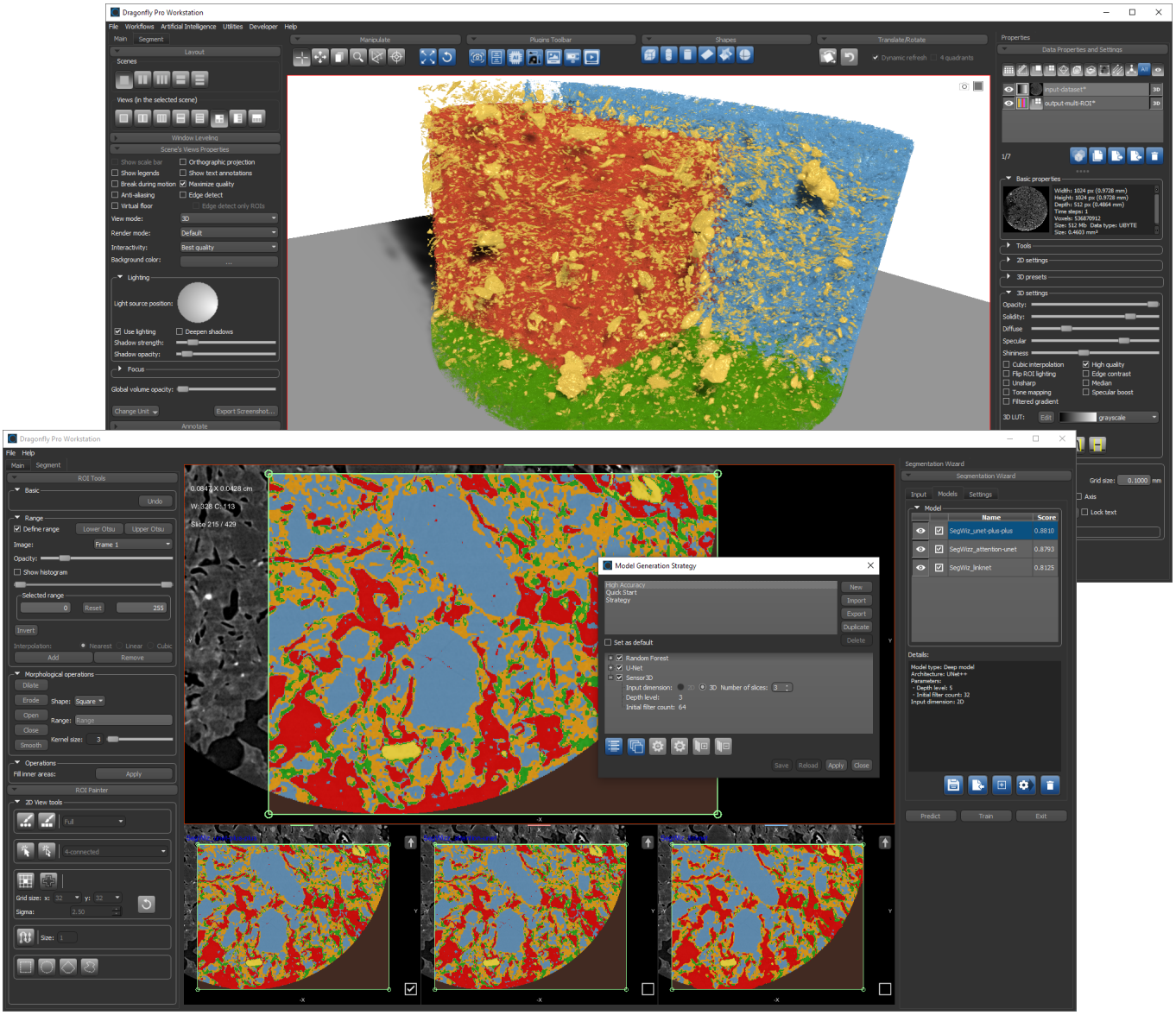
DRAGONFLY 2021.1

RELEASE NOTES



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COVER IMAGES

Training of deep neural networks in Dragonfly’s Segmentation Wizard for the segmentation of hardened block (bottom) and 3D visualization of fully segmented dataset (top). Data courtesy of the Digital Rocks Portal (www.digitalrocksportal.org/).

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Release date 2021-01-26
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This document describes the new features, product enhancements, and other improvements implemented in the Dragonfly and Dragonfly Pro 2021.1 software release. You should read these release notes before you install this new version.

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New Features and Product Enhancements

The 2021.1 software release for **Dragonfly** and **Dragonfly Pro** provides new features, product enhancements for the Segmentation Wizard and CT Reconstruction, new deep learning architectures, as well as support for additional file formats.

Segmentation Wizard

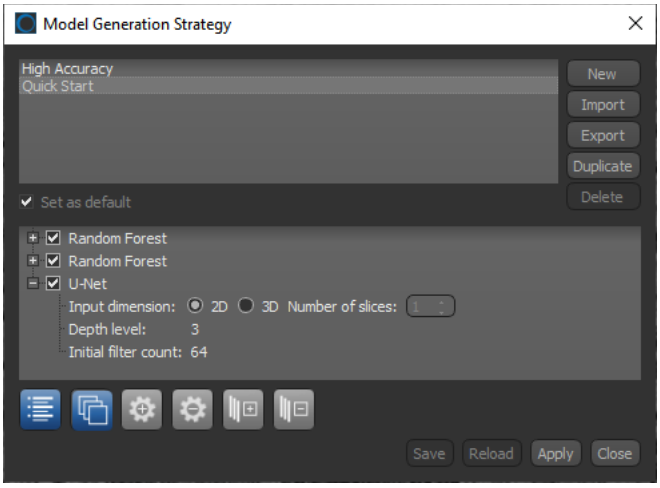
This Dragonfly release features a number of significant advancements for the Segmentation Wizard, which provides an easy-to-use, guided workflow for implementing powerful deep learning and machine learning segmentation of multi-dimensional images.

Model Generation Strategy

The reformatted Model Generation Strategy dialog provides new options for creating and editing model generation strategies, as well as for quickly reviewing and editing Deep Learning model settings and feature presets for Machine Learning (Classical) models.

The Model Generation Strategy dialog, shown below, appears when you click **Train** and the models list is empty. You can also click the **Open** button the Models tab to open the dialog (see Updates for the Models Tab on page 9).

Model Generation Strategy dialog

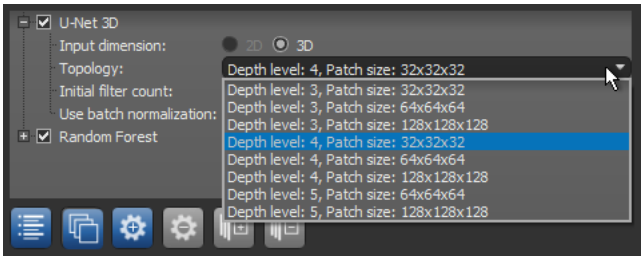


The Model Generation Strategy dialog includes a list of the ORS default strategies and user-defined strategies, as well as a list of each model included in the selected strategy. Each model in the selected strategy can also be expanded to review and edit its settings.

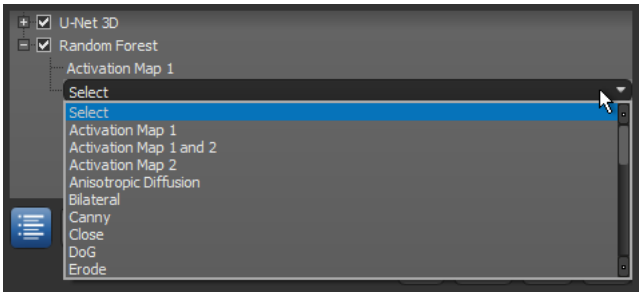
You can do the following in the Model Generation Strategy dialog:

- Add a new strategy, import and export strategies, duplicate a strategy, and delete a strategy.
- Set a strategy as the default.
- Edit user-defined strategies, including renaming, adding, and removing models.

- Edit the model parameters for Deep Learning models, as shown below.



- Add and remove feature presets for Machine Learning (Classical) models.

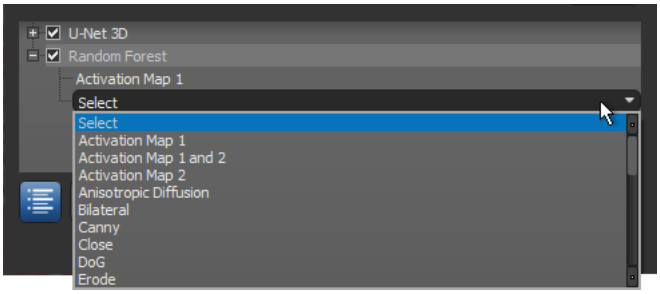


NOTE ORS defined strategies are read-only and all editing functionalities are disabled for these strategies.

The controls and options that are now available in the dialog are described below:

Controls and options for the Model Generation Strategy dialog

	Icon	Description
Expand all models		Expands all models in the list so that you can review and edit the parameters of Deep Learning models and the feature presets of Machine Learning (Classical) models.
Collapse all models		Collapses the list of all models.
Select all models		Selects all models in the list. **NOTE** Selected models will be generated whenever you click **Continue** or **Apply**.
Deselect all models		Deselects all models in the list.
Add new model		Adds a new model to the selected strategy. You can choose the type of model in the drop-down menu, as shown below. **NOTE** ORS defined strategies are read-only. You cannot add models to these strategies.
Remove selected model		Removes the selected model from the selected strategy. **NOTE** ORS defined strategies are read-only. You cannot remove models from these strategies.

	Icon	Description
Add new features preset		Lets you add a new features preset to the selected Machine Learning (Classical) model. You can choose features presets in the drop-down menu, as shown below.  **NOTE** ORS defined strategies are read-only. You cannot add feature presets to any Machine Learning (Classical) model in these strategies.
Remove selected features preset		Removes the selected features preset from the selected Machine Learning (Classical) model. **NOTE** ORS defined strategies are read-only. You cannot remove feature presets from any Machine Learning (Classical) model in these strategies.
Save		Saves any changes you made to the model generation strategy or to the settings of a model within a user-defined strategy.
Reload		Reloads the current strategy.
Continue/Apply		**Continue...** Is available when the Model Generation Strategy dialog appears after clicking 'Train'. In this case, all selected models in the current strategy will be generated when training begins. **Apply...** Appears when the Model Generation Strategy dialog is opened from the Models tab. In this case, all selected models will only be generated. **NOTE** You can choose to train or not train generated models on the Models tab on the Segmentation Wizard panel.
Close		Closes the dialog.

Default Strategies

Two ORS-defined default strategies — **Quick Start** and **High Accuracy** — are available for the Segmentation Wizard in this software release.

Quick Start... The models in this strategy, which are listed below, generally provide good results without excessive processing times.

- Random Forest with features presets Morphological, Gaussian_MS, and Neighbors.
- Random Forest with features preset Activation Map 2.
- U-Net (depth = 3, initial filters count = 64).

High Accuracy... The models in this strategy, which are listed below, are more demanding than those in 'Quick Start', but can provide a higher level of accuracy.

- Random Forest with features preset 'Activation Maps 2'.
- U-Net (depth = 4, initial filters count = 64, multi-slice input with 3 slices).
- Sensor 3D (depth = 3, initial filters count = 64).

Updates for the Input Tab

The following options are now available on the **Input** tab, shown below. These options let you change the image modality shown in the views, control the visibility of frames and label highlights, as well as save, import, and fill frames.

Input tab

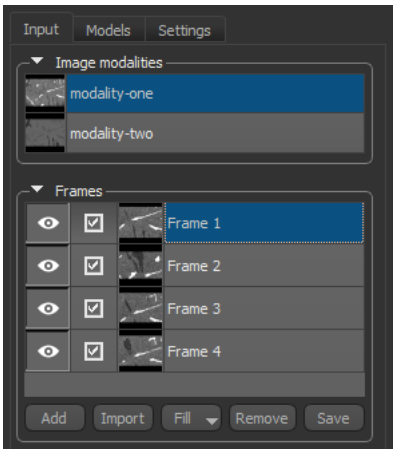
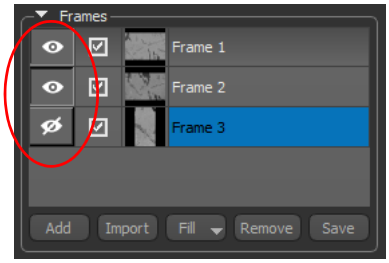


Image modalities... This new addition to the Input tab appears only when multiple datasets were selected for multi-modality training. Selecting an image in the list will automatically change the modality displayed in the workspace views and update the image data selected for defining a range in the ROI Tools panel.

Visibility controls... This new control, which appears on the left-side of the frames list, lets you show or hide a frame and the highlight applied to labeled voxels within the frame.



Import and Save... These new options for Dragonfly 2021.1 let you save frames as a labeled multi-ROI in the same shape as the input dataset(s), as well as to import saved frames to resume or duplicate a workflow.

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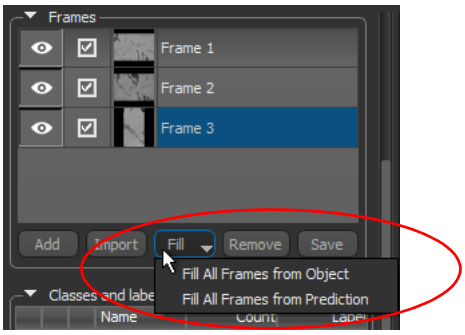
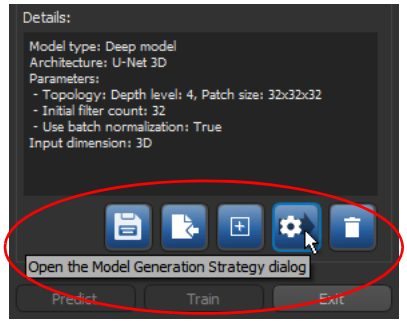
FILL... This modified item, which was previously 'Fill from Object', now lets you also fill all new frames from the currently selected model prediction.



Updates for the Models Tab

The **Models** tab now includes the option to open the Model Generation Strategy dialog, in which you can choose a model generation strategy, create new strategies, edit strategies, and generate models (see Model Generation Strategy on page 5). This new option is circled below.

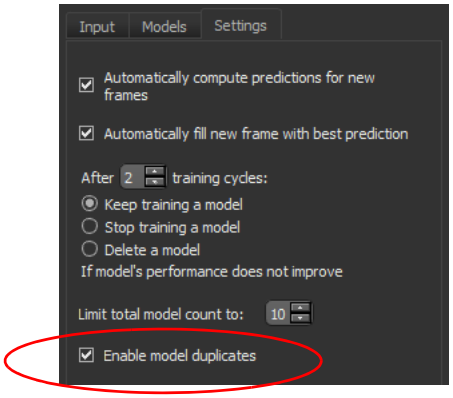
Models tab



Updates for the Settings Tab

The **Settings** tab now includes the option to allow duplicate models. This option, which is circled below, should be enabled if you plan to generate and train similar models that are set with different parameters.

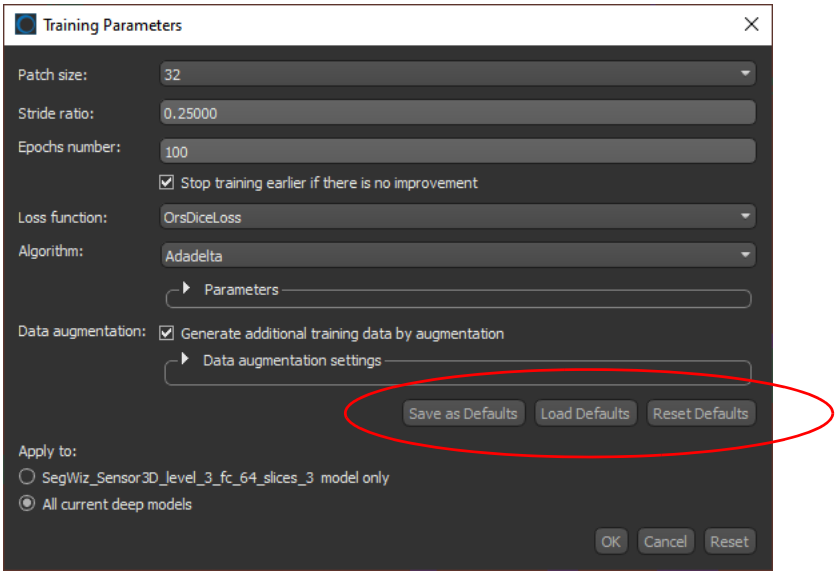
Settings tab



Training Parameters

A number of new options — Save as Defaults, Load Defaults, and Reset Defaults — are available for the edited training parameters of Deep Models. Right-click the Deep Model you need to edit on the Models tab and then choose **Update Training Parameters** in the pop-up menu to open the Training Parameters dialog, shown below.

Training Parameters dialog



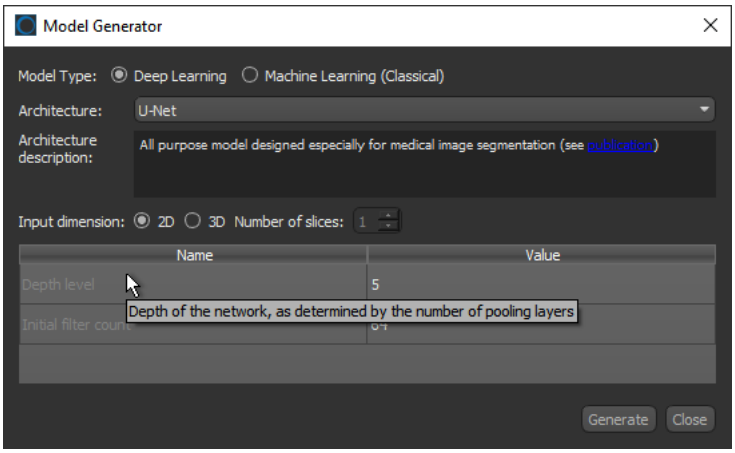
Options for saving and applying edited training parameters

	Description
Save as Defaults	Saves the current settings as the default values, which will be applied to new models.
Load Defaults	Restores the settings to the last saved default values.
Reset Defaults	Resets all settings to their original values.
Apply to	The 'Apply to' options have been streamlined to include the following: **Current deep model...** If selected, all changes will be applied to the selected Deep Learning model only. **All current deep models...** If selected, all changes will be applied to all Deep Learning models in the current Segmentation Wizard session.

Model Parameters

The model parameters for Deep Learning models selected in the Model Generator dialog have been renamed and also include informative tooltips, as shown in the following screen capture.

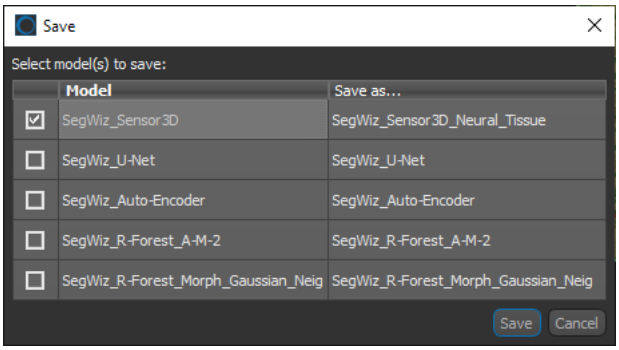
Model Generator dialog



Rename and Save Multiple Models

As an additional change for the Segmentation Wizard in Dragonfly 2021.1, whenever you exit the Segmentation Wizard, or click the **Save** button on the Models tab, a new Save dialog now appears onscreen.

Save dialog



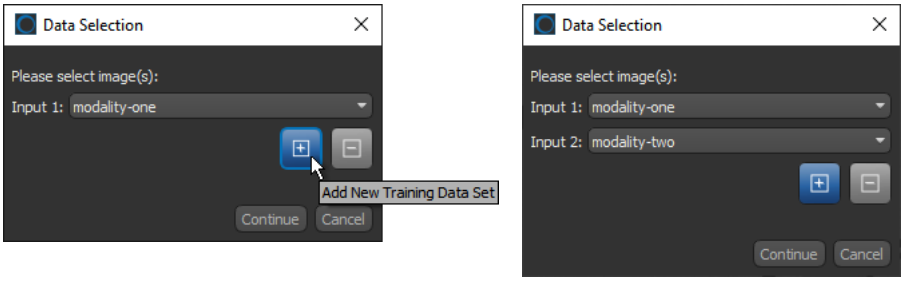
You can do the following in the reformatted Save dialog:

- Choose the model or models that you want to save.
- Rename a model before it is saved.

Data Selection

The Data Selection dialog, shown below, now appears whenever you open the Segmentation Wizard from data selected in the Data Properties and Settings panel.

Data Selection dialog

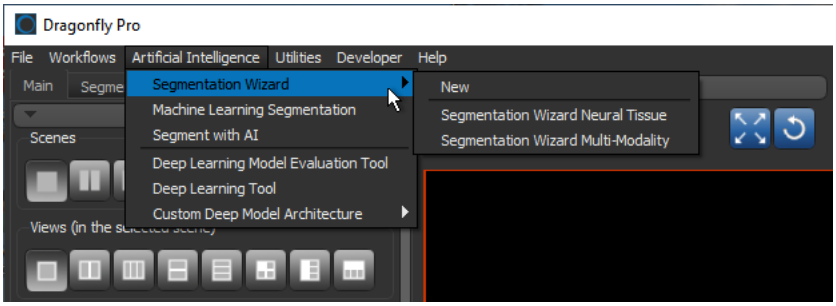


This change lets you easily choose the order of your inputs. You should also note that modalities order is important for training models and must be consistent for inference.

Open Wizard Session from the Menu Bar

Whenever you now choose to open the Segmentation Wizard from the Artificial Intelligence menu, you can reload an available Segmentation Wizard session. This new option is shown in the screen capture below.

Dragonfly menu bar



NOTE All frames, trained models, and training parameters are saved within Segmentation Wizard group objects. This lets you reproduce previous results, as well as share data with others.

New Deep Learning Architectures

The following deep learning architectures — Attention U-Net, LinkNet, and U-Net++ — are now available for the Deep Learning Tool and the Segmentation Wizard for training semantic segmentation models.

Attention U-Net

This novel attention gate (AG) model, which was originally designed for medical imaging segmentation, automatically learns to focus on target structures of varying shapes and sizes while suppressing irrelevant regions in input images. By highlighting salient features only, the necessity of using explicit external tissue/organ localization modules of cascaded convolutional neural networks (CNNs) is eliminated. Integrated into the standard U-Net architecture, AGs can increase model sensitivity and prediction accuracy.

REFERENCE... Oktay et al. *Attention U-Net: Learning Where to Look for the Pancreas*, arXiv, May 20, 2018 (https://arxiv.org/pdf/1804.03999.pdf).

LinkNet

This deep neural network architecture focuses on speed and efficiency for semantic segmentation tasks. Compared to other algorithms, LinkNet can learn with a more limited number of parameters and operations and still deliver accurate results.

REFERENCE... Abhishek Chaurasia and Eugenio Culurciello, *LinkNet: Exploiting Encoder Representations for Efficient Semantic Segmentation*, arXiv, June 14, 2017 (https://arxiv.org/pdf/1707.03718.pdf).

U-Net++

U-Net++ is a powerful architecture for medical image and semantic segmentation. This architecture is a deeply-supervised encoder-decoder network in which the encoder and decoder sub-networks are connected through a series of nested, dense skip pathways. The skip pathways help reduce the semantic gap between the feature maps of the encoder and decoder sub-networks.

REFERENCE... Zhou et al. *UNet++: A Nested U-Net Architecture for Medical Image Segmentation*, arXiv, July 18, 2018 (https://arxiv.org/pdf/1807.10165.pdf).

Updated Deep Learning Architectures

A number of updates and improvements for the PSPNet deep learning architecture are available in this software release.

PSPNet

The following changes were implemented for PSPNet, which can be trained for semantic segmentation.

Parameter to control filters count... Although this architecture has high memory demands, the newly implemented filters count controls should allow users with more limited GPUs to now train models with this updated version of PSPNet.

Default Patch size... Although PSPNet requires a Patch size of at least 256, the default has been reset to 512 for optimal performance.

In addition, a number of minor fixes were implemented for this architecture to improve data flow.

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CT Reconstruction

The following updates are available for the Beta version of the CT Reconstruction module in Dragonfly 2021.1.

Stripe Removal Filters for Pre-Processing

The following stripe and ring artifact removal filters are now available for pre-processing acquisition data prior to reconstruction.

Wavelet-Fourier... Removes horizontal stripes and ring artifacts from the sinogram using the Fourier-Wavelet (FW) based method.

Options for Wavelet-Fourier stripe removal

The following adjustable parameters are available for the Wavelet-Fourier stripe removal filter. You should note that you can generate multiple previews to test your settings prior to reconstructing data and then import the inputs from the best preview.

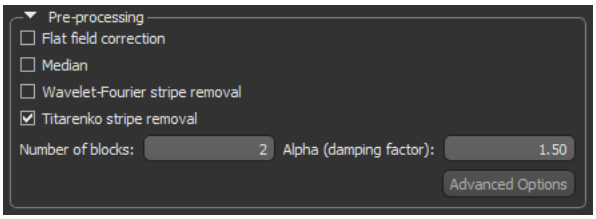
Adjustable parameters for Wavelet-Fourier stripe removal filter

Parameter	Description
Level	Lets you set the number of discrete wavelet transform levels.
Sigma	Lets you set the sampling parameter in Fourier space.
Wavelet	Lets you select the type of the wavelet filter — ‘db5’, ‘haar’, or ‘sym5’.

NOTE Refer to Münch et al. *Stripe and ring artifact removal with combined wavelet–fourier filtering*, Optics Express, 17(10):8567-8591, 2009 for more information.

Titarenko... Removes horizontal stripes and ring artifacts from the sinogram using Titarenko’s approach.

Options for Titarenko stripe removal



The adjustable parameters available for the Titarenko stripe removal filter include ‘Number of blocks’ and ‘Alpha (damping factor)’. You should note that you can generate any number of previews to test your settings prior to reconstructing data and then import the inputs from the best preview.

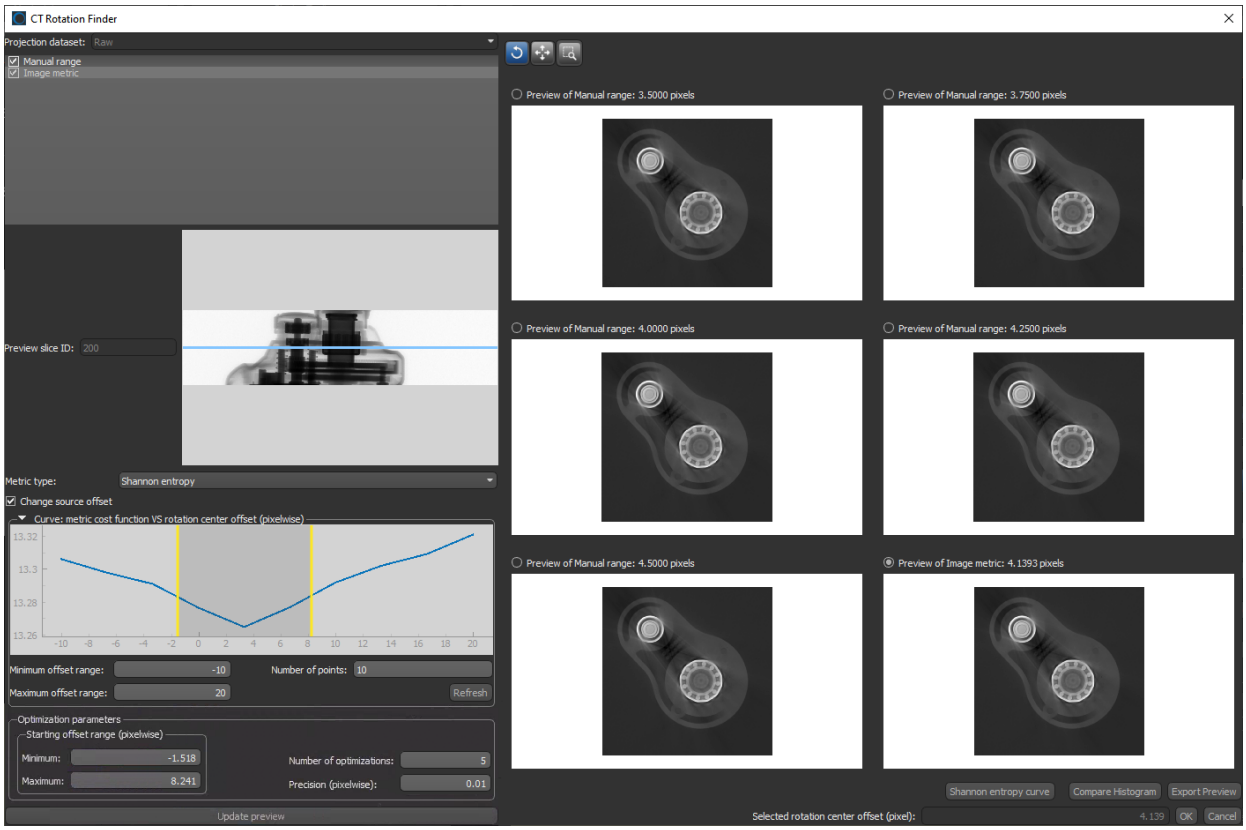
NOTE Refer to Miqueles et al. *Generalized Titarenko’s algorithm for ring artefacts reduction*, Journal of Synchrotron Radiation, 21(6):1333-1346, 2014 for more information.

Updates for the CT Rotation Finder

A number of updates are available in this software release for finding the center of rotation for reconstructing cone beam projections.

Choose **Workflows > CT Reconstruction** to start the CT Reconstruction module. You can then open the CT Rotation Finder dialog, shown below, by clicking the **Find Rotation Center** button in the Reconstruction engine box.

CT Rotation Finder dialog

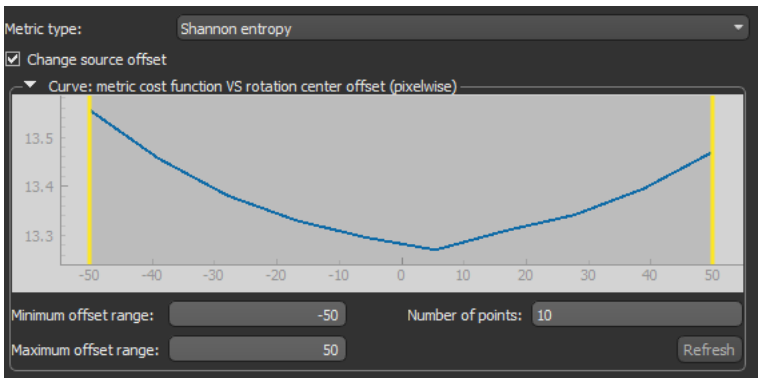


Do the following to change the source offset and optimize the algorithm for computing the center of rotation for cone beam projections:

1. Enter or import the acquisition parameters for the projection that you want to reconstruct in the CT Reconstruction dialog.
2. Click the **Find Rotation Center** button.

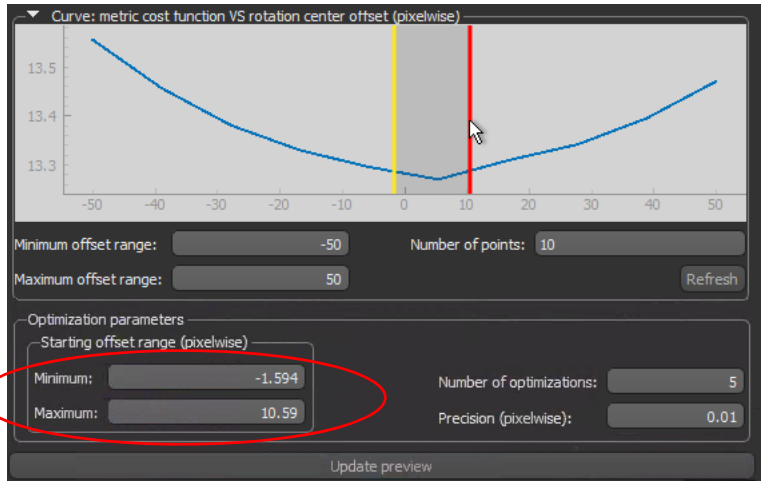
   The CT Rotation Finder dialog appears.
3. Select **Image metric** as the method in the CT Rotation Finder dialog.
4. Select a metric type — **Shannon entropy** or **Sharpness** — in the Metric type drop-down menu.
5. Check the **Change source offset** option.

6. Click the **Refresh** button to compute a metric cost function vs. rotation center offset curve, recommended.



NOTE If required, you can adjust the minimum and/or maximum offset ranges, as well as the number of points, before you compute the curve.

7. Set the Minimum and Maximum offset values (pixelwise) to an optimal range, recommended. Adjustments can be made on the curve by dragging the thresholds, as shown below, or by entering new values in the edit boxes, as circled below.



NOTE You can modify the Number of optimizations and Precision (pixelwise), if required.

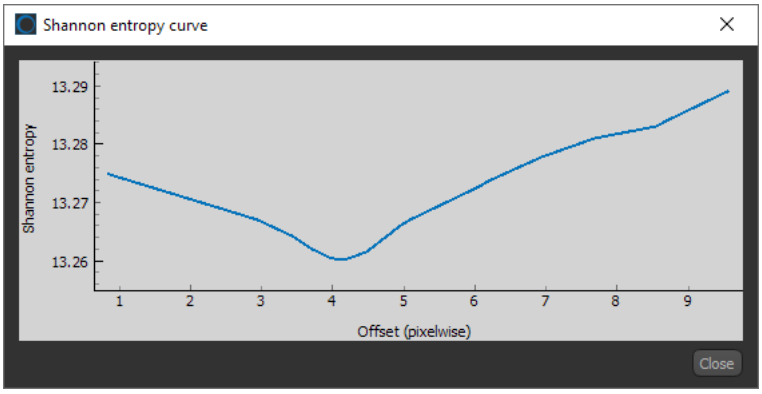
8. Click the **Update Preview** button to compute the optimal center of rotation.

   After the computation is complete, a preview of the result appears in the dialog.

9. Examine the preview with the Preview tools, recommended, and then do one or more of the following:

   - Click the **OK** button at the bottom right of the dialog to apply the computed rotation center offset value and update the Source offset and Detector offset values in the CT Reconstruction dialog.
   - Click the **Export Preview** button to export the preview and its settings. You can import the inputs from the best preview in the CT Reconstruction dialog.

- Click the **Shannon Entropy Curve** or **Sharpness Curve** button to plot the curve of the selected Image metric vs. the offset within the computed range, as shown below.

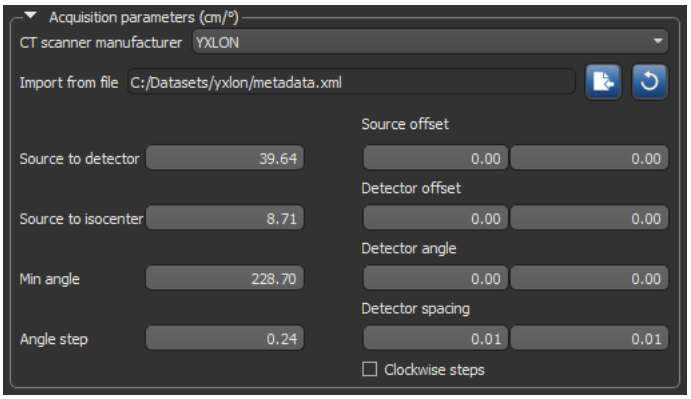


- Select **Manual range** as the method and then generate additional previews centered on the found value.

Support for YXLON Micro-CT Scans

This software release provides support for reconstructing projection data acquired with YXLON micro-CT scanning systems. As shown in the screen capture below, acquisition parameters can be imported from accompanying XML files (*.xml extension).

Acquisition parameters



NOTE You can use Dragonfly's CT Rotation Finder to accurately find the center of rotation (see Updates for the CT Rotation Finder on page 16.

Metadata Parser for SKYSCAN

A geometry reader is available in this software release for parsing the metadata of cone beam projections acquired with SKYSCAN micro-CT systems.

Select **SkyScan** in the CT scanner manufacturer drop-down menu and then click the **Import** button. You can choose the log file (*.log extension) with the scan metadata to load the acquisition parameters.

NOTE SKYSCAN is a registered trademark of the Bruker Corporation.

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Distributed Tasks

Dragonfly's high-performance compute (HPC) framework lets you distribute compute-heavy tasks to other Dragonfly workstations, dedicated HPC clusters, or to elastically instantiated compute nodes on Amazon's EC2 platform. Applicable tasks include training deep models with the Deep Learning Tool and the Segmentation Wizard, reconstructing projection data with the CT Reconstruction module, and generating simulations with MC X-Ray. Support for the inference of trained deep models, numerical modeling for LMB simulations, and image filtering will be available in future releases.

NOTE Distributed Tasks uses Python's distributed task queue Huey to support multi-threaded task execution, scheduled execution, periodic execution, resubmitting failed tasksIkr444e, and task result storage.

NOTE Distributed Tasks is available as beta only and is a separately licensed feature for Dragonfly. Contact sales@theobjects.com for more information about licensing for Distributed Tasks.

Updates in this software release for Distributed Tasks include the addition of a distributed tasks observer and an updated dialog for monitoring the progress of queued tasks for the Segmentation Wizard.

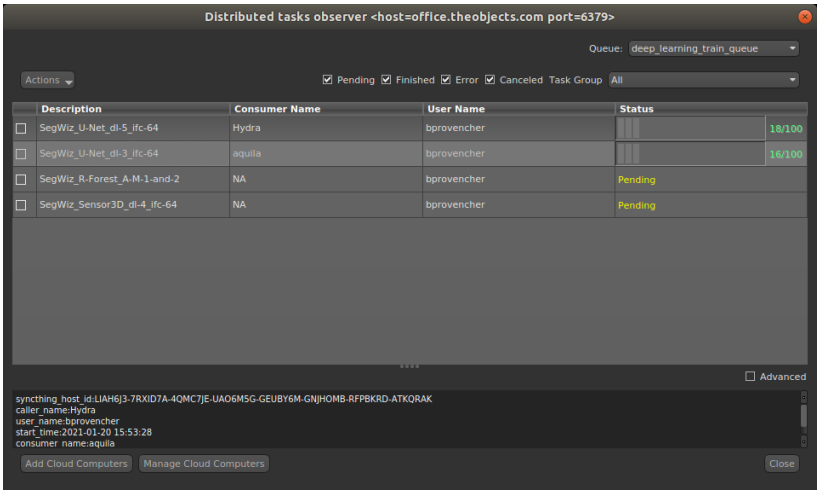
Distributed Tasks Observer

The newly implemented Distributed Tasks Observer dialog lets you monitor the progress of all tasks within a selected queue. Additional options let you:

- Clear completed tasks, tasks with error, pending tasks, or selected tasks.
- Resubmit processing tasks, as well as tasks with errors.
- Clear temporary data.
- Add and manage cloud computers.

Choose **Utilities > Start Distributed Tasks Queue Observer** on the menu bar to open the Distributed Tasks Observer dialog, as shown below.

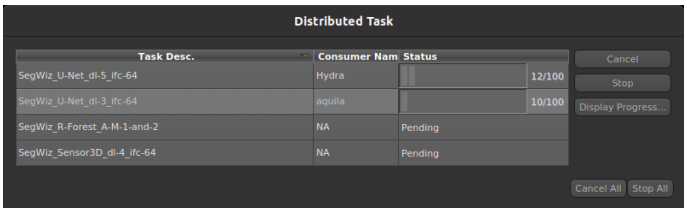
Distributed Tasks Observer dialog



Distributed Task Dialog

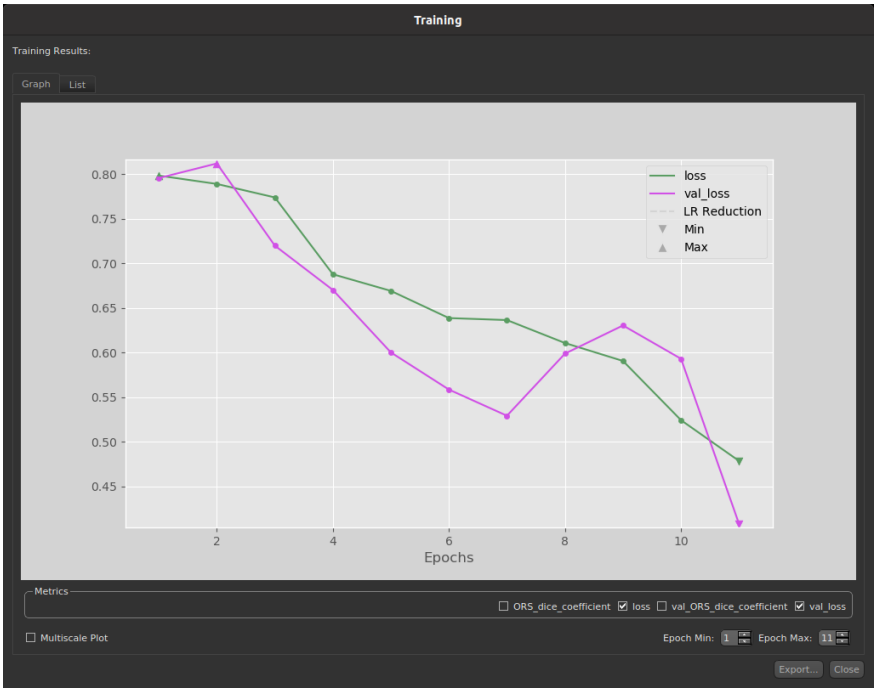
After launching a distributed task from the Segmentation Wizard for training a deep model, you can monitor training progress in Distributed Task dialog, shown below. Distributed tasks can be launched by clicking the **Train Distributed** button.

Distributed Task dialog



You can do the following in the Distributed Task dialog:

- Monitor the status — Pending, Executing, and Completed — and progress of all launched tasks.
- Cancel or stop a task.
- Display the details of the training task in progress. Click the **Display Progress** button to open the Training dialog, shown below.



Updates for the Deep Learning Tool

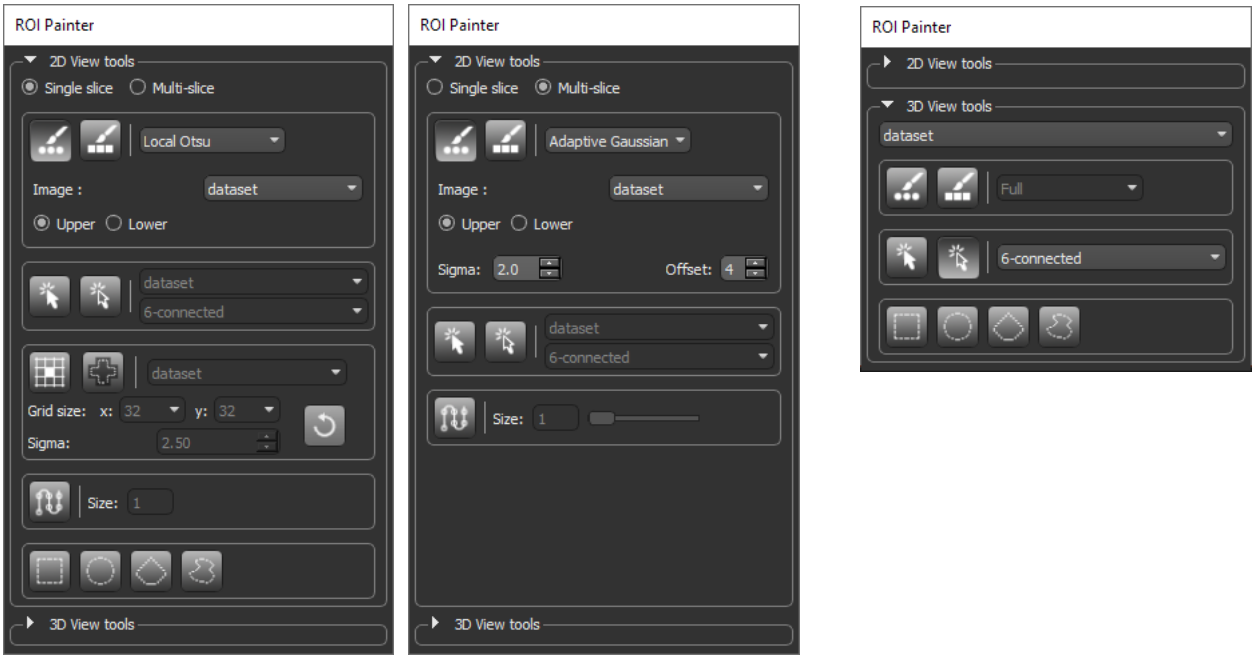
Updates for the Deep Learning Tool when using Distributed Tasks include additional controls to resubmit a training task, stop training, and to display the details of training progress. These are available by right-clicking a model on the Model Overview panel. You should also note that the Model Status was updated for Distributed Tasks.

ROI Painter Panel

The reformatted ROI Painter panel not only includes a more intuitive layout, but also provides new tools, such as a Local Otsu brush and Adaptive Gaussian brush, for tackling challenging segmentation tasks. Updates for the Path tool and the Point & Click tool are also included in this software release.

The reformatted panel for working in 2D and 3D views are shown below.

ROI Painter tools for 2D views (left) and 3D views (right)



NOTE Activation of the Round and Square Brushes now requires only a single click instead of two. Macros previously created with these brushes will only be supported for a limited time.

New ROI Painter Tools

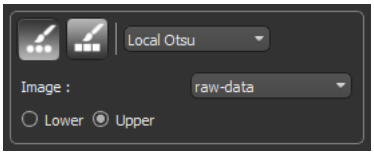
A number of new ROI Painter tools, including a set of local adaptive threshold brushes, are now available for tackling challenging segmentation problems. You should note that adaptive thresholding changes the threshold dynamically over an image by determining the threshold for a pixel based on a small region around it. This can provide better results for images with strong illumination gradients or shadows when compared to applying a constant threshold. The assumption is that smaller image regions are more likely to have approximately uniform illumination.

In addition to these new ROI Painter tools, this software release also provides an outline mode for the Point & Click tool and a selectable thickness for the Path tool when working in Multi-slice mode.

Local Otsu Brush

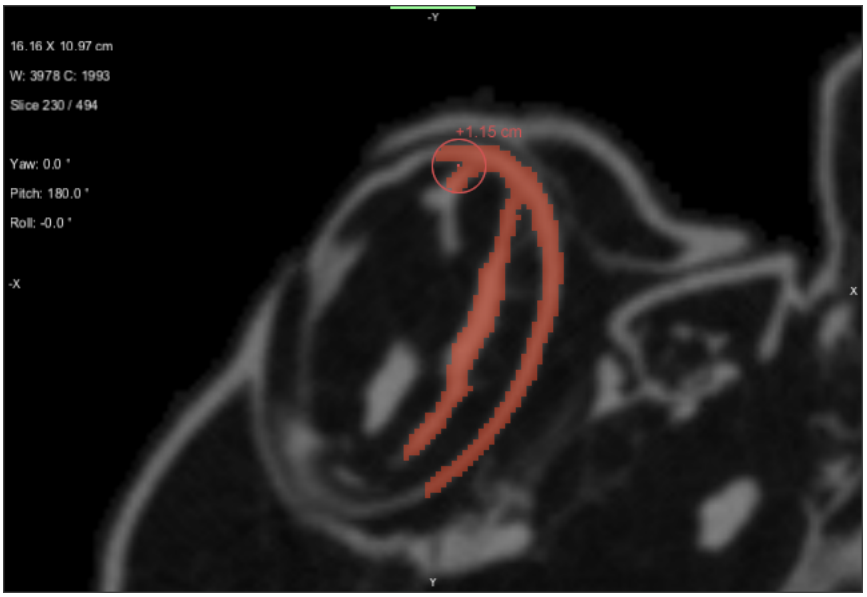
The threshold value of the new Local Otsu brush is determined by maximizing the variance between two classes of pixels of the local neighborhood defined by the area or volume of the Round or Square brush. The dataset that provides the values for computing the threshold can be selected in the Image drop-down menu and you can choose to paint within the **Lower** or **Upper** range.

Local Otsu brush settings



An example of painting with the Local Otsu brush set to the Upper class is shown in the screen capture below.

Painting with the Local Otsu brush



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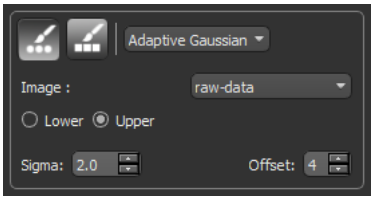
Adaptive Gaussian Brush

The threshold value of the new Adaptive Gaussian brush is the weighted sum of neighbourhood values subtracted by a constant, where the weights are a Gaussian window. The dataset that provides the values for computing the threshold can be selected in the Image drop-down menu and you can choose to paint within the **Lower** or **Upper** range. The neighbourhood is defined by the area or volume of the Round or Square brush.

Adaptive Gaussian brush settings

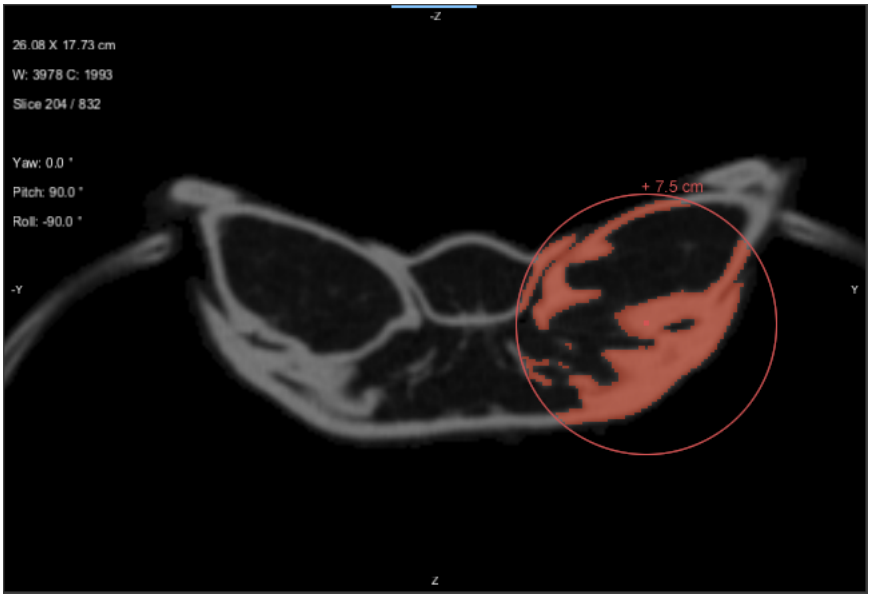


Sigma... Is the amount of variation or dispersion of the set of values within the defined neighborhood.

Offset... Is the constant subtracted from the weighted sum of neighborhood to calculate the local threshold value.

An example of painting with the Adaptive Gaussian brush set to the upper range is shown in the screen capture below.

Painting with the Adaptive Gaussian brush

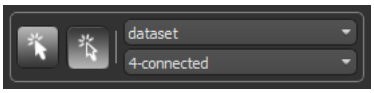


Point & Click Brush

You can now choose the level of connectivity — 4-connected and 8-connected for Single-slice mode and 6-connected and 26-connected for Multi-slice and 3D modes — for working with the Point & Click brushes.

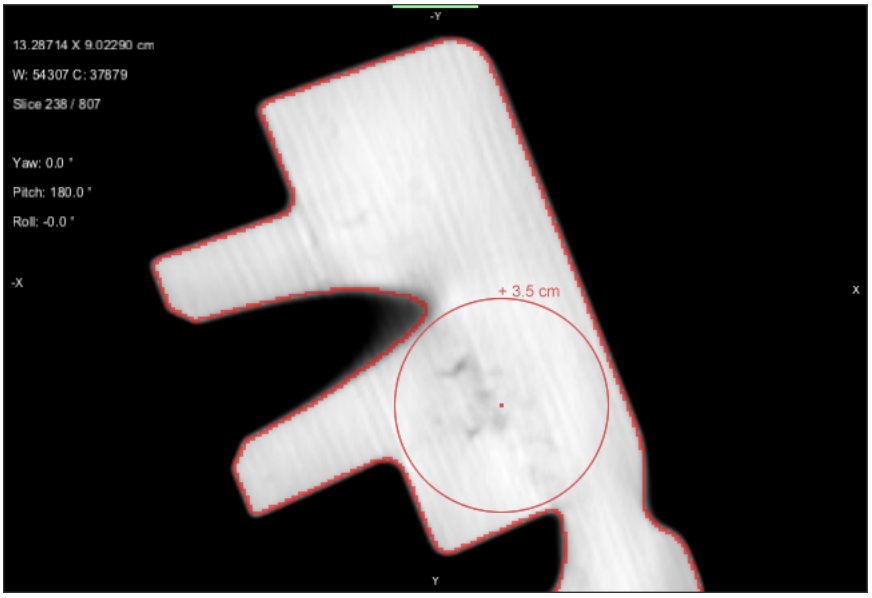
Other options for the Point & Click brush now include an Outline mode, which is activated in the screen capture shown below.

Point & Click brushes and settings



An example of painting with the Point & Click brush in Outline mode is shown below.

Painting with Point & Click brush in Outline mode



You should note that in image processing, connectivity is the way in which pixels in 2D images and voxels in 3D images relate to their neighbors.

When working in Single-slice mode in 2D views, connectivity is selectable as follows:

4-connected... Propagation is done by strictly using the 4 edges adjacent to the current seed and will result in the minimum number of connected pixels.

8-connected... Propagation is done by strictly using the 4 edges and 4 corners adjacent to the current seed and will result in the maximum number of connected pixels.

When working in Multi-slice mode in 2D views and in 3D views, connectivity is selectable as follows:

6-connected... Propagation is done by strictly using the 6 faces adjacent to the current seed and will result in the minimum number of connected voxels.

26-connected... Propagation is done by strictly using the 6 faces, 8 corners, and 12 edges adjacent to the current seed and will result in the maximum number of connected voxels.

Point & Click Outline Brush Preferences

The following configured actions are available for the new Point & Click Outline brush.

Configured actions for the Point & Click Outline brush

Action	Defaults
Activate point & click outline add	LEFT CTRL
Activate point & click outline remove	LEFT SHIFT
Add to Point & Click Outline	LEFT CTRL + Left mouse
Decrease point & click outline brush size in add mode	LEFT CTRL + Mouse wheel down
Decrease point & click outline brush size in remove mode	LEFT SHIFT + Mouse wheel down
Increase point & click outline brush size in add mode	LEFT CTRL + Mouse wheel up
Increase point & click outline brush size in remove mode	LEFT SHIFT + Mouse wheel up
Remove from Point & Click Outline	LEFT SHIFT + Left mouse

Path Brush

The Path brush now has a selectable thickness when working in Multi-slice mode. Thickness can be selected with the slider, as shown below.

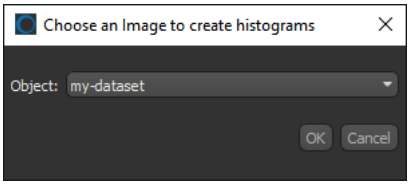
Thickness slider for the Path brush

Export Label Histograms

This software release provides the option to export histograms of labeled data in the comma-separated values (*.csv extension) file format. In this case, the data associated with each label will appear in a separate row and the number of pixels in each bin will appear in the columns.

Right-click the required multi-ROI labels in the Classes and scalar information box and then choose **Export Label Histograms to CSV** in the pop-up menu. You can then choose the image to extract the values for the histograms in the **Choose an image to create histograms** dialog, shown below.

Choose an image to create histograms dialog

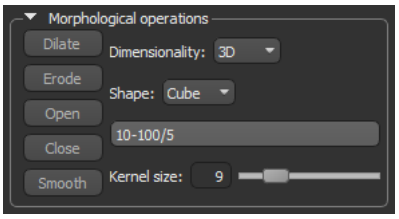


NOTE You can select up to a maximum of 1000 labels for exporting label histograms to CSV.

Morphological Operations

A number of new options are available on the ROI Tools panel for applying morphological operations to regions of interest and the selected class(es) of multi-ROIs. These are available in the Morphological operations box, which is shown below.

Morphological operations



Dimensionality... Lets you apply the selected morphological operation in 3D, in which case the operation will be applied to all axes, or in 2D, in which the case the operation can be applied along the X, Y, or Z axis.

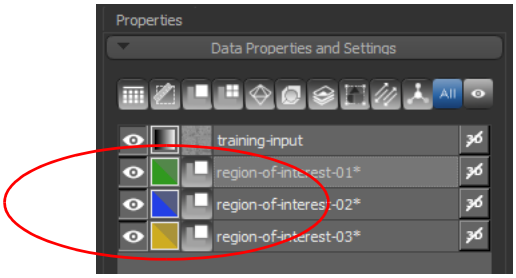
Range... You can choose selected slices, a range of image slices and an increment, or a combination of both, to which the selected morphological operation will be applied. For example, if you enter 1,2,3-5,6-15/3, then the operation will be applied to slices 1, 2, 3, 4, 5, 6, 9, 12, and 15.

ROI and Mesh Opacity Settings

You should note that for regions of interest and meshes, the applied color box is now split diagonally between the original color on the left, while the color on the right corresponds to the original color at the applied opacity setting.

Examples of the reformatted color boxes are circled in the screen capture below.

Data Properties and Settings panel



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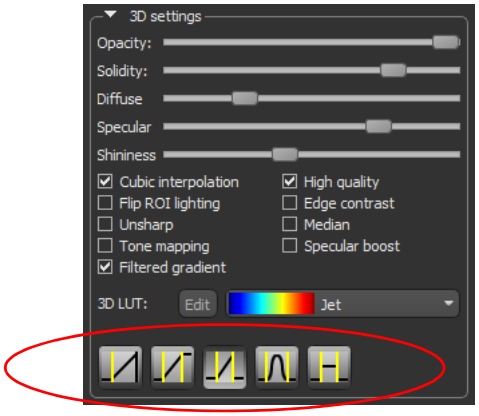
Window Leveling Modes for 3D Views

Available in the 3D settings box on the Data Properties and Settings panel and circled below, the additional Window Leveling modes that are available in Dragonfly 2021.1 can help you fine-tune renderings to optimize visualizations.

WL modes for 3D views



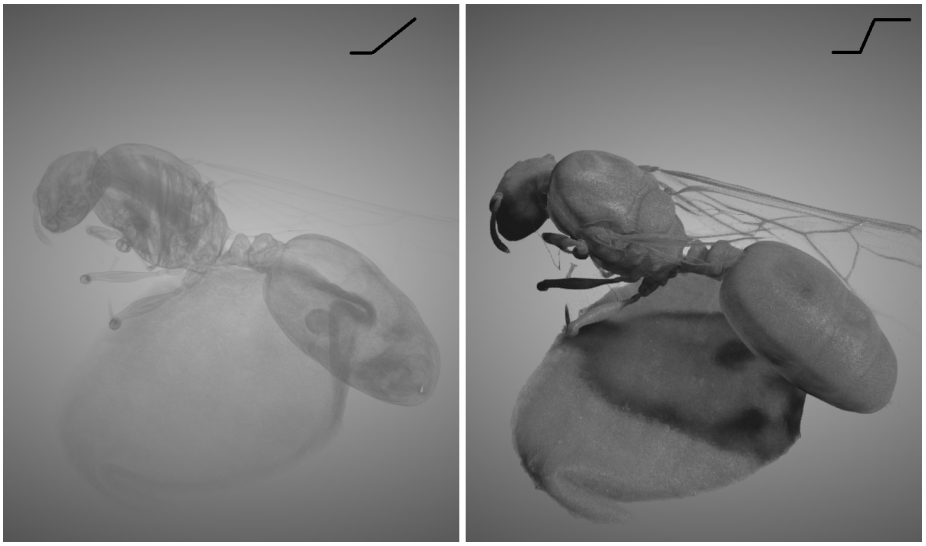
The following Window Leveling modes are available for 3D views in this software release.

Description of the WL modes for 3D views

Mode	Icon	Description
Left-gated ramp		In this mode, the opacity of the values to the left of the lower threshold will be set to 0, while the upper threshold is disabled. The opacity of the values within the window are set within a linear ramp, which can be modified by adjusting the local gamma on the Window Leveling panel. **NOTE** This mode was previously the default behavior for the next generation rendering engine.
Bi-gated ramp		In this mode, the opacity of the values to the left of the lower threshold will be set to 0, while the opacity of the values to the right of the upper threshold will be set as per the highest value within the window. The opacity of the values within the window are set within a linear ramp, which can be modified by adjusting the local gamma on the Window Leveling panel. **NOTE** This mode was previously the default behavior for the legacy rendering engine.
Band pass ramp		In this mode, the opacity of the values to the left of the lower threshold and to the right of the upper threshold will be set to 0. The opacity of the values within the window are set within a linear ramp, which can be modified by adjusting the local gamma on the Window Leveling panel.
Band pass Gaussian		In this mode, the opacity of the values to the left of the lower threshold and to the right of the upper threshold will be set to 0. The opacity of the values within the window are set within a Gaussian window, which can be modified by adjusting the local gamma on the Window Leveling panel.
Band pass constant		In this mode, the opacity of the values to the left of the lower threshold and to the right of the upper threshold will be set to 0. The opacity of the values within the window are set to a constant 50%. **NOTE** The local gamma cannot be adjusted in this mode.

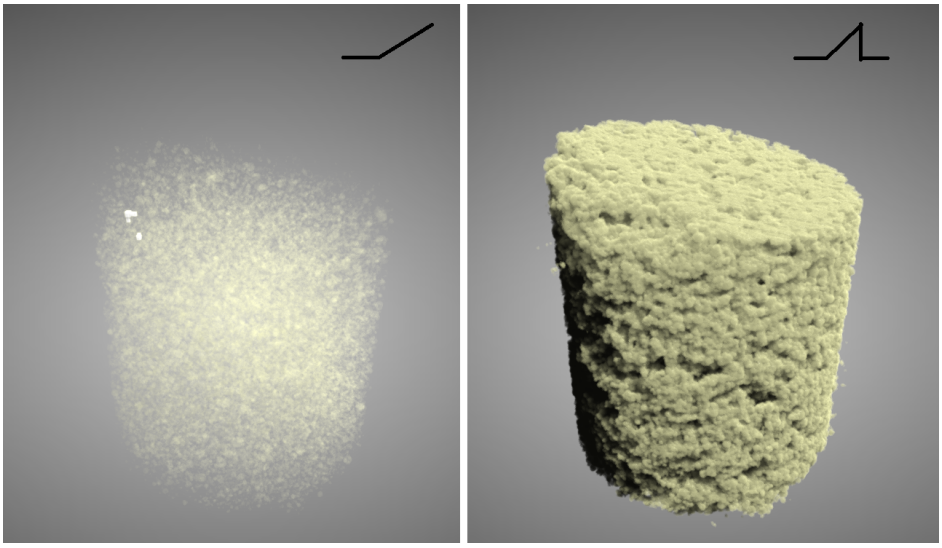
The following illustrations demonstrate some of the differences between the Window Leveling modes for 3D views.

Left-gated mode (left) vs. Bi-gated mode (right)



In this case, gating the upper values with the Bi-gated mode results in a much more detailed rendering.

Left-gated mode (left) versus Band pass ramp



In this case, setting the highest values to 0 with the Band pass ramp results in much more detail in the mid-level values.

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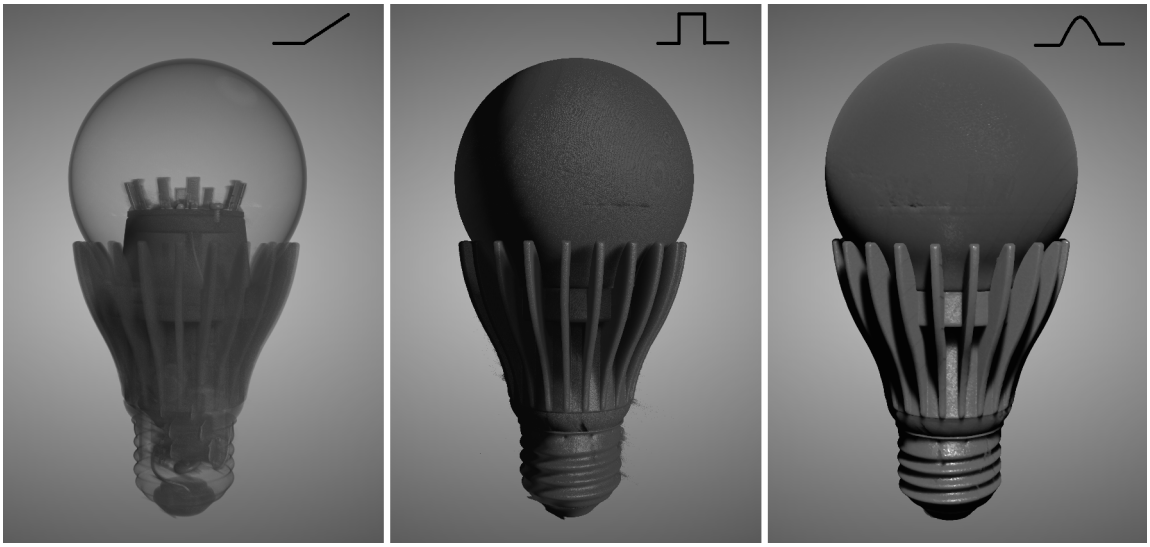
Left-gated mode (left) versus Band pass constant (middle) and Band pass Gaussian (right) modes



In this case, voxels within the middle and upper values appear with greater detail and solidity in the Band pass constant and Band pass Gaussian modes.

W/L Mode Preferences

A new set of preferences are available for setting a default WL mode for 3D views. This setting — **Default WL Mode** — is available in the **Views | 3D Settings** preferences, as shown below.

Default WL Mode preference

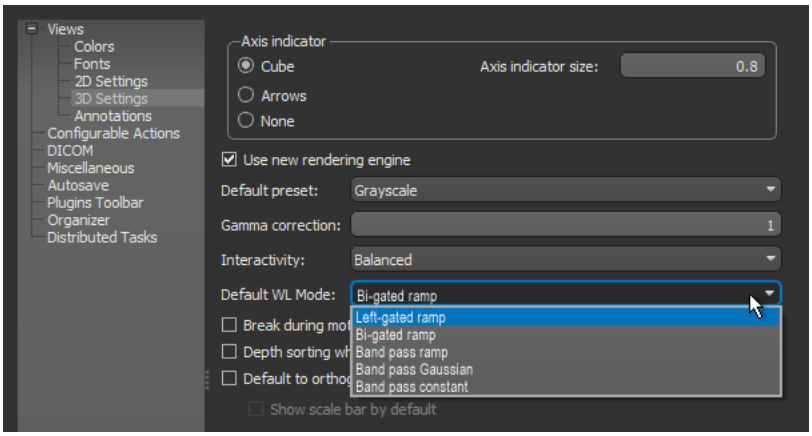


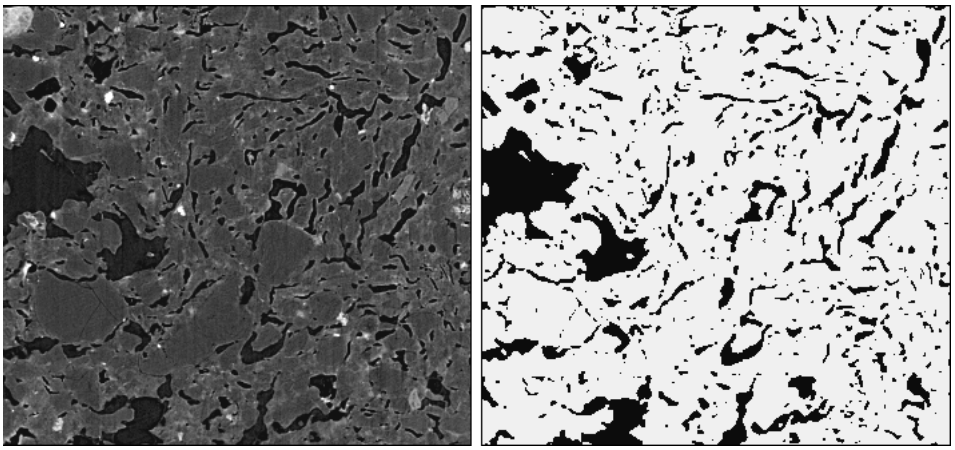
Image Filtering

The following updates are available for filtering image data in Dragonfly 2021.1.

Thresholding for Unimodal Images

There are many methods that provide appropriate threshold values for an image with a bimodal gray-level histogram. However, most of these methods cannot accurately and efficiently segment an image with a unimodal gray-level distribution. To address this limitation, the **Liu-Song-S** threshold filter has been added to Dragonfly for image filtering operations. By analyzing the morphology of the gray gradient distribution histogram, an optimal threshold for image segmentation can be obtained for images with unimodal gray-level distributions, as shown in the example below.

Original image (left) and the result of Liu-Song-S thresholding (right)



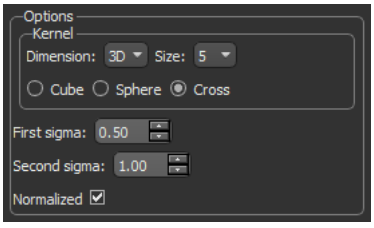
NOTE Refer to Song et al, *A new automatic thresholding algorithm for unimodal gray-level distribution images by using the gray gradient information*, Volume 190, July 2020 (https://www.sciencedirect.com/science/article/abs/pii/S0920410520301674) for additional information about this filtering technique.

Updates for Image Filters

A number of updates are available for the following filters in Dragonfly 2021.1.

DoG... The Difference of Gaussian (DoG) edge detection filter now supports 3D structuring elements, as shown in the following screen capture.

New kernel options for DoG filter



NOTE In some cases, it can be more useful to interpret the input data of an image processing algorithm as a 3D volume instead of a sequence of 2D planes.

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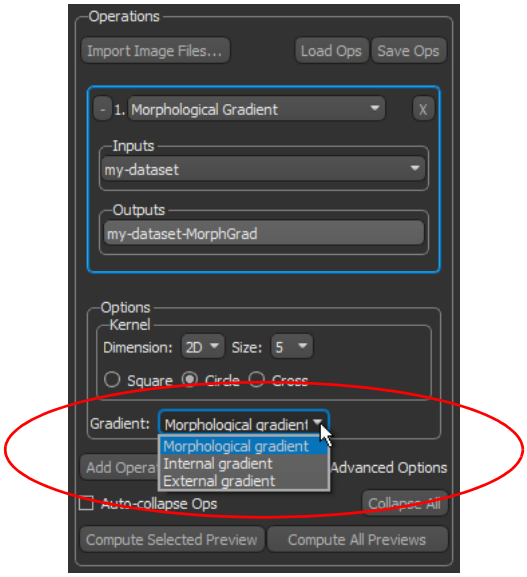
Morphological gradient... This filter now includes the option to compute the external and internal gradients of the input image, circled below.

Gradient options for the Morphological Gradient filter



You should note that a morphological gradient is the difference between the dilation and the erosion of an image. It is an image in which each pixel value indicates the contrast intensity in the close neighborhood of that pixel. It is useful for edge detection and segmentation applications.

Mathematically, the morphological gradient (G) of f is given by:

$G(f) = D(f) - E(f)$, where D and E denote dilation and erosion with the selected structuring element, respectively.

The internal gradient is given by: $G_i(f) = f - E(f)$.

The external gradient is given by: $G_e(f) = D(f) - f$.

NOTE The internal and external gradients are "thinner" than the gradient. Gradient peaks are located on the edges, whereas the internal and external ones are located at each side of the edges. You should also note that $G_i + G_e = G$.

Three-Point Circle Tool

The new Three-Point Circle tool for annotations, circled below, lets you create a circular region by simply clicking on a succession of three points in a 2D view. The smallest circle that can pass through the three points is computed automatically.

Three-Point Circle tool (circled)

Measurements available for this region tool include the area and perimeter of the circle. You can also adjust the thickness of the annotation, select a control point size and style, as well as plot a histogram of the data values within the region.

Configured Actions for the Three-Point Circle Tool

The following configured actions are available for the Three-Point Circle tool.

Configured actions for the Three-Point Circle tool

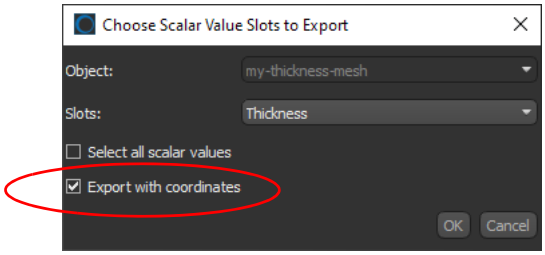
Action	Default key
Create circle from 3 points	Left mouse

Thickness Meshes

You can now choose to export the X-Y-Z coordinates of thickness meshes along with the scalar values when you export data in the comma-separated values (*.csv extension) file format.

Right-click the thickness mesh, choose **Export Scalar Values** in the pop-up menu, and then select **Export with coordinates** in the Choose Scalar Values Slots to Export dialog, as show below.

Choose Scalar Value Slots to Export dialog



The exported comma-separated values (*.csv extension) file will include columns for the X-axis coordinate, the Y-axis coordinate, and the Z-axis coordinate for each vertex, along with the corresponding scalar value(s).

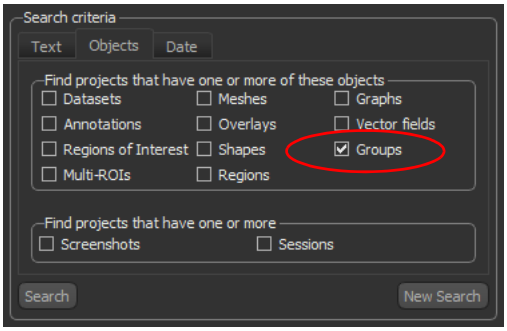
Organizer Updates

Updates for Dragonfly's Organizer include the option to find projects that contain session groups, such as those created by the Bone Analysis, Plug Analysis, and Segmentation Wizards, as well as a reformatted Organizer Settings dialog.

Search Criteria

The selectable objects for finding projects now includes **Groups** on the Objects tab in the Search Project dialog. This option is circled on the screen capture below.

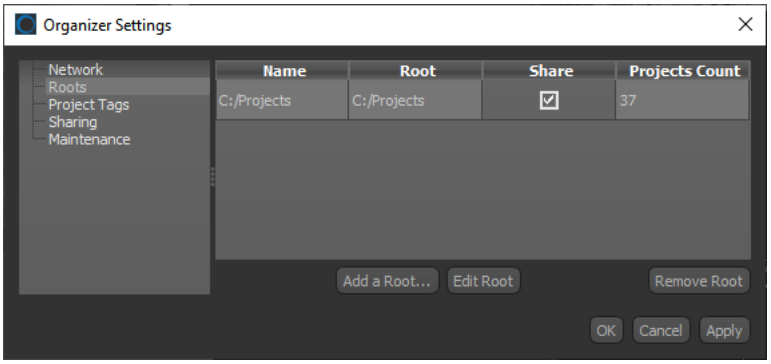
Search criteria



Organizer Settings

The Organizer Settings are now arranged with a tree view on the left side and the parameters related to the current selection on the right. Click the **Manage Settings** button in the Organizer dialog to open the Organizer Settings dialog shown below.

Organizer Settings dialog



The Organizer Settings are available as described below.

Network... Lets you designate a server port and also lists the current IP address.

Roots... Lists the configured roots and lets you add and edit roots.

Project Tags... Lets you setup tags that are mandatory or optional when new projects are created.

Sharing... Lets you enable sharing and to add authentication.

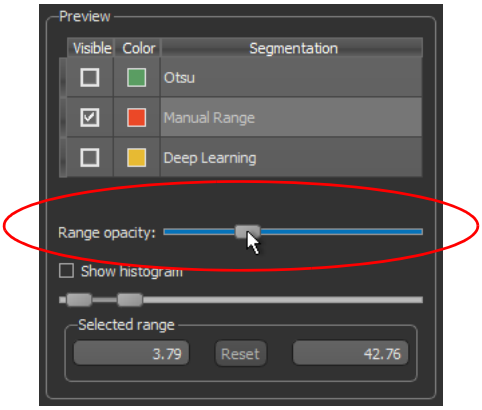
Maintenance... Provides the option to build the database. Rebuilding may be required if you manually delete objects in a project or remove projects from a root folder outside of Dragonfly.

Plug Analysis

As an update for Dragonfly's Plug Analysis module, which provides a dedicated workflow for analyzing core plugs acquired from rock samples and other porous media, you can now control the opacity of the selected range highlight when using the Manual Range option to apply a threshold segmentation.

The option to adjust the opacity of the range highlight with the Range opacity slider, circled below, is available in the Preview box.

Range opacity slider

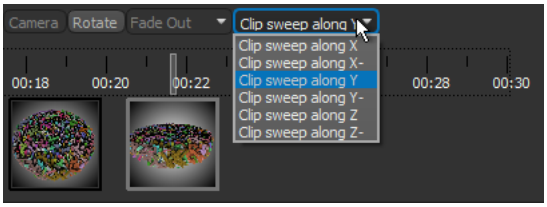


Movie Maker

This new release also features a number of improvements and enhancements for Dragonfly's Movie Maker.

Clip sweeps... The option to choose the direction of clip sweeps is now available. To add a clip sweep, select the required keyframe and then choose a clip sweep in the Clip sweep drop-down menu, as shown below.

Clip sweep options



2D Animations

This new release provides the option to record 2D animations in the APNG file format (*.png extension) from the 2D Animation panel.

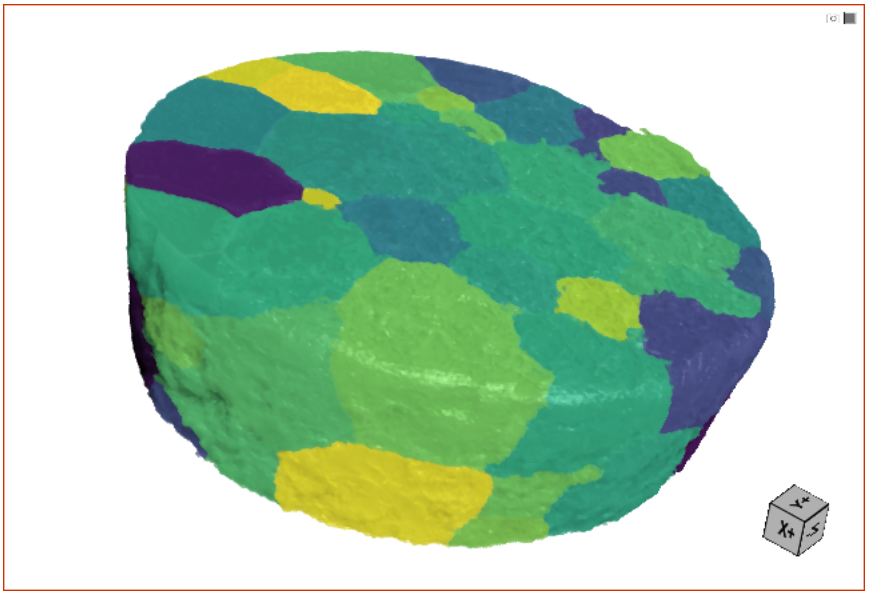
NOTE Animated PNG files will play automatically in most internet browsers, such as Google Chrome and Windows Edge. You should also note that animated PNGs generally have better quality than other file formats, such as GIF.

Support for H5 Files

For Dragonfly Pro users, this software release includes a reader for importing files created with Xnovo's GrainMapper3D software (*.h5 extension) from processed TXM files. GrainMapper3D provides non-destructive 3D crystallographic imaging through LabDCT on ZEISS Xradia 520/620 Versa X-ray microscopes made for laboratory use.

Choose **File > Import GrainMapper File (h5)** on the menu bar to automatically import a selected GrainMapper file.

Visualization of a GrainMapper H5 file in 3D



NOTE Subsequent analysis of grain maps in Dragonfly Pro lets you filter, analyze, and visualize data with parameters such as orientation, volume, sphericity, and others. Color coding can be chosen according to the selected scalar value.

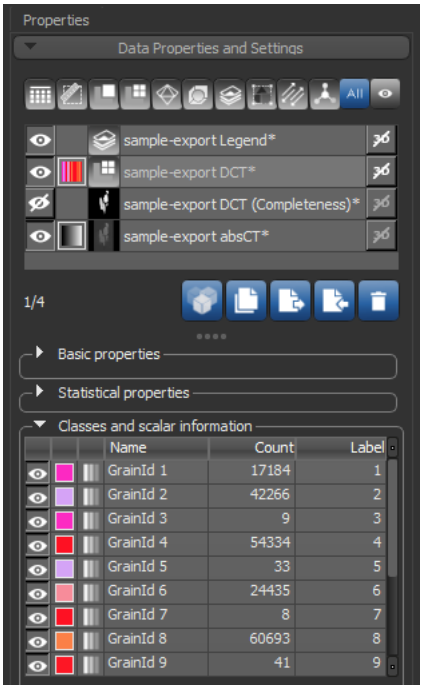
Dragonfly Pro's .h5 reader imports:

AbsorptionCT/Data... As a 3D dataset of the CT reconstruction, which is usually registered with the TXM reconstruction from the same experiment.

LabDCT/GrainID... As a 3D multi-ROI in which each GrainID appears in the Name column, along with the number of corresponding labeled voxels and scalar slots for completeness, Eigen values, and Rodrigues vectors.

The items available for an imported H5 file are shown in the following screen capture of the Data Properties and Settings panel.

Imported .h5 file data in the Data Properties and Settings panel



NOTE GrainMapper3D is a registered trademark of Xnovo Technology ApS.

NOTE This option is available for Dragonfly Pro only. Contact ORS for information about the availability of this version of Dragonfly.

Additional Support for CZI Images

The additional support for importing CZI files in Dragonfly Pro now includes automatically reading stage positions from the metadata in order to orient data appropriately. You should also note that a known issue with scaling has also been resolved.

NOTE The option to import CZI files is available for Dragonfly Pro only. Contact ORS for information about the availability of this version of Dragonfly.

Export Images to VTK

The option to export image data in the VTK (*.vtk extension) file format is available in this software release.

Right-click the data you need to export in the Data Properties and Settings panel and then choose **Export > Export Image to VTK** in the pop-up menu. In this case, a channel as a `vtkStructuredPoints` with the channel data as a scalar slot will be exported.

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Menu Bar Changes

The following new items are available on the menu bar in Dragonfly 2021.1.

File Menu

A number of new items, listed below, are available in the **File** menu.

File menu changes

	Description
Import GrainMapper File (h5)	Lets you import files created with Xnovo's GrainMapper3D software (*.h5 extension) from processed TXM files (see Support for H5 Files on page 35).

Utilities Menu

A number of new items, listed below, are available in the **Utilities** menu.

Utilities menu changes

	Description
Start Distributed Tasks Consumer	Opens the Distributed Tasks Consumer dialog, in which you can monitor the activity of consumers within a selected queue, as well as de-register synched consumers.
Start Distributed Tasks Queue Observer	Opens the Distributed Tasks Observer dialog, in which you can clear completed tasks, tasks with errors, pending tasks, or selected tasks, as well as resubmit processing tasks and clear temporary data (see Distributed Tasks Observer on page 19).

Changes to Contextual Menus

The following changes for the contextual menus available in the Data Properties and Settings panel are implemented in Dragonfly 2021.1.

NOTE The item ‘Extract Action Log from Object’ was renamed as ‘Extract Object History as Macro’ for this software release. Extracted macros not only provide an audit trail to help troubleshoot processing issues, but can be edited and replayed to create new objects.

Dataset Pop-Up Menu

A number of new and modified items, listed below, are available in the **Dataset** pop-up menu.

Dataset pop-up menu changes

	Description
Export	Two additional items now appear in the Export submenu. **As RBG...** This option, which lets you export selected RGB channels in the BMP, JPEG, and PNG file formats, was previously available as a stand-alone item in Dataset pop-up menu. **To VTK...** Lets you export image data in the VTK (*.vtk extension) file format (see Export Images to VTK on page 36).

Multi-ROI Pop-Up Menu

A number of new items, listed below, are available in the **Multi-ROI** pop-up menu in the Data Properties and Settings panel.

Multi-ROI pop-up menu changes

	Description
Label Histograms to CSV	Lets you export label histograms in the comma-separated values (*.csv extension) file format (see Export Label Histograms on page 25).

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Preferences Changes

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

Click **Preferences** on the Status bar or choose **File > Preferences** on the Menu bar to open the Preferences dialog.

Views Preferences

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

Views preferences changes

	Description
3D Settings	
Default WL Mode	Lets you select a default window leveling mode for 3D renderings (see Window Leveling Modes for 3D Views on page 27).

Configurable Actions

New configurable actions are available for annotations and the Point & Click Outline brush. Chose **File > Preferences > Configurable Actions** to access the configurable actions for Dragonfly.

Three-Point Circle tool... See Three-Point Circle Tool on page 32 for the configured actions that let you create a circular region by simply clicking on a succession of three points in a 2D view.

Create a point in Point mode... The default action for adding points in Point mode was changed to LEFT CTRL + LEFT MOUSE in this software release. This should facilitate adding points to 3D views.

Point & Click Outline brush... See Point & Click Outline Brush Preferences on page 25 for the actions related to the new Point & Click Outline brush.

Resolved Issues

A number of issues reported by users have been resolved in this software release.

Labeling Multi-ROIs

A number of updates and fixes for labeling multi-ROIs are included in Dragonfly 2021.1. These include a reformatted ROI Painter panel (see ROI Painter Panel on page 21), new ROI Painter tools (see New ROI Painter Tools on page 22), and new patterns for working in 'Remove' mode. You should note the following when working in 'Remove' mode.

- When a single label of a multi-ROI is selected in the Classes and scalar information box and you are working in 'Remove' mode, only voxels within the selected class will be removed. All other labels will remain *as is*.
- If no label of a multi-ROI is selected, then all labeled voxels will be removed when you are working in 'Remove' mode.

Working in 3D Views

Issues related to working with visual planes and clipping in cases in which a mesh is visible in the 3D view have been resolved in this software release.

3D Settings for Loaded Sessions

Settings for 3D visualizations, such as the applied LUT and the selected opacity, solidity, and other 3D settings, are now retained in saved sessions and will be reinstated when a session is loaded.

Issues with AMD Graphic Cards

Issues related to rendering data in 3D on systems with AMD cards have been fixed.

Movies Rendered in 4K

Reported issues related to rendering movies in 4K with Dragonfly's MovieMaker have been fixed.

Exported Screenshots

Some users have reported that the values on legends in exported screenshots are not always well positioned. For example, numbers sometimes overlap with each other or the bar when exporting at different resolutions. This has been fixed.

Smoothing Meshes

Issues related to smoothing meshes with the Laplacian method should no longer occur in this software release.

Interpolating ROIs

The issue reported for interpolating the slice intervals of regions of interest in the ZY plane has been resolved in Dragonfly 2021.1.

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System Requirements

This release supports the base system requirements (see http://www.theobjects.com/dragonfly/system-requirements.html).

Publicly Available Source Code

Users can freely download and examine the source code of the following.

TensorFlow

A number of Dragonfly's artificial intelligence applications, such as the Deep Learning Tool, the Segmentation Wizard, and Segment with AI, use TensorFlow APIs to facilitate training and inference of deep neural networks. Created by the Google Brain team, TensorFlow is a free and open-source library widely used for deep learning applications and traditional machine learning. You should note that the version of TensorFlow implemented in Dragonfly 2021.1 and in previous versions is 1.14.0.

Users can freely download and examine the TensorFlow source code from:

https://github.com/tensorflow/tensorflow/releases/tag/v1.14.0.

Qt

Dragonfly is designed and developed with Qt, which is a free and open-source toolkit for creating graphical user interfaces and cross-platform applications. Qt is developed by The Qt Company, a publicly listed company, and is available under both commercial licenses and open-source GPL 2.0, GPL 3.0, and LGPL 3.0 licenses.

Users can freely download and examine the Qt source code from:

https://download.qt.io/official_releases/qt/5.9/5.9.7/.

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 **Utilities > 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.

Learning Dragonfly

You'll find some great free resources, such as our latest instructional videos, recorded webinars, and user forums just by taking a quick look around www.theobjects.com/dragonfly/. You can also take advantage of the course offerings listed below to further benefit from our training team's in-depth product knowledge.

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.

NOTE All scheduled Dragonfly workshops have been postponed or cancelled due to worries about the coronavirus pandemic. We will resume our workshop schedule as soon as possible. You can check for updates at http://www.theobjects.com/dragonfly/workshops.html.

Online Training

Get connected with an online training session and follow along with a Dragonfly product specialist as they demonstrate the features and benefits of Dragonfly and walk you through specialized modules. Web-based training, which can be adapted to individual needs and interests, offers an interactive approach that lets you practice new techniques on numerous case studies.

NOTE Online training is available upon request. Contact support@theobjects.com for information about availability.

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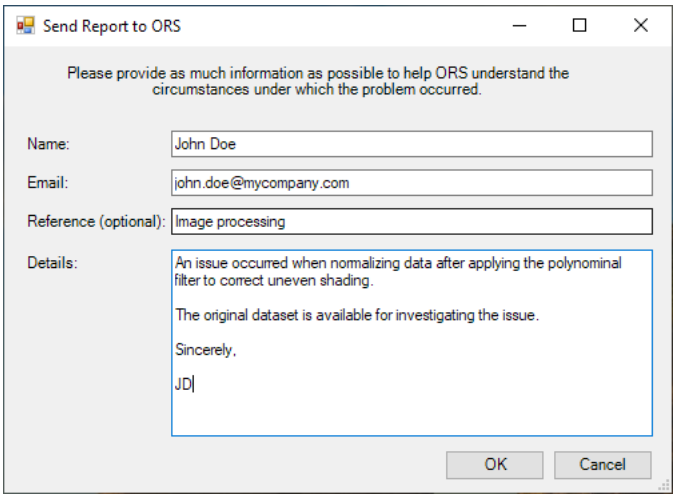
Reporting Issues

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



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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