rulers and paths, as well as a selectable diameter, is available in the updated Intensity Profile dialog, shown below.

Intensity Profile dialog

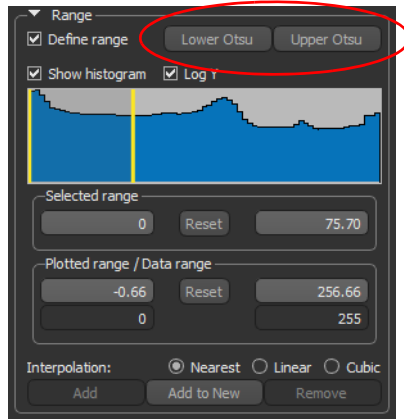


NOTE You can show the "unaveraged" minimum and maximum values as a series of dotted lines on the profile by selecting the Extra lines option **Individual minimum and maximum**.

New Segmentation Options

The updated Range box, shown below, now includes options to automatically set ranges defined by the Otsu threshold.

Range box



Lower Otsu... Automatically sets the defined range between 0 and the Otsu threshold.

Upper Otsu... Automatically sets the defined range between the Otsu threshold and the maximum value in the data range.

NOTE The reformatted Range box, in which you can define intensity domains for threshold segmentations and for editing regions of interest, also provides more responsive performance and additional information, such as the selected sample's data range and the range of plotted values on the histogram.

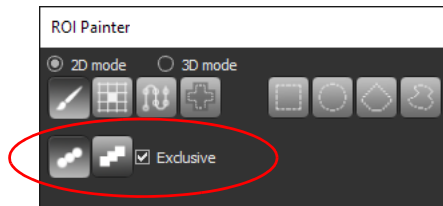
New Options for Editing Regions of Interest

To edit a segmentation, you can now automatically re-assign labeled voxels from one region to interest to another with the Brush tools. For example, in cases in which an automated bone segmentation resulted in voxels corresponding to trabecular bone being erroneously labeled as cortical bone or vice versa. In the example below, cortical bone (highlighted in yellow) was mistakenly assigned to the trabecular regions.

Automated segmentation result



NOTE You can also choose to work in the newly introduced *Exclusive* mode with the Brush tools. In this mode, only the labeled voxels belonging to the selected regions of interest will be affected when painting. This option is available on the ROI Painter panel as shown below.



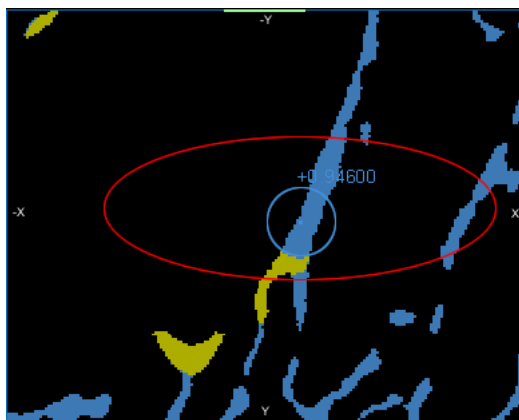
Do the following to re-assign labeled voxels from one ROI to another:

1. Select the 2D view in which you plan to edit the regions of interest.
2. Select the required regions of interest on the Data Properties and Settings panel. The selected ROIs are identified as (A) and (B).
3. Select a 2D or 3D Brush on the ROI Painter panel.
4. Select the **Exclusive** option, if required.

In this mode, painting will only be applied to the labeled voxels of the selected regions of interest. Unlabeled voxels will not be painted.

5. Do the following, as required:
 - Add and re-assign labeled voxels to ROI (A) from ROI (B) by holding down LEFT CTRL (or your configured *Add with* key) and then painting.

As shown below, only labeled voxels highlighted in yellow are re-assigned to those highlighted in blue when painting in Exclusive mode. Unlabeled voxels are not painted.



- Remove and re-assign labeled voxels from ROI(A) to ROI(B) by holding down LEFT SHIFT (or your configured *Remove with* key) and then painting.

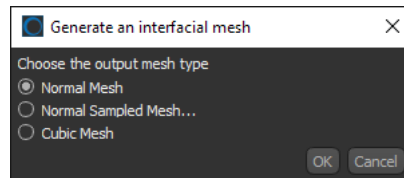
New Options for Segmented Regions

A number of new options, such as interfacial mesh generation, extraction of three-phase boundaries, anisotropy computations, and smoothing, are available in this software release for regions of interest.

Interfacial Meshes

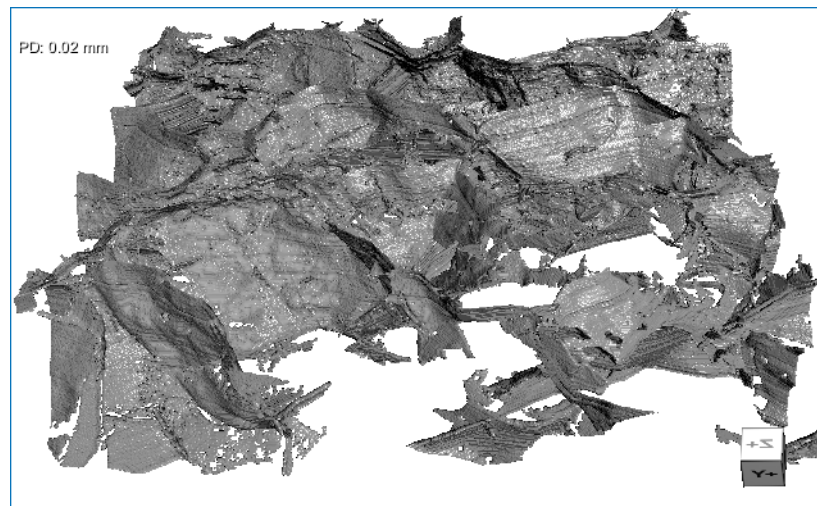
Normal, sampled, or cubic meshes that describe interfacial surfaces, which can be defined as the point of contact between two phases, can be generated for selected regions of interest or multi-ROIs. Right-click the required regions of interest or multi-ROIs in the Data Properties and Settings panel and then choose **3D Modeling > Generate Interfacial Mesh** in the pop-up menu to compute the mesh. You can choose a mesh type in the Generate an Interfacial Mesh dialog, shown below.

Generate an interfacial mesh dialog



An example of an interfacial mesh extracted for a segmented phase is shown in the following screen capture.

Interfacial mesh



NOTE If more than two regions of interest or multi-ROIs are selected, the interfacial surface generated will be between the first object selected (A) and the union of all other selected objects (B + C + D...).

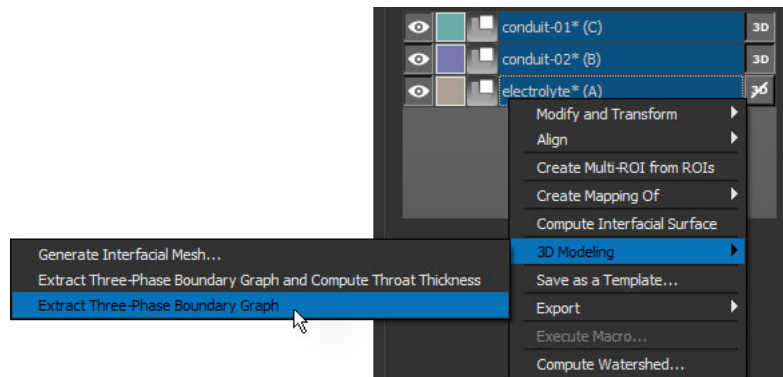
NOTE Interfacial mesh representations are approximations only and computed surfaces may not correspond to the actual surface. Computing interfacial surfaces from regions of interest, which are performed in 3D with interpolated surfaces, is the recommended alternative for an analysis. In some cases, smoothing a mesh may help to align surface measurements to those computed from regions of interest.

Three-Phase Boundaries

This Dragonfly release includes the option to extract graphs of the three-phase boundary shared between selected regions of interest and to compute pore throat thickness. The concept of a three-phase boundary (TPB) is most commonly described in fuel cell literature and employed in research, especially with respect to solid oxide fuel cells and polymer electrolyte membrane fuel cells. The TPB concept postulates that hydrogen oxidation and oxygen reduction reactions can only occur at confined spatial sites where electrolyte, gas, and electrically connected catalyst regions contact.

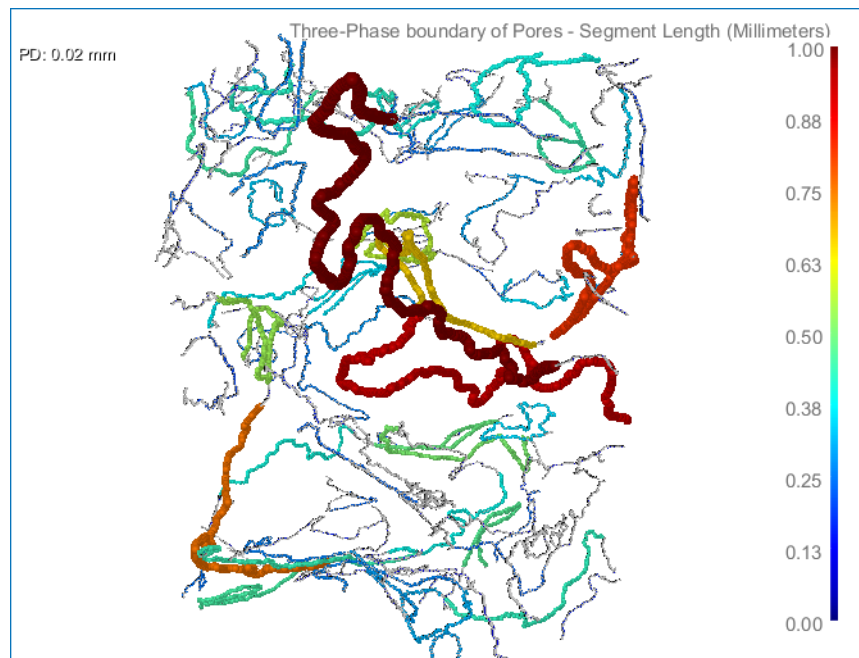
To extract a three-phase boundary graph, select the regions of interest that describe the three phases and then choose **3D Modeling > Extract Three-Phase Boundary Graph** in the pop-up menu. If you additionally need to compute throat thickness, choose **3D Modeling > Extract Three-Phase Boundary Graph and Compute Throat Thickness**.

Extract three-phase boundary options for regions of interest



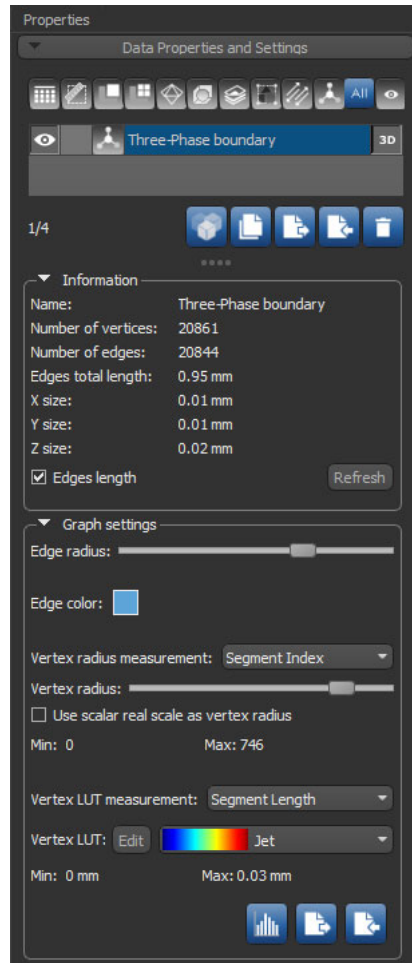
The result is a three-phase boundary graph that can be examined in a 3D view.

Three-phase boundary graph



Information and settings related to the graph are available on the Data Properties and Settings panel, as shown in the following screen capture. You should note that scalar values related to computed throat thicknesses are available in the Graph settings box and that these values can be further examined with the help of the Measurement Inspector.

Properties for three-phase boundary graphs



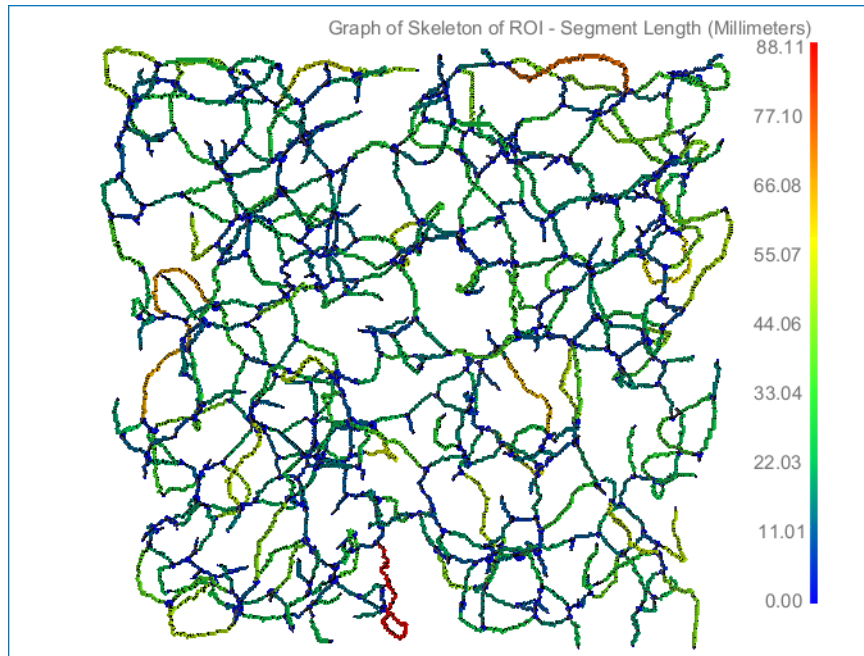
NOTE You can further analyze graphs with Dragonfly's new Graph Analysis tool (see [Graph Analysis Tool](#) on page 18).

Get Skeleton of ROI as Graph

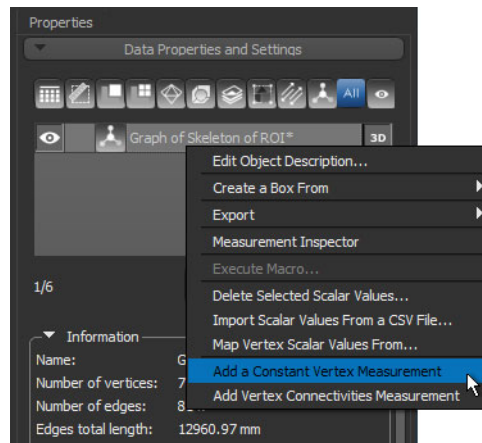
This new option for regions of interest automatically creates a graph in which the segments contained within the skeletonized region of interest are assigned to edges and vertices. The scalar values of Segment Index, Segment Euclidean Length, Segment Length, and Segment Tortuosity are also computed automatically and available for evaluation.

Right-click the required region of interest and then choose **3D Modeling > Get Skeleton of ROI as Graph** to create a graph from an ROI, as shown below.

Graph of skeleton of an ROI



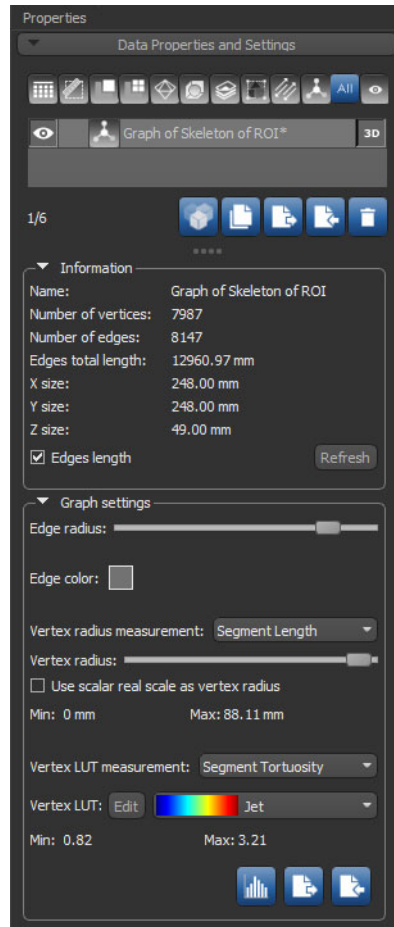
NOTE The additional options of adding a constant vertex measurement or vertex connectivities measurement is available in the pop-up for graphs, as shown below.



You should also note that applying a constant to the vertex radius measurement can facilitate the evaluation of some graphs.

Information about the selected graph, as well as the graph settings, are available on the Data Properties and Settings panel, as shown below.

Graph information and settings



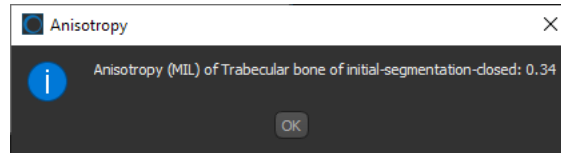
NOTE You can also evaluate graphs with the help of Dragonfly's Measurement Inspector. Right-click the graph and then choose Measurement Inspector in the pop-up menu to open the Inspector tab on the right sidebar.

NOTE You can further analyze graphs with Dragonfly's new Graph Analysis tool (see [Graph Analysis Tool](#) on page 18).

Anisotropy Computations

This software release provides the opportunity to compute anisotropy, which is a measure of how highly oriented substructures are within a volume, using the mean intercept length (MIL) or star volume distribution (SVD) method. To compute anisotropy, right-click the required region of interest and then choose **Compute Anisotropy Using > Mean Intercept Length (MIL)** or **Compute Anisotropy Using > Star Volume Distribution (SVD)** in the pop-up menu. The result appears in a message box after the computation is complete.

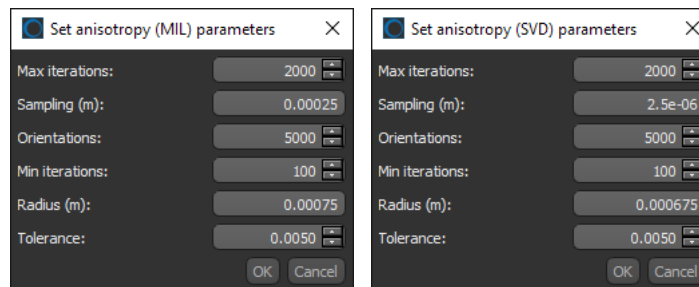
Anisotropy computation



NOTE For an isotropic (perfectly oriented) system, the degree of anisotropy (DA) is equal to 0. As the system becomes more anisotropic (less well-oriented), the DA increases to some value less than 1.

The settings for computing the degree of anisotropy, for example of segmented trabecular bone, are available in the Set Anisotropy Parameters dialogs, shown below.

Set Anisotropy Parameters dialogs



Refer to the table below for a description of the settings applicable to anisotropy computations.

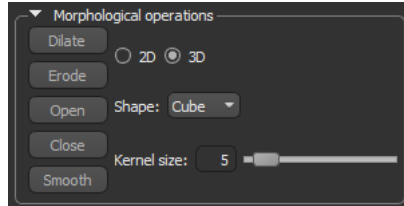
Settings for computing anisotropy

	Description
Max iterations	Is the maximum number of random points in the sample that will be analyzed. Fitting will stop automatically after this number is completed or if the coefficient of variation (tolerance) is reached.
Sampling (m)	Is the resolution, or distance between subsequent samples along each vector. You should note that the entered value can be equal to the voxel size of the input region of interest.
Orientations	Is the number of lines to analyze per sampling sphere.
Min iterations	Is the minimum number of random points in the sample that will be analyzed.
Radius (m)	Is the radius of the sampling sphere, which determines the length of each sampling vector.
Tolerance	Is the coefficient of variation. Sampling new random points will continue until either a coefficient of variation equal to the tolerance is reached or the maximum number of iterations is completed.

Smoothing Operation for ROIs

In some cases, such as after creating a threshold segmentation, it may be necessary to smooth a region of interest by removing noise from the surface of an object. This software release provides a new morphological operation for smoothing ROIs in the Morphological operations box, shown below, which is available on the ROI Tools panel.

Morphological operations



The precise effect of the smoothing operation is determined by the selected structuring element. If the *Range* option is also selected, the operation will be limited to the defined range. An example of smoothing is shown in the following screen captures.

Original ROI (left) and smoothed ROI (right)

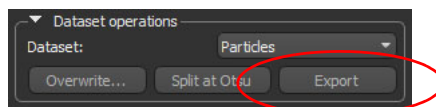


Export Dataset Mask

It can often be necessary, or useful, to restrict measurements or processing to a subset of the data that needs to be analyzed. This software release provides the option to export a subvolume of a dataset that only includes data values that intersect with the labeled voxels of a selected region of interest.

This option is available in the Dataset operations box on the ROI Tools panel, as shown below.

Export option



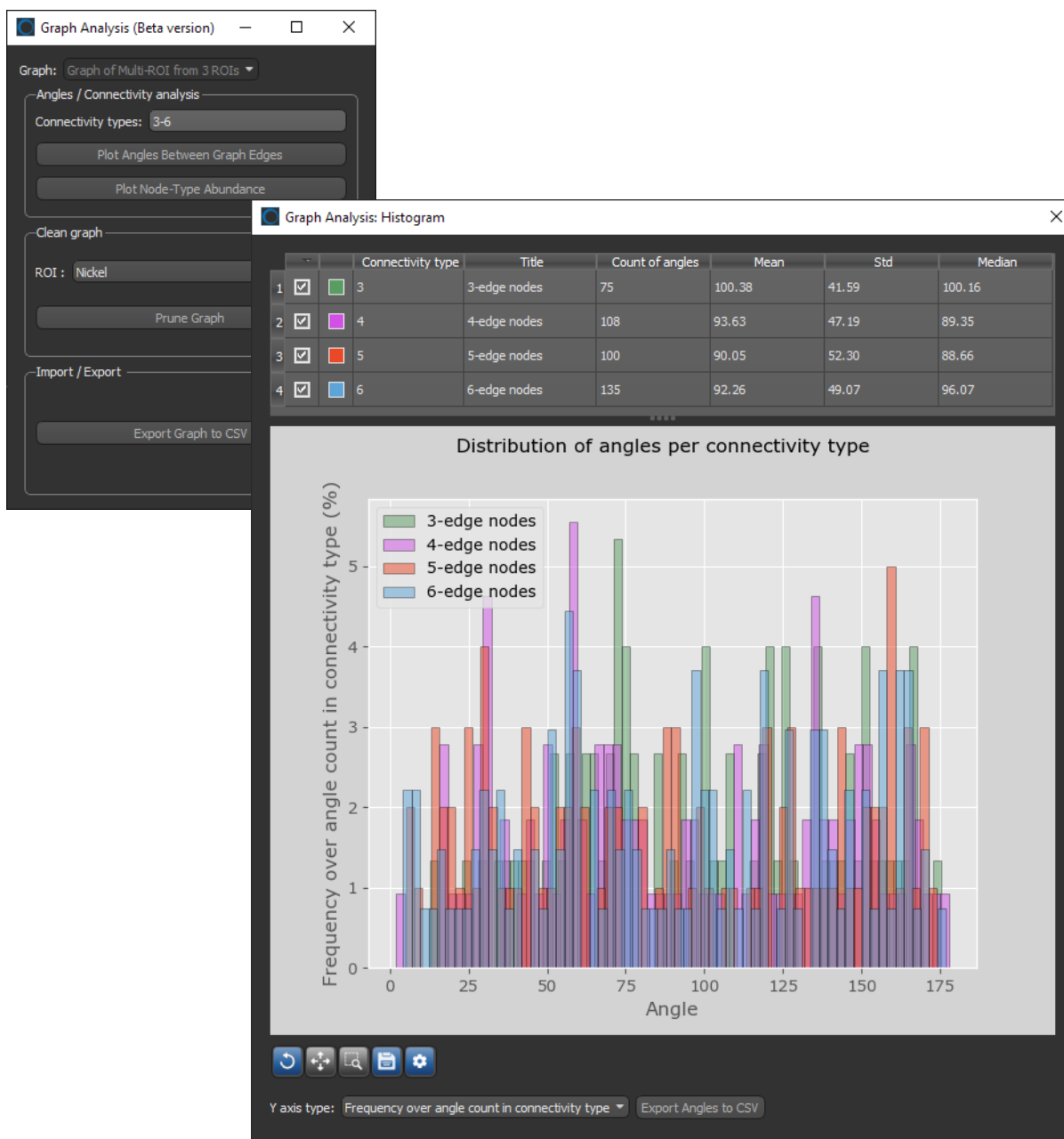
NOTE Dataset masks are exported in the shape of the selected region of interest.

Graph Analysis Tool

Included in this software release is a Beta version of Dragonfly's new Graph Analysis tool. This module lets you conduct a detailed analysis of a selected graph, such as plotting angles between graph edges and node-type abundance, as well as prune graphs in cases in which nodes or links are not compliant with the graph properties.

To open the Graph Analysis tool, right-click the graph you need to analyze and then choose **Graph Analysis** in the pop-up menu. The screen captures below include the Graph Analysis and the Graph Analysis Histogram dialogs.

Graph Analysis dialogs



New Options for Box Shapes

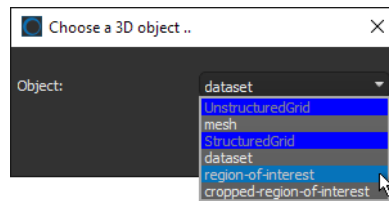
A number of new options for automatically resizing boxes to a selected 3D object are now available in the Shape contextual menu and include the following:

Grow to Contain 3D Object... Expands the box to fully enclose the bounding box of the selected 3D object. In this case, the box will not be contracted or reoriented.

Wrap 3D Object... Resizes and/or reorients the box to tightly wrap the bounding box of the selected 3D object.

You can select the 3D object — such as a mesh, dataset, region of interest, or multi-ROI — that you want to contain or wrap to in the Choose a 3D Object dialog, shown below.

Choose a 3D Object dialog

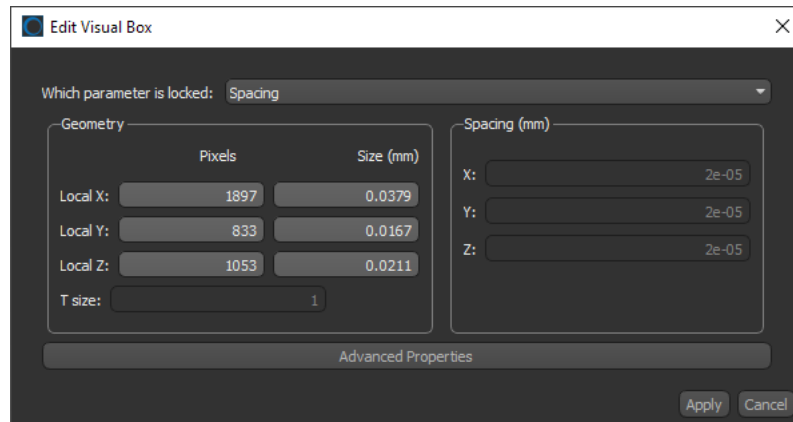


Edit Visual Box

In some post-processing and analysis operations, it might be necessary to modify the spacing of a Box shape or to create a box with a specific granularity. For example, when choosing a box for computing vector fields describing anisotropy for a bone analysis.

To open the Edit Visual Box dialog, shown below, right-click the required Box shape and then choose **Edit Visual Box** in the pop-up menu.

Edit Visual Box dialog



NOTE You can also edit the advanced properties of a box, such as its position in space or orientation.

New Image Filters

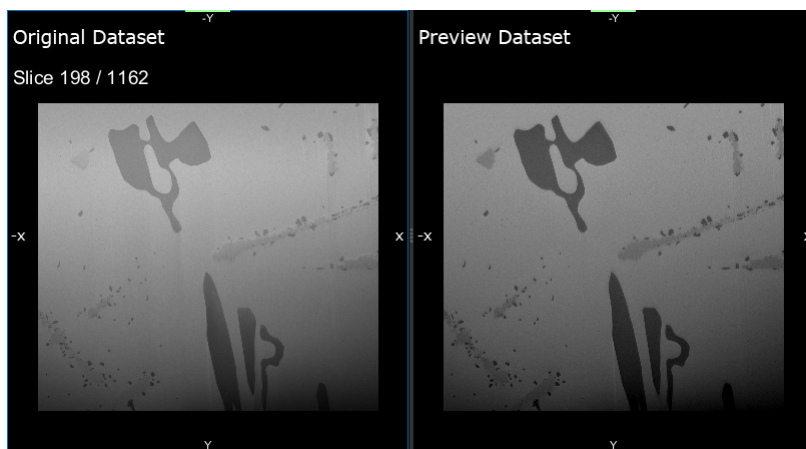
The following new filters are available in this software release for processing image data and for training deep learning models and classifiers for trainable segmentation.

Gradient-Domain Fusion Filter

The new gradient-domain fusion filter helps remove inter-image discontinuities, while preserving intra-image detail, from registered image stacks acquired from modalities such as scanning electron microscopy (SEM). You should note that gradient-domain fusion filtering is a two-step process. First, anisotropic smoothing is applied by convoluting the image stack with an anisotropic Gaussian with low variance in XY and a higher one in Z. This step removes both low and high frequencies. Then, Poisson blending is applied to restore the high frequencies by fusing the high frequency of the original image and the lower one of the smoothed data by doing a frequency space blend.

The result of gradient-domain fusion filtering is illustrated in the example on the following page.

Original data (left) and preview after gradient-domain fusion filtering (right)



Ring Artifact Removal

Ring artifacts can be a common issue affecting CT image systems and often correspond to detector defects. These artifacts usually appear at fixed positions and form a circle (360 degrees scan) or half circle (180 degrees scan) on tomographic slices. The best solution is to avoid these artifacts at the source. However, in cases in which only reconstructed slices are available, a new **Ring Removal** filter is available in this Dragonfly release.

NOTE For more information about this new filter, refer to: https://tomopy.readthedocs.io/en/latest/api/tomopy.misc.corr.html#tomopy.misc.corr.remove_ring.

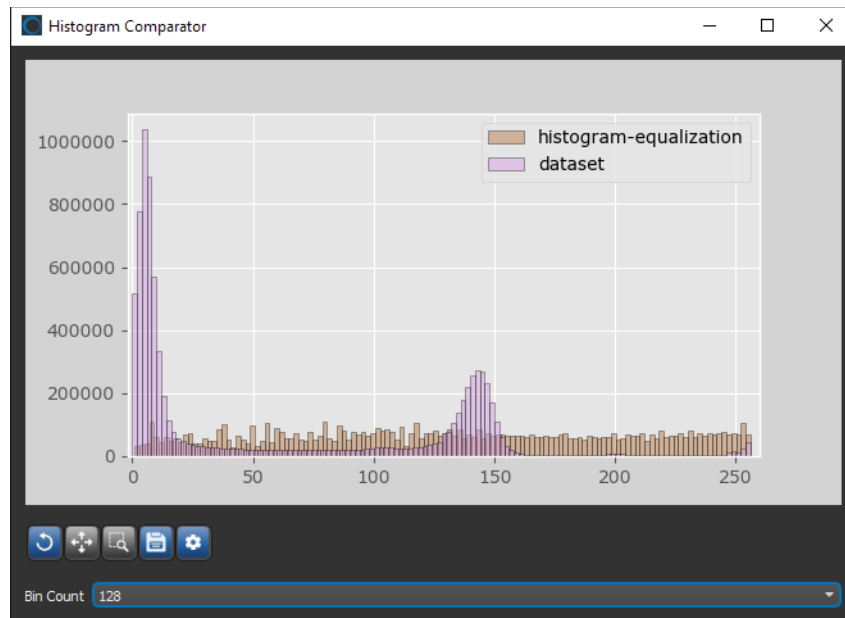
Filter Updates

Some users have reported that the previews for the K-Means filters can be unpredictable and that results might not match previews. This was due to a random centroid initialization and random reassignment. In the updated version of these filters, the centroid initialization is now deterministic, not random.

Histogram Comparer

This software release adds the option to directly compare the histograms of multiple datasets, as shown below. To compare histograms, select the required datasets in the Data Properties and Settings panel and then choose **Compare Histograms**.

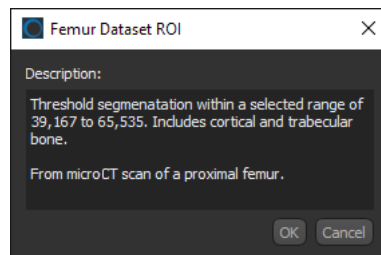
Histogram Comparator



Object Descriptions

You can now add a description to any object, including image data, regions of interest, meshes, graphs, and others. Right-click the required object and then choose **Add Object Description** to open the dialog shown below.

Object Description dialog



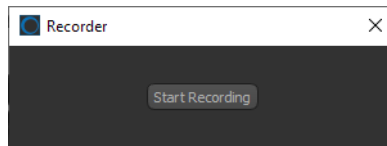
Application Recorder

This release features a simple, easy-to-use application recorder that lets you automatically record your full screen while working with Dragonfly. The application recorder, which could be used to make tutorial videos or to illustrate issues you may experience when working with Dragonfly, does the following:

- Records full screen in high-quality resolution and full color.
- Mouse highlighting spotlights the location of the cursor.
- Recordings can be saved in the MPEG4 (*.mp4 extension), AVI (*.avi extension), and GIF (*.gif extension) file formats.

Choose **Tools > Application Recorder** on the menu bar to open the Recorder panel, shown below.

Recorder panel



Export Animated GIFs

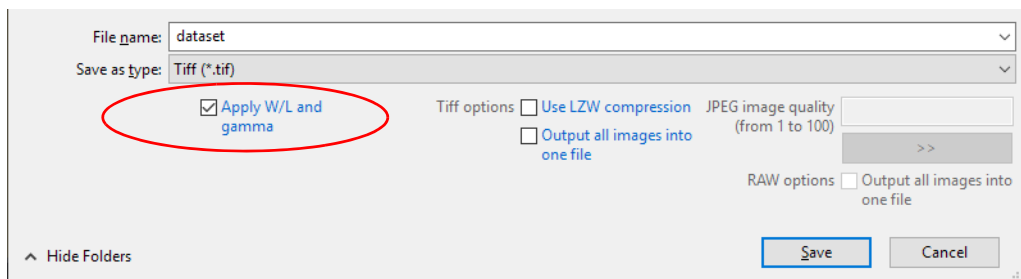
The option to export animations and application recordings in the animated GIF file format (*.gif extension) is now available from the 2D Animation panel, the Movie Maker, and from the Application Recorder.

NOTE When exporting an animated GIF, Dragonfly will first render the full sequence as an MPEG and then calculate the best color palette for the animated GIF, which is limited to 256 colors. The temporary MPEG will not be retained in memory.

Apply W/L and Gamma Values

In some cases, you may want to apply the window leveling settings and gamma value you selected for reviewing images to exported image data. This new option, circled below, is available in the Save As dialog when you choose to export images.

Save As options



NOTE This is available only for Dragonfly Pro. Contact Object Research Systems for information about the availability of this version of Dragonfly.

Developer Tools

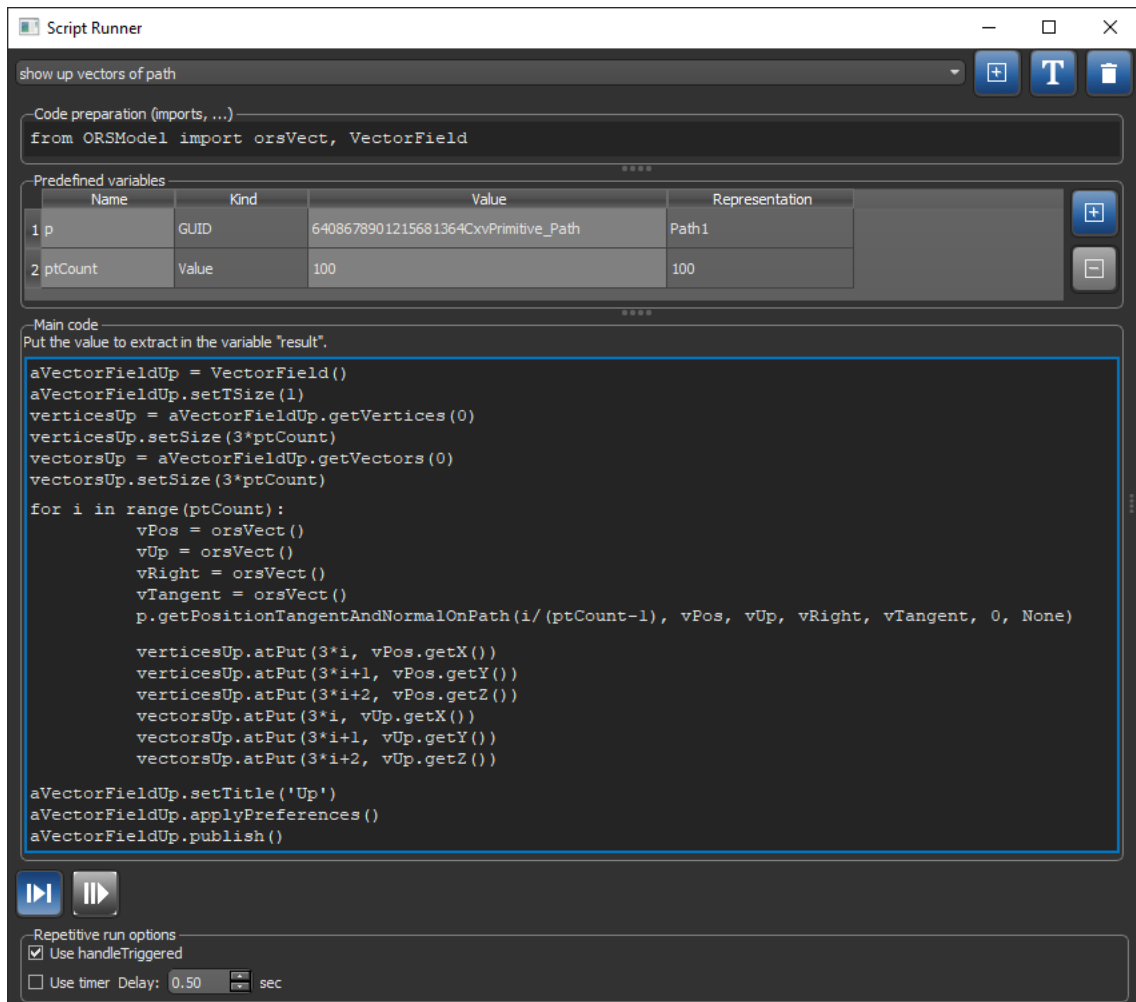
A number of new tools designed for developers, such as the Script Runner and File Loader Generator, are available in this software release.

Script Runner

The new Script Runner is a tool designed to execute custom code. It can be used for introspection purposes on any Python object in the application, such as class instances, widgets, or ROIs. It can also be used to evaluate code snippets or to debug a few lines of code that is used in a file-based extension, such as a generic menu item. This tool is similar to the Python console for its ability to execute any code. Multiple scripts can be kept and recovered after the application is restarted. Moreover, the Script Runner provides options to repeat the execution of the provided script, enabling live introspection of objects being manipulated while the script is run.

Choose **Developer > Script Runner** on the menu bar to open the Script Runner dialog, shown below.

Script Runner dialog



File Loader Generator

The new File Loader Generator generates a file canvas from the provided parameters recognized as a File Loader extension. A File Loader extension allows developers to load a dataset having a specific file format.

Choose **Developer > File Loader Generator** on the menu bar to open the File Loader Generator dialog.

Product Enhancements

This release provides the following product enhancements for Dragonfly. Information about new features, such as depth probing, image filters, and the application recorder, as well as newly implemented options for pore network modeling and segmented regions, is available in the topic [New Features](#) on page 5.

Bone Analysis

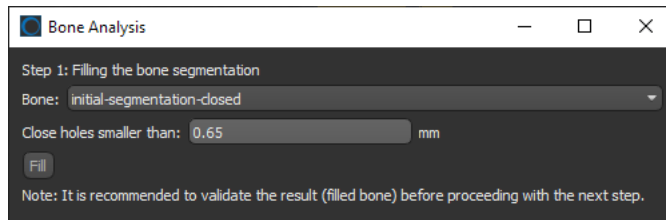
Dragonfly 4.1 includes a number of improvements for the Bone Analysis module. These enhancements include guided segmentation steps, expanded inputs for computing global measurements, and masking to limit lengthy computations.

Guided Segmentation Steps

A series of guided segmentation steps were added to the Bone Analysis dialog that let you close cortical pores and vascular inlets and fill an initial bone segmentation before proceeding to the separation of the cortical and trabecular bone.

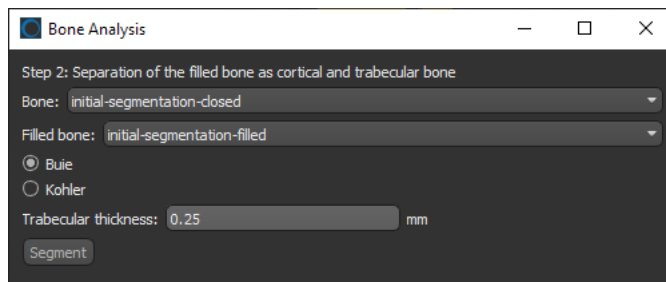
The first step of the new guided segmentation scheme is shown below.

Filling bone segmentations



The second step of the guided segmentation, shown below, lets you choose a segmentation method for separating filled bone into cortical and trabecular components.

Segmenting cortical and trabecular bone

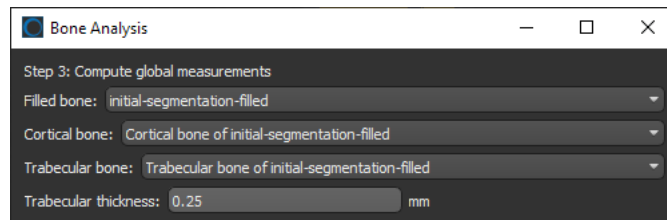


Inputs for Computing Global Measurements

The workflow of Bone Analysis has been changed so that global measurement computations now rely on input cortical bone and trabecular bone segmentations, instead of the previously automated cortical and trabecular area segmentations. This change offers the opportunity to edit automated bone segmentations, as well as to input any region of interest that satisfies the requirements.

The new inputs for computing global measurements are shown in the following screen capture.

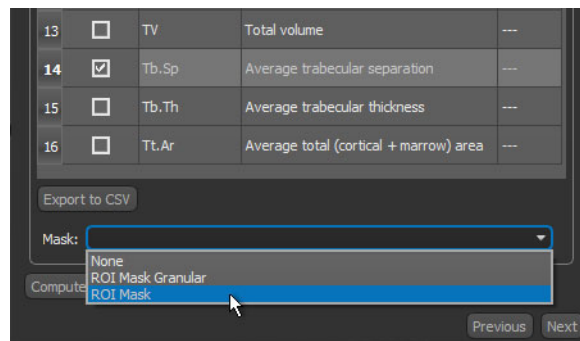
Inputs for computing global measurements



Masking for Computations

You can now apply a mask to limit the area in which average trabecular separation thickness will be computed.

Mask for computing average trabecular separation



Deep Learning Improvements

This software release features a number of enhancements for Deep Learning, including the following:

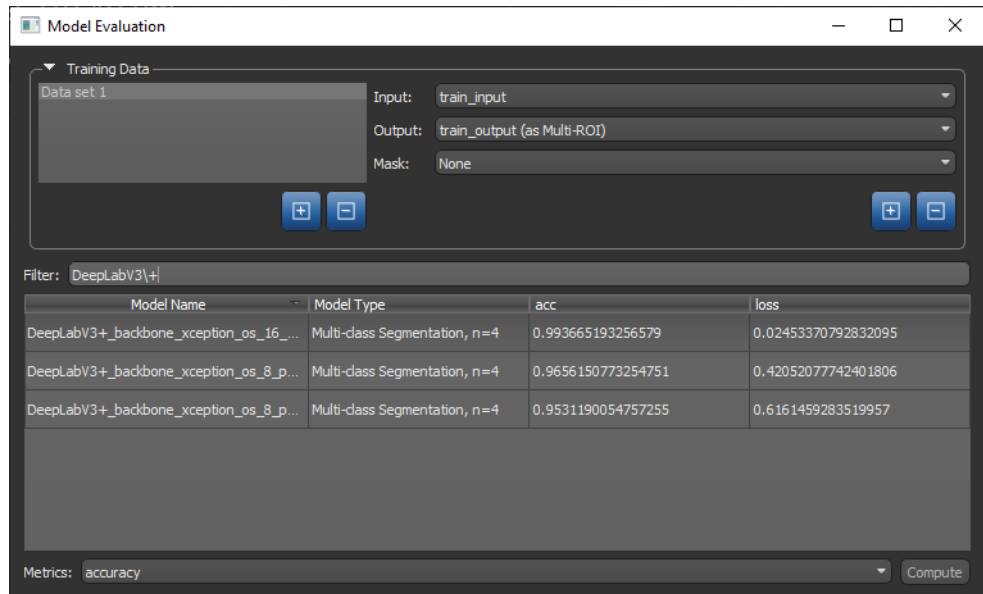
- Custom loss function/metrics, including weighted categorical cross-entropy, Dice, PSNR, SSIM, and Jaccard similarity coefficient.
- Support for loading/saving a model with custom layers, loss functions, and evaluation metrics.
- Use of the first layers of a Deep Model to compute feature vectors in the Segmentation Trainer.

Model Evaluation Tool

To help evaluate Deep Learning segmentation quality, this software release features a model evaluation tool that lets you compare different models with selected metrics, such as binary cross entropy, mean absolute error, and Poisson for regression, as well as Jacard similarity, accuracy, and Dice for binary segmentation.

Choose **Tools > Deep Learning Model Evaluation Tool** on the menu bar to the open the Model Evaluation dialog, as shown below.

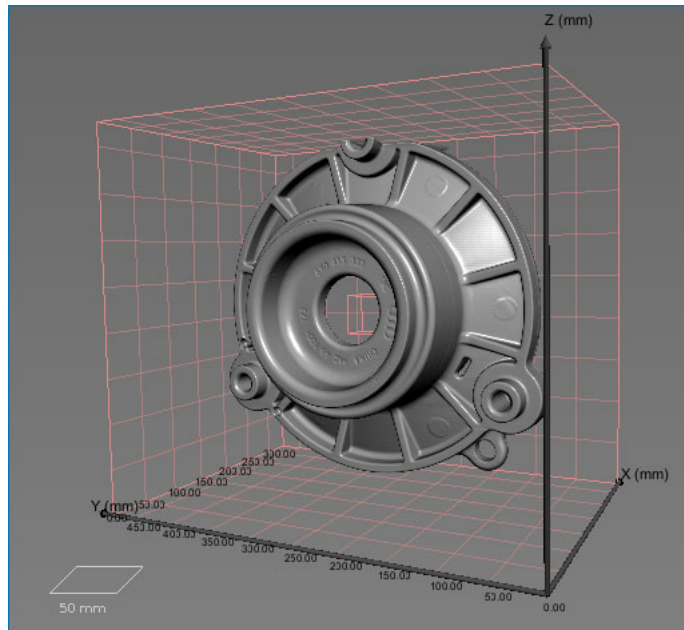
Model Evaluation dialog



Clip Box Updates

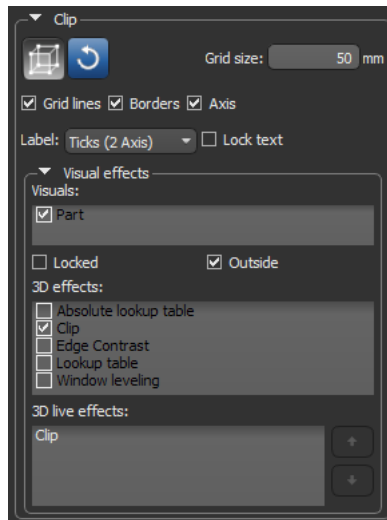
Updates for the Clip box, shown in the following screen capture, let you add X, Y, and Z axis markers, as well as labels that show the length measurements for each axis or graduated “tick marks” that are aligned on the border of the box. You can also now choose to show or hide the grid lines and box borders.

Clip box



The additional settings for the Clip box are available on the Data Properties and Settings panel, shown below.

Clip settings



Clip box settings

	Description
Grid lines	If checked, grid lines will be shown on the Clip box.
Borders	If checked, the borders of the Clip box will be shown.
Axis	If checked, the X, Y, and Z axes will be identified and shown on the Clip box.
Label	Lets you choose what labels you want to appear on the Clip box. None... If selected, no labels will be shown. Ticks (2 Axes)... If selected, tick marks will be shown at intervals equal to the grid size along two axes of the Clip box. Ticks (3 Axes)... If selected, tick marks will be shown at intervals equal to the grid size along the X, Y, and Z axes of the Clip box. Length... If selected, the current length of each axis of the Clip box will be shown. You should note that the initial Clip box applied to an unstructured grid, such as a mesh or graph, will be padded by 1% for visualization purposes. If resized, the Clip box will report the actual dimensions of the unstructured grid.
Lock text	If selected, text associated with the tick marks will not move when the camera is rotated.

NOTE You can select the default colors for the axis and tick marks in the Colors preferences, as well as the default appearance of the Clip box in the 3D Settings preferences (see [Views Preferences](#) on page 40).

Automatic Rotations for 3D Views

Automatic rotations for 3D views, which can included in animated sequences, are available in this software release. Right-click the required 3D view and then choose **Start Rotation** in the pop-up menu. The rotation will start automatically from the current pivot position.

A number of new configurable actions for spinning objects in a 3D view are also available. These include the following:

Spin an object in 3D... Lets you configure a keyboard shortcut to start a spin.

Stop 3D spin... Lets you configure a keyboard shortcut to stop spinning.

Switch to 3D spin mode... Lets you configure a keyboard shortcut to enter spin mode.

Visibility Toggles

This software release introduces as series of keyboard shortcuts that let you set all objects selected in the Data Properties and Settings panel to non-visible or visible in the current 2D scene views or to toggle the opacity of ROIs, multi-ROIs, and datasets selected in the Data Properties and Settings panel. See [Configurable Actions](#) on page 40 for a list of all new actions for toggling visibility.


Visual Planes

In this software release, the Visual Plane panel has been removed and all plane settings, such as *Show data*, are now available on the Data Properties and Settings panel. In addition a new option to add multiple planes with a single click is available on the Shapes panel, shown below.

Shapes panel

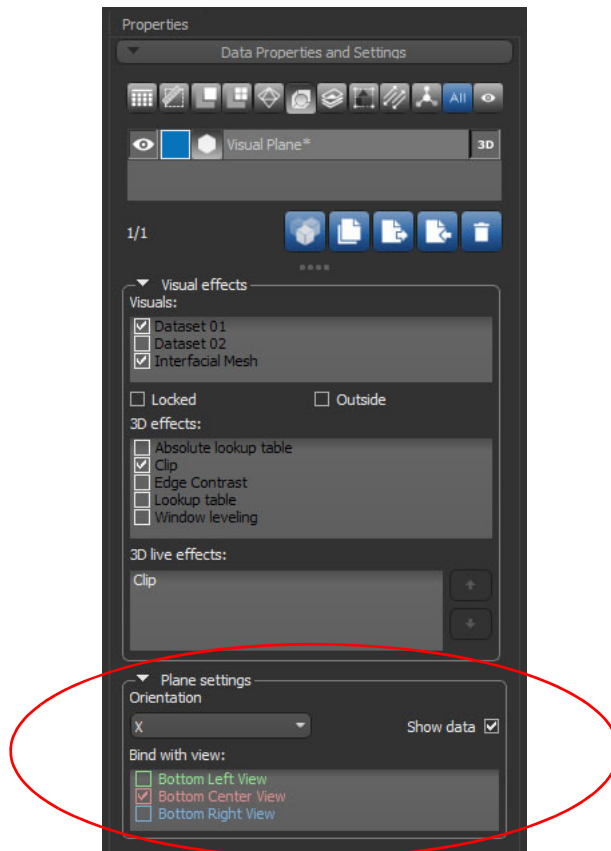


Visual Plane options

	Description
	Adds three new planes to the Data Properties and Settings panel.

The options in the Plane settings box on the Data Properties and Settings panel let you choose an initial orientation for the selected plane or to bind a plane with a selected 2D view. You can also choose to show corresponding 2D data in the scene's 3D view. As is the case for all other shapes, you can choose the additional visual effects you want to apply to the selected plane in the Visual effects box.

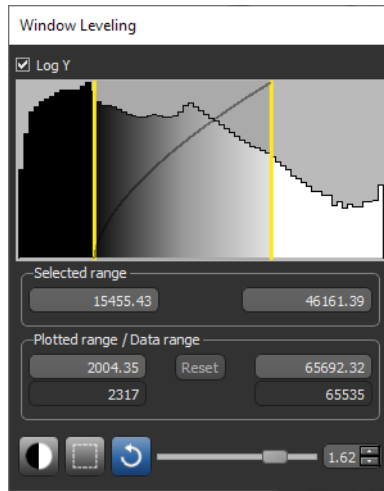
Visual Plane settings



Window Leveling

This software release features a reformatted Window Leveling panel that provides more responsive performance, particularly when working in 3D views, and additional information, such as the selected sample's data range and the range of plotted values on the histogram. The reformatted panel is shown below.

Window Leveling panel

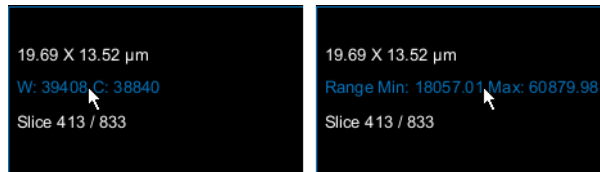


NOTE This software release also features an update to PyQt from Matplotlib for computing histograms, which should result in quicker computations.

Configurable Window Leveling Text Annotation

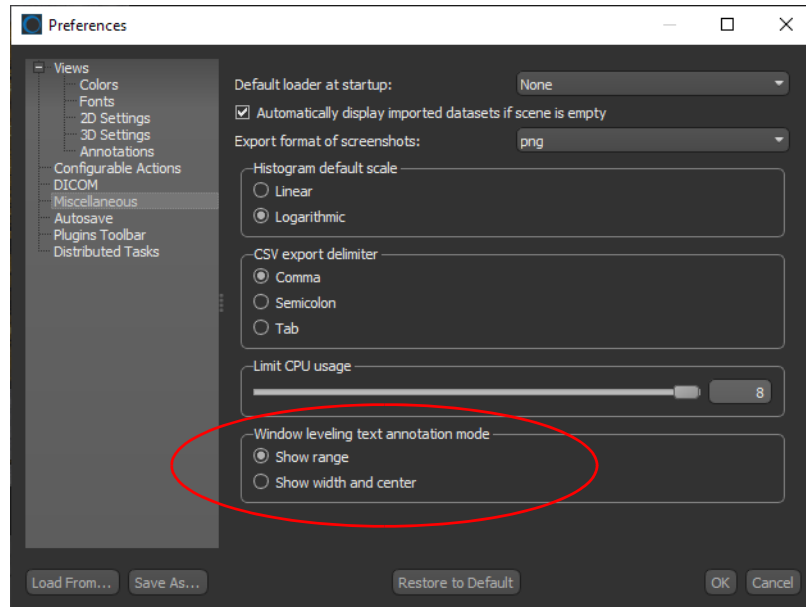
New options for selecting a mode for the Window Leveling text annotation is available in this software release, as shown below.

Window leveling text annotation options



You can choose to show the window width and center values (on left above) or the minimum and maximum values of the selected range (on right above). These options are available in the Miscellaneous preferences, as shown in the following screen capture.

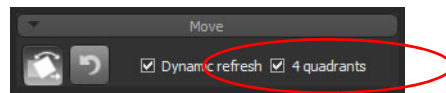
Miscellaneous preferences



Move Tool Update

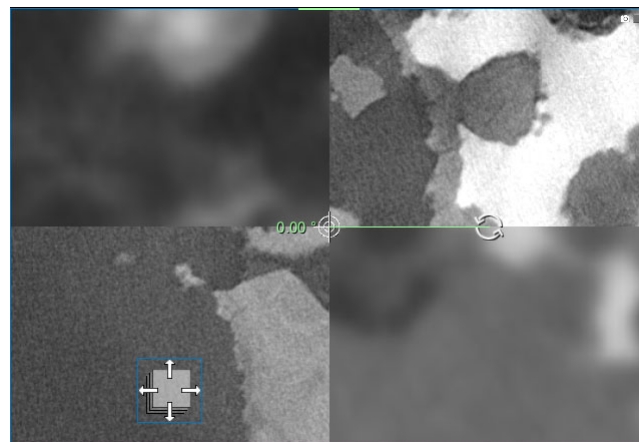
An additional option — *four-quadrants* — is now available for manually registering datasets with the Move tool. This option is circled below.

Move panel



If the option is selected, the 2D views in the workspace will be divided into four quadrants, with the quadrants on the top left and bottom right showing one dataset and the remaining quadrants showing the other dataset. This arrangement was implemented to help align features within the selected datasets, as shown in the following screen capture.

2D views



3D Modeling

A number of improvements, listed below, are available for 3D modeling in this software release.

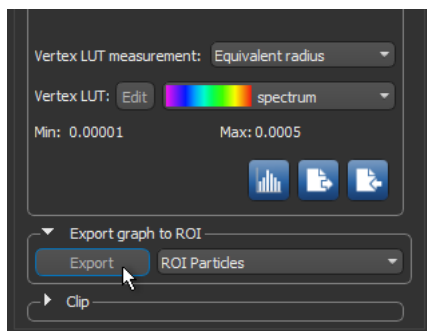
Graph Appearance

The rendering of graphs is dynamic in this software release, which means that when the data includes a limited number of nodes, more vertices are displayed. Likewise, when the data includes a large number of nodes, less vertices will be displayed. This is aimed at helping to both accelerate and improve visualizations.

Export Graph to ROI

This software release provides the option to export a graph as a region of interest, as shown below.

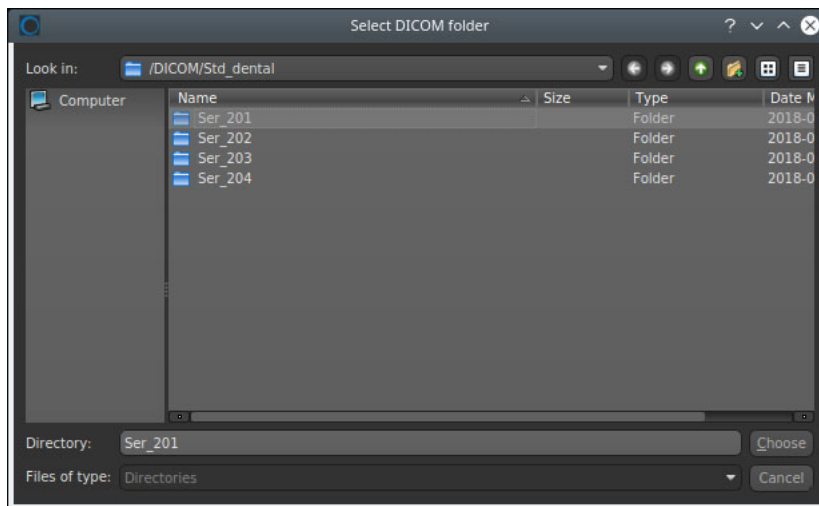
Export graph to ROI option



Import DICOM Images for Linux

The option to import DICOM images is now available for the Linux version of Dragonfly. Choose **File > Load DICOM Folder** on the menu bar to open the Select DICOM Folder dialog, shown below.

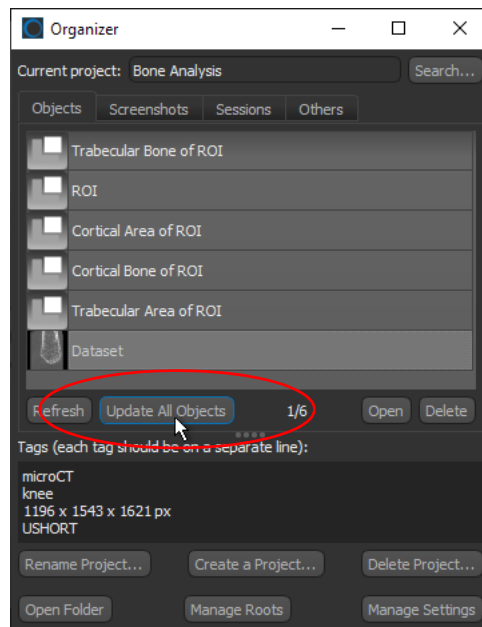
Select DICOM Folder dialog



Auto Updates for the Organizer

As an update for Dragonfly's Organizer, you can now synchronize a project with changes made in the workspace. For example, after editing a region of interest. As shown below, simply click the **Update All Objects** button to save all of the changes that were made to all of the objects opened from the current project.

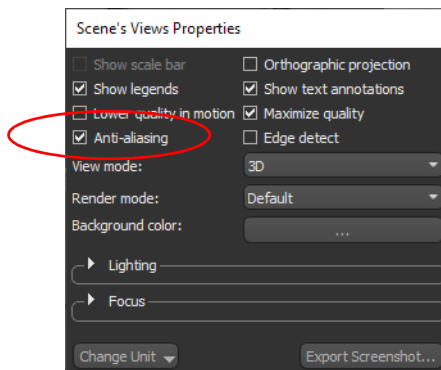
Organizer dialog



Scene's Views Properties

The option to apply anti-aliasing to 3D scene views, in order to smooth jagged edges on curved lines and diagonals, is now available on the Scene's Views Properties panel. This option is circled below.

Scene's Views Properties panel

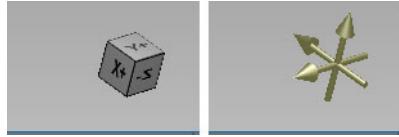


NOTE You should also notice additional improvements for setting the Lighting properties for 3D views.

Configurable Axis Indicator

An additional representation for the Axis Indicator that appears in 3D views is available in this software release. Right-click the 3D view and then choose **Axis Indicator** in the pop-up menu. You can select **Cube**, **Arrows**, or **None** in the submenu.

Axis Indicator styles



NOTE You can choose a default appearance for the Axis Indicator in the 3D Settings preferences (see [Views Preferences](#) on page 40).

Developer Documentation

The developer documentation for Dragonfly has been updated for version 4.1. Choose **Help > Dragonfly Developer Documentation** on the menu bar to open the documentation system.

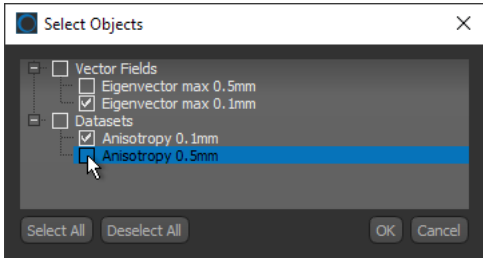
Menu Bar Changes

The following changes and new items for the menu bar are implemented for Dragonfly 4.1.

File Menu

The new items listed below, and other changes, are available for the File menu.

File menu changes

	Description
Import Selected Object(s) from File	<p>Lets you import selected objects from an ORS Object file (*.ORSObject extension) that contains multiple objects. You can select all of the objects that you want to import in the Select Objects dialog, shown below.</p> 

Tools Menu

The new items listed below, and other changes, are available for the Tools menu.

Tool menu changes

	Description
Application Recorder	Opens the Recorder dialog, which lets you record your screen while working with Dragonfly (see Application Recorder on page 22).
Deep Learning Model Evaluation Tool	Opens the Model Evaluation dialog (see Model Evaluation Tool on page 27).
Pore Network Modeling	Opens the OpenPNM tab on the left sidebar (see Pore Network Modeling on page 5).

Developer Menu

The new items listed below, and other changes, are available for the Developer menu.

Developer menu changes

	Description
Script Runner	Opens the Script Runner dialog (see Script Runner on page 23).
File Loader Generator	Opens the File Loader Generator dialog (see File Loader Generator on page 24).

Changes to Contextual Menus

The following changes and new items for the contextual menus are implemented for Dragonfly 4.1.

Data Properties and Settings Panel

The following contextual menu items are now available for datasets, annotations, regions of interest, multi-ROIs, meshes, shapes, vector fields, and graphs on the Data Properties and Settings panel.

Dataset Pop-Up Menu

A number of new items, listed below, are available for the Dataset pop-up menu.

Dataset pop-up menu changes

	Description
Compare Histograms	Available for multiple selections, this option lets you directly compare the histograms of selected datasets (see Histogram Comparer on page 21).
Edit Object Description	Lets you enter a description for the selected dataset (see Object Descriptions on page 21).

Annotation Pop-Up Menu

A number of new items, listed below, are available for the Annotation pop-up menu.

Annotation pop-up menu changes

	Description
Edit Object Description	Lets you enter a description for the selected annotation (see Object Descriptions on page 21).

ROI Pop-Up Menu

A number of new items, listed below, are available for the Region of Interest pop-up menu. You should also note that the ROI pop-up menu was reformatted into groups, such as Modify and Transform, Connected Components, and 3D Modeling, for easier access to the available options.

ROI pop-up menu changes

	Description
Edit Object Description	Lets you enter a description for the selected region of interest (see Object Descriptions on page 21).
Compute Anisotropy Using	<p>Mean Intercept Length (MIL)... Lets you compute the degree of anisotropy for the selected region of interest using the mean intercept length (MIL) method (see Anisotropy Computations on page 16).</p> <p>Star Volume Distribution (SVD)... Lets you compute the degree of anisotropy for the selected region of interest using the star volume distribution (SVD) method (see Anisotropy Computations on page 16).</p>

	Description
3D Modeling	<p>Get Skeleton of ROI as Graph... Lets you create a graph of a skeletonized region of interest (see Get Skeleton of ROI as Graph on page 14).</p> <p>Generate Interfacial Mesh... Lets you generate an interfacial mesh from multiple regions of interest (see Interfacial Meshes on page 11).</p> <p>Extract Three-Phase Boundary Graph and Compute Throat Thickness... Lets you extract a graph of the three-phase boundary shared between selected regions of interest that includes scalar values of pore throat thickness (see Three-Phase Boundaries on page 12).</p> <p>Extract Three-Phase Boundary Graph... Lets you extract a graph of the three-phase boundary shared between selected regions of interest (see Three-Phase Boundaries on page 12).</p>

Multi-ROI Pop-Up Menu

A number of new items, listed below, are available for the Multi-ROI pop-up menu.

Multi-ROI pop-up menu changes

	Description
Edit Object Description	Lets you enter a description for the selected multi-ROI (see Object Descriptions on page 21).
Generate Interfacial Mesh	Lets you generate an interfacial mesh from multiple multi-ROIs (see Interfacial Meshes on page 11).

Mesh Pop-Up Menu

A number of new items, listed below, are available for the Mesh pop-up menu.

Mesh pop-up menu changes

	Description
Edit Object Description	Lets you enter a description for the selected mesh (see Object Descriptions on page 21).
Add a Constant Vertex Measurement	Lets you add a constant vertex measurement to the selected mesh. The name of the measurement and its value can be entered in the Name and Value dialogs, respectively.

Shape Pop-Up Menu

A number of new items, listed below, are available for the Shape pop-up menu.

Shape pop-up menu changes

	Description
Grow to Contain 3D Object*	Automatically expands a box to fully enclose the bounding box of a selected 3D object (see New Options for Box Shapes on page 19).
Wrap 3D Object*	Automatically resizes and reorients a box to tightly wrap the bounding box of a selected 3D object (see New Options for Box Shapes on page 19).
Edit Visual Box*	Lets you modify the spacing of a Box shape or to create a box with a specific granularity (see Edit Visual Box on page 19).

* Available for box shapes only.

Vector Field Pop-Up Menu

A number of new items, listed below, are available for the Vector Field pop-up menu.

Pop-up menu changes for vector fields

	Description
Edit Object Description	Lets you enter a description for the selected vector field (see Object Descriptions on page 21).

Graph Pop-Up Menu

A number of new items, listed below, are available for the Graph pop-up menus.

Pop-up menu changes for graphs

	Description
Edit Object Description	Lets you enter a description for the selected graph (see Object Descriptions on page 21).
Graph Analysis	Opens the Graph Analysis dialog, in which you can conduct detailed analyzes, such as plotting angles between graph edges and node-type abundance, as well as prune graphs (see Graph Analysis Tool on page 18).
Add a Constant Vertex Measurement	Lets you add a constant vertex measurement to the selected graph. The name of the measurement and its value can be entered in the Name and Value dialogs, respectively.
Add Vertex Connectivities Measurement	Lets you add vertex connectivities measurements to the selected graph.

Views Pop-Up Menus

A number of new options are available for the views pop-up menus.

2D Views Pop-Up Menu

A number of new items, listed below, are available for the 2D Views pop-up menu.

2D Views pop-up menu changes

	Description
Orthogonalize Other 2D Views	Lets you set the 2D views in a scene to be orthogonal to a selected oblique or double-oblique view.

3D Views Pop-Up Menu

A number of new items, listed below, are available for the 3D Views pop-up menu.

3D Views pop-up menu changes

	Description
Start Rotation	Lets you start an automated rotation of the view (see Automatic Rotations for 3D Views on page 29).
Axis Indicator	Lets you choose a style for the Axis Indicator (see Configurable Axis Indicator on page 35).
Hide Movie Maker	Lets you hide the Movie Maker panel in the selected 3D view. In this case, all thumbnails on the timeline will be kept.
Close Movie Maker	Lets you close the Movie Maker panel in the selected 3D view. In this case, all thumbnails will be removed from the timeline.

Preferences Changes

A number of new items, listed below, and other changes have been implemented for the setting the application preferences.

Views Preferences

Changes for the Views preferences are indicated in the following table.

Views preferences changes

	Description
Colors	
Clip box	<p>Lets you choose the default colors applied to the Clip box.</p> <p>X axis... Lets you select the color used to identify the X axis.</p> <p>Y axis... Lets you select the color used to identify the Y axis.</p> <p>Z axis... Lets you select the color used to identify the Z axis.</p> <p>Ticks color... Lets you select the color of the tick marks.</p> <p>Plane color... Determines the color applied to the selected plane of a Clip box.</p>
3D Settings	
Axis indicator	<p>Lets you choose the default appearance of the Axis Indicator.</p> <p>Cube... If selected, the Axis Indicator will appear as a cube.</p> <p>Arrows... If selected, the Axis Indicator will appear as a series of three interconnected arrows.</p> <p>None... If selected, the Axis Indicator will not be shown.</p> <p>Axis indicator size... Determines the size, in screen percentage, of the Axis Indicator.</p>
Clip box	<p>Lets you choose the default appearance of the Clip box.</p> <p>Show grid lines... If selected, grid lines will appear by default on newly created Clip boxes.</p> <p>Show border... If selected, borders will appear by default on newly created Clip boxes.</p> <p>Show axis... If selected, axes will appear by default on newly created Clip boxes.</p> <p>Show ticks... If selected, graduated "tick marks" will appear by default on newly created Clip boxes.</p> <p>Axis size... Lets you choose the thickness of the axis lines.</p> <p>The following settings are available in the Clip box ticks font box to customize the appearance of the clip box tick marks:</p> <p>Font... Lets you choose a font face for the tick marks.</p> <p>Font size (in screen percentage)... Lets you choose a font size, relative to the resolution of the views in the workspace, for the tick marks.</p> <p>Minimum font size (in points)... Lets you set a minimum font size, in points, that determines how small the tick marks can decrease when views are resized.</p>

Configurable Actions

Changes for the Configurable Actions preferences are indicated in the following table.

Configurable Actions preferences changes

	Description
Set all selected objects non-visible in 2D	Lets you configure a keyboard shortcut to set all objects selected in the Data Properties and Settings panel to non-visible in the current 2D scene views.
Set all selected objects visible in 2D	Lets you configure a keyboard shortcut to set all objects selected in the Data Properties and Settings panel to visible in the current 2D scene views.

	Description
Toggle the 2D visibility of the selected object	Lets you configure a keyboard shortcut to toggle the visibility of all objects selected in the Data Properties and Settings panel to visible in the current 2D scene views.
Toggle the 2D opacity of selected ROIs, multi-ROIs, and datasets	Lets you configure a keyboard shortcut to toggle the opacity of ROIs, multi-ROIs, and datasets selected in the Data Properties and Settings panel or Opacity Settings dialog. Toggling will be between 0 and the set opacity value.
Spin an object in 3D	Lets you configure a keyboard shortcut to start spinning objects in the selected 3D view.
Stop 3D spin	Lets you configure a keyboard shortcut to stop spinning.
Switch to 3D spin mode	Lets you configure a keyboard shortcut to enter spin mode.

Miscellaneous

Changes for the Miscellaneous preferences are indicated in the following table.

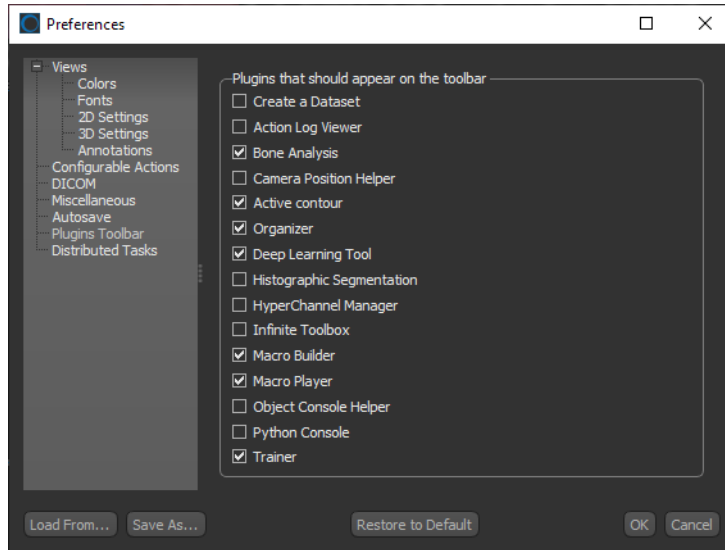
Miscellaneous preferences changes

	Description
Window leveling text annotation mode	Lets you choose the default mode — Show range or Show width and center — for the Window Leveling text annotation (see Configurable Window Leveling Text Annotation on page 31).

Plugins Toolbar

This new set of preferences lets you configure the Plugins Toolbar panel with a selected number of plugins.

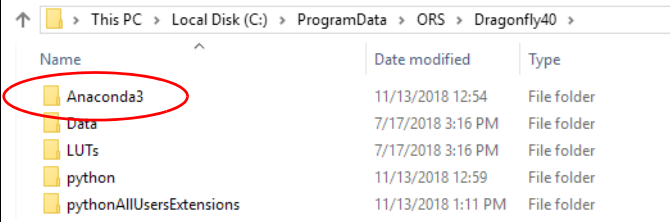
Plugins Toolbar preferences



System Requirements Changes

This release supports the base system requirements. Any differences in those requirements are noted below.

System requirements changes

Version	Changes to system requirements
3.0.0	None.
3.1.0	None. NOTE Dragonfly 3.1 includes a new Anaconda distribution for Python. You should note that the current version of Python accessed by Dragonfly will be updated automatically to version 3.6 when you install this new release.
3.5.0	None.
3.6.0	None.
4.0.0	None. NOTE The Anaconda distribution was changed to version 5.2.0 for this software release. You should also note that the current version of Python accessed by Dragonfly will be updated automatically to version 3.6.5 when you install this new release. In addition, the Anaconda distribution will be installed in the ProgramData folder, as shown below, instead of the Program Files directory.  <p>This change was implemented to allow users to update Dragonfly without running in Administrator mode. If you are updating a previous installation, the current Anaconda distribution will be deleted from the Program Files folder.</p>
4.1.0	None.

Extending Dragonfly

Dragonfly's Infinite Toolbox, an open exchange platform for the Dragonfly user community, lets you submit, browse, and download extensions that implement new features and workflows for all of your image processing or analysis needs.

Choose **Tools > Infinite Toolbox** on the menu bar to open Dragonfly's Infinite Toolbox.

Requesting New Features

Let us know if you have a suggestion for a new feature, or an idea for an improvement to an existing workflow.

Getting Help

Learning Dragonfly

Just by taking a quick look around www.theobjects.com/dragonfly, you'll find some great free resources, such as our latest instructional videos, recorded webinars, and user forums.

Dragonfly Workshops

Our hands-on training workshops are a great way to get up and running quickly. Combining in-depth instruction with class exercises, our product specialists will quickly teach you how to use key Dragonfly features and functions to optimize your image visualization and analysis tasks.

Check for upcoming workshops on our website at:
<http://www.theobjects.com/dragonfly/workshops.html>.

Reporting Issues

Dragonfly includes an integrated reporting module that lets you include comments and other information along with generated DMP and log files whenever you encounter an issue that results in a crash or application freeze.

Send Report to ORS dialog

Send Report to ORS

Please provide as much information as possible to help ORS understand the circumstances under which the problem occurred.

Name: John Smith

Email: john.smith@gmail.com

Details: An issue occurred when normalizing data after applying the polynomial filter to correct uneven shading.
The original dataset is available for testing, if required.
Sincerely,
JS|

OK Cancel

You should note that you can also report an issue at any time by choosing **Help > Report an Issue** on the menu bar.

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