GeoDict

GUI, Menu, and Toolbar Reference

User Guide

GeoDict release 2024

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GeoDict

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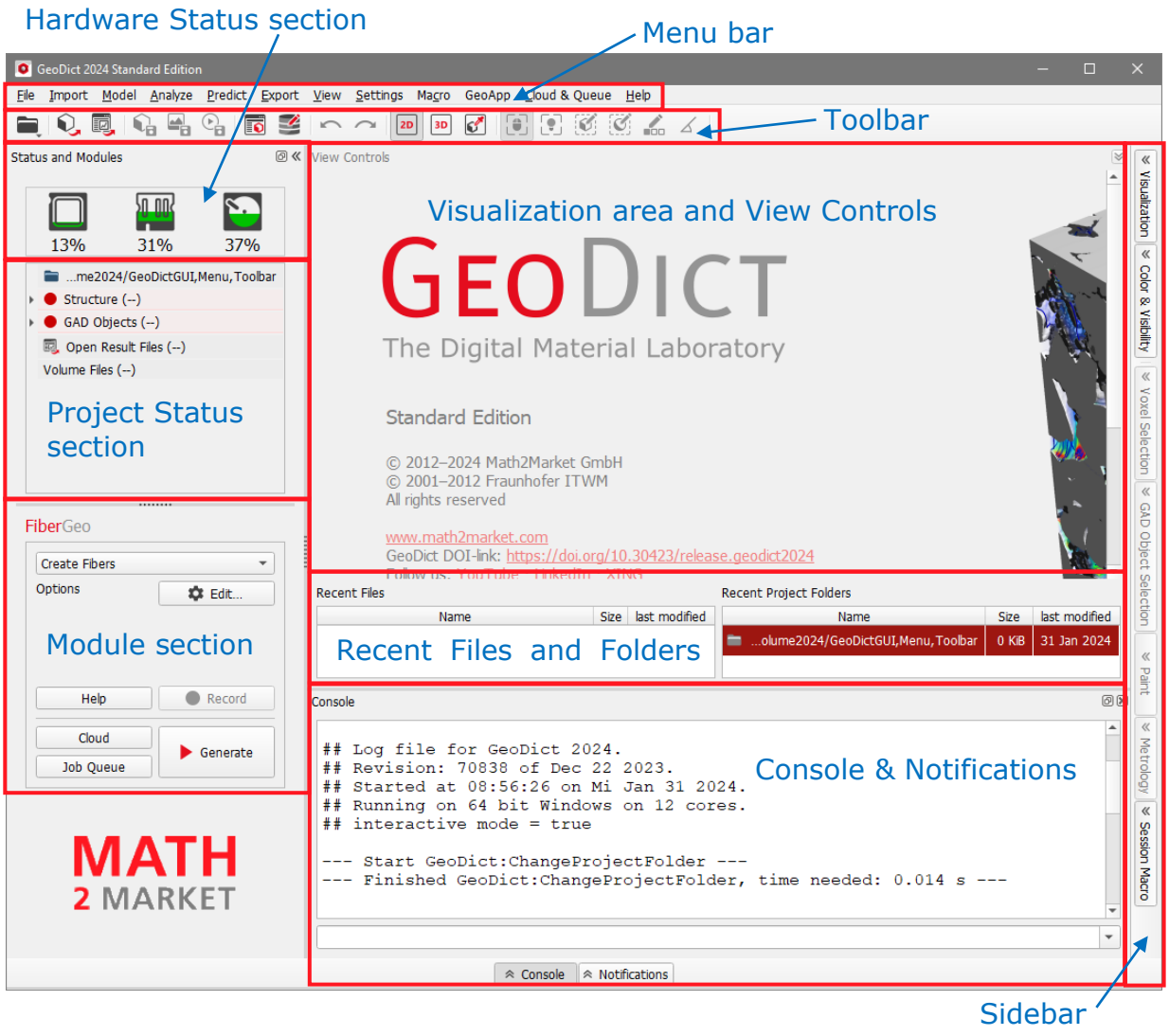
GeoDict GUI, Menu, and Toolbar

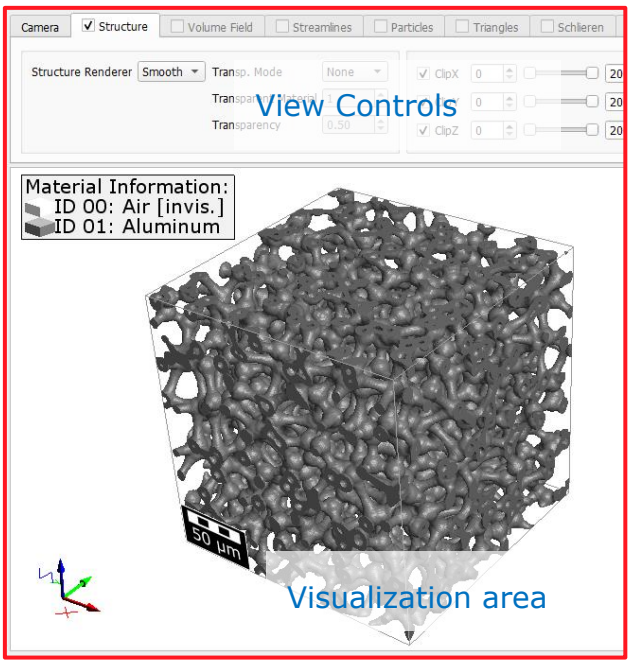
This handbook describes the basic elements of the GeoDict GUI (Graphical User Interface). The standard GUI is partitioned into:

- **Menu bar** (see page 4), that gives access to the main features of GeoDict,
- **Toolbar** (see page 3), that provides several shortcuts to the most common tools,
- **Project Status section** (see page 43), where information about the current project is shown and the loaded structure and volume fields can be edited in the right-click menu,
- **Module section** (see page 59), where commands and their options for the chosen module can be selected,
- **Visualization area** and **View Controls** panel (see page 61), where the structure is shown and visualization settings can be made,
- **Sidebar** (see page 68), where modifications of the visualization or the structure can be made,
- **Recent Files and Folders** section (see page 2), which shows the last used folders and files on the start screen,
- **Console** and **Notifications** (see page 90), that display messages from GeoDict.



At the program start, the heading for the **Module** section is for one of the licensed modules, e.g., the FiberGeo module. The **Visualization area** shows the program's splash screen.

When a structure model is displayed, the **View Control** panel with several tabs appears above the **Visualization area** to control the visualization of the structure or the results computed for it.

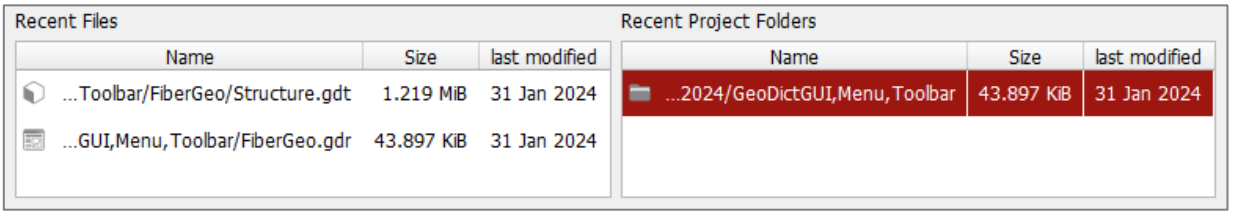


This handbook does not describe all features that are accessed through the GUI. Features described in separate handbooks of the User Guide are not described here again. In this case, only a link to the corresponding handbook is provided.

A first overview of how a basic workflow in GeoDict might be performed is described in the First steps in GeoDict tutorial.

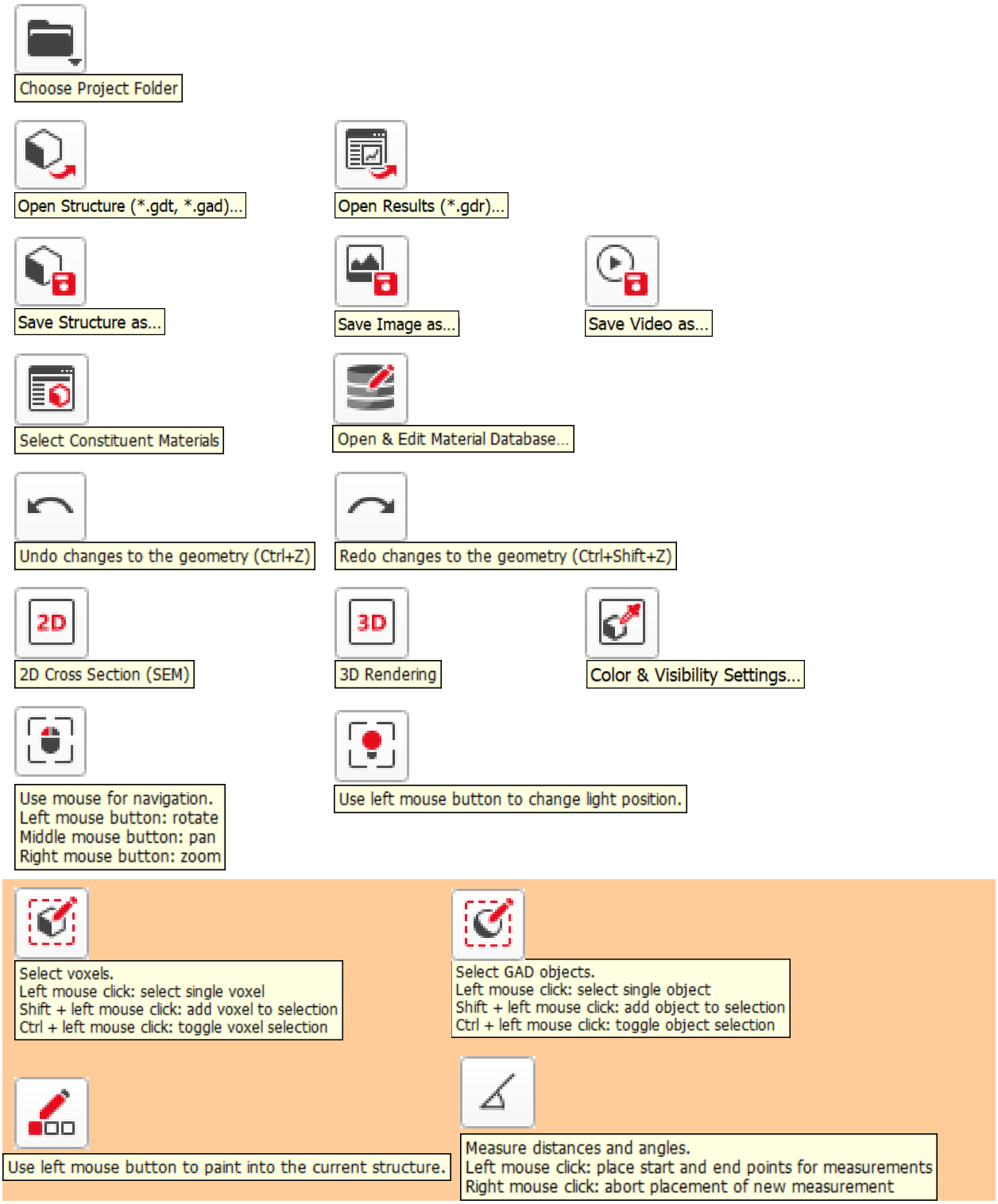
Recent Files and Folders

If no structure is in memory and the initial splash screen is shown, the **Recent Files** and **Recent Folders** sections are visible below. There, the **Name**, **Size** and date when it was **last modified** are shown. Clicking on a file opens it directly in the Visualization area or the Result Viewer. Clicking on a folder changes the current project folder.



TOOLBAR

The **Toolbar** displays tools for selected functions, mostly included in the **Menu bar**, frequently used in GeoDict. Resting the mouse pointer over a tool for a moment prompts a tool tip explaining the function.



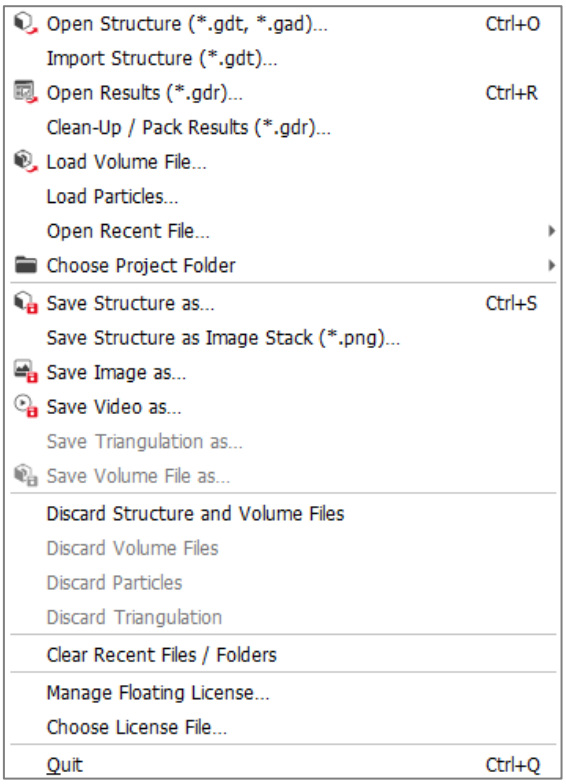
The selecting and editing functionality of Voxel Selection, GAD Object Selection, Paint and Metrology are part of the GUI Sidebar, and thus, are explained below starting on page 68.

MENU BAR

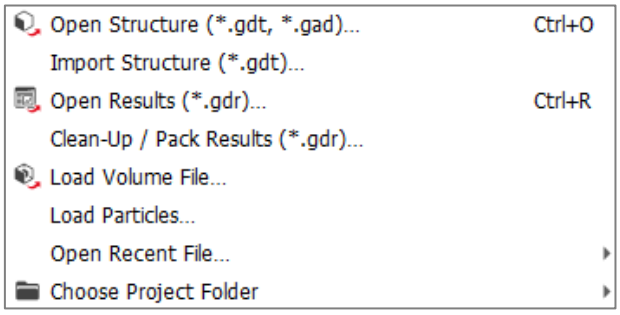
The **Menu bar** contains the menus: **File**, **Import, Model**, **Analyze**, **Predict**, **Export**, **View**, **Settings**, **Macro**, **GeoApp**, **Cloud & Queue**, and **Help**. Their functions are accessible by scrolling down in the pull-down menus.

FILE

The **File** menu entries are organized into panels:



OPEN FILES, PACK AND LOAD RESULTS, PROJECT FOLDER



OPEN STRUCTURE (*.GDT, *.GAD)

Select **Open Structure (*.gdt, *.gad) ...** to browse for and open a saved generated structure file in **GDT** format (GeoDict compressed format), in **GAD** format (GeoDict analytic data) or in an index image format (***.leS** and ***.g32**). Such files are usually saved and, thus, located in a personal project folder created by the user for the current project. Loading a *.leS or *.g32 file with **Open Structure** imports the file as a structure in GeoDict, assigning the indices to the 256 material IDs. First, the

index 0 is assigned to ID00. Then, the other indices are assigned to the other 255 IDs equally. That means, index 01 gets ID 01, index 02 gets ID 2 and so on till index 255 gets ID 255. If more than 256 indices are contained in the *.g32, then the IDs are assigned again starting with ID 01 for index 256. Loading such files with **File → Load Volume Field** instead (see page 6), loads it as an index image.

The toolbar icon  is the shortcut to open structures.

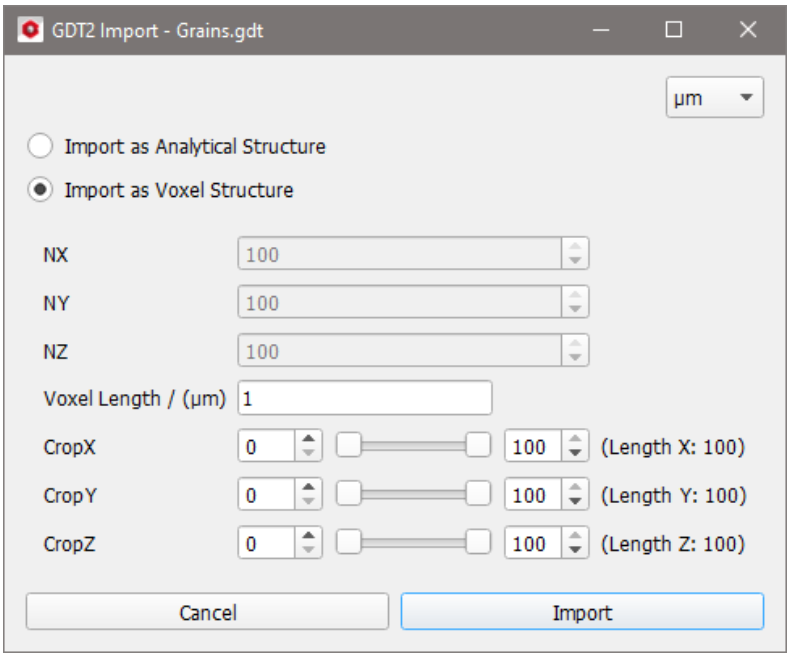
Import Structure (*.gdt)

With **Import Structure (*.gdt)...** only files in **GDT** format can be loaded into GeoDict. In contrast to **Open Structure**, after selecting a file to open, the **Import Structure dialog** offers several options, such as changing the voxel length and cropping the structure.

For a file which contains analytical information of the microstructure, the user can decide to **Import** the structure **as Analytical Structure** or to only **Import as Voxel Structure**. Importing as analytical structure allows, e.g., to change the origin or to rotate the structure. The options are explained in more detail in the Import GAD data section of the GadGeo handbook.

If **Import as Voxel Structure** is checked, the dimensional values of **NX**, **NY**, **NZ** cannot be changed. The **Voxel Length** can be changed and has no impact on the number of voxels. The unit can be selected from the pull-down menu in the upper right corner of the dialog.

A sub-region to load can be set by adjusting the sliders for **CropX**, **CropY** and **CropZ** or entering the exact voxel number in the corresponding boxes. The resulting **Length** is shown on the right in units of voxels.



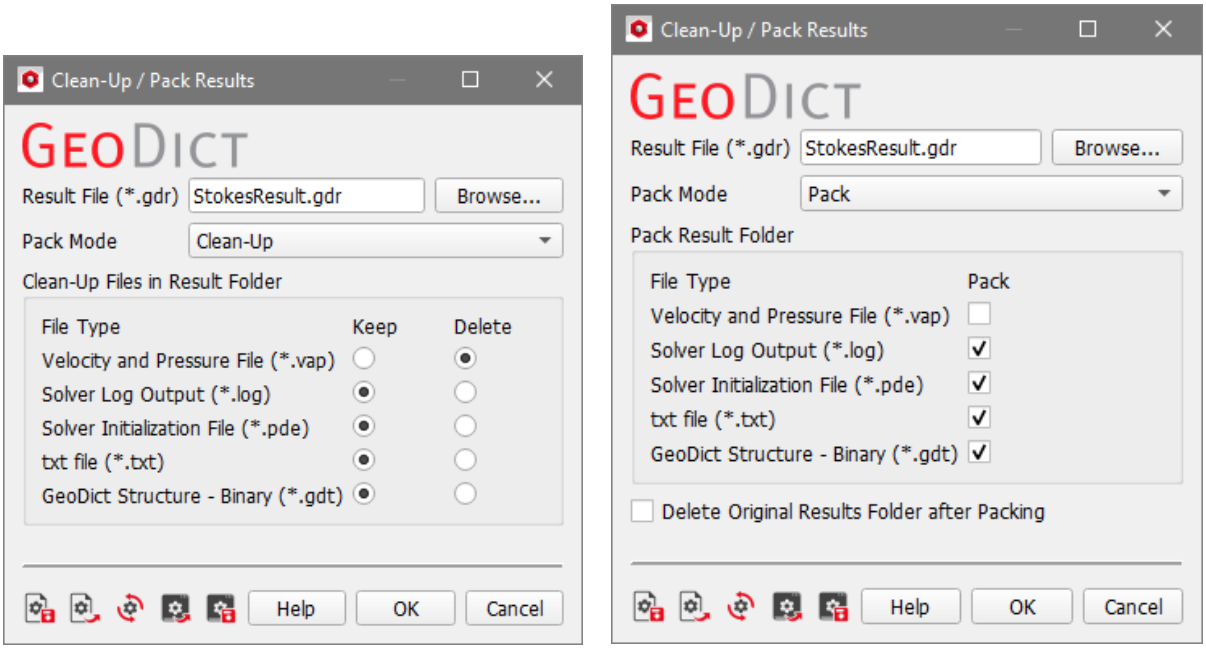
Open Results (*.gdr)

Select **Open Results (*.gdr)...** to open and load result files in **GDR** format (GeoDict results), obtained from a previous run of a GeoDict solver or structure generator, and saved in the project folder.

The toolbar icon  is the shortcut to open results.

Clean-Up / Pack Results (*.gdr)

Select **Clean-Up / Pack Results (*.gdr)...** to delete or compress additional files that are saved in the result folder of the chosen result file.

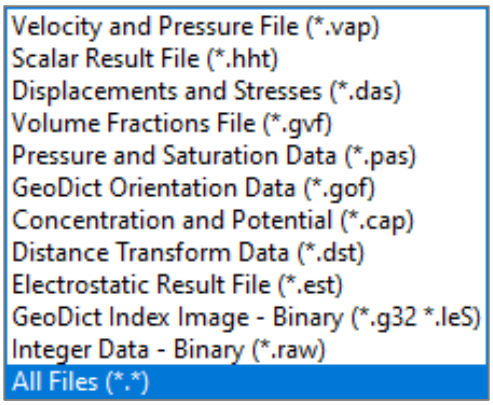


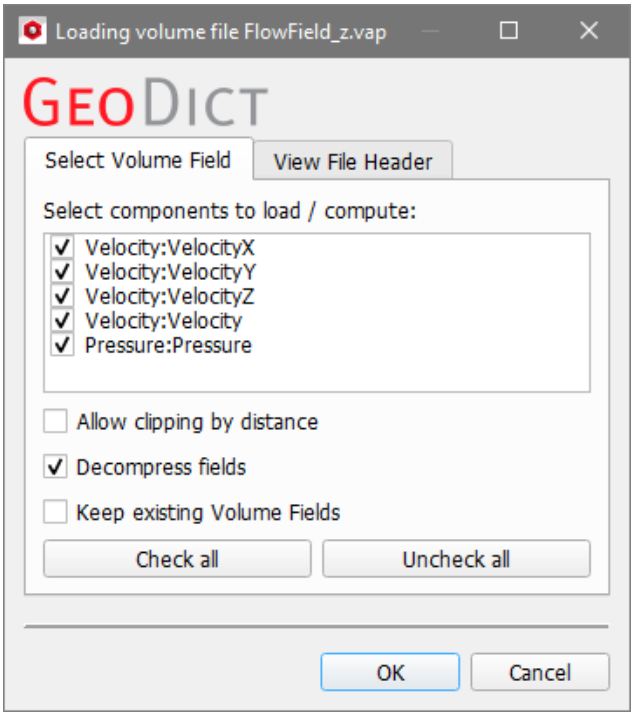
When the Pack Mode **Clean-Up** is selected, you must decide for every file type in the result folder if it should be kept or deleted.

When choosing **Pack**, select all the file types which should be contained in the compressed ZIP-folder. The original files are still present in the results folder. Select **Delete Original Results Folder after Packing** to also delete the original files inside the folder.

Load Volume File

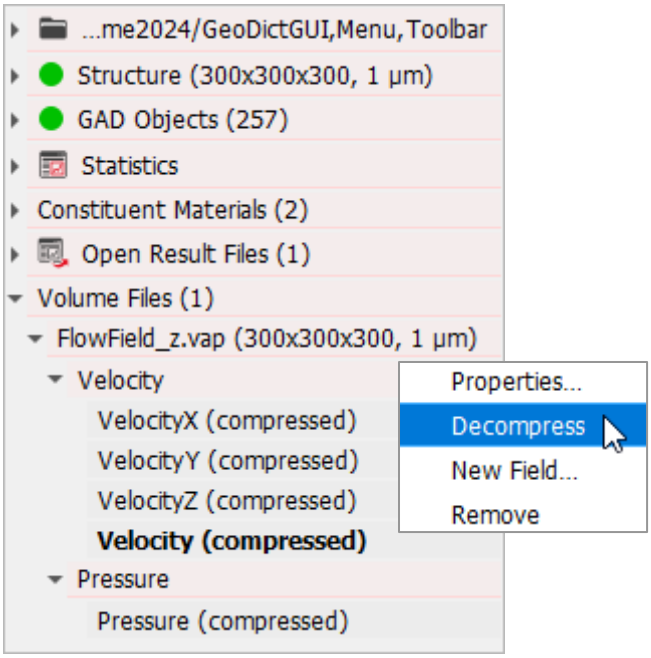
Select **Load Volume File...** to open volume files and visualize the contained volume fields, e.g., *.vap files (velocity and pressure) located in the result folders. You can open and load result files for visualization in numerous formats.





In the opening **Loading volume file** dialog, select the volume fields you want to load. Select **Allow clipping by distance** additionally computes a distance field using a signed Euclidean distance transform (see MatDict handbook for more information). Later, the distances can be used to threshold the other loaded volume fields.

If a compressed volume field is opened, it is possible to load the field in compressed form or to decompress it during loading. A compressed field is saved when checking **Write Compressed Volume Fields** under the Solver tab of the **LIR Solver Options** dialog. Notice, that some operations and visualization features of volume fields (e.g the visualization of the adaptive grid) are available only if the field is loaded in decompressed form. It is also possible to load a volume file in compressed form and decompress it later. In the project status section on the left, right click on the volume image and choose **Decompress**.



Check **Keep existing Volume Fields**, if already loaded volume fields should be kept in the GeoDict memory.

With the buttons **Check all** and **Uncheck all**, the fields from the volume file you want to load can be selected or deselected at once.

In the **View File Header** tab you can see the header of the volume file. The header provides information about the domain size, voxel length, boundary conditions, and many more. Nothing can be edited in this tab, only the available information, depending on the volume file type, is shown. When opening a volume file with a text editor the header is the only readable part of this file, but it is more comfortable to view it during the import in GeoDict. Moreover, for large volume files, a text editor needs a long time to open the file or is even unable to open it.

Clicking **OK** starts the import of the volume file.

Load Particles

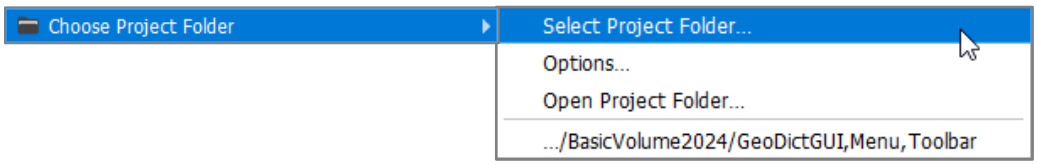
Select **Load Particles...** to open and visualize particle trajectories and particle positions for FilterDict or AddiDict simulations (*.gpt and *.gpp files). This option is only available if a structure is currently loaded into GeoDict.

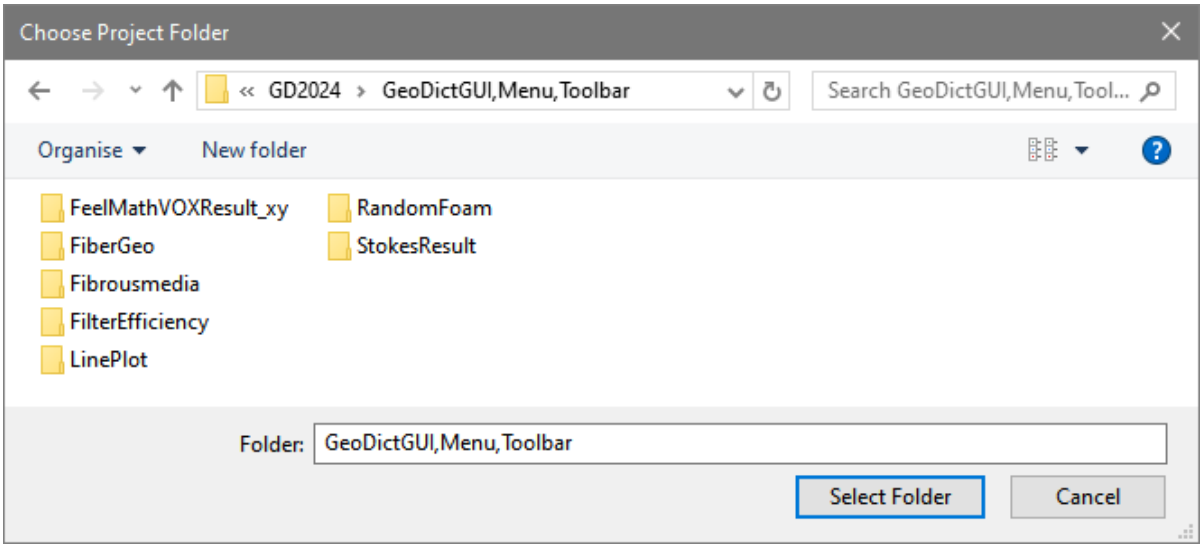
Open Recent File

Select **Open Recent File...** to choose a file from a list. This list of files opened or created in the last GeoDict session is shown in the Recent Files section (see page 2).

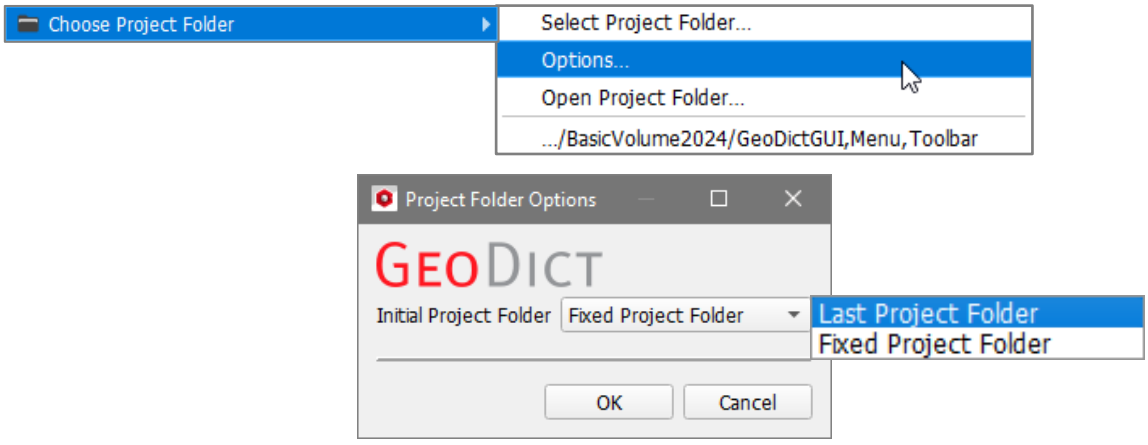
Choose Project Folder

For **Choose Project Folder** a sub-menu opens when hovering above. Click **Select Project Folder...** to open the **Choose Project Folder** dialog. Find the path to a previously created and already listed project folder, or right-click in the dialog to create a new project folder to save the results and settings files produced with GeoDict.





Follow **Choose Project Folder** → **Options...** to set up how the project folder is selected at the start of GeoDict. **Last Project Folder**, or a **Fixed Project Folder** can be selected.

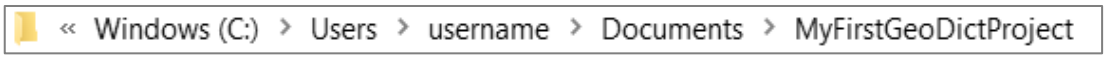


Click **Open Project Folder...** to open the currently selected project folder with the Windows Explorer. Below, if available, the last project folders are listed as it is done in the Recent Project Folder section (see also page 2).

The toolbar icon  is the shortcut to choose the project folder.

The **project folder** will contain the files with the generated structures and the result files from the solvers' computations.

The location of the project folder is defined by the user at his/her convenience. The initial project folder for the first start of GeoDict, is located in Windows, by default at

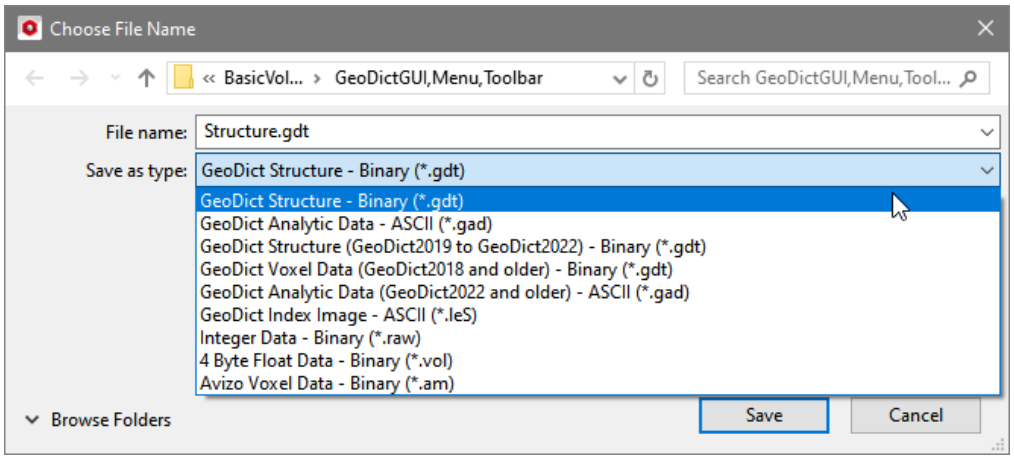


SAVE STRUCTURE, IMAGE, VIDEO, TRIANGULATION, OR VOLUME FILE

SAVE STRUCTURE

Select **Save Structure as...** to save the generated structure in the supported file formats (**GDT**, **GAD**, **leS**, and **RAW**).

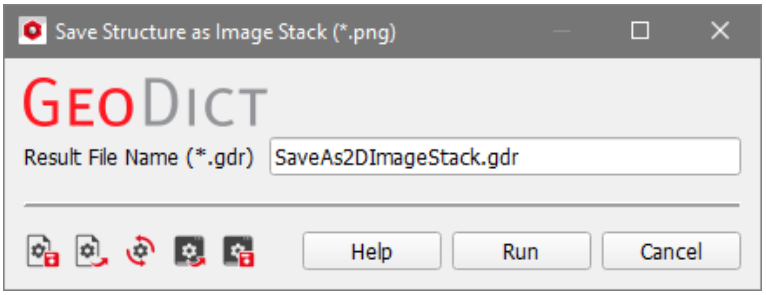
The toolbar icon  is the shortcut to this function.



The automatically chosen folder to save the file containing the structure data is the current project folder. But it is also possible to choose another location.

SAVE STRUCTURE AS IMAGE STACK

With **Save Structure as Image Stack (*.png)...** each Z-slice can be saved as a *.png file. Each material ID is converted into a gray value. In the options menu, a Result File Name can be specified. The *.png files are then saved into a folder with the same name and a result file will be created.

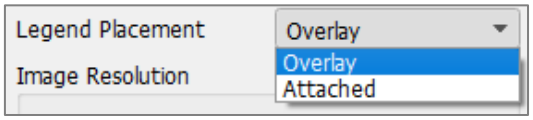


Save Image

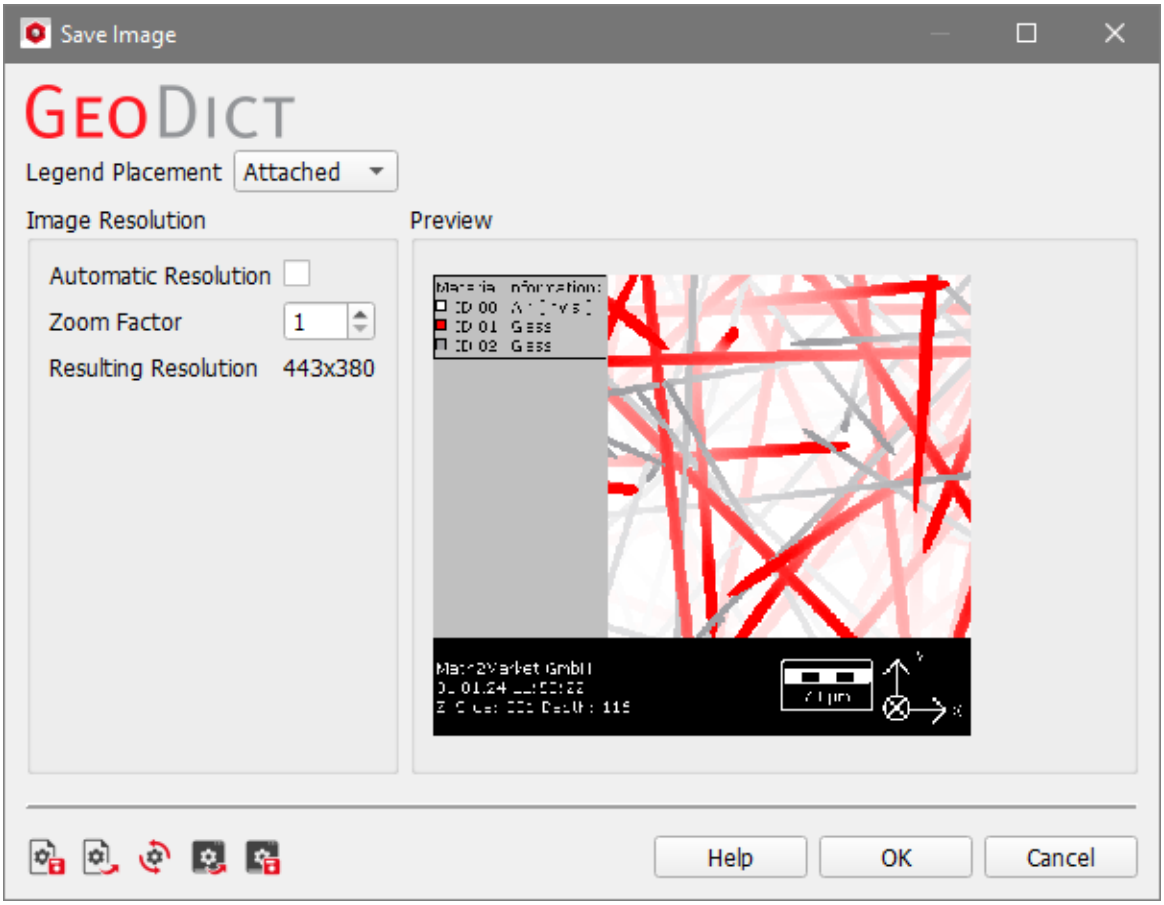
Choosing **Save Image as...** saves the current content of the visualization area in the supported file formats (***.png**, ***.jpg**, ***.xpm**, ***.xbm**, ***.bmp**, ***.pgm**, ***.ppm**, and ***.pbm**) in the project folder.

The toolbar icon  is the shortcut to this function. The opening dialog is different depending whether 2D view or 3D view was previously selected.

For 2D images, in the **Save Image** dialog that opens, select first where to place the legend in the image.

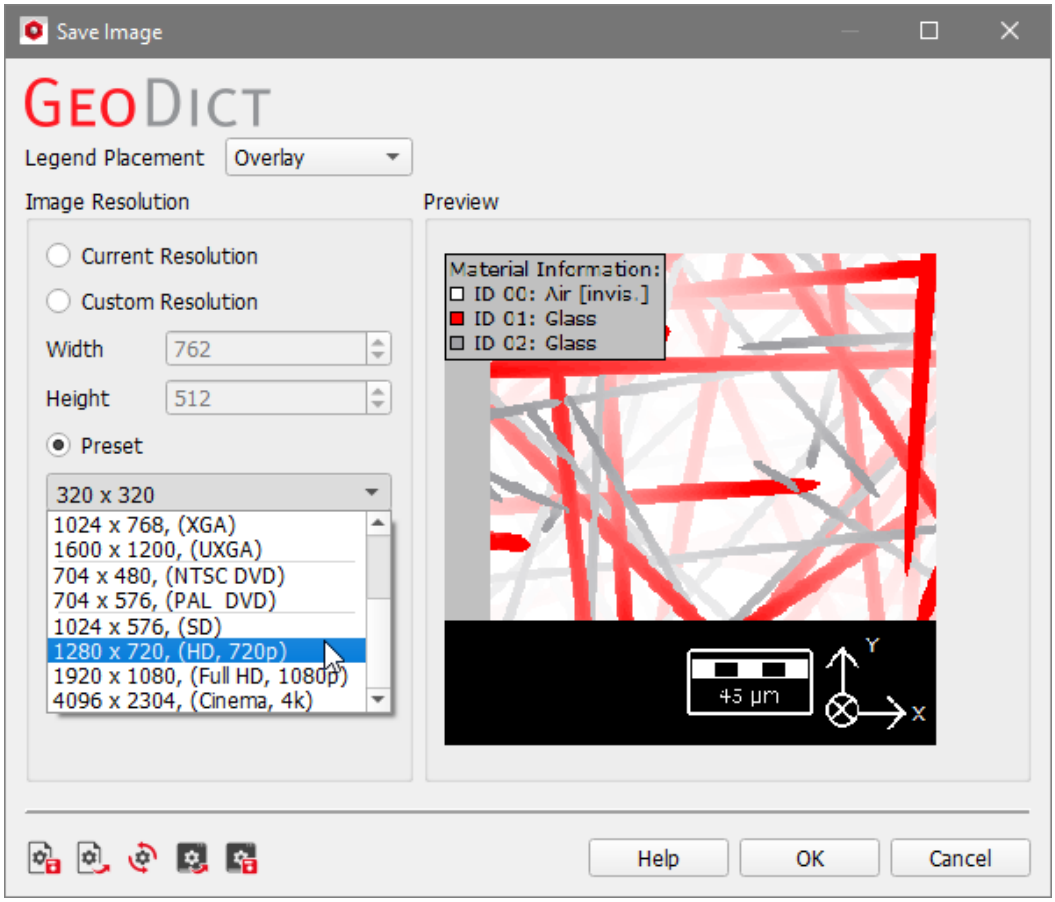


- Choose **Attached** to place the legend outside of the image but attached to it. If this is selected, the resolution can be selected automatically or manually by defining a zoom factor. Uncheck the **Automatic Resolution** box, to set the zoom factor.

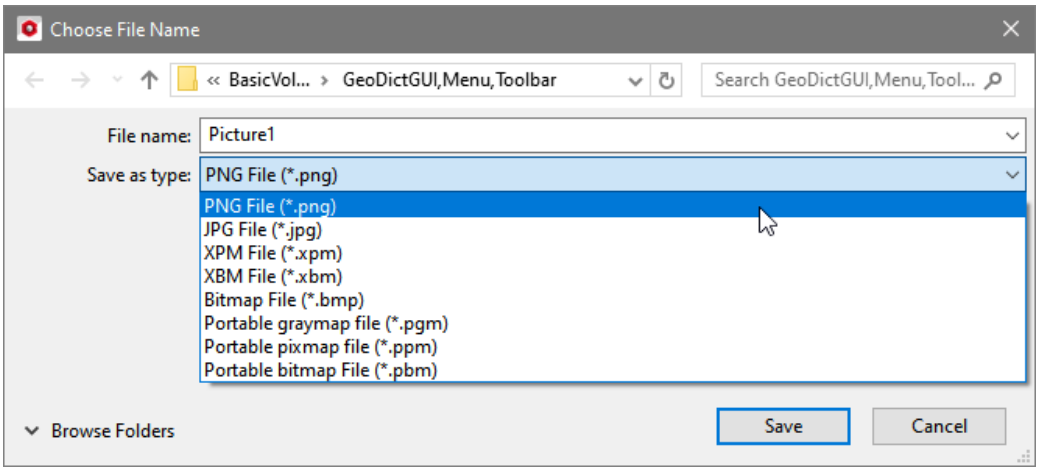


- Choose **Overlay** as the **Legend Placement** to allow that the legend overlaps the image. In this case, the user can choose to save the image with the **Current Resolution**, to define a **Custom Resolution** or to use the **Preset** resolution values that fits best.

A preview of the image is shown in the right part of the dialog. Click **OK** to select the settings.



Choose a file name and an image format and save the image by clicking **Save**.



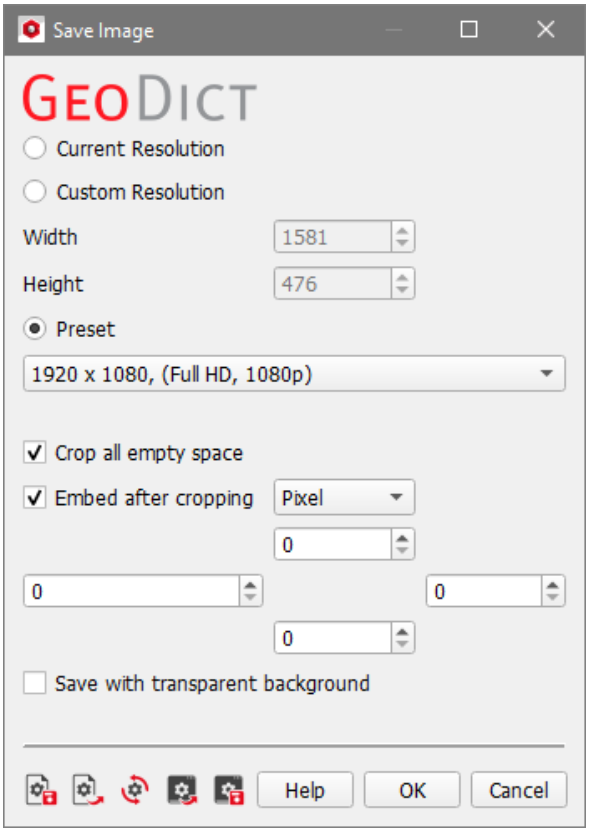
For 3D images, choose the resolution to save the image with the **Current Resolution**, define a **Custom Resolution** or use a **Preset** resolution.

Select **Crop all empty space** to reduce the image size by removing all borders in background color.

If this is selected, the image can be embedded in borders with the background color **(Embed after cropping)**. The number of pixels or a percentage value for each border can be defined separately in this case.

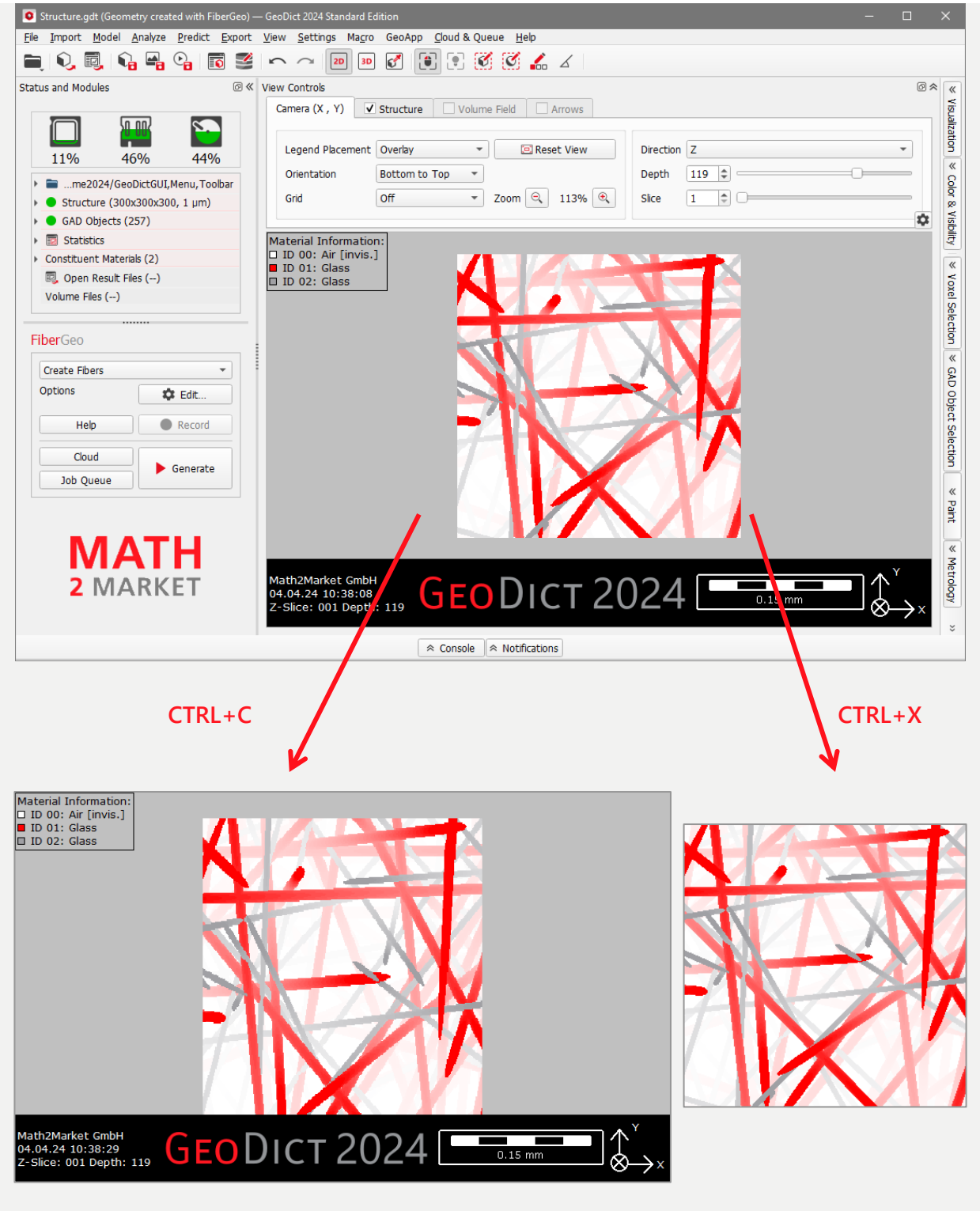
Finally, check **Save with transparent background** to save the image without a background color.


Save Image
GEODICT
Current Resolution
Custom Resolution
Width
1581
Height
476
Preset
1920 x 1080, (Full HD, 1080p)
Crop all empty space
Save with transparent background
Help
OK
Cancel

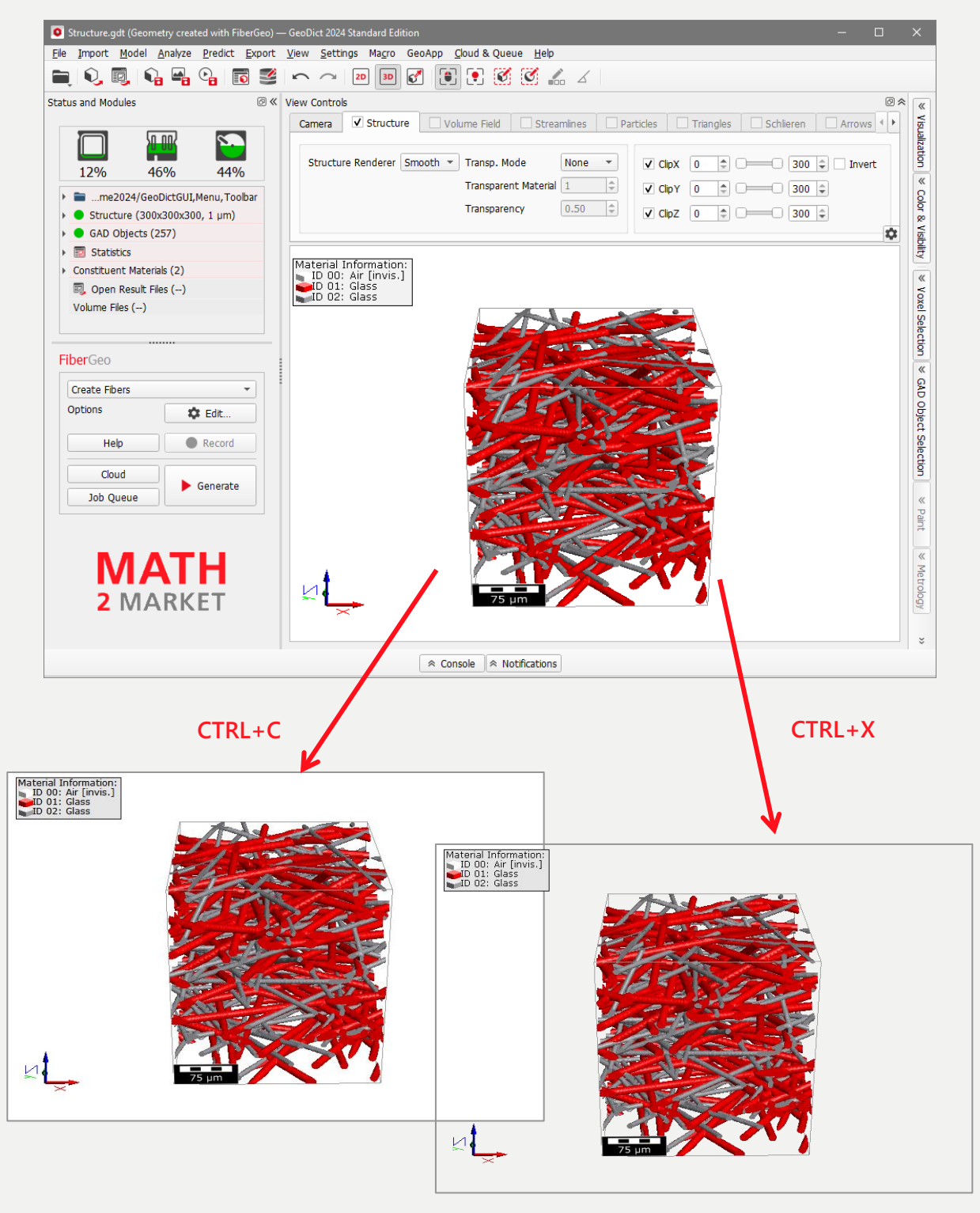

Save Image
GEODICT
Current Resolution
Custom Resolution
Width
1581
Height
476
Preset
1920 x 1080, (Full HD, 1080p)
Crop all empty space
Embed after cropping
Pixel
0
0
0
0
Save with transparent background
Help
OK
Cancel

Additionally, there is a shortcut to copy the content of the visualization area to the clipboard. Press **CTRL+C** to copy the whole visualization area with the same resolution as it is currently displayed. The result is the same as if you took a screenshot of the visualization area. The combination CTRL+C works both in 2D view and 3D rendering.

With **CTRL+X**, an image of only the current domain is copied to the clipboard. The image has a 1:1 resolution of the structure, meaning that 1 voxel will be represented by 1 pixel in this image.



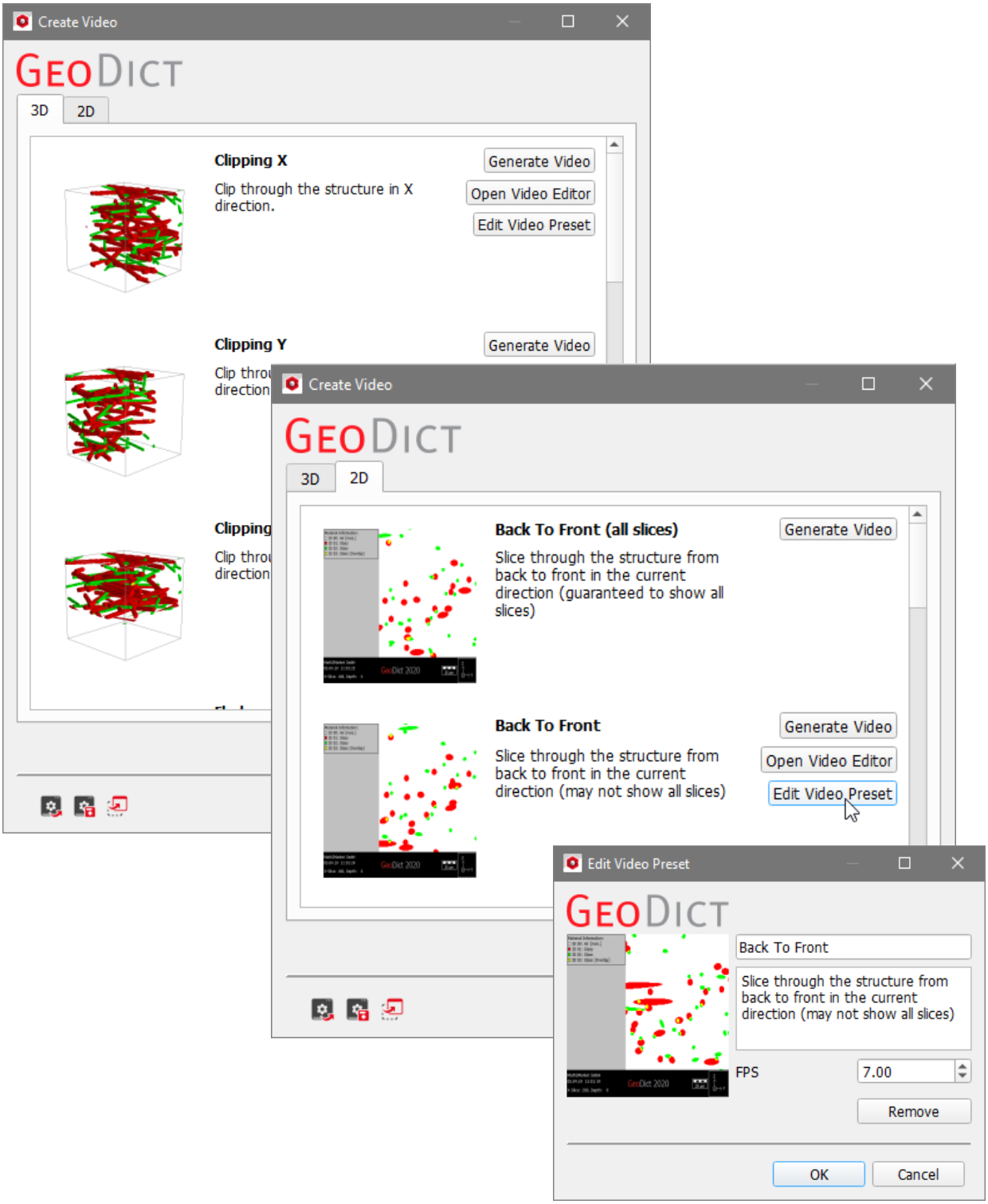
Starting with GeoDict 2024 Service Pack 2, CTRL+X also works in 3D rendering, but it copies the whole visualization area with transparent background to the clipboard.



Save Video

Selecting **Save Video as...** opens the Create Video dialog, which allows choosing preset scripts that execute the making of a video with appropriate standard settings.

The toolbar icon  is the shortcut to the Create Video dialog. The preset video scripts are organized in the two tabs 2D and 3D.



Clicking on **Generate Videos** opens the **Save Videos** dialog, where the output options like the video file name can be entered. The video is then created without any modifications of the underlying script.

Click **Open Video Editor** to open the Video Editor for modifications. **Edit Video Preset** allows to change the description of the video preview.

The following preset movie clips are available:

- In 3D: **Clipping X**, **Clipping Y**, **Clipping Z**, **Fly-by**, **Follow Particle**, **Particle Animation**, **Rotate X**, **Rotate Y**, **Rotate Z**, and **Streamlets**. Also given is the option to import settings from the Video Dialog 3D to be listed in the preset video scripts (**Import as Video GeoApp**), to produce a 3D video using 2D images from a stack of scanned images (**Create Video from Image Stack**), and to simply open the Video Dialog 3D editor without loading a specific preset video script (**Open Editor**).
- In 2D: **Back To Front (all slices)**, **Back To Front**, **Front To Back (all slices)**, **Front To Back**, **Import as Video GeoApp**, **Create Video from Image Stack**, and **Open Editor**.

See the Create Videos handbook for more details about creating videos in GeoDict.

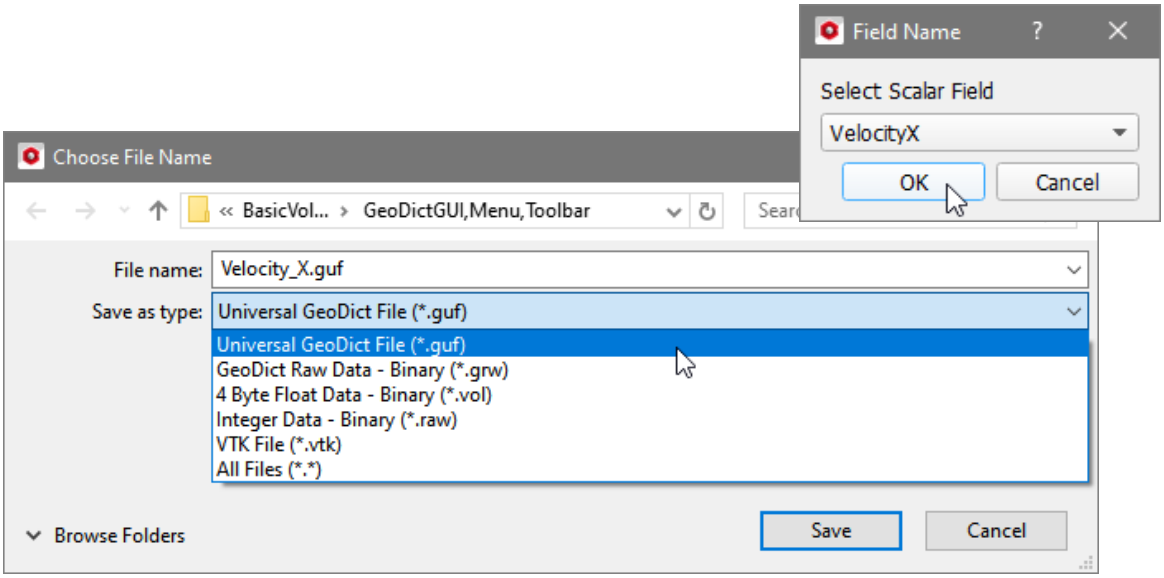
The use of **Save Image as... and Save Video as...** are excellent and easy-to-use choices when the user intends to present to the public structures and visualized results after working with GeoDict.
The high resolution achievable when saving images or videos this way is suitable for press-ready flyers and posters.

Save Triangulation

Select **Save Triangulation as...** to save triangulations obtained by creating a mesh through MeshGeo or by importing in ImportGeo-CAD. More information can be found in the ExportGeo-CAD with MeshGeo handbook.

Save Volume File

Select **Save Volume File as...** to save simulation results in several file formats. For example, after running a flow simulation with FlowDict, select a name to save the field of the velocity in X-direction as raw float data (*.vol) or GeoDict universal file (*.guf).

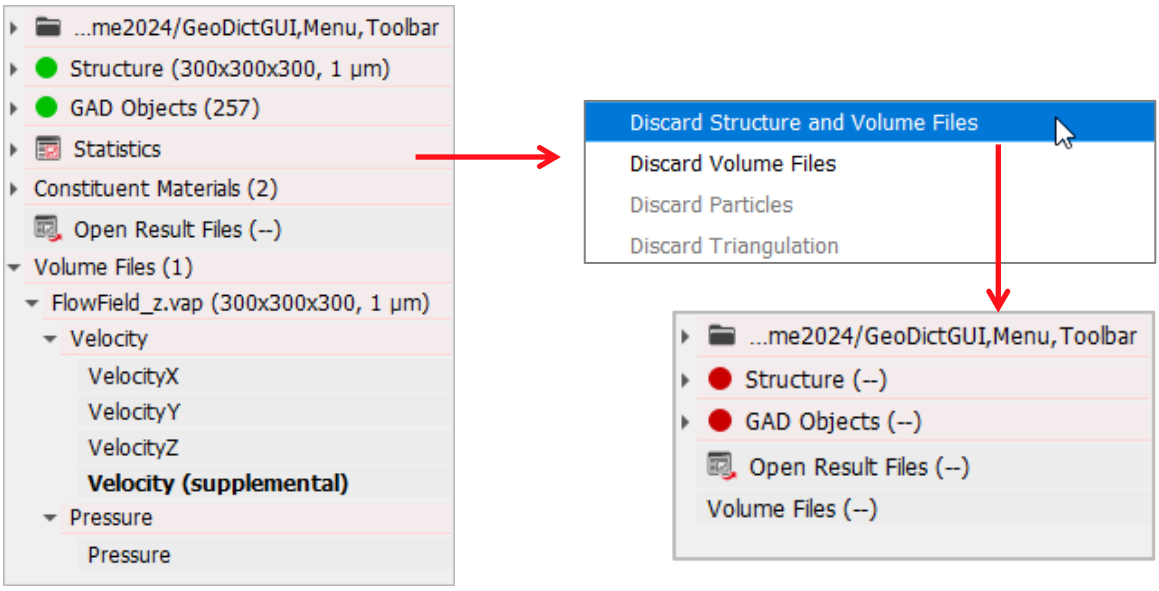


DISCARD STRUCTURE OR SIMULATION RESULTS

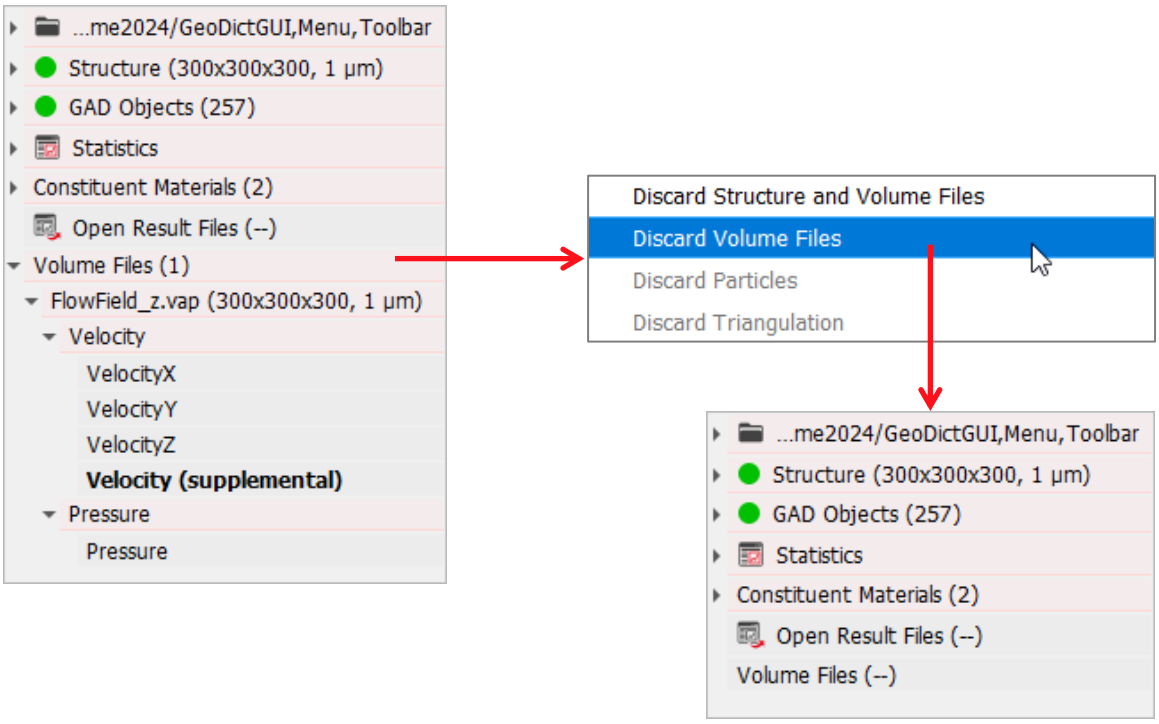
Selecting **Discard Structure and Volume Files** makes the structure, and all simulation result fields available for this structure, disappear from memory and from the Visualization area. The initial GeoDict splash screen appears in the visualization area instead.

In the example shown here, a fiber structure is loaded in GeoDict, together with the volume fields of velocities in X-, Y- and Z-direction, loaded from the .vap file of a flow simulation.

Clicking **Discard Structure and Volume Files** removes the structure, and the simulation result fields (volume fields) from the memory.



Selecting **Discard Volume Files** eliminates only the simulation result fields (volume fields) that are currently loaded from the memory. The structure displayed in the visualization area is not deleted.



In the same way, for a particle simulation result (created with FilterDict or AddiDict), if particle trajectories or positions are available in GeoDict memory, **Discard Particles** removes the particle information from memory.

A structure in STL format (Stereosurface triangulation language), imported with ImportGeo-CAD, and shown in the Visualization area, is deleted from memory when **Discard Triangulation** is selected.

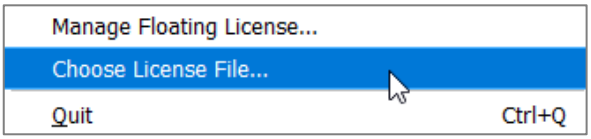
Clear Recent Files / Folders

Clicking **Clear Recent Files / Folders** clears the list of Recent Files and Recent Project Folders shown in the GUI.

Manage Floating License, Choose license file, and Quit

Clicking **Manage Floating License...** allows a floating license user to choose which of the licensed modules they would like to use in this session. Deselected modules will be shown as unlicensed in GeoDict's menu, and their license will then be free for other users to use. More information can be found in the Download, Installation and Licensing handbook.

Select **Choose License File...** to select a license file, e.g., to change the license from evaluation to purchased or leased license, to upgrade the license for another term, or to request a new license file following the procedure explained in **Licensing** GeoDict in the Download, Installation and Licensing handbook.

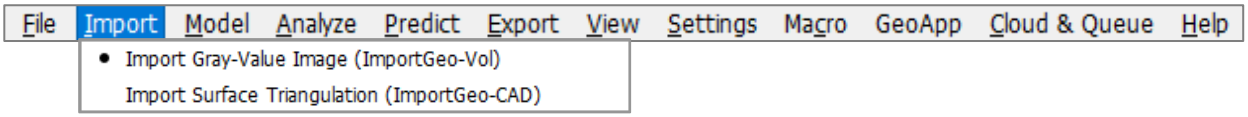


Selecting **Quit** opens the **Exiting GeoDict** dialog, where you have to confirm with **Yes** to end the current GeoDict session. Selecting **No** does not end the GeoDict session. GeoDict can also be terminated by clicking the close button in the title bar. The exiting dialog also opens here to prevent you from accidentally closing the session.

IMPORT

Accessible from the menu bar are interfaces to import image and structure files into GeoDict (ImportGeo). Modules that have not been licensed appear under **unlicensed** in the list.

Start an ImportGeo module by clicking **Import** in the menu bar and selecting one of the sub-modules available to import a file into GeoDict. If a module is selected, a dot appears in front of it in the module list and the module section changes to show this module.

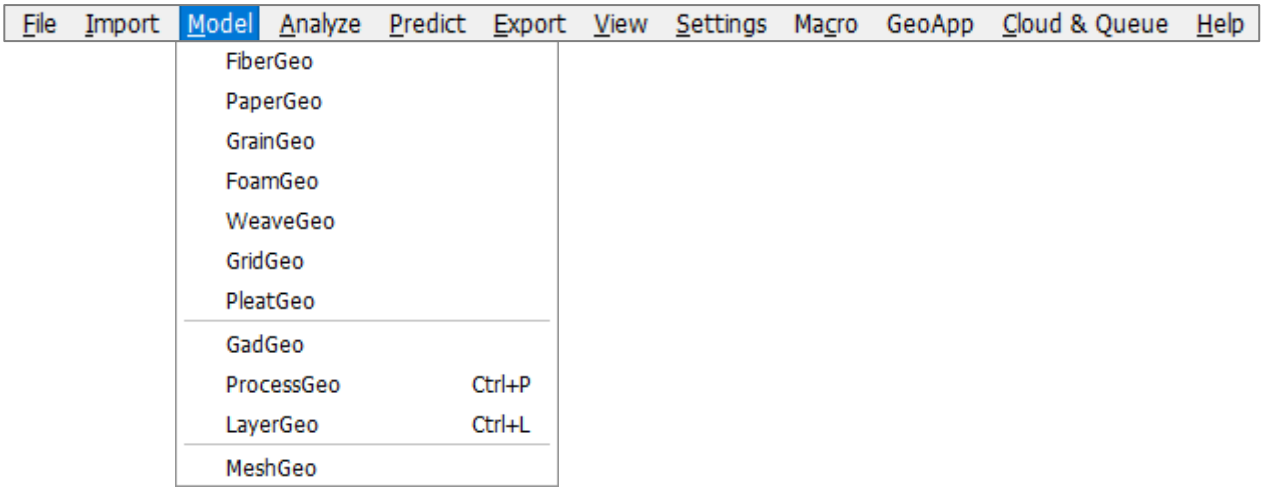


- ImportGeo-Vol is used to import most image file formats for 3D visualization, 3D image processing and segmentation. On imported gray value images, ImportGeo-Vol can perform 3D processing with a variety of filtering techniques. Subsequent segmentation converts gray values to material index values typically stored in the GeoDict Binary file format. For more information, check the ImportGeo-Vol handbook.
- ImportGeo-CAD imports surface triangulation files that describe only the surface geometry of a three-dimensional object. During import, these files can be converted to 3D material models. For more information, check the ImportGeo-CAD handbook.

MODEL

The **Model** menu gives access to the list of modules for digital material modeling that are included in the user's license. GadGeo, ProcessGeo, and LayerGeo can always be used because they are included in the GeoDict Base Package. Other modules that have not been licensed appear in the list under **unlicensed**.

The GeoDict modules for digital material design available for licensing are:



Complete information on the individual modules is found in the corresponding handbooks:

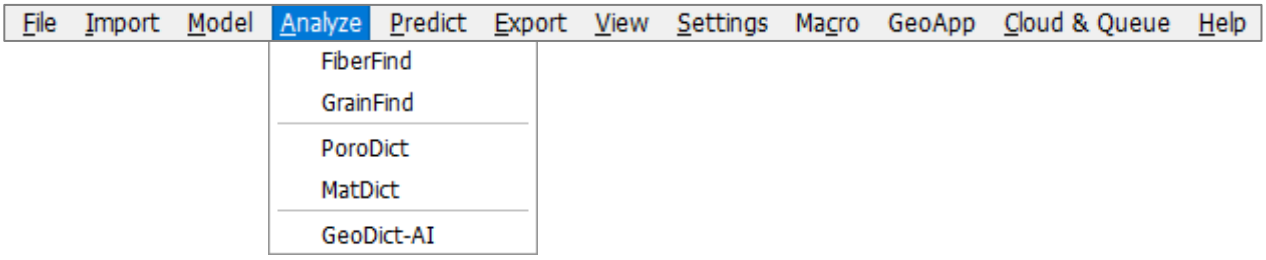
- FiberGeo handbook
- PaperGeo handbook

- GrainGeo handbook
- FoamGeo handbook
- WeaveGeo handbook
- GridGeo handbook
- PleatGeo handbook
- GadGeo handbook
- ProcessGeo handbook
- LayerGeo handbook
- MeshGeo handbook

ANALYZE

The **Analyze** menu gives access to the list of modules for digital material analysis that are included in the user's license. Modules that are not licensed appear in the list under **unlicensed.**

The GeoDict modules for digital material analysis available for licensing are:



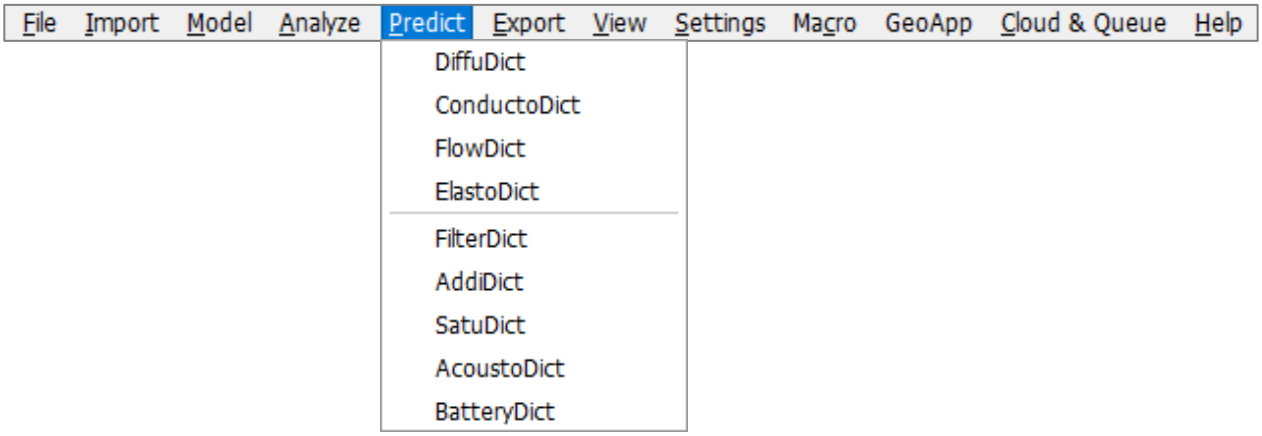
Complete information on the individual modules is found in the corresponding handbooks:

- FiberFind handbook
- GrainFind handbook
- PoroDict handbook
- MatDict handbook
- GeoDict-AI handbook

PREDICT

The **Predict** menu gives access to the list of modules for the prediction of material properties that are included in the user's license. Modules that are not licensed appear in the list under **unlicensed.**

GeoDict modules available for prediction of material properties are:



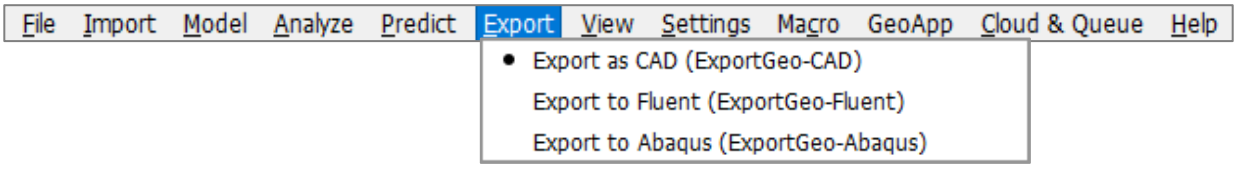
Complete information on the individual modules is found in the corresponding handbooks:

- DiffuDict handbook
- ConductoDict handbook
- FlowDict handbook
- ElastoDict handbook
- FilterDict handbook
- AddiDict handbook
- SatuDict handbook
- AcoustoDict handbook
- BatteryDict handbook

EXPORT

Accessible from the menu bar are interfaces to export structure files, images, and simulation results from GeoDict (ExportGeo) to many other software packages.

To export a GeoDict file to other formats, select **Export** in the menu bar, and choose between Export as CAD (MeshGeo), Export to Fluent (ExportGeoFluent), and Export to Abaqus (ExportGeoAbaqus).



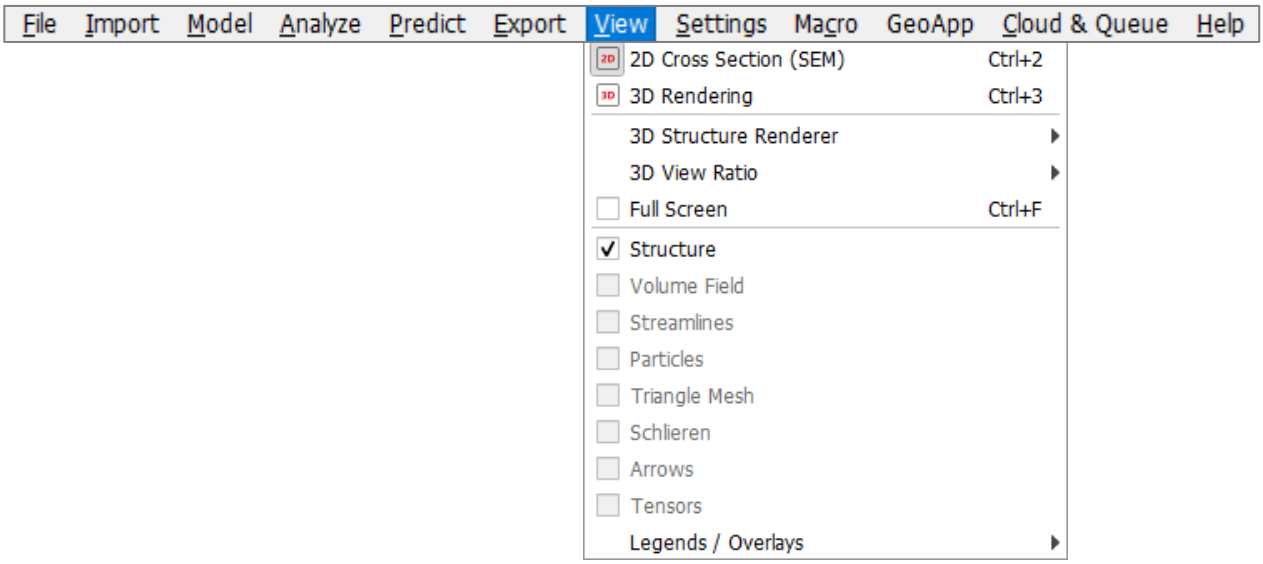
With ExportGeo, structures from GeoDict can be exported to other formats so that files produced by the GeoDict user are compatible with other software and can be used for customized workflows:

- ExportGeo-CAD converts voxelized or analytic structures to commonly used surface triangulation and CAD formats like STL, VRML, or Parasolid.
- ExportGeo-Fluent and ExportGeo-Abaqus convert voxelized data to formats for flow and heat computations with **Fluent™** or elasticity computations with **Abaqus**.

For complete information on interfaces from GeoDict, see the ExportGeo-CAD / MeshGeo handbook, the ExportGeo-Fluent handbook, and the ExportGeo-Abaqus handbook.

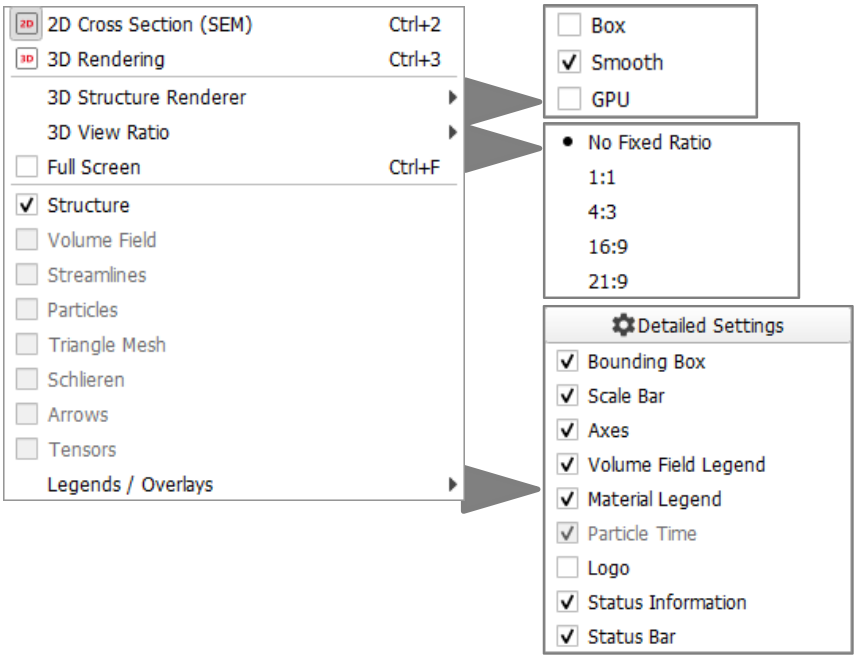
VIEW

After modeling a structure, either by generating it in GeoDict or after importing 3D µCT or FIB/SEM images, choosing between the **View** menu entries changes the visualization settings. A shortcut to many of these parameters can also be set through the Visualization Side Bar, as explained shortly below and in more detail in the Visualization handbook.



The **View** menu allows to:

- choose the visualization type to be **2D Cross Section (SEM)**, or **3D Rendering**, with more settings under **3D Structure Renderer** and the **3D View Ratio**.
- display the Visualization area in **Full Screen** which makes the Visualization area occupy the entire computer screen. Pressing the **Esc** key on the keyboard returns the program to the normal display.
- select which components are displayed in the **visualization**.
- choose the **Legends / Overlays** to be displayed.

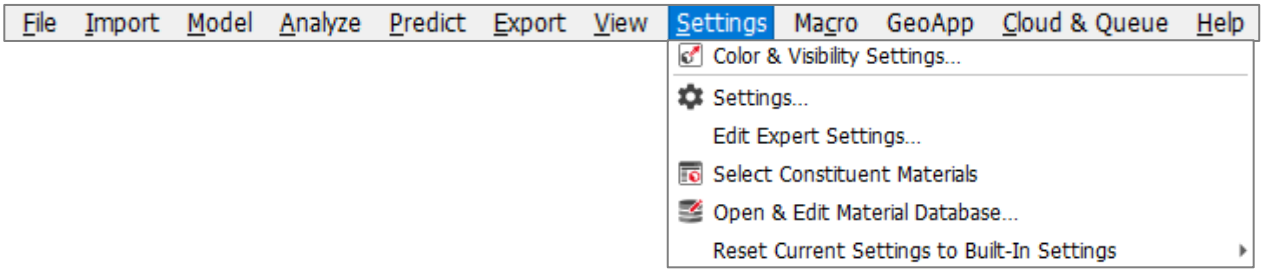


Some of these options are only accessible when choosing to visualize in **3D Rendering** or when visualizing solver results (**Volume Field**, **Streamlines**, **Particles**, **Triangle Mesh**, **Schlieren**, **Arrows**, and **Tensors**).

Choose **Legend / Overlays → Detailed Settings** to access the Visualization Side Bar. Its functionalities are explained in the Visualization handbook.

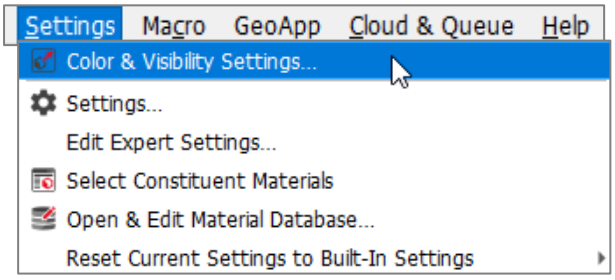
Settings

The **Settings** menu includes **Color & Visibility Settings**, **Settings**, **Edit Expert Settings**, **Select Constituent Materials**, and **Edit Material Data Base**.



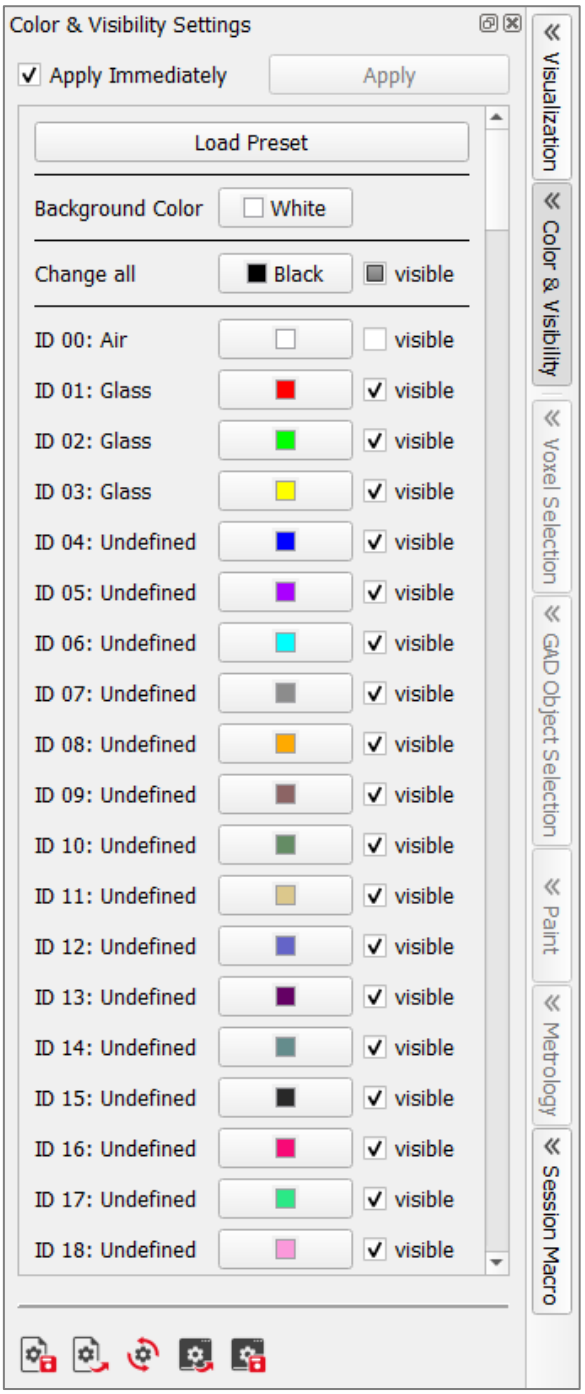
Color & Visibility Settings

The default color settings applied to the background and materials during the generation with GeoDict, can be changed through the **Color & Visibility Settings** dialog, that opens from the GUI Sidebar on the right of the Visualization Area.

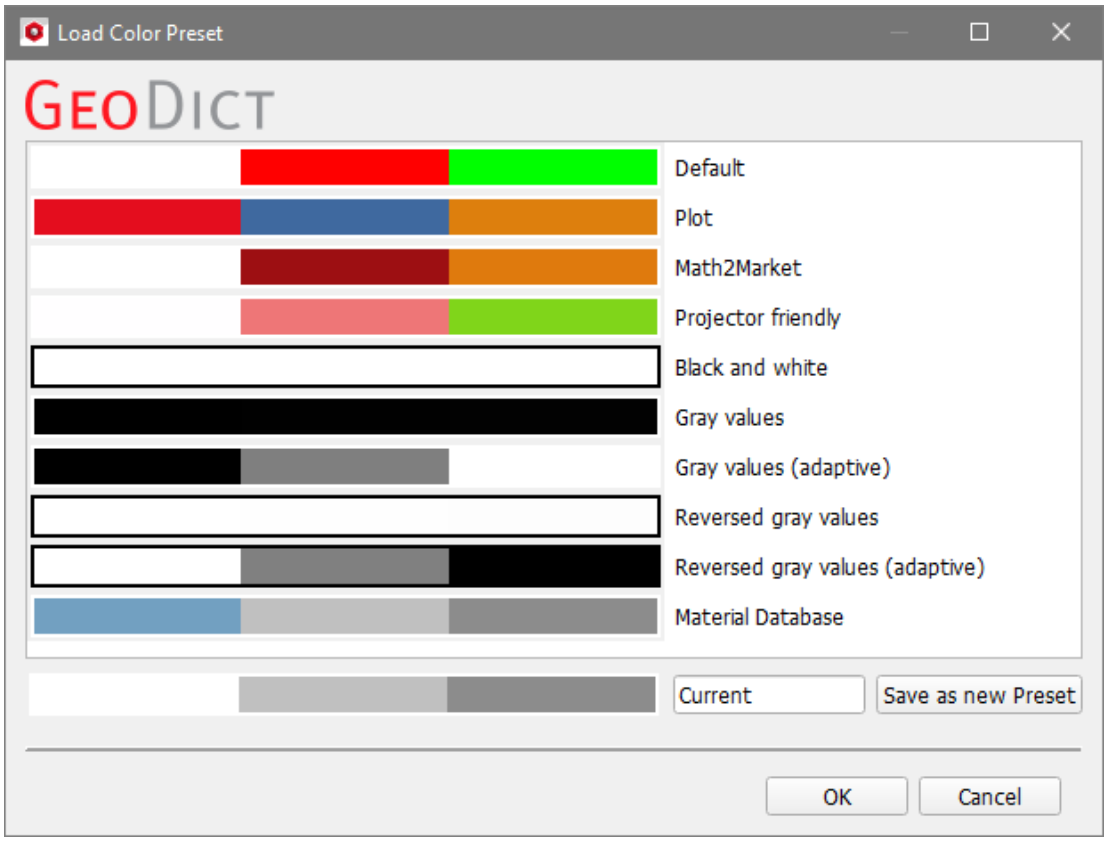


If a structure is currently in memory, only the Material IDs present in the structure are editable in the Color & Visibility settings. Otherwise all 256 Material IDs are displayed.

First, decide whether the chosen settings should be applied directly to the structure in memory by checking **Apply Immediately**. Otherwise, the **Apply** button must be pressed.



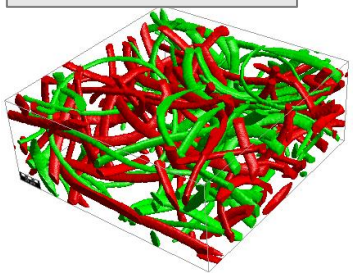
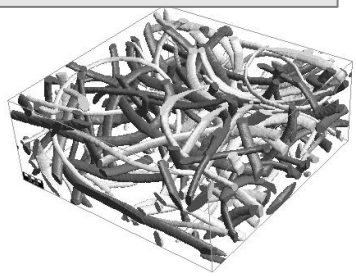
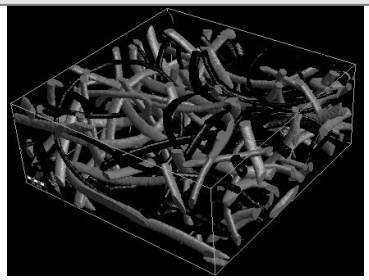
A color preset is a particular group of colors that are applied together. Click **Load Preset** and, in the **Load Color Preset** dialog, select whether to display the generated structure's materials using one of the presets.



Change all allows to change the color of all material IDs to the same color. By checking **visible** all material IDs can be set to be visible at once.

Below, this can also be done for each material ID separately.

Keeping a **Color & Visibility Settings** dialog open, instead of closing it, is helpful when trying to find the most adequate settings for a particular visualization.

Default	Gray values (adaptive)	Reversed gray values (adaptive)
		

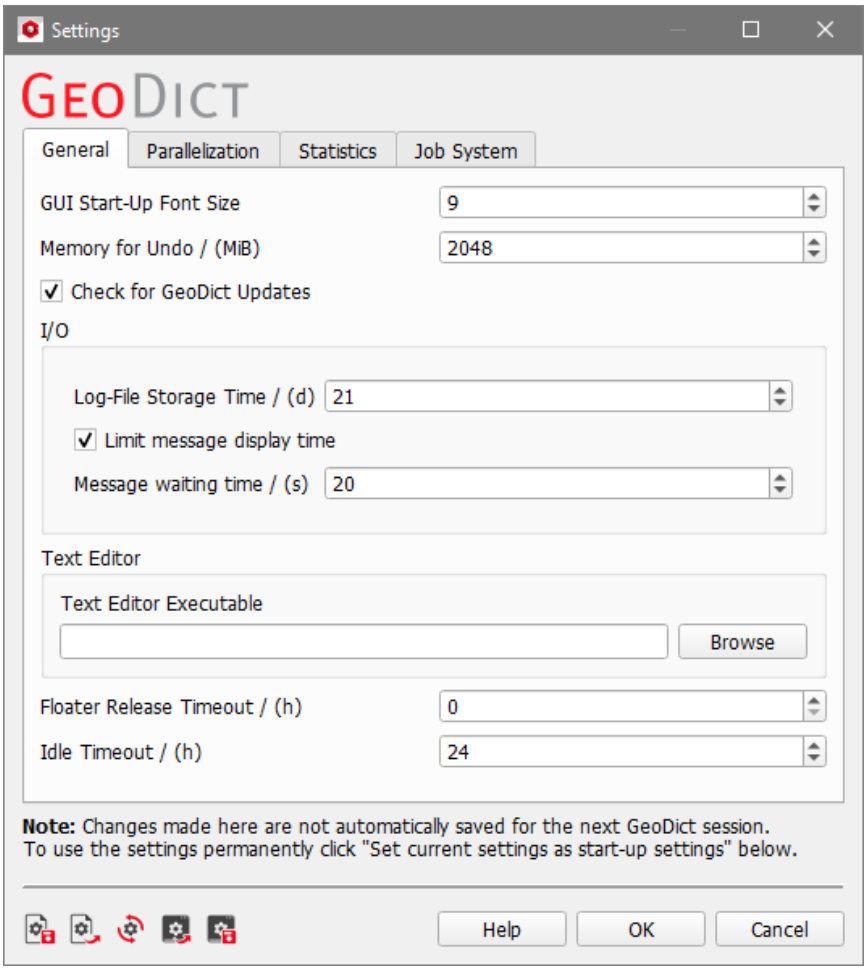
After selecting new colors through the buttons in the **Color & Visibility Settings** dialog, the current group of colors can be saved as a preset (**Load Preset → Save as new Preset**), to have it appear in the list of color presets later.

More details about the GeoDict colors and visibility settings are found in the Visualization handbook.

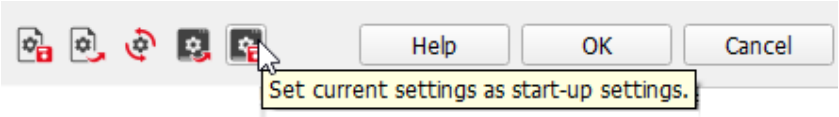
SETTINGS

Selecting **Settings...** from the **Settings** menu opens the **Settings** dialog to modify the general preferences or properties when working with GeoDict. The dialog contains the **General, Parallelization**, **Statistics**, and **Job System** tabs.

They contain a collection of settings that a user typically wants to apply to any GeoDict session.



Resting the mouse pointer over the icons in the lower left of settings dialogs prompts a tool tip showing the icon's function to appear. For example, if the chosen settings should not apply only to this GeoDict session but instead should also be set at the next GeoDict startup, click the icon at the bottom of the dialog:



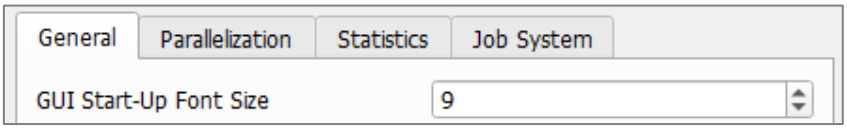
After setting the current settings as start-up setting, click **OK**.

The parameters entered in the **Settings** dialogs can also be saved into GPS (*.gps, GeoDict Project Settings) files and/or loaded from them.

Clicking **OK** at the bottom of the dialog results in carrying out the modifications and closing the dialog. Select **Cancel** to discard the modifications entered in the dialog.

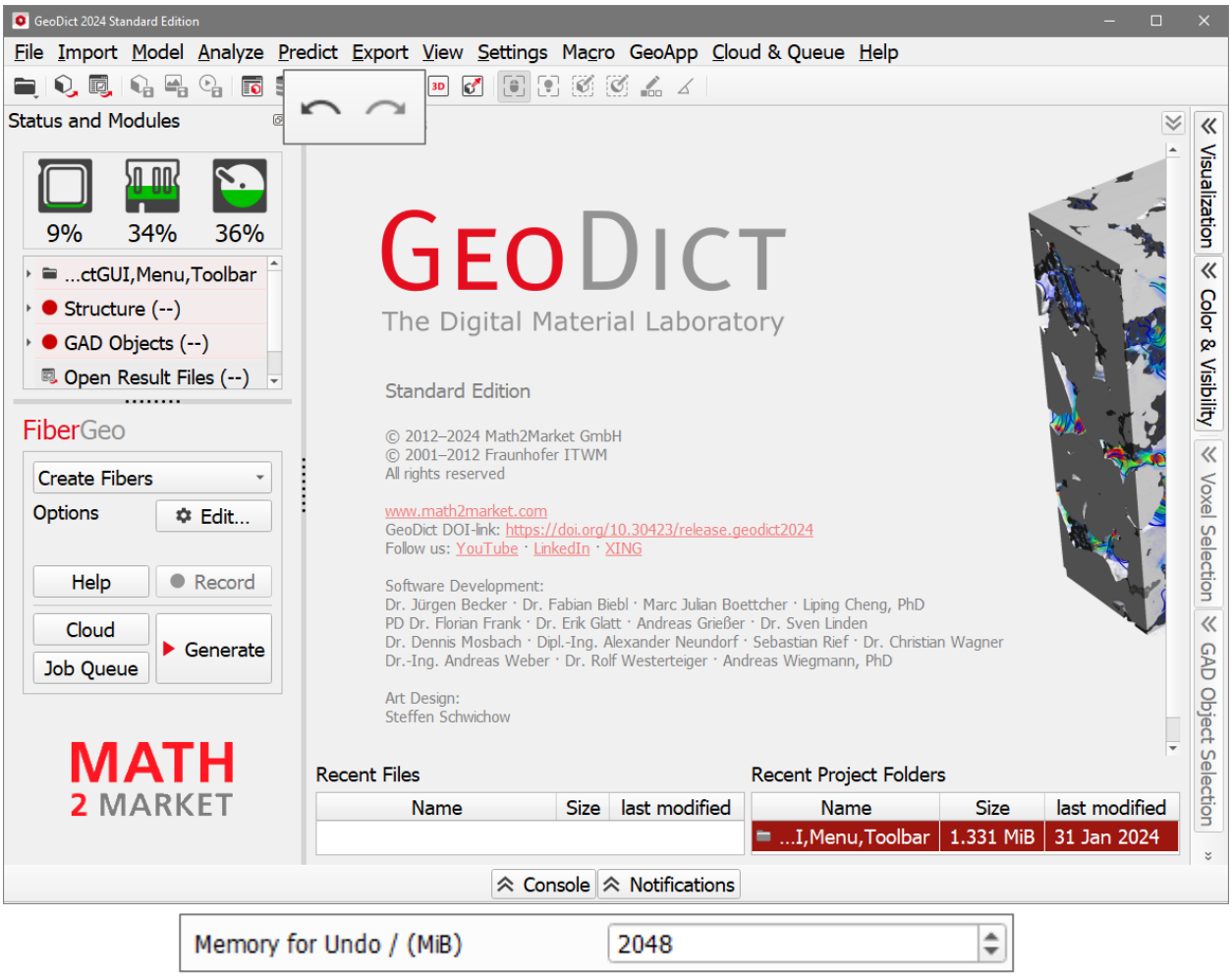
GENERAL

The first option under the General tab controls the size of the fonts used in the GUI at start-up (**GUI Start-Up Font Size**).



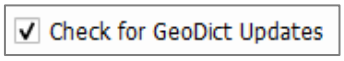
For example, increasing the **GUI Start-Up Font Size** to 14 results in the display of a larger font overall in the GUI after restarting GeoDict.

GeoDict automatically stores a copy of the previous 3D structure, before applying any changes to it, until the **Memory for Undo** is filled up. This allows to quickly undo any changes using the undo function.



The disadvantage of keeping a copy of the last structure is that some runtime and hard disk space is required for saving the structures. Thus, it can be disabled by setting the **Memory for Undo** to 0 MiB.

If **Check for GeoDict Updates** is checked, GeoDict will automatically search if updates are available (requires internet connection) and print a message if an update is found.

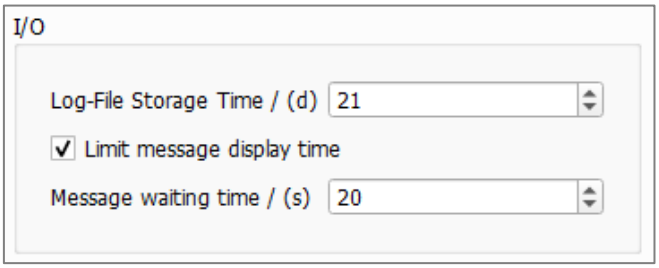


GeoDict will not automatically download or install those updates.

In the corresponding panels underneath are the options for disk usage (**I/O**), for setting a default **Text Editor**, and the **Timeout** options can be specified.

I/O

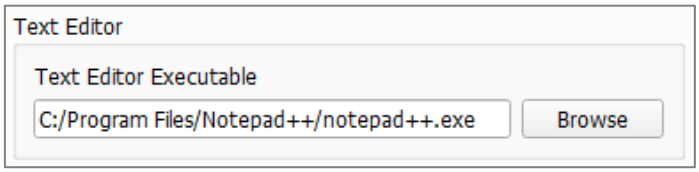
In the **I/O** (input/output) options, define how many days the log files should be kept. In the log files the events happening while running GeoDict are recorded.



Also define whether the time a warning message is displayed should be limited, and the time of the limitation in seconds. If 0 is selected, pop-up messages are not shown at all.

Text Editor

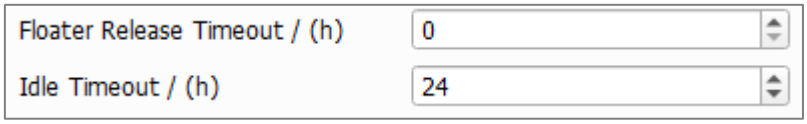
The user can set which text editor is to be opened automatically when editing macros and other editable files. Click **Browse** to search and set the path to the location where the executable for the favorite text editor is located.



For a list of text editor recommendations refer to the GeoPy Scripting handbook.

Timeout options

The last two options are for floating license users only. Define after how many hours the **Floater Release Timeout** will be triggered. Then all non-required floaters are freed and are available for other users. This is especially useful if long-running computations are performed. The same behavior occurs when pressing the **Release Floaters** button in the progress bar during a simulation run.



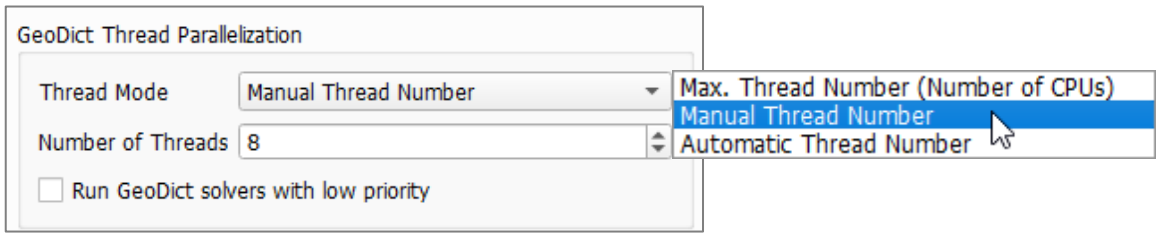
The **Idle Timeout** triggers if after the defined hours no computation or user interaction was made. Then all floaters, including the GeoDict-Base floater, are freed and available for other users. It is possible to re-acquire the freed floaters when returning to the GeoDict application in the then opening dialog.

PARALLELIZATION

GeoDict Thread Parallelization

The user can set the number of parallel processes (threads) GeoDict should use, e.g., for the visualization, for the image processing, and for the structure generation. It is possible to set the Thread Mode to **Max. Thread Number** which equals the **Number**

of CPUs the machine has. When not all available CPUs of the computer should be used, for example to allow other users to work simultaneously on the same machine or to improve the performance of other programs, the number of used parallel processes can be limited by setting a **Manual Thread Number**.



Choosing **Automatic Thread Number** uses the maximum number of cores, if up to eight cores are available. If more than 8 cores are available, the maximum of 8 and the number of available cores divided by two is used. For example, if the machine has 12 cores available, automatic thread number takes the maximum of 8 and 12/2=6 which is 8.

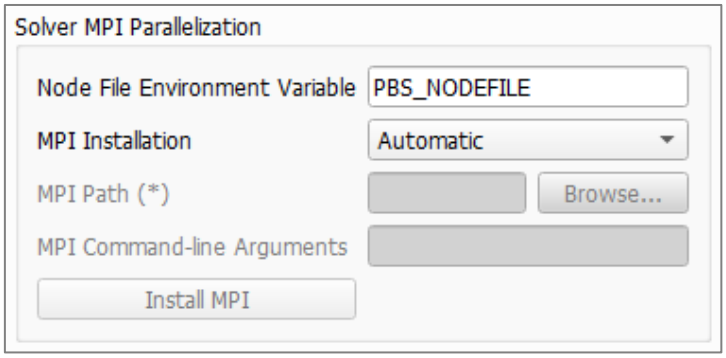
This option does not influence the number of solver processes, which can be set for all GeoDict solvers in the Dict modules independently.

Check **Run GeoDict solvers with low priority** to make the system more responsive when working interactively while a GeoDict solver (e.g. LIR or SimpleFFT) is running.

Solver MPI Parallelization

For cluster computations, set the environment variable that holds the location of the node file, i.e., the file that contains the list of assigned compute nodes.

For MPI parallel computations, set the path to the **MPI Installation** that should be used for the parallelization. Select **Automatic** to look automatically for MPI installations.



For more information, refer to the High Performance Computing handbook.

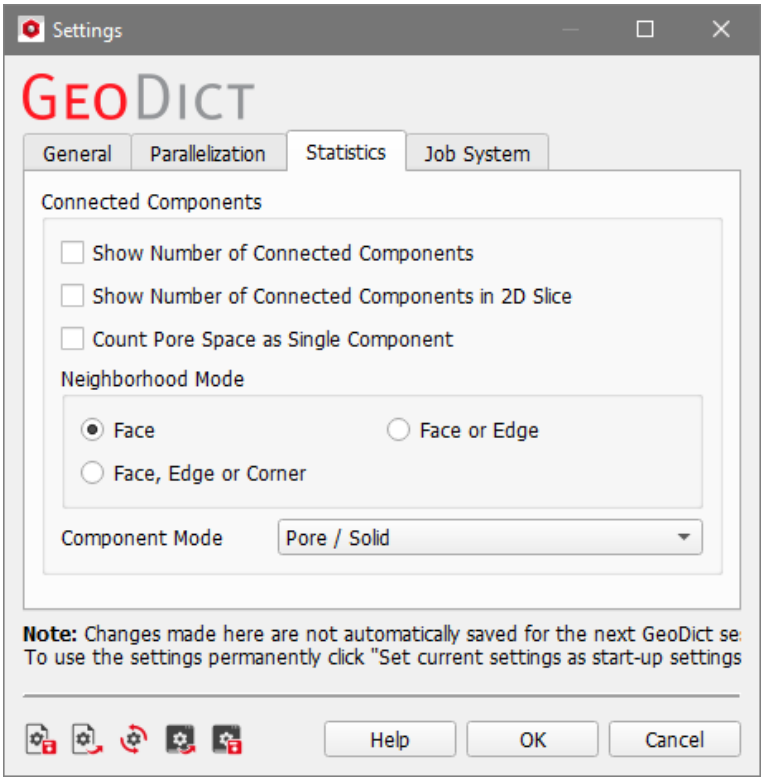
Statistics

The **Statistics** tab contains the **Connected Components** panel. A connected component is defined as a complete set of connected voxels with respect to the chosen neighborhood mode and component mode.

Checking **Show Number of Connected Components** or **Show Number of Connected Components in 2D Slice**, and clicking **OK**, adds the number of **Components** to the **Statistics** section in the Status section (see page 46ff.)

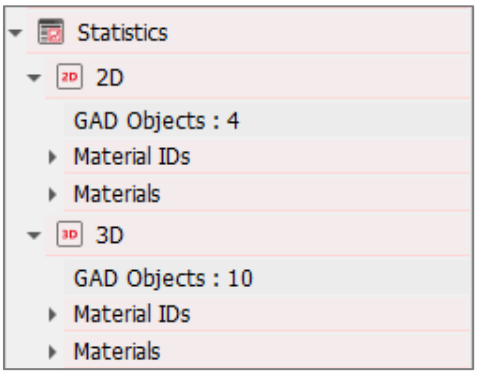
If the pore space is divided by the structure into several parts, it can be counted as one connected component with **Count Pore Space as Single Component** checked.

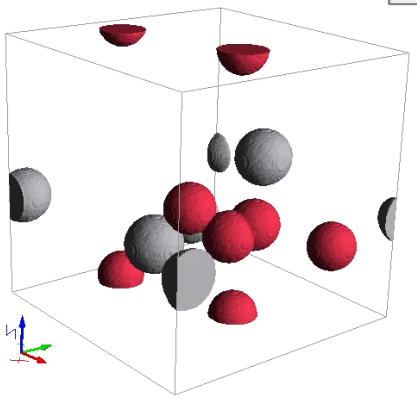
The pore space does not count as an object and does not add to the number of **Objects**.

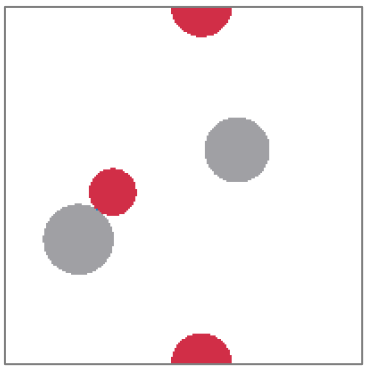


As an example, a simple periodic structure model containing 10 spheres is shown. At the corners, it is the same grey sphere that disappears and reappears on the other side. Two red spheres are also cut in half. They disappear and reappear in Z-direction. Three of the red spheres overlap and one of the red spheres touches a grey sphere.

The number of **GAD Objects** in 3D is 10, but the number of **GAD Objects** in 2D is only 4 (2 grey and 2 red spheres) in the 2D-Slice 126 in X-direction (shown below). The pore space is not counted as object.





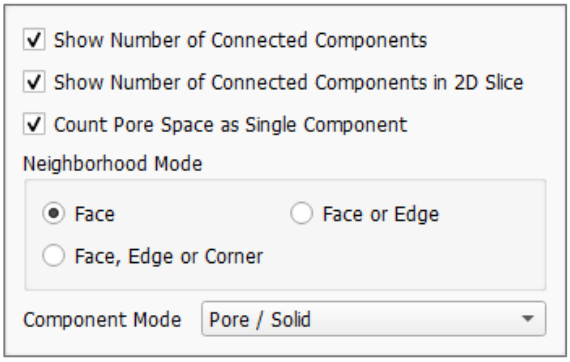


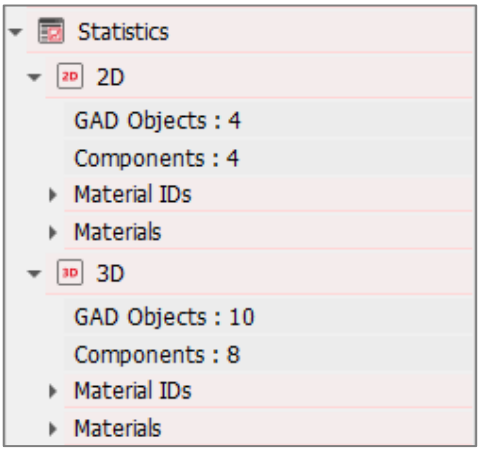
Now, see how the connected components in 3D and 2D are counted when checking **Show number of Connected Components** and **Show Number of Connected Components in 2D Slice**.

Neighborhood Mode and **Component Mode** define criteria for the connectivity of the components and are explained below. For this example, we choose **Face** as Neighborhood Mode, which means that two voxels are connected if they share a face. As Component Mode we choose **Pore / Solid**, so that solid voxels can form a component independent of their material ID.

The number of Objects 3D and 2D are the same as before. Connected components in the 2D slice shown above are 4 (1 grey sphere + 1 red sphere + 1 [1 red sphere+1 grey sphere] component + 1 pore space).

Connected components in 3D are 8 (3 grey spheres + 3 red spheres + 1 [3 red spheres+1 grey sphere] component + pore space).

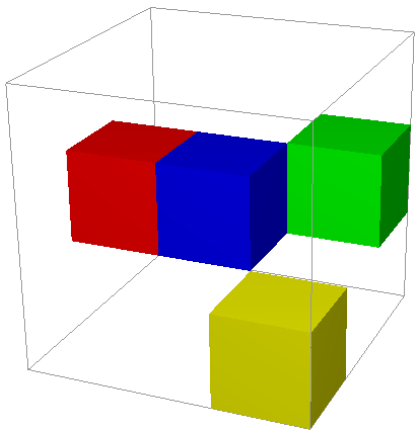




The example structure shown is periodic, thus, objects that end on one side of the domain and reappear on the opposite side are counted as being the same connected component. Periodicity of the domain is saved in the structure file and can be edited through GadGeo → Edit Domain (see the GadGeo handbook for more information). This might change the number of components, e.g., if GAD objects lie outside of the domain if it is non-periodic. When changing to a periodic domain the objects are then placed inside the domain and coed for the number of components.

Neighborhood Mode

The **Neighborhood Mode** defines if two voxels are connected (and belong, depending on the component mode, to the same connected component) or not. The different modes are explained using this example.



Two voxels can be connected through faces, edges, and corners. Voxels that share a face, do also share edges and corners, as you can observe for the red and the blue voxel. The blue and the green voxel share an edge and the corner points of this edge. Finally, the blue and the yellow voxel share only one corner point. This means, that voxels with common corners always belong to the same connected component.

Thus, checking **Face** is more restrictive than choosing **Face or Edge**, and this is more limiting than selecting **Face, Edge or Corner**.

When choosing the Neighborhood Mode **Face** only the red and the blue voxel are connected. When choosing **Face or Edge** the red and the blue voxel and the blue and the green voxel are connected. Finally, if **Face, Edge or Corner** is chosen the red and the blue voxel, the blue and the green voxel and the blue and the yellow voxel are connected.

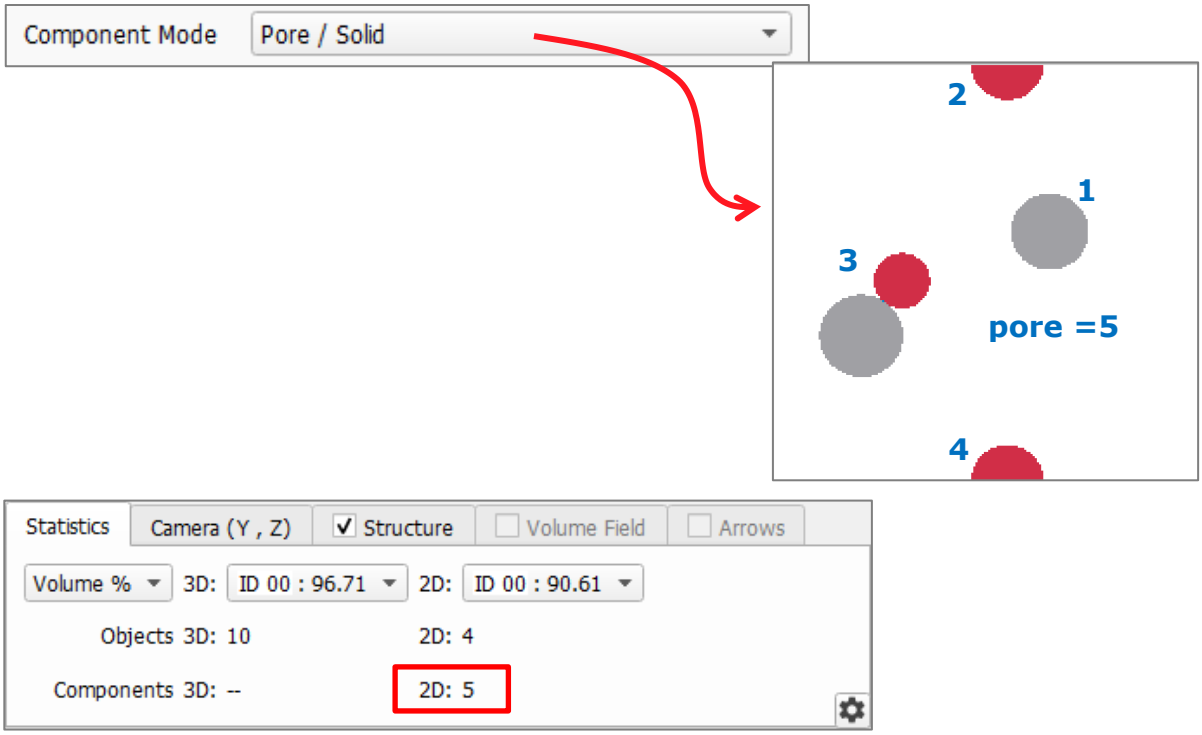
Component Mode

For structures with more than one material, selecting **Pore / Solid** from the **Component Mode** pull-down menu determines whether the components are considered connected or not, based on being empty voxels (background) or solid voxels (structure), regardless of their material ID. When selecting **Material ID**, the Material ID (color) of the solid voxels (structure) is determinant for the components to be considered connected or disconnected.

Periodicity: un-checked for all directions

Neighborhood mode: Face

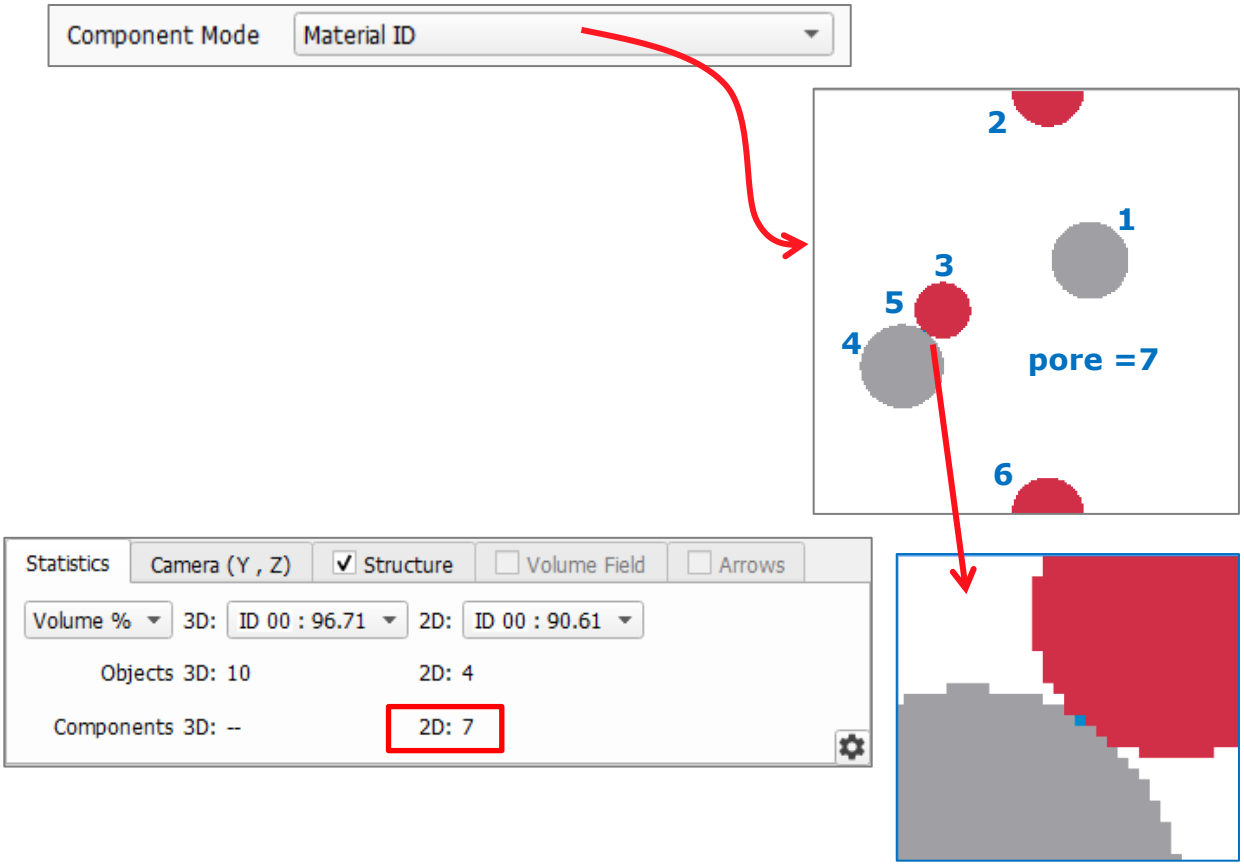
5 connected components 2D = #1, #2 (half sphere top), #3 (2 spheres touching), #4 (half sphere bottom), and #5 pore.



Periodicity: un-checked for all directions

Neighborhood mode: Face

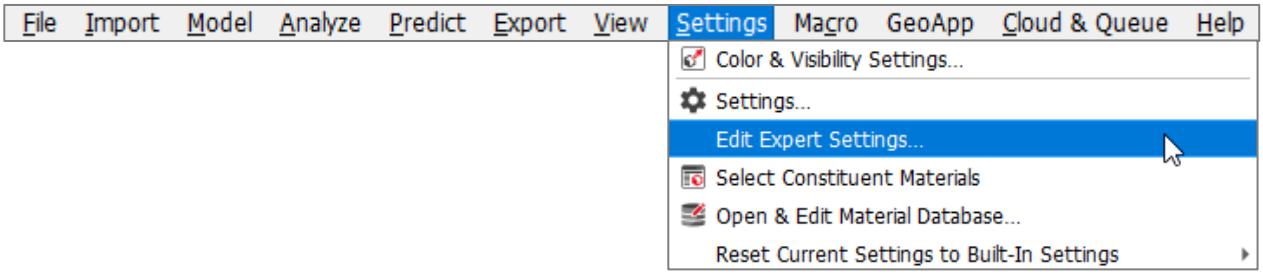
7 connected components 2D = #1 (grey sphere), #2 (half red sphere top), #3 (red sphere), #4 (grey sphere), #5 (1 blue overlapping voxel), #6 (half red sphere bottom), and #7 pore.

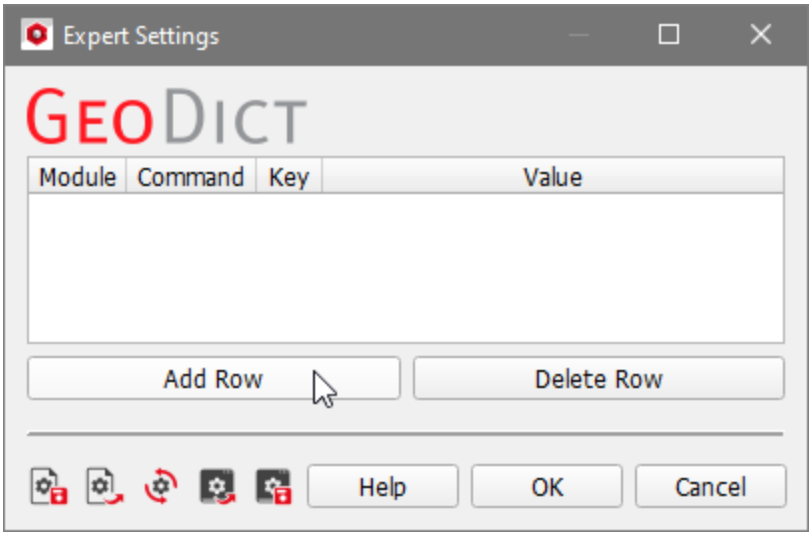


Edit Expert Settings...

For many commands available in GeoDict's modules, additional parameters exist that are not available through the dialog widgets that open in the corresponding modules. These parameters are also not stored in the parameter lists of those commands inside the python macros. By default, no expert settings are set, and well-chosen default values are used.

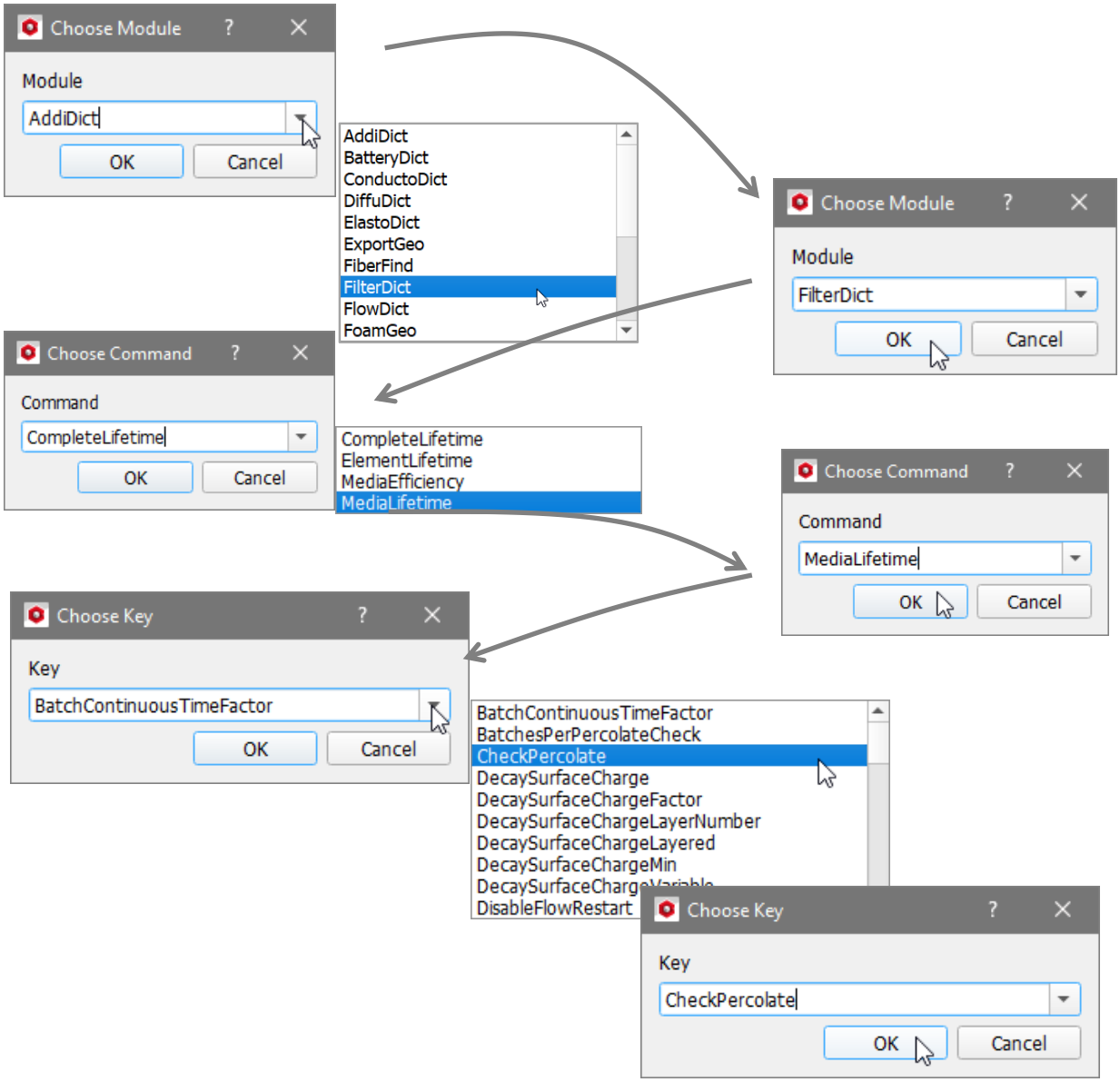
Some expert settings allow to access experimental or unstable features. Others allow to access solver variants that are only useful in very special circumstances. In general, a user should not set any expert settings without consultation of Math2Market's support.



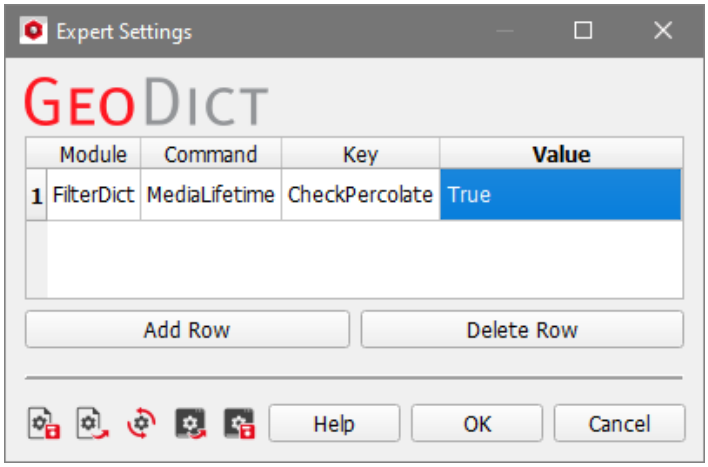


To activate an expert setting, after selecting **Edit Expert Settings...**, the user clicks **Add Row** to sequentially select the **Module**, the **Command**, and the **Key** that define the expert setting that should be edited. Afterwards, a **Value** for the chosen key is entered, typically **True** or **False**.

Clicking **OK** at the bottom of the dialog results in carrying out the modifications and closing the dialog. Select **Cancel** to discard the modifications entered in the dialog.



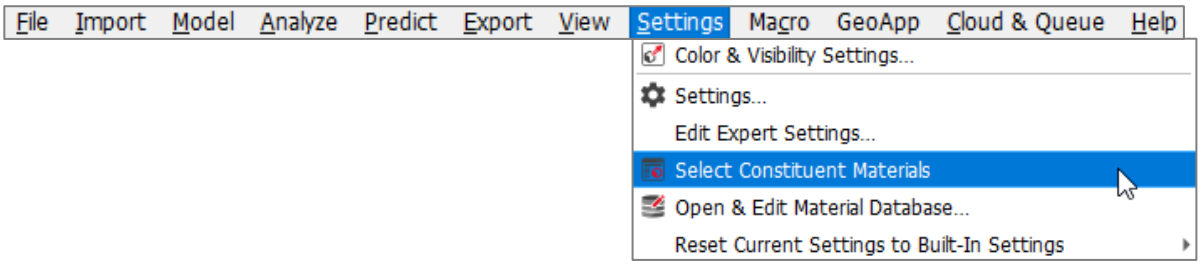
The choices of module, command, and key are entered as columns into the first row. The user can now click the cell under **Value** and manually enter it.



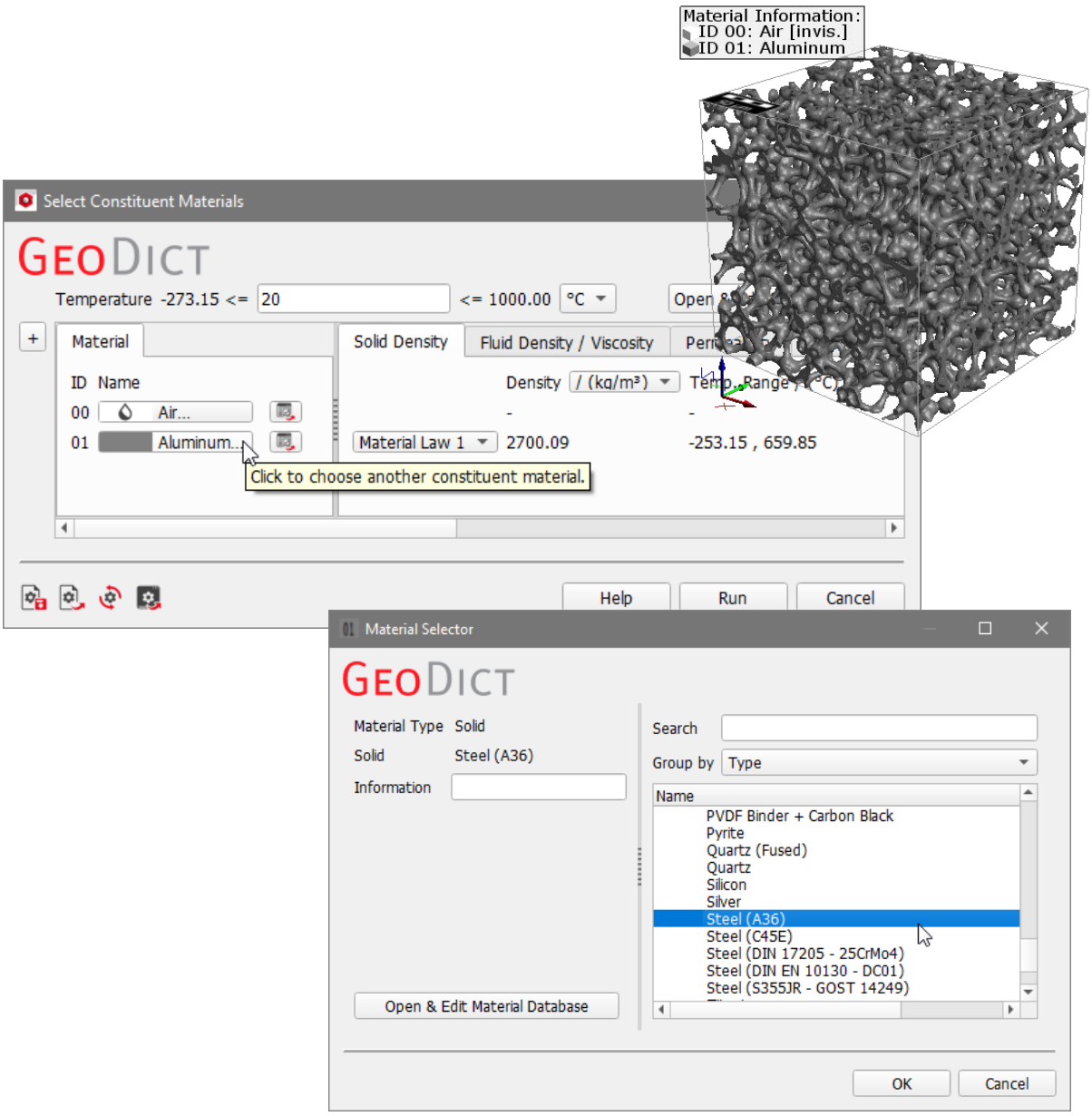
Select Constituent Materials

A Constituent Material from the Material Database consists of a name for the raw material and the material's physical properties and represents the properties of a material in a structure model.

With a structure model in memory, showing in the Visualization area, select **Settings → Select Constituent Materials** to change the raw material of a Material ID or assign a material to a Material ID with undefined material in a structure model.

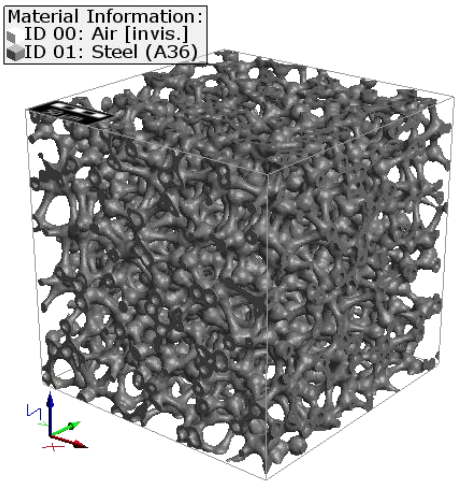


For example, in a foam structure the Material ID 01, initially defined as Aluminum, is changed to be made of Steel as follows:



After the new material is selected, close the Material Selector dialog by clicking **OK** and click **Run** in the Select Constituent Materials dialog.

Observe in the Material Information legend how the constituent material of Material ID 01 has changed from Aluminum to Steel.

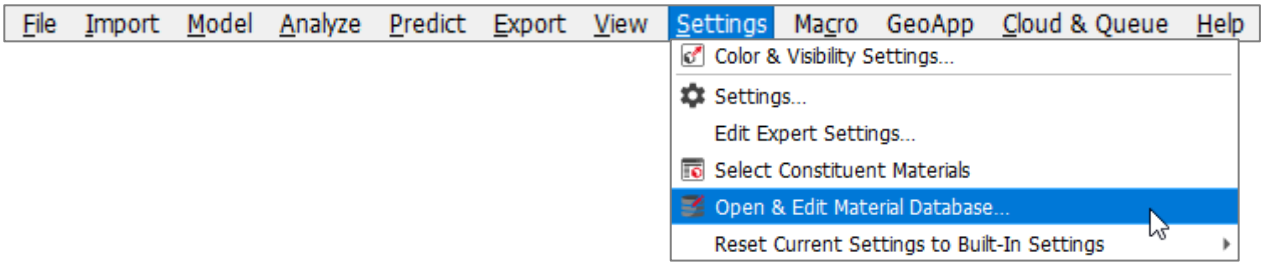


Open and Edit Material Data Base...

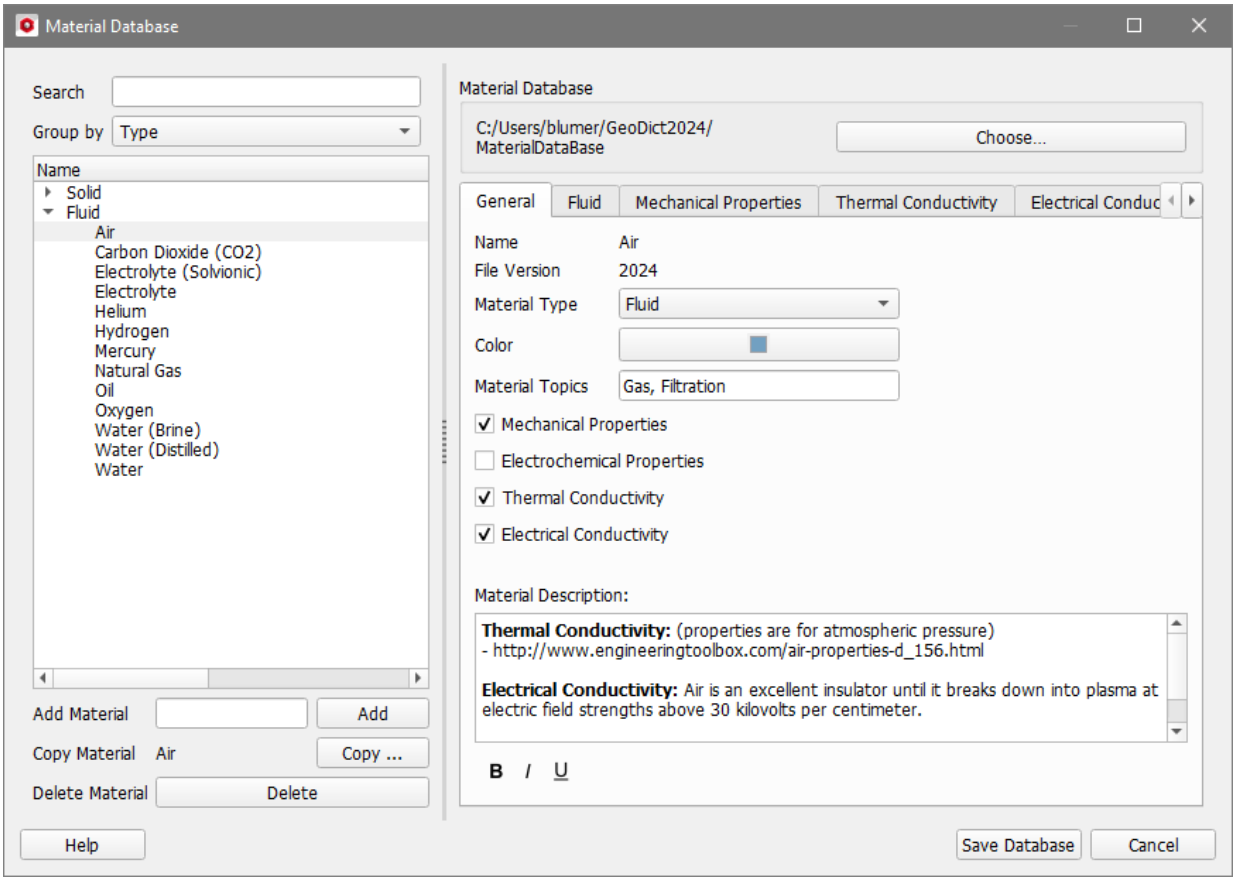
In GeoDict, constituent materials (and their physical properties) are **globally assigned to a structure** and not just to a property predictor simulation.

The GeoDict Material Database is a catalogue of the constituent materials that can be assigned to correctly identify digital materials in the structure models with properties of real materials.

The user can access and edit the GeoDict Material Database from many modules or select **Settings → Open & Edit Material Database...** to directly access the catalogue from the menu bar.



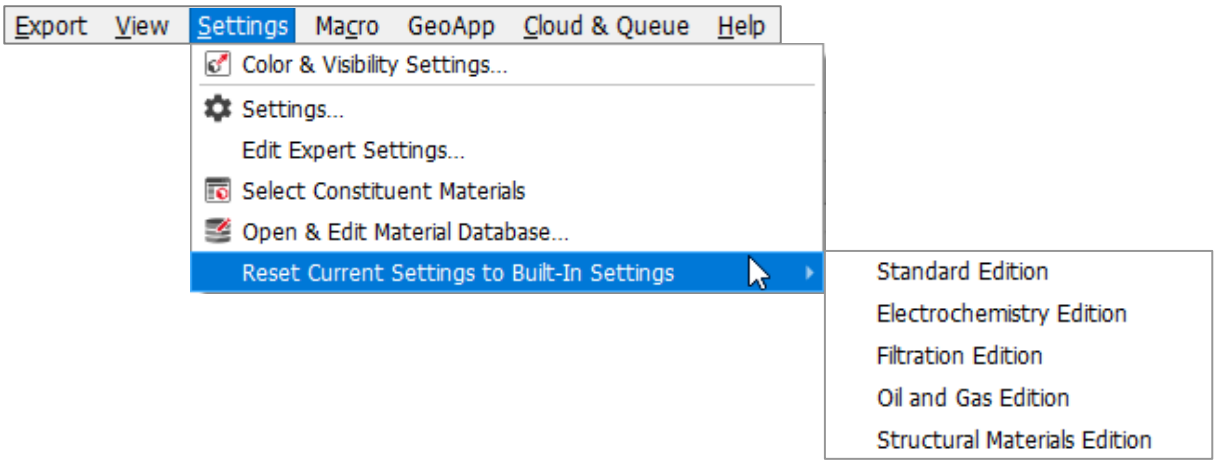
User-defined materials can be added to expand the GeoDict Material Database, or further properties can be listed for a material already included in the database. This is described in detail in the Material Database handbook.



Each material in the database, together with its properties and description, is saved as a text-file with the name of the material. The user can edit these files in any text editor. The default GeoDict Material Database is located at:

Reset Current Settings to Built-In Settings

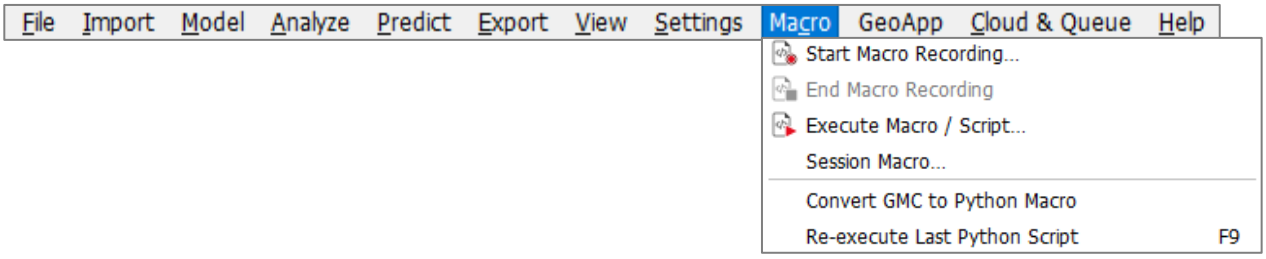
With **Reset Current Settings to Built-In Settings** the built-in settings for a specific GeoDict Edition can be reloaded.



This is similar to the  button in the options tabs but affects the settings in all GeoDict commands. Furthermore, the built-in settings from another edition than the currently activated edition can be loaded. The current edition, with which the license is connected, can be found in the window title of the title bar.

MACRO

The Macro menu contains the entries **Start Macro Recording**, **End Macro Recording**, **Execute Macro / Script**, and **Session Macro**.

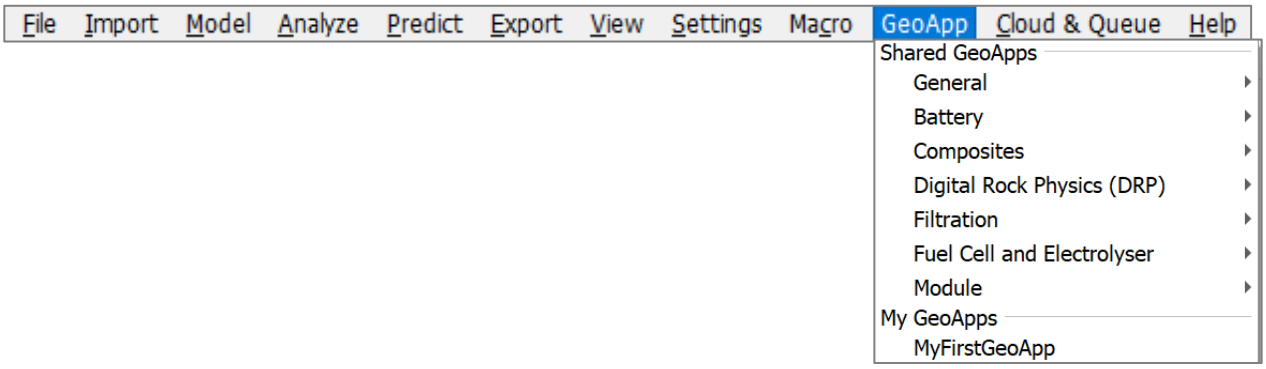


The entry **End Macro Recording** can be selected only during the recording of a macro to end the recording.

Macro recording and execution and the options **Convert GMC to Python Macro** and **Re-execute Last Python Script** are explained in detail in the GeoPy Scripting handbook.

GEOAPP

When selecting **GeoApp** in the menu bar, a pull-down menu of GeoApps opens. The **Shared GeoApps** are groups of apps delivered with GeoDict and, later, apps that you and your colleagues create or modify to be shared with each other. Under **My GeoApps** find an example GeoApp provided by Math2Market. Use this section for local GeoApps, which should not be accessible by your colleagues, yet. Create your own GeoApps and place it in the GeoDict settings folder (%username%\GeoDict2024\MyGeoApps) to find it here.

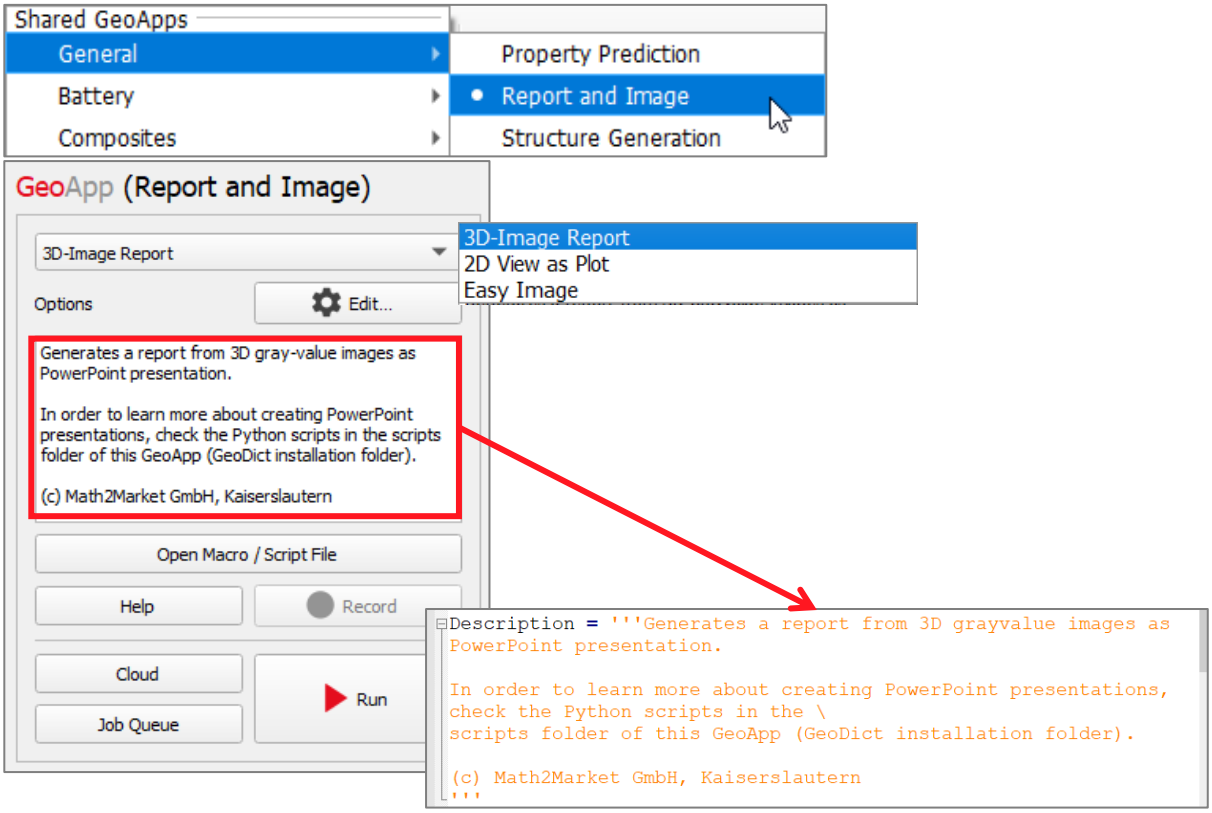


The individual GeoApps are sorted by their application fields or the module they belong to. Selecting a GeoApp from the list opens the **GeoApp** section, located left of the Visualization area. It contains a pull-down menu that lists the available Python scripts for the corresponding GeoApp.

When selecting one of the available scripts, the description area displays a report about the script. In the script, this report content can be found inside the apostrophes after **Description = ''' '''** and can be edited at any time after opening the script with a text editor.

For the **3D-Image Report** script from the **Report and Image** GeoApp, the text in the macro and the description area are shown below.

Click the Options' **Edit ...** button to edit the parameters of the macro. To open the GeoApp in an editor, click **Open Macro / Script File**. Clicking **Run** executes the script.

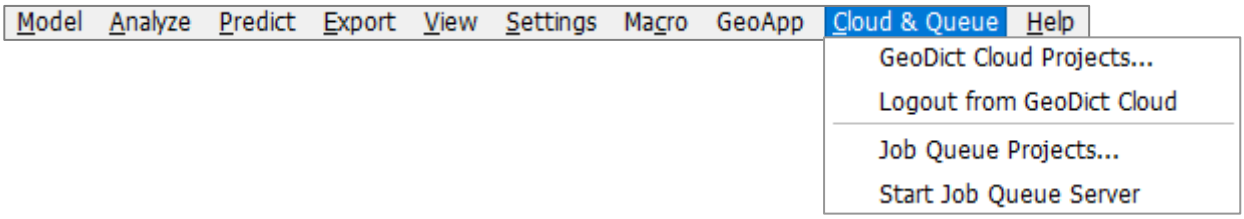


The GeoApp scripts listed in the pull-down menus can be found in the GeoDict installation folder in the subfolder GeoApp or in the subfolder of the corresponding module.

More details about using GeoApps can be found in the GeoApps handbook.

Cloud & Queue

The **Cloud & Queue** menu allows to manage simulation jobs in the GeoDict Cloud and on Job Queue Servers.



Clicking on **GeoDict Cloud Projects...** opens the **Login dialog to the GeoDict Cloud Service**. After login in, an overview of all cloud projects is opened. Log out from the Cloud by clicking on **Logout from GeoDict Cloud**.

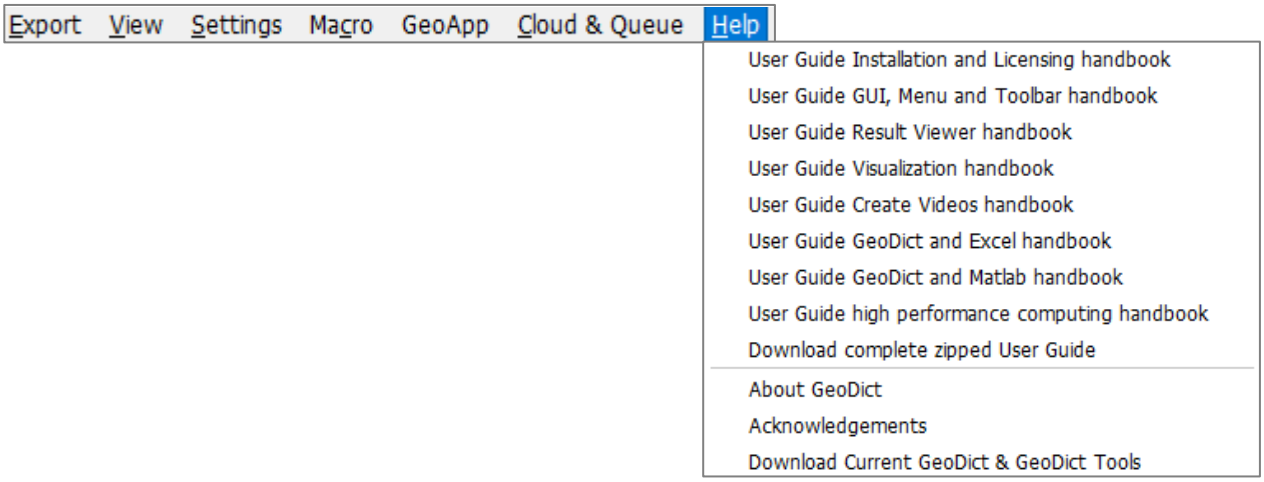
More information on the GeoDict Cloud can be found in the High Performance Computing handbook.

A list of projects in the job queue system can be obtained by clicking on **Job Queue Projects...**. Clicking **Start Job Queue Server** opens a terminal window in which the job queue server runs.

More information on the Job Queue can be found in the High Performance Computing handbook.

HELP

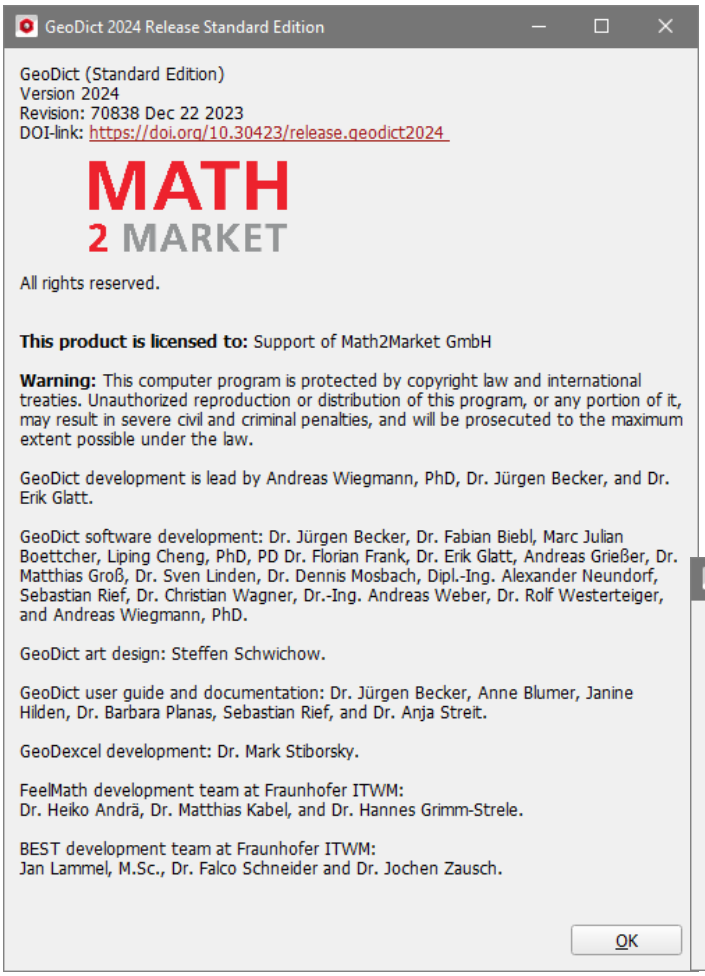
The **Help** menu links directly to several handbooks of the User Guide on the GeoDict web page. Direct links are provided for information on installation and licensing of GeoDict, the introduction to the GUI, menu and toolbar, the Result Viewer for the result files, visualization and video creation in GeoDict, using GeoDexcel and GeoLab, and setting up high performance computing.



All User Guide handbooks can be downloaded as a block in zipped .pdf format.

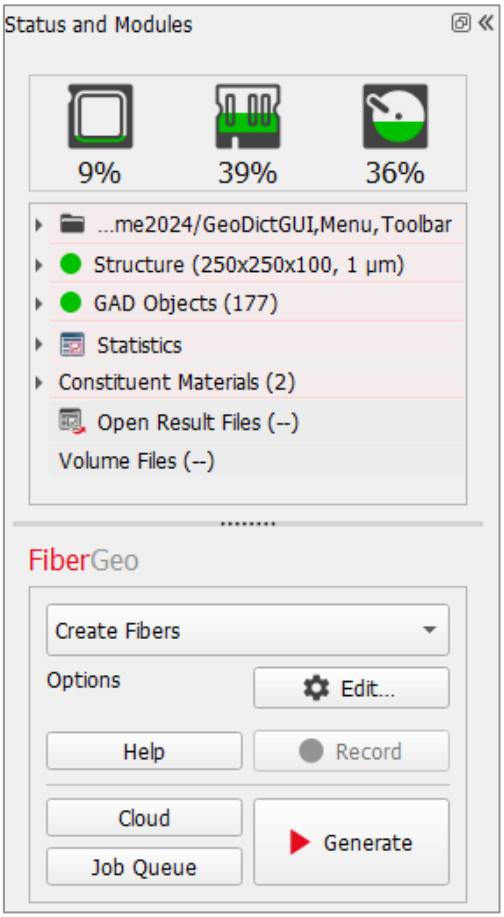
Clicking **About GeoDict** opens a window giving information on GeoDict version, revision number, and licensing.

We also acknowledge the third-party components used in GeoDict.



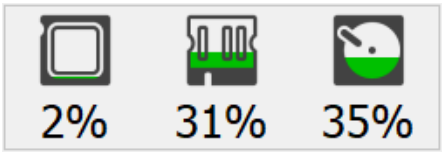
Hardware status, project status, and Module Section

The **Status and Modules** section is divided into the **hardware status** section, the **project status** Section, and the **module** section. It can be collapsed by clicking on the « icon or expanded in a new window by clicking on the ⧉ icon.



Hardware status section

At the top of the status and modules section, the hardware status is shown. The icons are described in order of their appearance from left to right. First, the current **CPU** load is displayed. The second icon shows the currently used **RAM**. Both refer to all processes running on the computer, not only to GeoDict. Finally, the percentage of **Disk Space** occupied on the hard drive where the project folder is located is given.

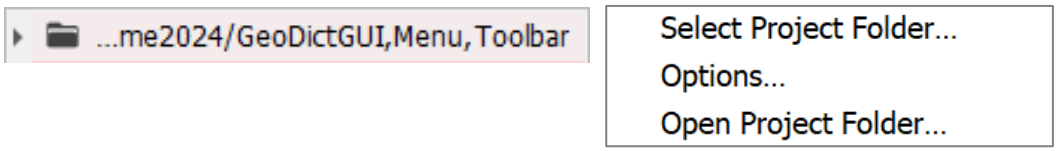


Project status section

In the **Project Status** section several information about the current project and the loaded files is shown. Sections can be expanded by clicking on the small triangle on the left or double clicking on it. Most of the sections offer an additional menu when performing a right-click on it. Often, these are shortcuts to commands that are available in the menu bar or are part of the GeoDict Base module.

Current Project Folder

First, the path of the **Current Project Folder** is given. Expanding the section lists all GeoDict Result files (*.gdr) which are stored in the project folder. Double clicking on a file name opens it directly in the Result Viewer.

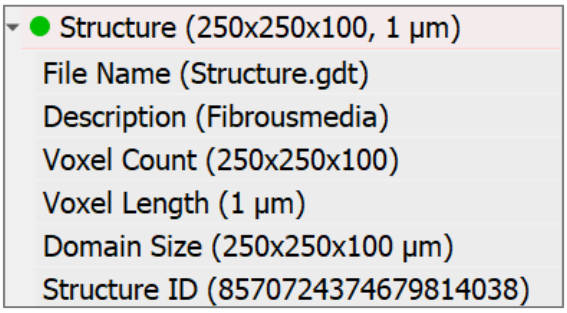


A right-click on the Current Project Folder row opens a menu used as shortcut for Choose Project Folder (see page 8 for details).

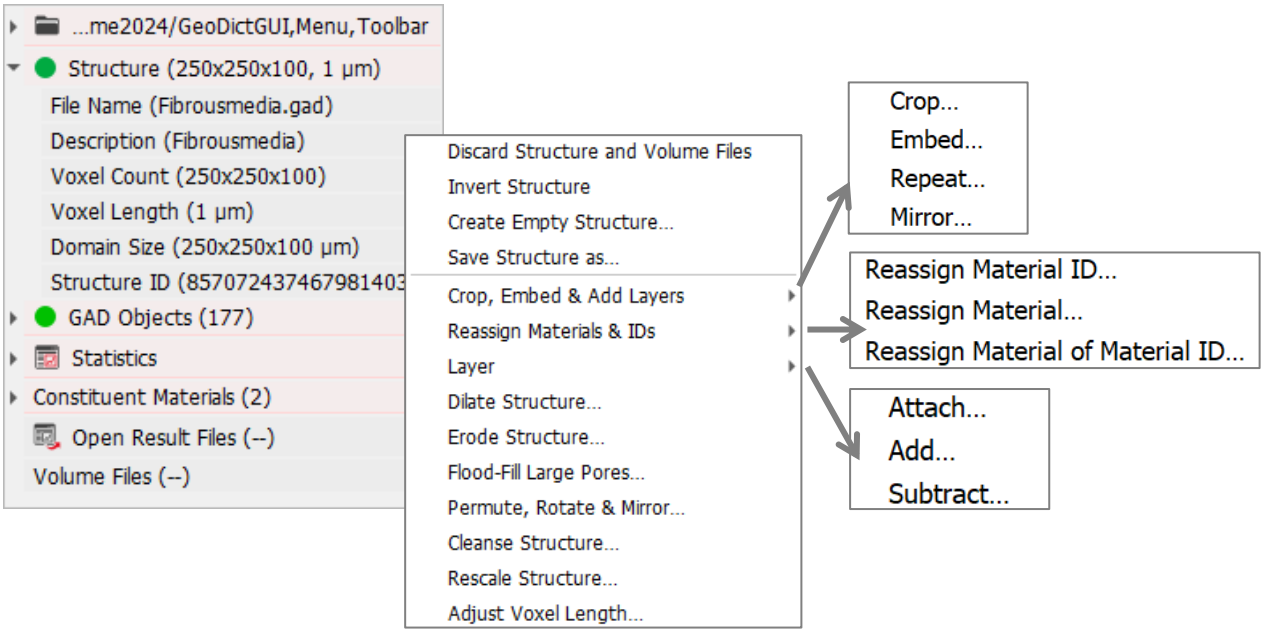
Structure

The color dot in front of **Structure** shows whether any voxelized structure is loaded into GeoDict (green dot), or not (red dot).

The **Structure** model is identified by File Name, Description, Voxel Count, Voxel Length, Domain Size and the internally hashed **Structure ID** number. A structure generated, e.g., with FiberGeo, GrainGeo, PaperGeo, WeaveGeo, GridGeo, or PleatGeo, with the same parameters and the same random seed, has always the same **Structure ID** number. The **Structure ID** number changes as soon as the structure is modified in any way.



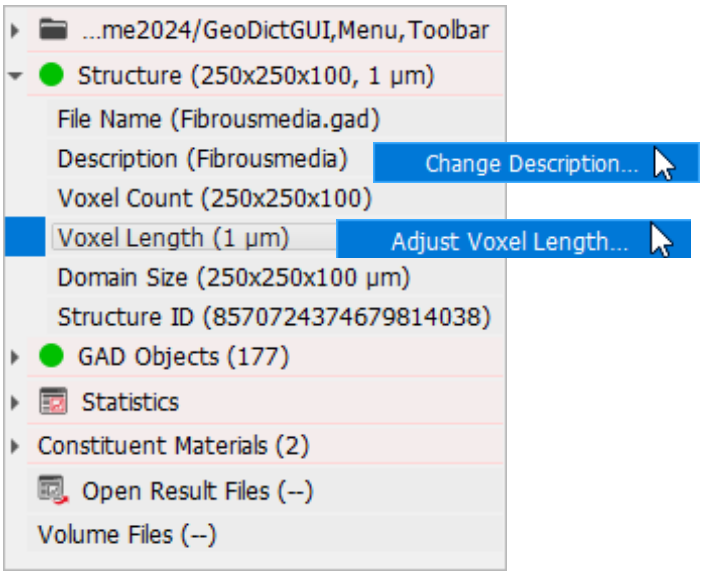
Right-clicking on the **Structure** row opens a menu used as a shortcut to apply modifications to the microstructure.



Most of the commands in this menu are shortcuts to several functions included under the **File** menu in the menu bar (see page 4ff.), in the ProcessGeo module (Model → ProcessGeo, see also the ProcessGeo handbook), or in the LayerGeo module (Model → LayerGeo. See also the LayerGeo handbook).

By right-clicking on **Description** the description of the structure can be changed.

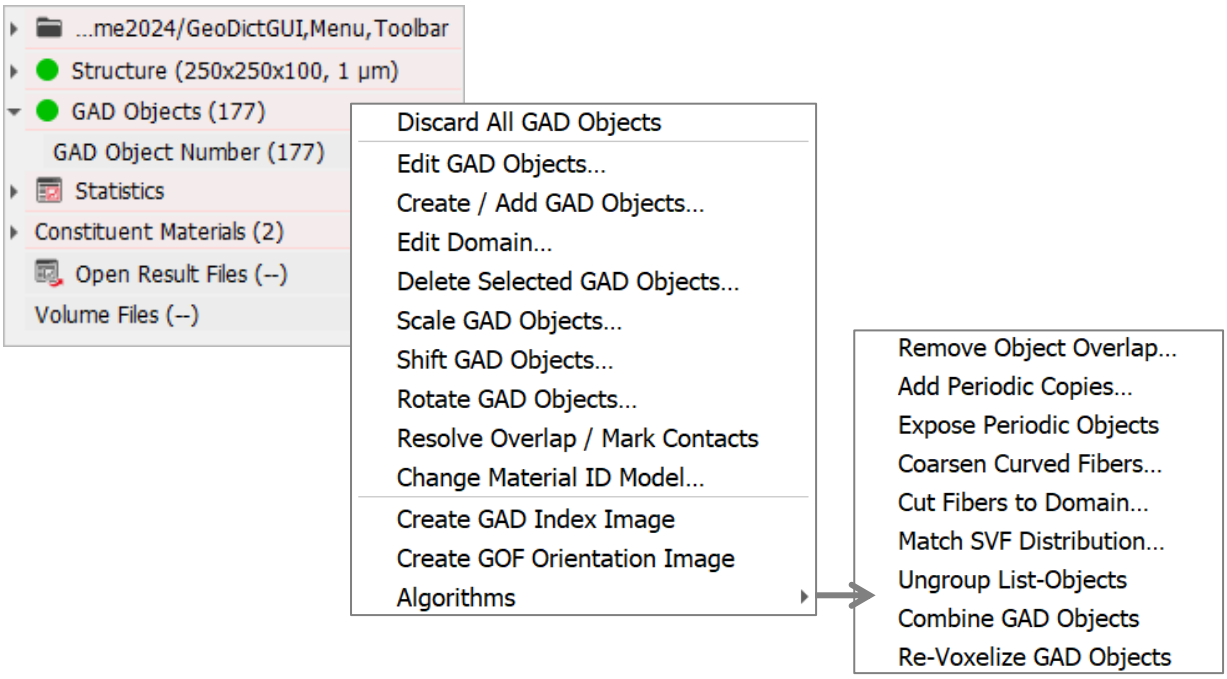
The **Adjust Voxel Length** command can be accessed by right-clicking on **Voxel Length**, where the current voxel length is shown in the selected units (m, mm, µm, nm, Inch).



GAD Objects

The color dot in front of **GAD Objects** shows whether analytical information about the objects inside of the current structure is available (green dot), or not (red dot).

The dot is yellow when information about objects inside of the current structure is available, but this information does not describe the current voxelized structure completely. This may happen, for example, when the structure has been modified after the generation (e.g., with ProcessGeo or LayerGeo).



Also shown is the number of GAD objects (such as fibers, grains, etc.) in the structure (**GAD Object Number**).

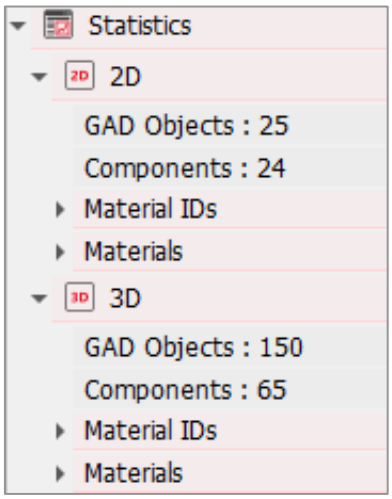
Right-clicking on **GAD Objects** opens a list of possible modifications, like editing the GAD objects or the domain, creating, adding, deleting, scaling, shifting and rotating GAD objects, resolve overlap and mark contacts, change the Material ID model, or to create a GAD index image or an orientation image. All of these modifications can be accessed also from the module GadGeo and are explained in the GadGeo handbook.

By choosing **Algorithms**, all manipulations of analytic objects, available in the section Algorithms of GadGeo can be accessed.

STATISTICS

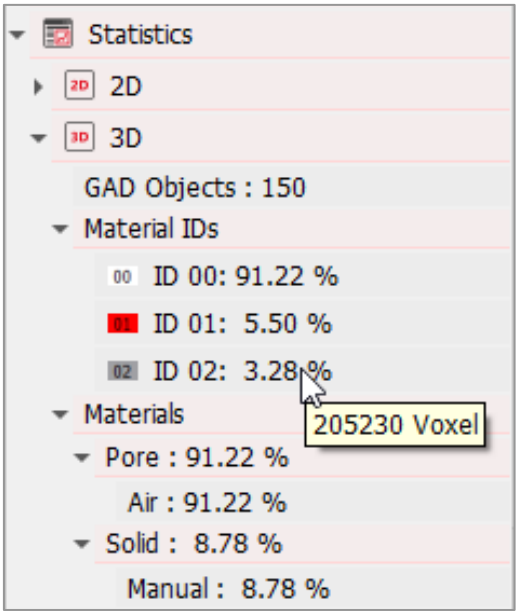
The **2D** statistics are only shown if the 2D Cross Section is activated. Then, the number of **GAD Objects** contained in the currently selected 2D slice is shown. The values vary when choosing (in the **Camera** tab) another cutting plane from the **Direction** pull-down menu and/or moving the **Slice** slider. Next, the volume percentage of all **Material IDs** present in the structure are listed. Unfold the Material IDs by clicking on the small black triangle. When hovering above an entry with the mouse the number of voxels of this material ID is shown in the tooltip. Unfolding **Materials** shows the volume fraction of each material in the structure. The materials are classified as Pore and Solid. Again, hovering above an entry shows the number of voxels of this material in the current 2D slice.

If the option **Show Number of Connected Components in 2D Slice** has previously been activated through the **Settings** → **Settings...** dialog in the **Statistics** tab (see page 29ff.) **Components** is the number of connected components contained in the currently shown 2D slice.



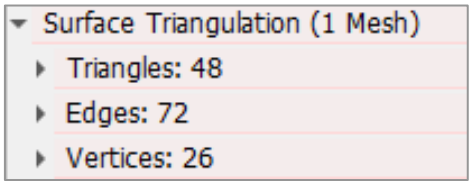
The **3D** statistics are shown in both the 2D cross section view and 3D rendering. The information shown is the same as for the 2D statistics, but the values refer to the entire 3D image.

The number of **Components** is the number of connected components contained in the entire image. This value is only shown if the option **Show Number of Connected Components** has previously been activated through **Settings** → **Settings...** dialog in the **Statistics** tab.



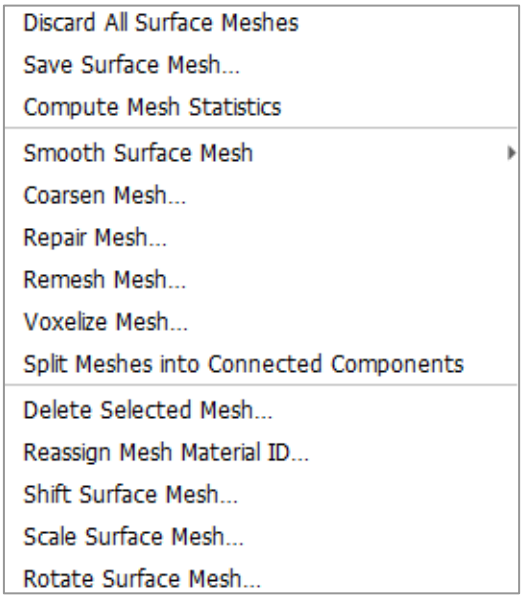
SURFACE TRIANGULATION

If a triangulation is loaded into the GeoDict Memory, the **Surface Triangulation** section is displayed.



When unfolding it, the number of triangles, edges, and vertices is shown. For the triangles and edges, the average, minimum, and maximum values are given. For the vertices, the minimal and maximal coordinate in all directions can be observed.

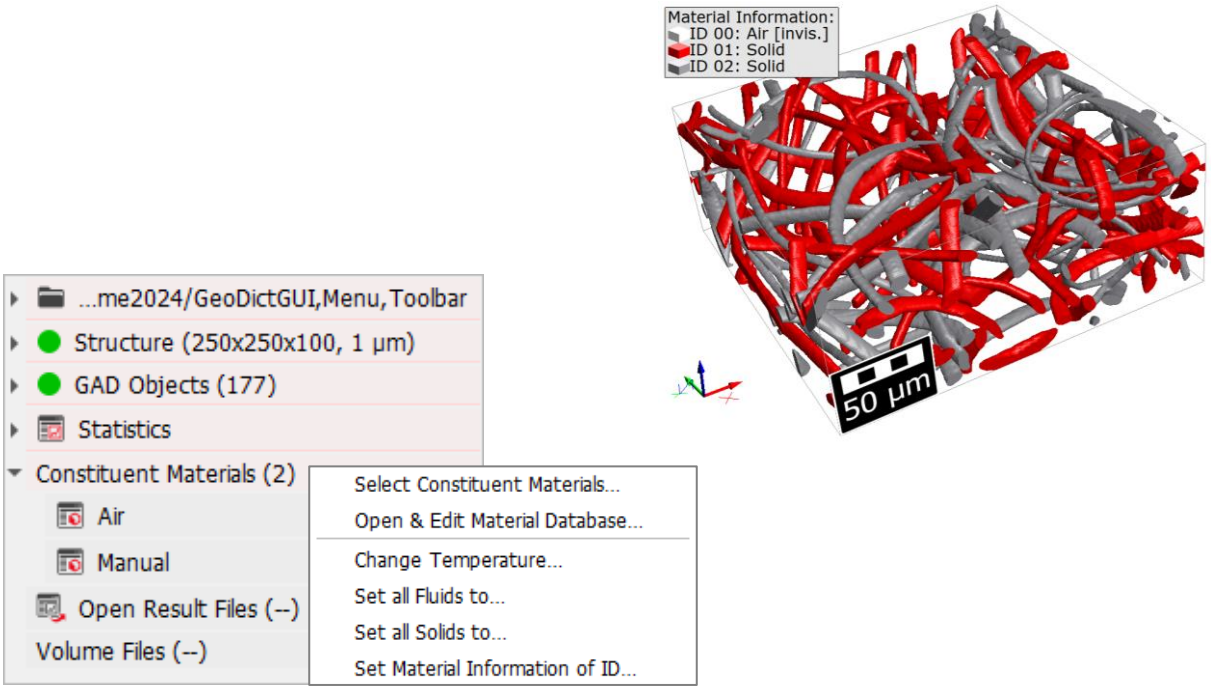
A right-click on **Surface Triangulation** opens a context menu which gives access to many functions from the MeshGeo module. The commands are all described in the MeshGeo handbook.



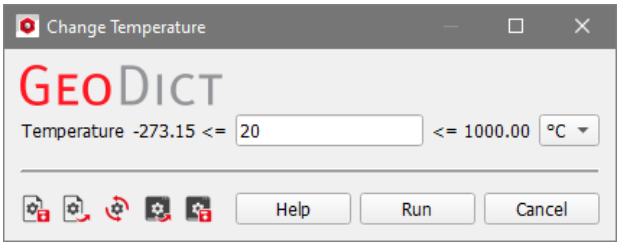
Constituent Materials

The next entry in the project status section is **Constituent Materials**. This block lists the materials that are present in the structure and are shown in the **Material Information** legend next to the microstructure in the Visualization area.

Right-clicking on **Constituent Materials** gives access to the **Select Constituent Materials** dialog (see page 36) and is a shortcut to selecting **Settings → Select Constituent Materials** in the menu bar. **Open & Edit Material Database** is a shortcut to **Settings → Open & Edit Material Database** (see page 38).

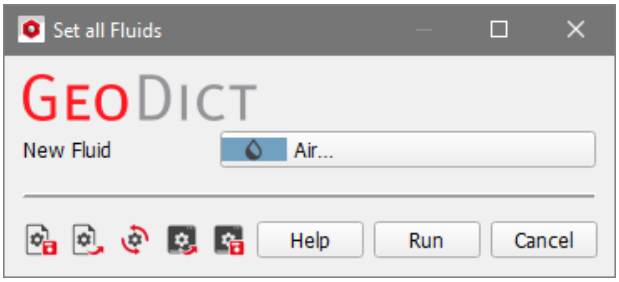


The current temperature can be edited in the constituent materials dialog and also by clicking on **Change Temperature...** , which opens a separate dialog.

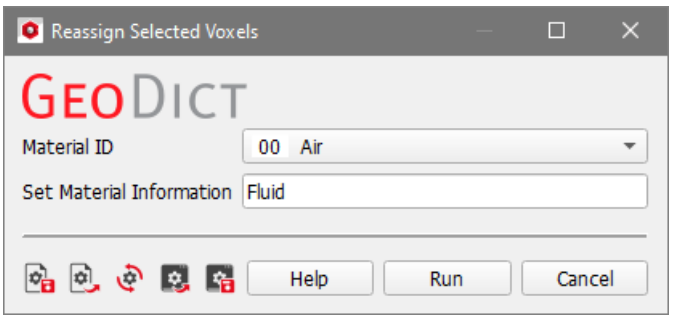


Choose the temperature unit from the drop-down menu on the right. Available are **K**elvin, **°C**elsius, and **°F**ahrenheit. Then enter the value, which must be in the temperature range given by the numbers on the left and the right.

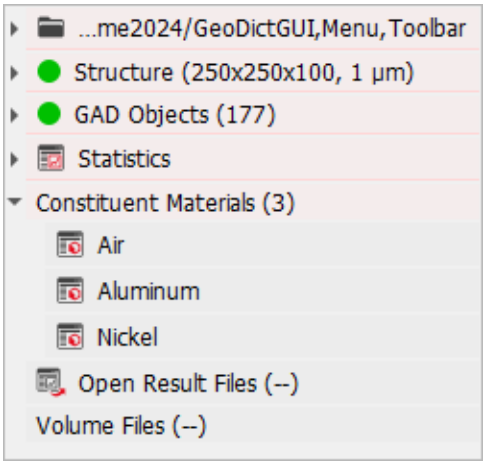
It is also possible to **Set all Fluids to...** one chosen material. This option changes the material of all material IDs with a material of type fluid or pore. With **Set all Solids to...**, the same can be done for all solid materials.

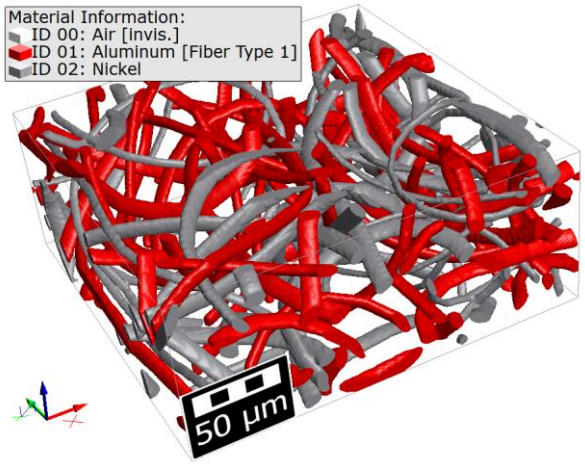


The user can also **Set Material Information** for any material ID. Type the information in text form in the **Set Material Information** box and click **Run**. The information is then displayed in squared brackets in the material legend in the visualization area.



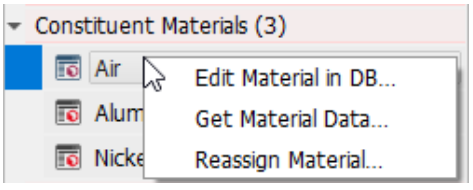
In the example shown above, two **Constituent Materials** are listed in the **Project Status** section (Air and Manual), corresponding to *Air* and *Solid* in the **Material Information** legend. The fibers with material ID 01 and material ID 02 are set to be made of the same constituent material.



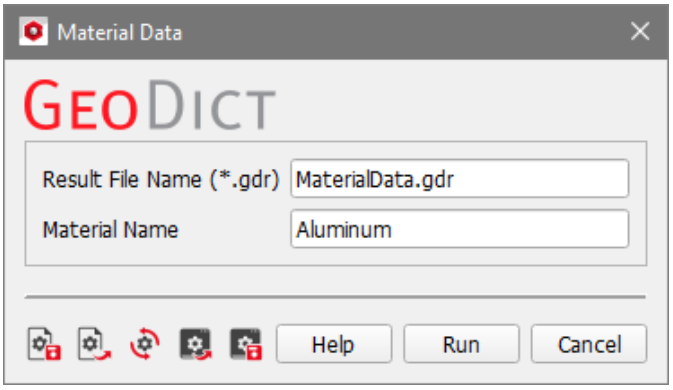


After selecting the constituent material and changing the material of material ID 01 to *Aluminum* and material ID 02 to *Nickel*, the number of **Constituent Materials** in the **Project Status** section changes from (2) to (3). The **Material Information** of *Aluminum* was additionally set to *Fiber Type 1*.

A right-click on a single material offers the following options. With **Edit Material in DB...** the entry in the material database of the corresponding material is opened. The Material Database handbook explains how a material can be edited.



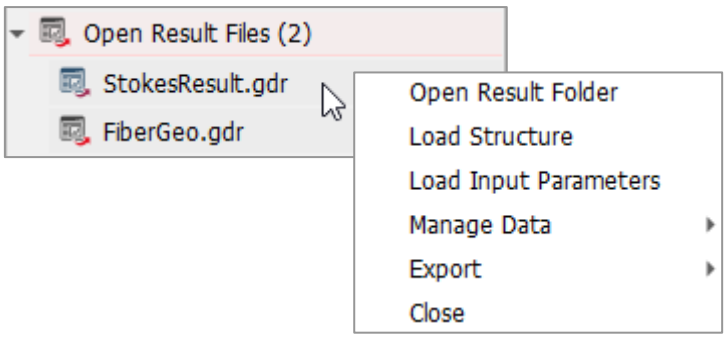
By clicking on **Get Material Data...** a dialog is opened where a result file name and a material can be entered. Clicking on **Run** produces a GeoDict result file which contains all information from the material database of the chosen material as key-value map.



With **Reassign Material...** the chosen material can be reassigned to another material (See the ProcessGeo handbook for more information).

Open Result Files

Open Result Files shows the number and names of result files (after expanding the list) that are currently opened in the **Result Viewer**. Double-clicking on the file name raises the result viewer. With a right-click on **Open Result Files** the option to **Close all GDR-Files** appears.

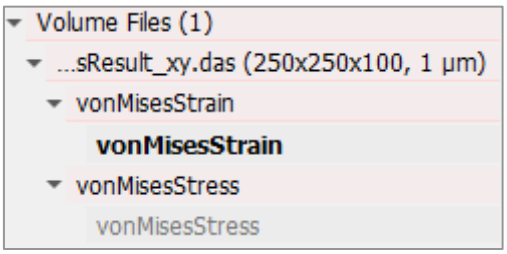


A right-click on a gdr file name opens a context menu, which offers shortcuts to functionalities that are available in the result viewer. The Result Viewer handbook provides more information on these commands.

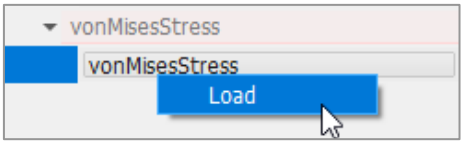
Volume Files

The last entry in the **Project Status** section is **Volume Files**. After loading a volume file (e.g., after an effective stiffness simulation with ElastoDict-FeelMath-VOX), the number of the loaded **Volume Files** appears in the **Project Status** section.

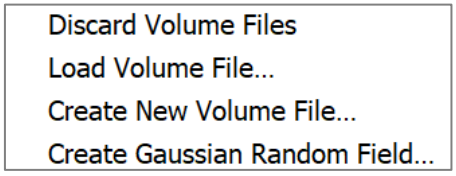
Each of the volume files consists of volume images and they contain volume fields. In the example shown here, the volume file StrainStressResult_xy.das is loaded. It has the volume images vonMisesStrain and vonMisesStress, and they contain a volume field with the same name, respectively. The volume filed vonMisesStress is greyed out, because it was not selected in the loading volume file dialog (see page 6)



With a right click on the name of the volume field, the **Load** option is available. Alternatively, double clicking on a volume field loads it into GeoDict and it can be seen in the Visualization area.



Right-clicking on Volume Files opens a list of options.

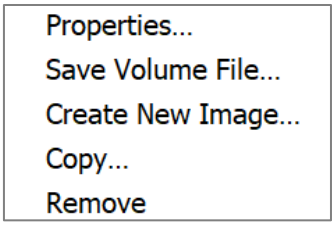


Discard Volume Files and **Load Volume File** are the same as those from the **File** menu in the menu bar (see page 4ff.). It is also possible to **Create New Volume File**s or to **Create a Gaussian Random Field**.

In the **Create New Volume File** dialog, enter a **Filename** und define the **Type** of the volume file. The user can choose a preset of GeoDict volume file structures or choose **empty**. In the latter case, the created volume file does not contain any image or field. Instead, the user can fill the file with **Create New Image** and **New Field**, which are described below.

If a predefined volume file was chosen, the volume file contains the standard images and fields. For example, the preset **vap** produces a volume file that contains a **Velocity image** with the fields **VelocityX**, **VelocityY**, **VelocityZ**, and **Velocity** and a **Pressure image** with the **Pressure** field. All the fields contain zero values and can be filled afterwards using, e.g., the **Math Operations** (see page 54ff.) or via Python scripting with GeoPy (find more information in the GeoPy Scripting handbook). A description on how to **Create** a **Gaussian Random Field** can be found here in the GrainGeo handbook.

A right click on a loaded volume file name provides further options.



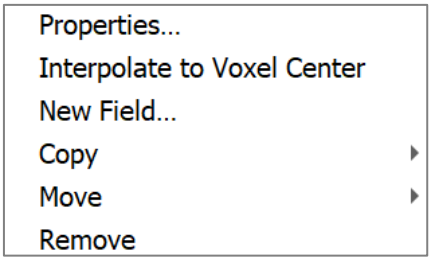
Choose **Properties** to get information on the volume file loaded.

This volume file can also be **saved** to the hard disk as **Current File Type**, **Universal GeoDict File (*.guf)**, or as **GeoDict Raw Data (*.grw)**.

With **Create New Image** two types of images can be created. If **Scalar** is chosen, an empty volume image is created and a new volume field can be created as shown below. If **Vector** is chosen, the unit for the vector field must be entered (e.g. m/s for a velocity field).Then, a volume image with 3 volume fields (containing only zeros) is generated and also the norm is automatically computed and shown. The created volume fields are the component fields for the X-, Y-, and Z-direction. With **Copy...** the entire volume file including all images, fields, and values is copied, after entering a name for the new volume file. The new file is only stored in GeoDict. To save it to

the hard disk, click on **Save Volume File**. Click on **Remove** to delete the volume file including all its images and fields from the GeoDict memory.

Right-clicking on a volume image opens further options.



Choose **Properties** to get information on the volume image and to change its name.

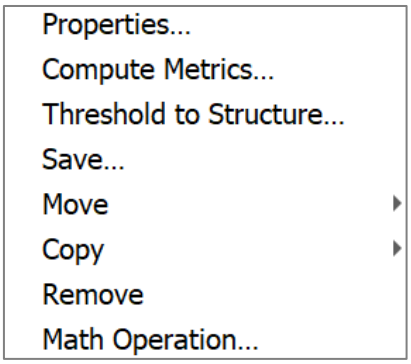
The function **Interpolate to Voxel Center** interpolates the data to the voxel centers using the values on edges and faces of the voxels. It is only available for vector images and not for scalar images.

The user can also create and add a **New Field** to a volume image. In the opening dialog, enter a **Fieldname** and the desired **Unit** of the volume field. Select the **Data Type** and the **Fill Method** from the corresponding drop-down menu. The fill method determines if the values in the new field are zeros, ones, randomly distributed (between 0 and 1) or gaussian randomly distributed around zero.

With **Remove** a volume image can be deleted from the GeoDict memory. It is not deleted from the volume file saved in the project folder.

Some of the options are not available if a compressed volume file is loaded without decompressing it during the import. Instead, the option to **Decompress** the file when it is already in the GeoDict memory is available.

Finally, a right click on a volume field provides other possibilities.



With **Properties** the **Name** and **Unit** of a volume field can be edited.

The commands **Compute Metrics** and **Threshold to Structure** are explained in the sub-sections below.

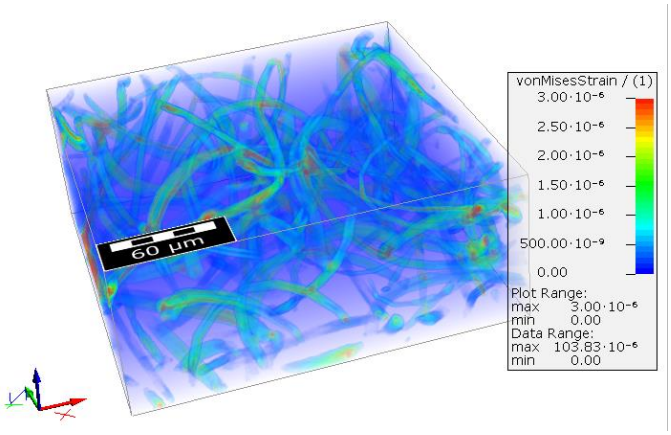
The selected volume field can be **Save**d as *.guf file or in another file format as described on page 16.

It is possible to **Move** or **Copy** the volume field to another volume image of the same size, and to **Remove** it from the GeoDict memory.

The **Math Operations** on a volume field are described below on page 54.

Compute Metrics

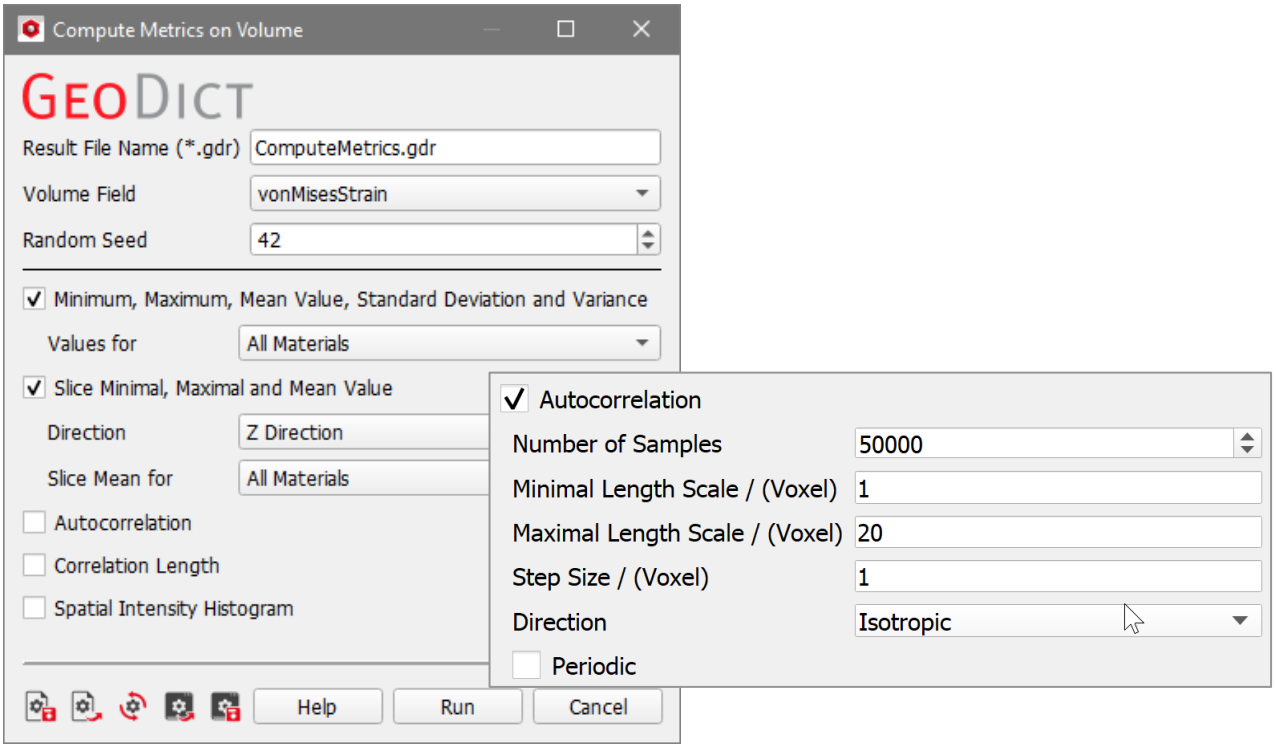
With **Compute Metrics**, access statistical properties of the volume field.



Enter a **Result File Name (*.gdr)** to save the results in. Then, select on which of the loaded **Volume Field**s the properties should be computed.

The **Random Seed** influences the results of Autocorrelation and Correlation Length.

Below, choose which metrics should be computed.



Minimum, Maximum and Mean Values, Standard Deviation and Variance can be computed for either Pore, Solid, All Materials, Chosen Materials or Chosen Material IDs.

Minimal, Maximal and Mean Values can also be determined **slice**-wise for a chosen direction and Pore, Solid, All Materials, Chosen Materials or Chosen Material IDs.

When **Autocorrelation** is selected, the similarity of voxels in a given distance between **Minimal Length Scale** and **Maximal Length Scale** is measured. This is similar to the MatDict command 2-Point Correlation and details on the selectable options are described in the MatDict handbook.

The **Correlation Length** is a measure on which length scale the values of the volume field change.

With **Spatial Intensity Histogram** a histogram of the values in the volume field is computed with respect to the entered **Number of Bins**.

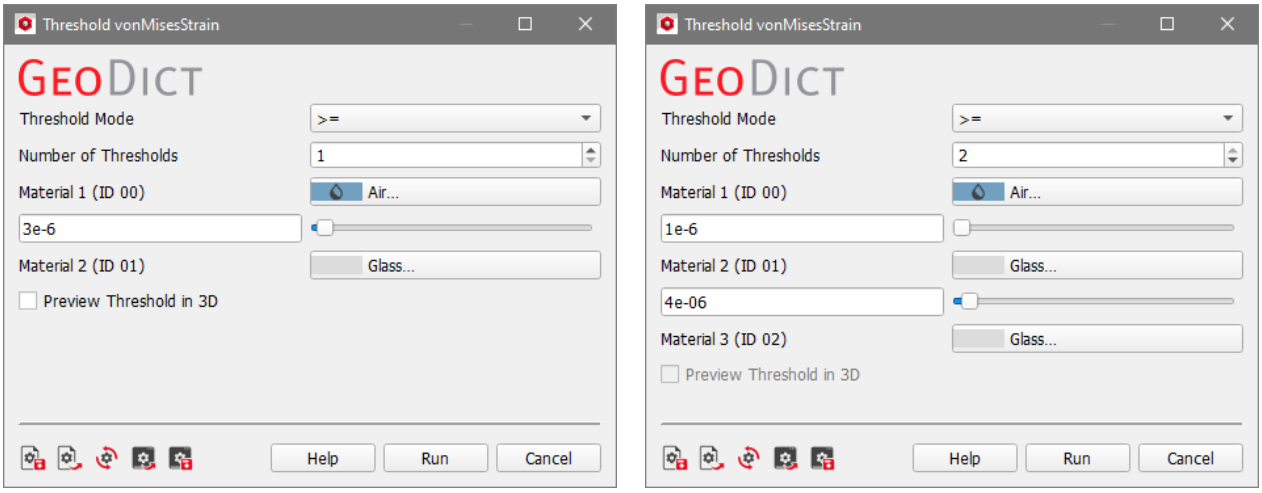
Clicking **Run** computes the chosen metrics. After the run is finished, the result viewer opens and shows the results in the report tab. Additional plots are available in the Plots subtab for **Slice Minimal, Maximal and Mean Value**, **Autocorrelation**, or **Spatial Intensity Histogram** selected.

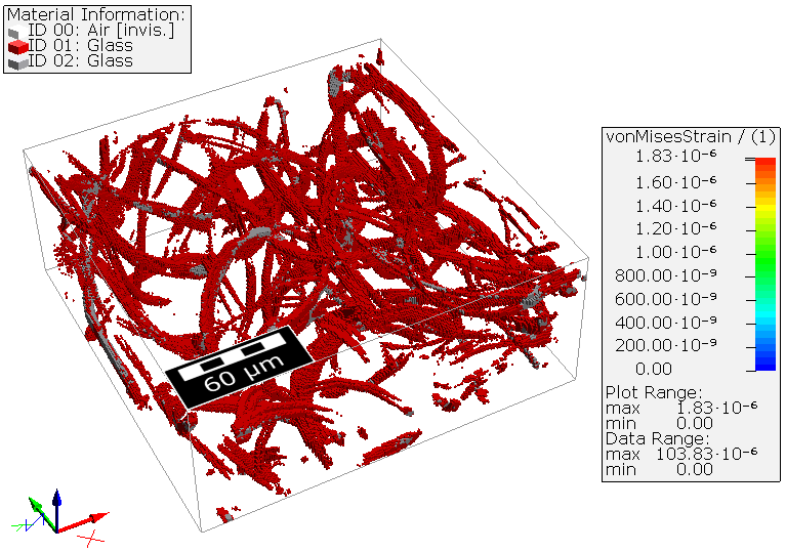
Threshold to Structure

Select **Threshold to Structure** to create a structure with voxels above or below a defined threshold of a volume field. One or two thresholds can be defined.

If 3D rendering was chosen before check **Preview Threshold in 3D** to visualize the created structure already before clicking **Run**. This is only available for one threshold.

Define e.g. 2 thresholds to create a structure with voxels of ID 01 where the von Mises Strain of the fibrous structure is above 1e-06, and with voxels of ID2 at locations with von Mises Strain above 4e-06.



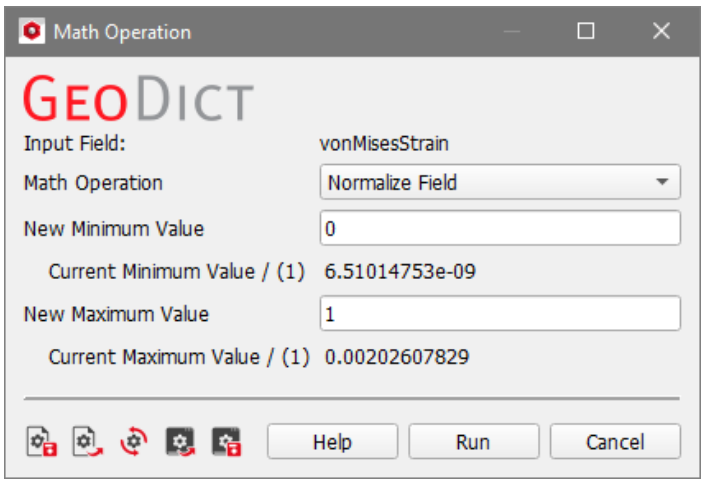


Math Operation

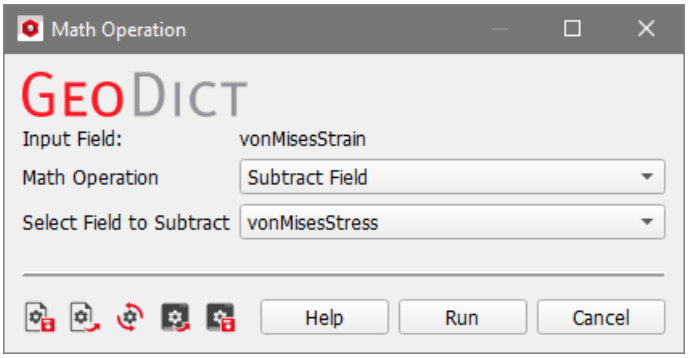
Choose **Math Operation** to open a dialog that allows to manipulate the volume field in different ways. Each math operation generates a new volume image containing the

modified volume field. The single volume fields can be saved in *.guf format or the complete modified volume file can be saved, after the unwanted volume images were removed.

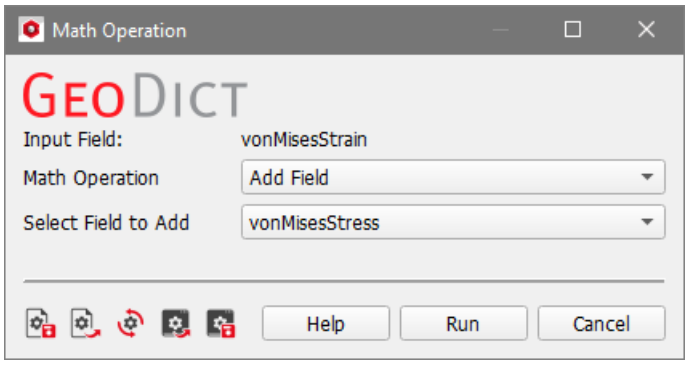
- **Normalize Field:** Define a new minimum and maximum value and normalize the values of the volume field accordingly.



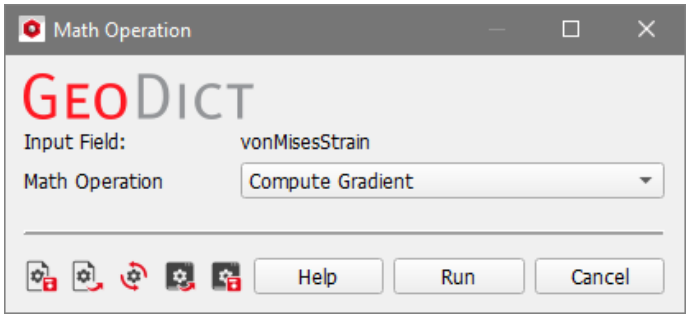
- **Subtract Field**: Choose another volume field, e.g., from another result file, that will be subtracted from the current volume field. Note that the volume fields must be of equal size.



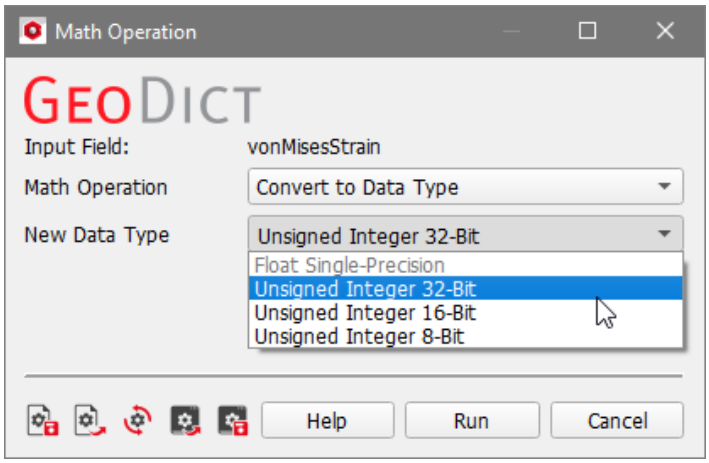
- **Add Field**: Choose another volume field of the same size that will be added to the current one.



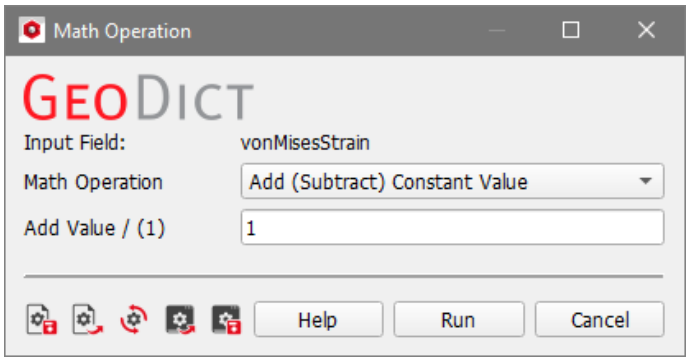
- **Compute Gradient**: No further parameters are needed to compute the gradient for the current volume field. This results in a vector image with the three component vector fields.



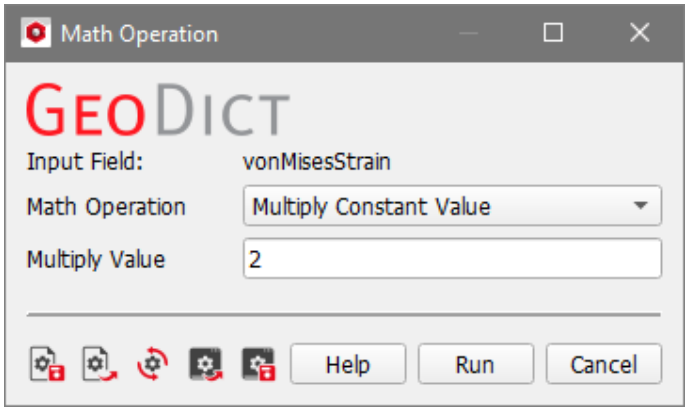
- **Convert to Data Type**: Choose a new data type (single, uInt32, uInt16 or uInt8) and convert all values of the current volume field to this type. The current data type is greyed-out and cannot be selected.



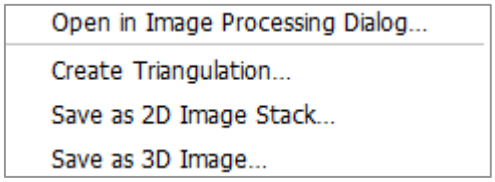
- **Add (Subtract) Constant Value**: Add a constant value to the volume field. Enter a negative value to subtract it from the volume field.



- **Multiply Constant Value:** Multiply each entry in the volume field by a constant factor.



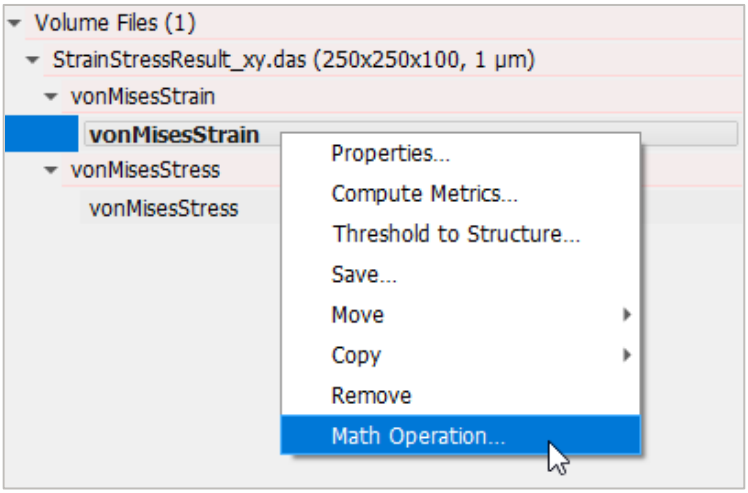
The math operation **Convert to Data Type** with the type uInt8 or uInt16 chosen offers further possibilities in the right-click context menu for the converted volume field.



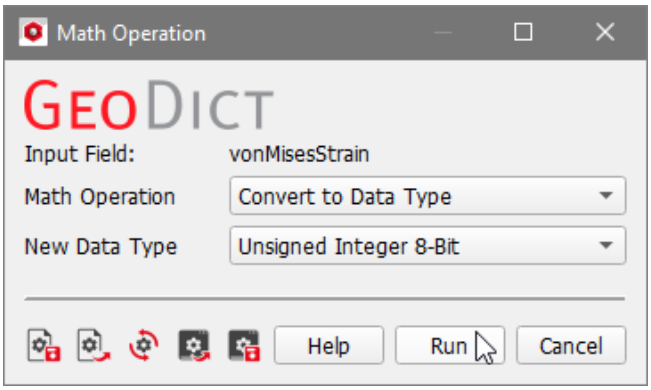
The volume field can be **Open**ed **in** the **Image Processing Dialog** (see the ImportGeo-Vol handbook). The user may choose to **Create** a **Triangulation** (more details can be found in the MeshGeo handbook), **Save as 2D Image Stack**, or **Save as 3D Image**.

Use the math operation **Convert to Data Type** to save a volume field as RAW-file. For example, the field "vonMisesStrain" is saved in the following way:

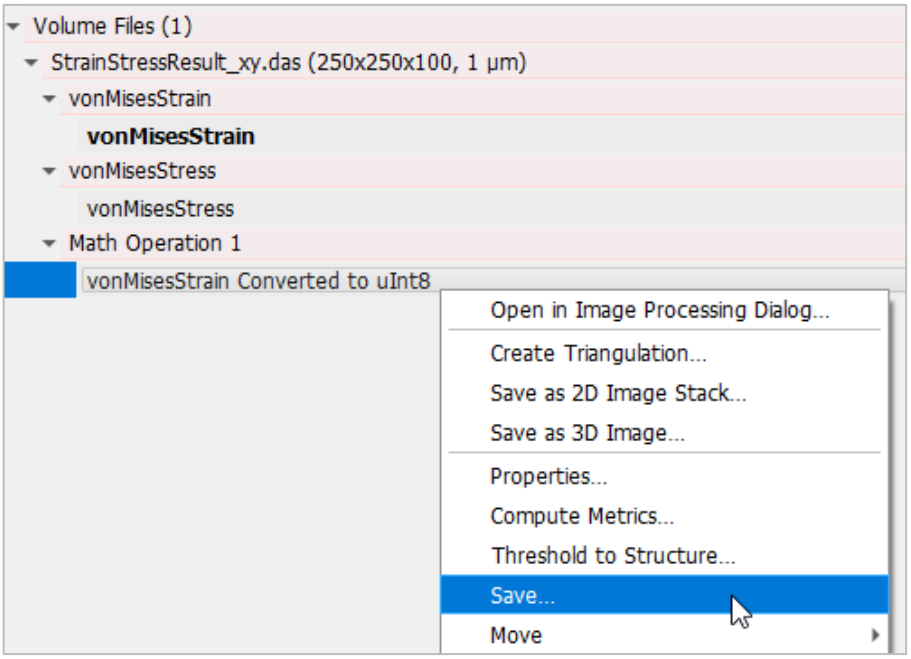
1. First, convert the data in the field to the right data type. Right-click on the **vonMisesStrain** field and choose **Math Operation...**.



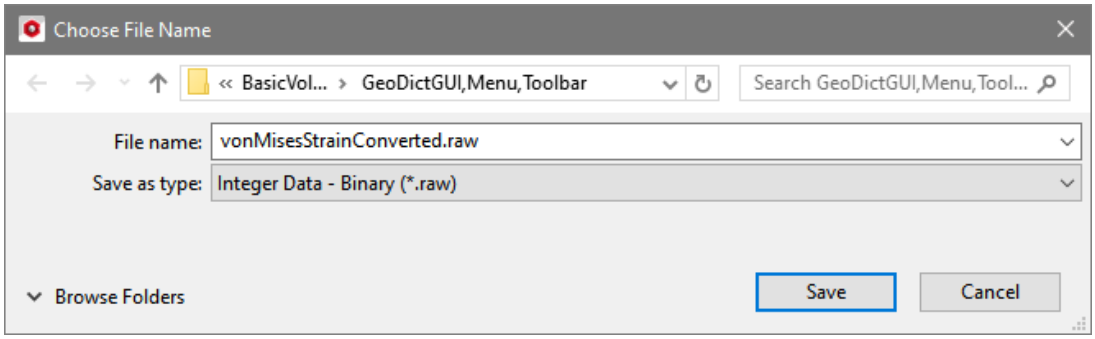
2. In the dialog select **Convert to Data Type** from the first pull-down menu and **Unsigned Integer 8-Bit** from the second. Then click **Run**.



3. A new Volume Image appears under the currently loaded Volume File: **Math Operation 1**. There, the new Volume Field **vonMisesStrain Converted to uInt8** is shown. Right-click on it and choose **Save.**

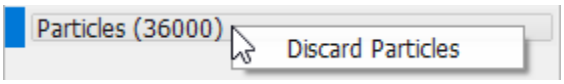


4. Select a name and choose **Integer Data - Binary (*.raw)** as file type. Then, the volume field is saved in the current project folder, or another folder may be chosen.



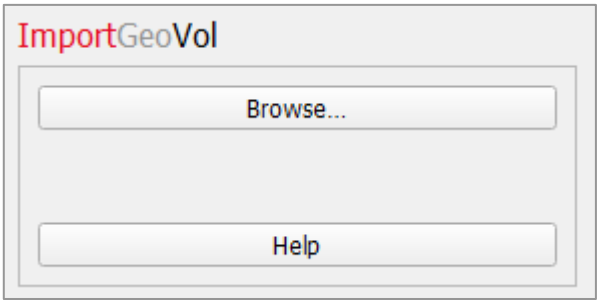
PARTICLES

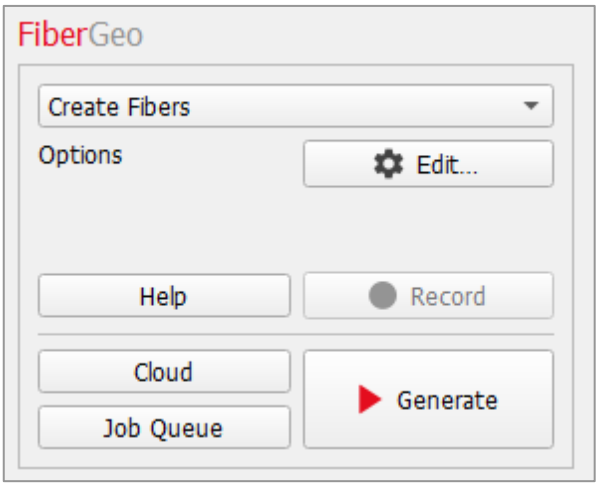
If Particles are loaded into the GeoDict memory, the number of particles is shown in the status section. With a right-click, the option to **Discard Particles** is available. This is the same as the **Discard Particles** option from the File menu (see page 17).



Module section

The heading of the **Module** section changes to the GeoDict module selected from the menu bar. The GeoDict modules are organized into modules to **Import** and pre-process files and 3D image data, generator and structure-modifying modules to **Model** microstructures, structure analyzing modules to **Analyze**, properties predictor modules to **Predict**, and modules to **Export** files to other formats.

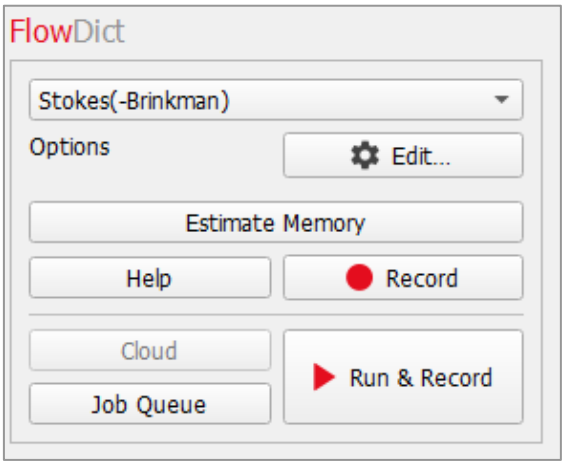




The module section contains a pull-down menu, from which you can choose a command to execute. Depending on the chosen command, there is either a **Browse...** button for choosing files or an **Edit...** button, where the options necessary for GeoDict's generators, modifiers, or solvers, can be edited. The **Help** button directly links to the handbook where the chosen command is explained in the handbook of the corresponding module. The Help button is also available in the options dialogs that open when clicking on **Edit**.

Depending on the module, the button **Generate**, **Run**, or **Export** starts the actions of the generator, the solver or the export. For ProcessGeo, LayerGeo, and BatteryDict the button specifies the particular modifying process (Reassign, Rescale, Compress, Attach, Erode, Dilate, Design, Analyze, Charge etc.).

The module section includes a **Record** button (except for the Import modules), which is selectable when **Macro → Start Macro Recording...** is selected in the menu bar. Clicking **Record** records the settings and actions of the module without obtaining the results (yet), while **Run & Record**, which appears instead of **Run** after starting macro recording, starts the computation and additionally records the action in the macro file.



For some modules, the module section includes an **Estimate Memory** or **Estimate Memory & Disk-Space** button, that becomes active for the functionalities that support such an estimation. It allows you to estimate the memory (and disk-space) required for the computation before starting the computation.

The button **Cloud** allows to perform the calculations in the GeoDict Cloud and with **Job Queue** the simulation run can be executed on a job queue server. More information on how to start a calculation in the cloud or the job queue can be found in the High Performance handbook.

The use of the modules is explained in the handbook for each module. See page 19ff. for links to the individual handbooks).

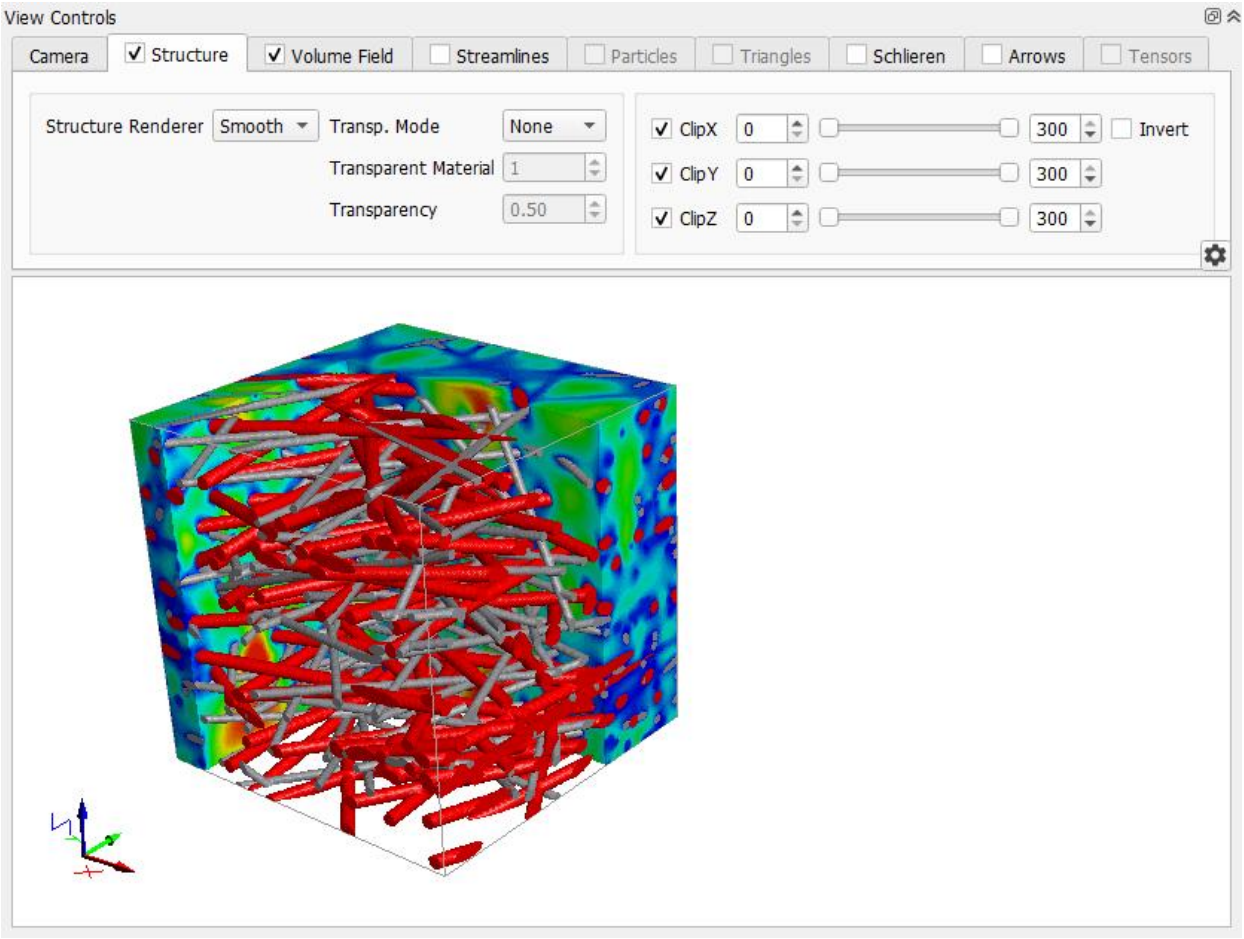
VISUALIZATION AREA AND VIEW CONTROL PANEL

When you load image data into GeoDict it is shown in the **Visualization Area**. The image might be of a fibrous-, paper-, granular-, sintered-, pleated-, woven-, or grid-structure created with one of GeoDict's structure generators, an image from an opened *.gdt file, an image imported and segmented with ImportGeo-Vol or ImportGeo-CAD from a stack of 3D image data (µCT, FIB/SEM), or other structure models. Result Data from GeoDict's predictor modules, such as velocity fields and particle trajectory files, can also be loaded as image data. Above the visualization area, the **View Controls** panel is one of the access points to change the visualization of the image.

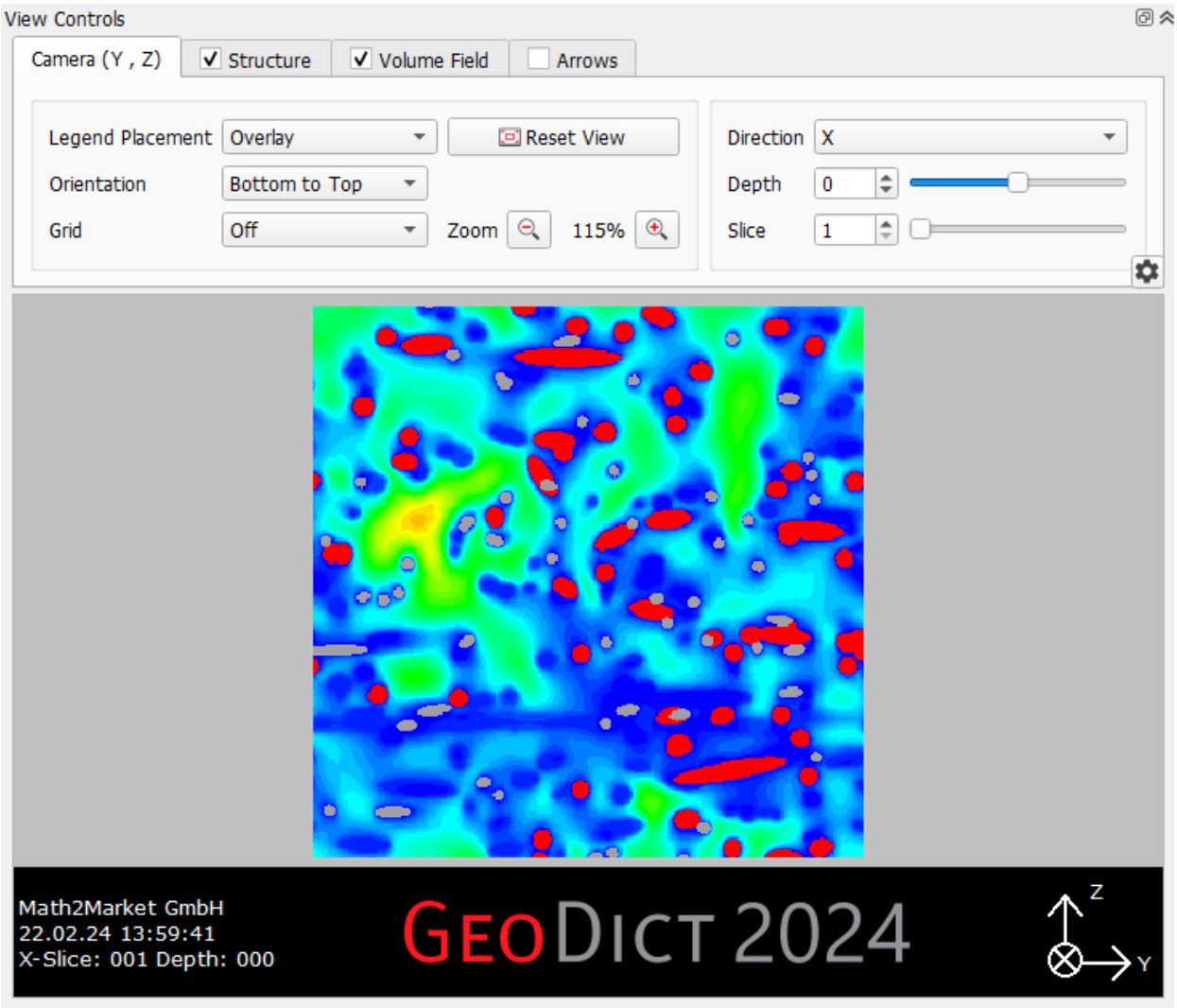
Other access points are the **View** menu (see page 22) and the **Color & Visibility Settings** in the **Settings** menu (see page 24).

The View Control panel looks different for the **2D Cross Section (SEM)** view and the **3D Rendering** mode. For the 2D View and the 3D rendering the tabs **Camera**, **Structure**, **Volume Field**, and **Arrows** are available. The volume field and arrows tabs are greyed-out if no corresponding data is loaded. Some data from volume files can only be visualized in 3D rendering mode. Thus, in 3D rendering the additional tabs **Streamlines**, **Particles**, **Triangles**, **Schlieren**, and **Tensors** appear.

To start the visualization of results, a result file must be loaded through **File** → **Load Volume Field ...** or **Load Particles ...** in the menu bar, or directly by loading from the **Visualization** tab of the GeoDict **Result Viewer**.



Expand the View Controls panel to a new window using the ⧉ button and collapse it with ⌃ to have more space for the visualization area.



More detailed information about visualization in GeoDict can be found in the Visualization handbook.

What are voxelized and analytic structure models?

Structure models in GeoDict can be described in two different ways:

- **Analytic representation**: The structure is described analytically (e.g. multiple spheres with given diameters and positions). The structure information is stored as GAD-objects (GAD = **G**eoDict **A**nalytic **D**ata).
- **Voxel representation**: The structure is described by its voxel grid.

Editing and modification of structure models can be done on the structure's voxel geometry description or analytic description.

Simple and complicated microstructures can be edited by manual drawing, e.g., to correct problematic boundary effects. Among other applications, voxel and analytic data editing can be used to remove artifacts from 3D structures built from imported 3D-image data (micro-CT, nano-CT, SEM, …).

For structure models created using GeoDict's generator modules, undesired fragments of the structure can be easily modified or eliminated, without having to reset the parameters and generate again.

This direct editing or modification of voxelized structure models is a complement to the GadGeo module. GadGeo generates and edits on the analytic level on structures with available analytic information, whereas editing is also applicable to structure models with voxelized formats.

Structure models can be manually edited with GeoDict, using the following icons in the toolbar:

2D / 3D		**Select voxels (**see page **69)**
2D / 3D		**Select analytic (GAD) objects** (see page 74)
2D		Edit in a way similar to the Windows standard editor **Paint** (see page 77). Observe results in 3D (edited objects can be three-dimensional)

Clicking on an icon changes the functionality of the cursor and opens the corresponding menu from the sidebar. Part of the functionality for structure editing can be accessed also by a right mouse click in the visualization area, see page 64.

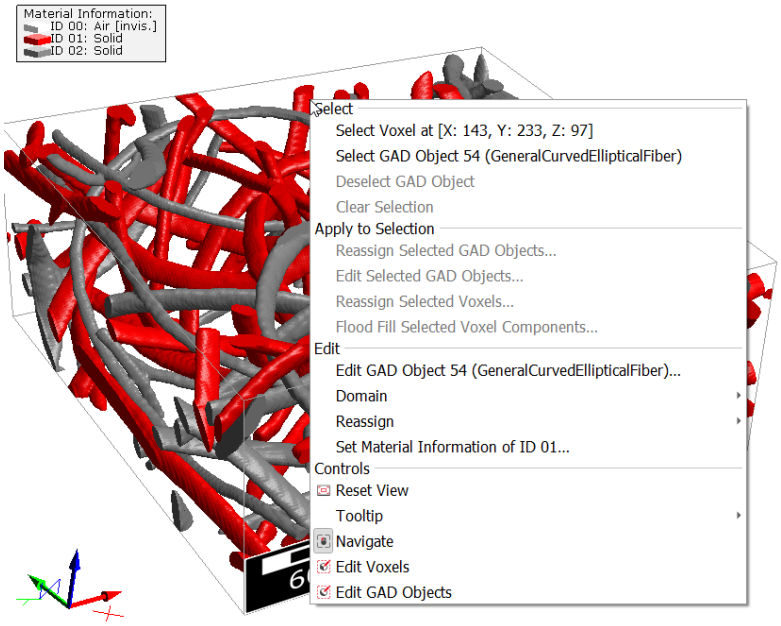
Here, as a simple structure example, a fibrous media model is generated with FiberGeo. Additional to the voxel representation, analytic data is available for the structure, which consists of 177 GAD objects. The structure model contains curved fibers of two different raw materials, initially set as Manual (Solid).

Below examples to edit and modify this fibrous media model structure in both representations follow. After editing, the structure must be saved to preserve all modifications.

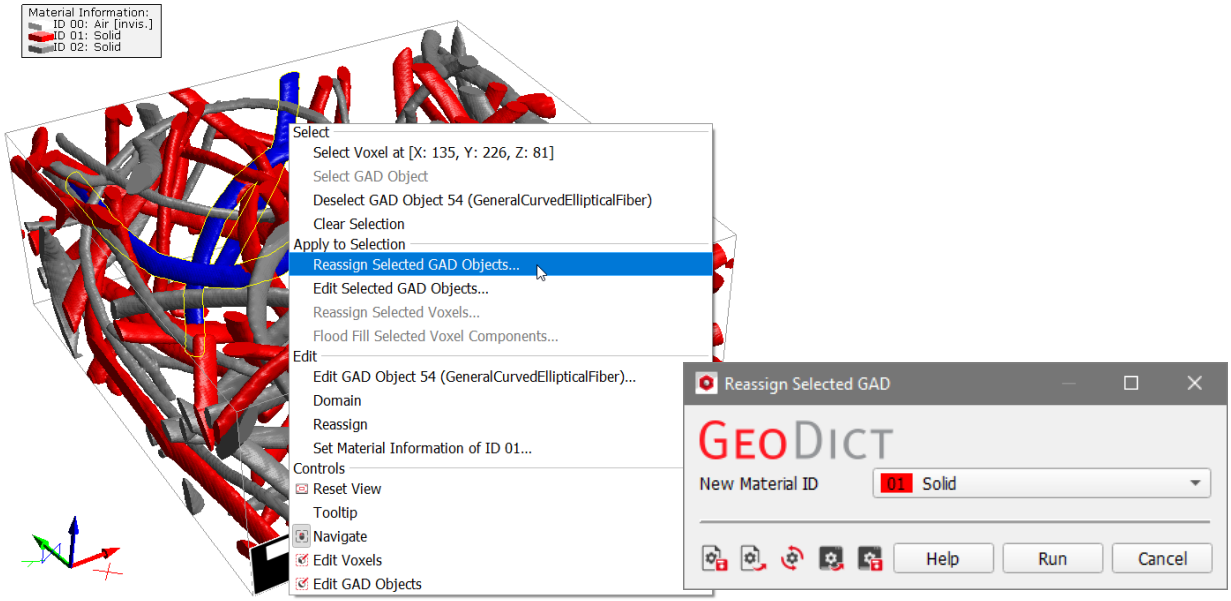
SHORTCUT TO SELECTION AND EDITING FOR VOXEL AND ANALYTIC DATA

Right click with the mouse in the visualization area to get access to shortcuts to select voxels and / or GAD objects, apply algorithms to the selection, edit the selected voxels or objects, and control the mouse functionality.

Part of the selection and editing functionalities are also available from the GUI sidebar and their explanation starts on page 68. The voxel or the GAD object, on which the right-click was made, can be selected and is added to the **Voxel Selection** sidebar or the **GAD Object Selection** sidebar. Previously selected GAD objects can be removed from the selection list with **Deselect GAD Object**, or the selections of both dialogs can be removed completely (**Clear Selection**).



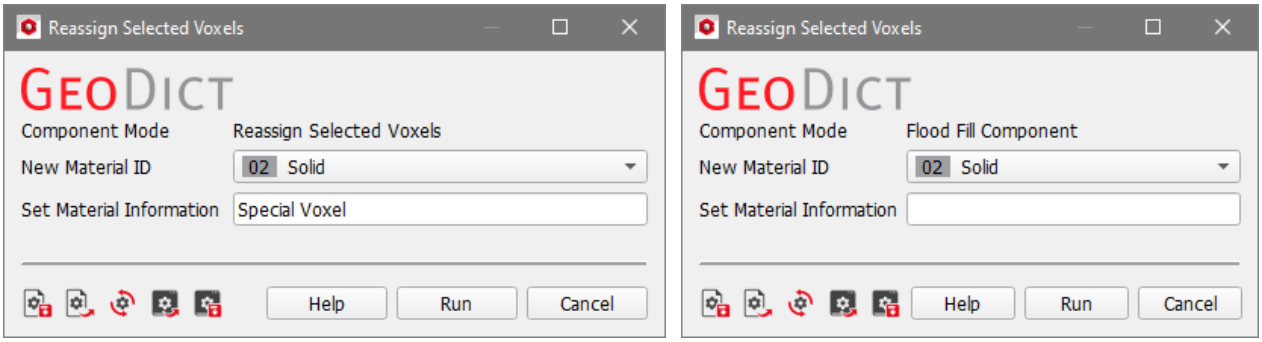
After a selection has been made, different modifications can be applied to the selection (**Apply to Selection**).



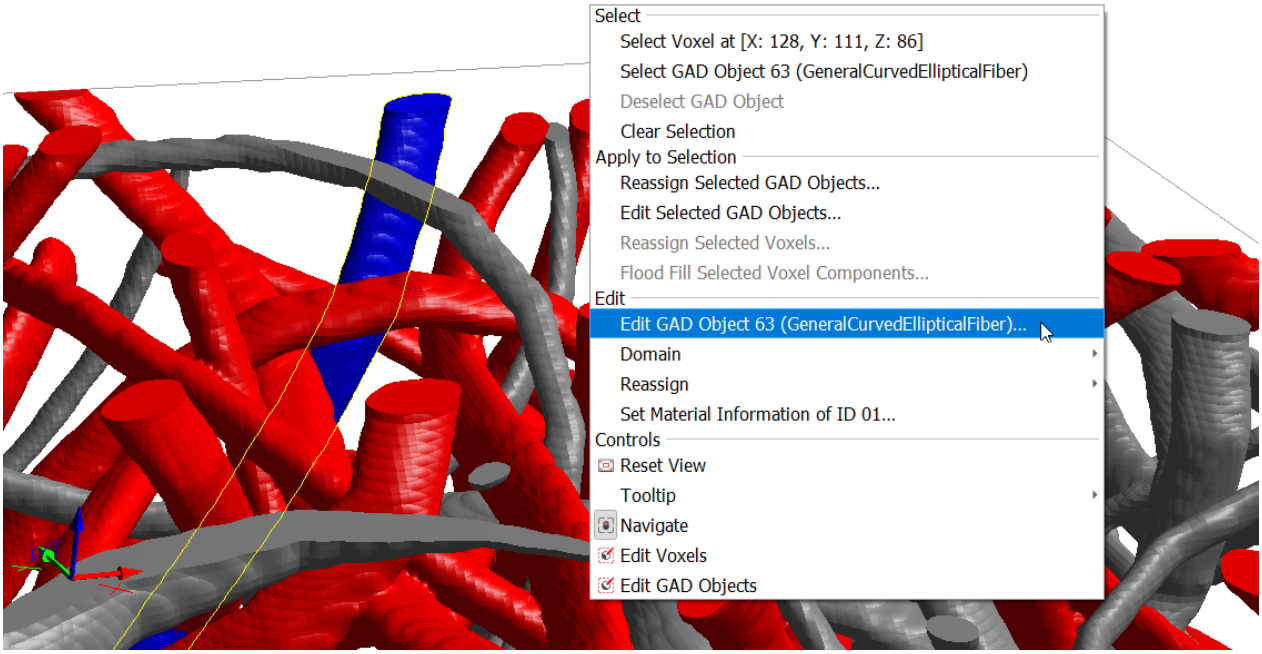
It is not necessary to click again on a selected voxel or GAD object. Choose **Reassign Selected GAD Objects** to assign a new material ID to the selected objects.

With **Edit Selected GAD Objects**, all objects listed in the **GAD Object Selection** dialog can be modified at once. Have a look into the GadGeo handbook for a description of this command.

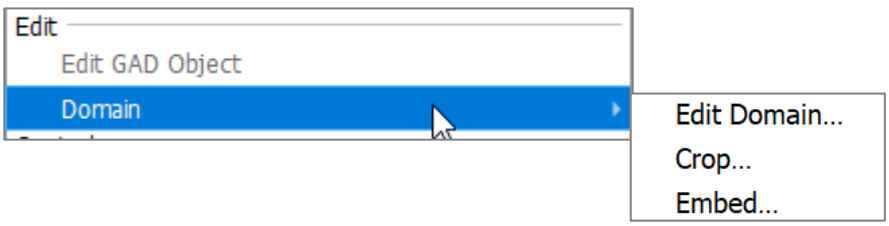
Voxels listed in the **Voxel Selection** dialog or the whole components connected to them, can be reassigned to a new Material ID with **Reassign Selected Voxels** or **Flood Fill Selected Voxel Components**. In the opening dialog, choose the new Material ID for the operation. You can also add a material information which is displayed in the material legend. For example, you can reassign a voxel to a not already present material ID and set the material information to a specific property of this voxel.



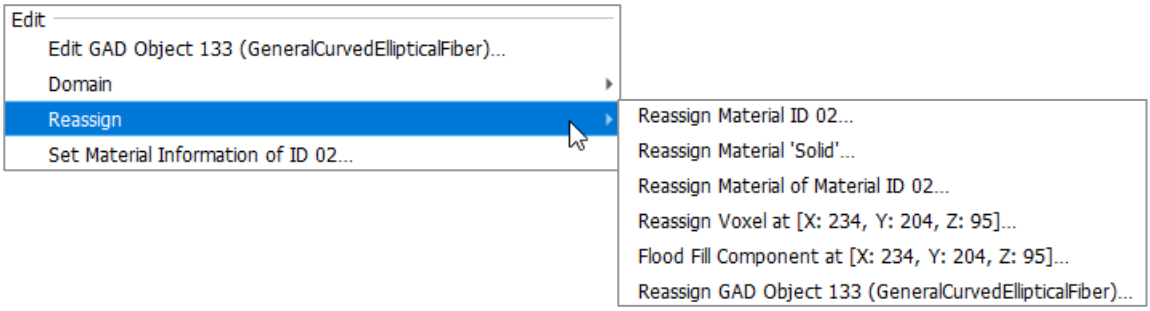
The options in the **Edit** section apply modifications to the structure without the need to make any selection of voxels or GAD objects. With **Edit GAD Object** the GAD object on which the right click was made can be modified in the same way as it can be done for selected GAD objects.



Under **Domain**, **Edit** the current **Domain** (see the GadGeo handbook) or use **Crop** and **Embed** from ProcessGeo.

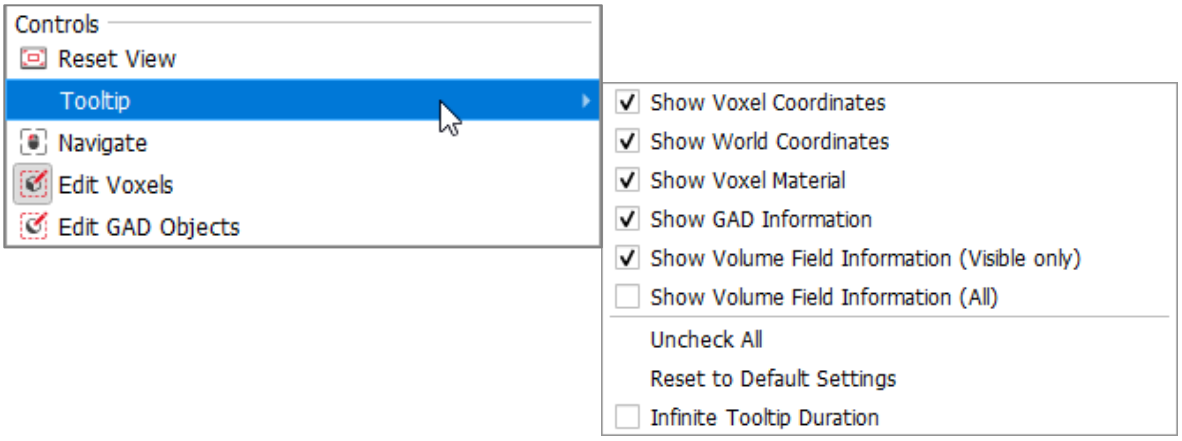


With **Reassign**, Material IDs and Materials can be reassigned as it is described in the ProcessGeo handbook.



When choosing **Reassign Material ID**, **Reassign Material** or **Reassign Material of Material ID**, the Material ID or Material at the voxel where the right click was made is set as old Material ID or Material. With **Reassign Voxel at** the voxel at this point can be reassigned to another Material ID. **Flood-Fill Component at** is similar to Flood-Fill Component for a selection of voxels (see page 70), but here for the current voxel. Finally, with **Reassign GAD Object** the GAD Object at this position can be reassigned to a new Material ID.

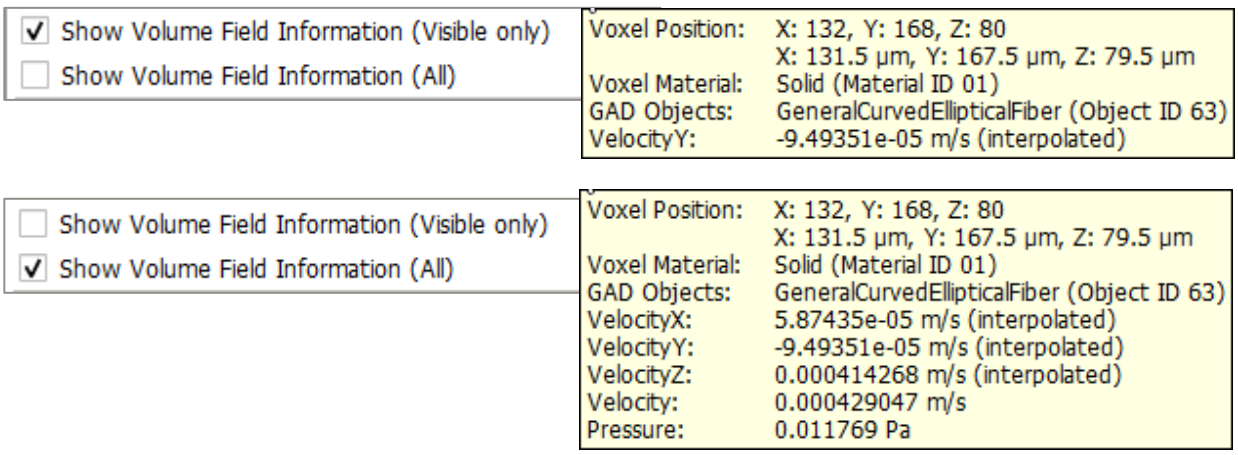
Select the options available under **Controls**, to **Reset View** settings according to the startup-settings (also available in the Camera tab in the view control panel), to switch between the icons of the toolbar for the mouse functionalities (**Navigate**, **Edit Voxels** and **Edit GAD Objects**), and to change the settings for the **Tooltip** shown for the structure.



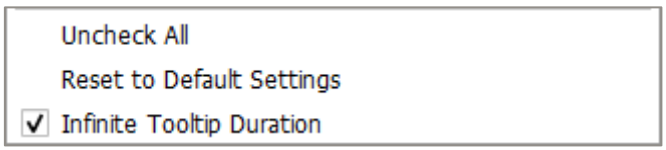
Choose which information should be shown for the position of the mouse pointer in the structure. For the position of a voxel, the coordinates can be shown in number of voxels in each direction (**Show Voxel Coordinates**) or as coordinates in length units with respect to the origin of the structure (**Show World Coordinates**).

Check **Show Voxel Material** to add the Material and Material ID information to the tooltip. Check **Show GAD Information**, to show the object type and Object ID of the GAD object the voxel belongs to (only shown if analytic object data is available for the structure).

Select **Show Volume Field Information (Visible Only)** or **Show Volume Field information (All)** to show the value of the currently selected volume field, or of all volume fields available, at the current position, if a volume field is loaded for the structure.



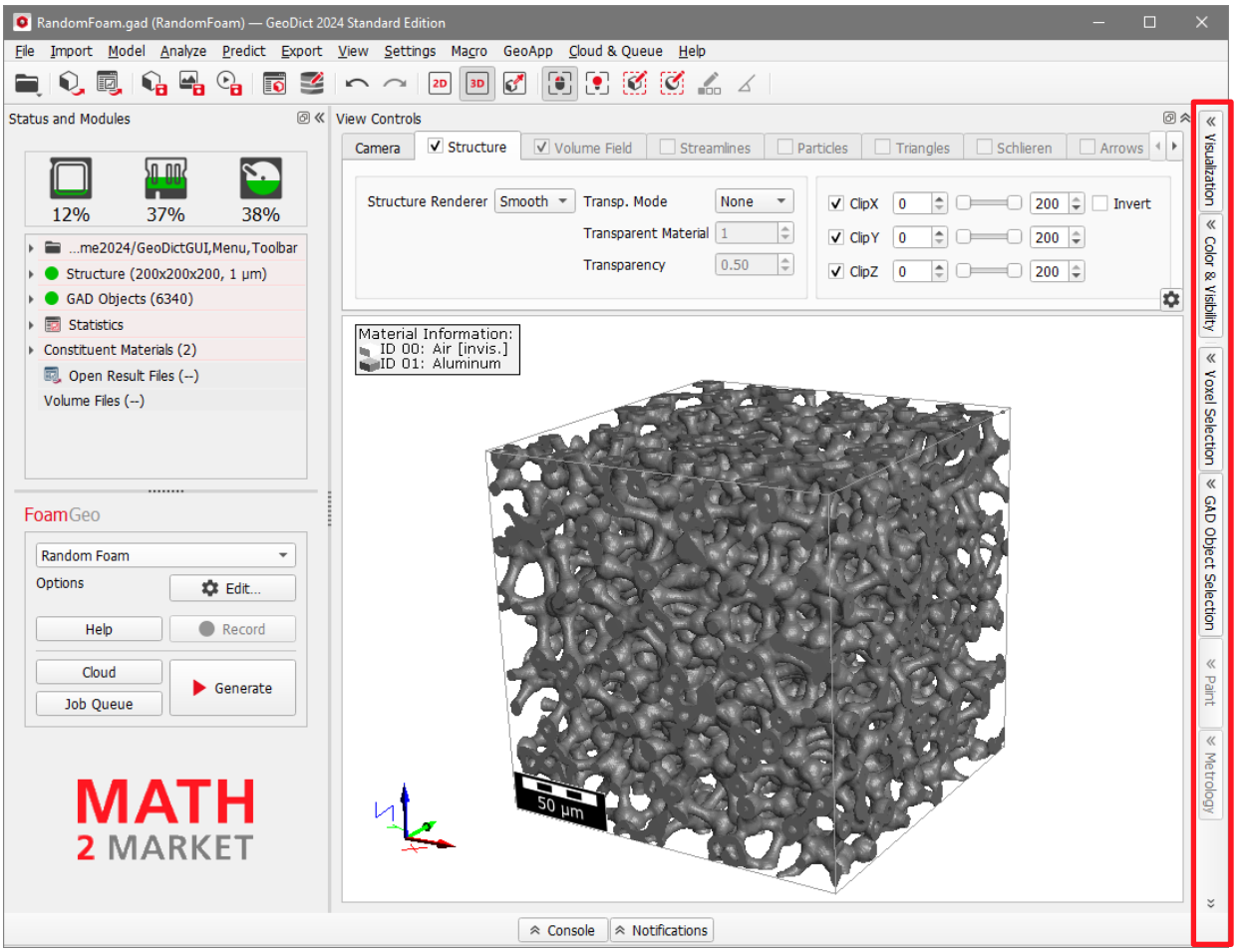
Use **Uncheck All** to deselect all boxes of the Tooltip options, or **Reset to Default Settings** to reload the GeoDict default settings for the tooltips.



Check **Infinite Tooltip Duration** to prevent the tooltip from vanishing after a few seconds.

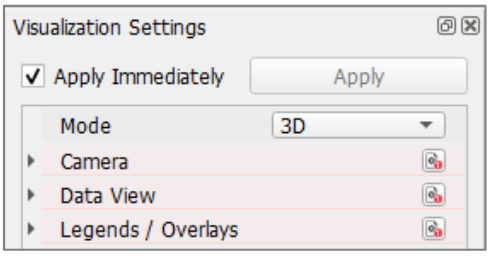
GUI Sidebar

Many functionalities for **Visualization**, **Color & Visibility**, editing and modifying on the voxel structure (**Voxel Selection**) or the analytic data (**GAD Object Selection**), modifying the material ID of selected voxels (**Paint)**, measuring distances and angles (**Metrology**) and saving the recently executed commands (**Session Macro)** are opened directly from the GUI sidebar.



Some tabs of the sidebar are hidden if GeoDict is not in full screen mode. Expand and collapse the sidebar by clicking on the icon at the bottom. Each dialog can also be expanded and collapsed by clicking on the icon at the top of the tab.

When expanded, the sidebar panel can be un-docked by clicking the icon at the top of the open panel and turned into a dialog that can be moved around.



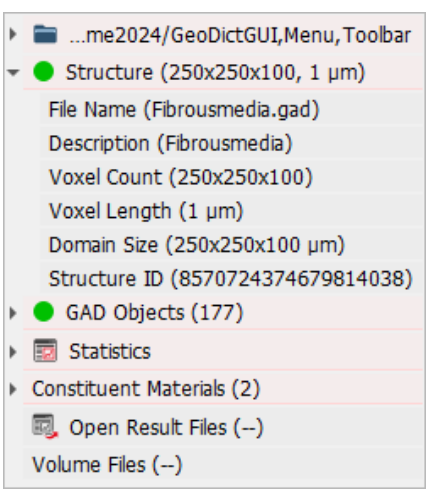
Information about the **Visualization** tab and the **Color & Visibility** tab from the GUI sidebar are described in detail in the Visualization handbook.

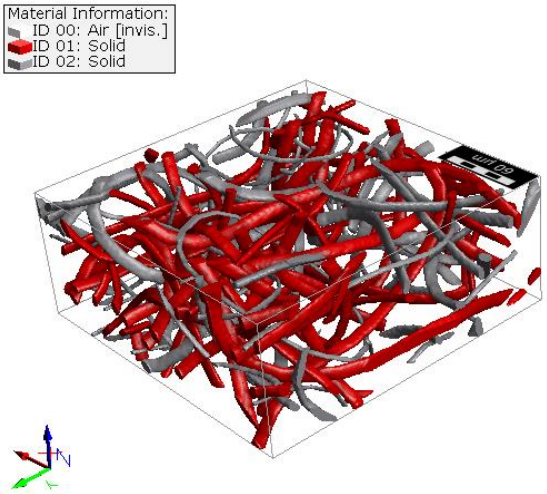
The **Session Macro** tab is explained in the GeoPy Scripting handbook.

The functionality of the tabs **Voxel Selection**, **GAD Object Selection**, **Paint** and **Metrology** is explained below.

VOXEL SELECTION

A voxel structure of a fibrous media model generated with FiberGeo is loaded (indicated by the green dot before Structure) and also analytical data fitting to the voxel data is available (indicated by the green dot before GAD Objects).

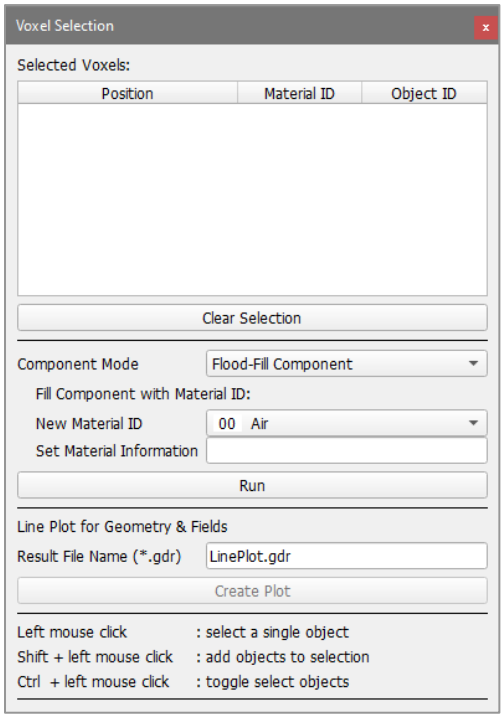


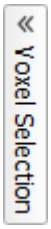


We now want to edit the structure by editing the voxels. The analytic object information will not be modified, and therefore the analytic object description in the model does not fit anymore to the loaded structure after editing. The initially green dot before **GAD Objects** turns yellow, if one of the operations listed below is applied.

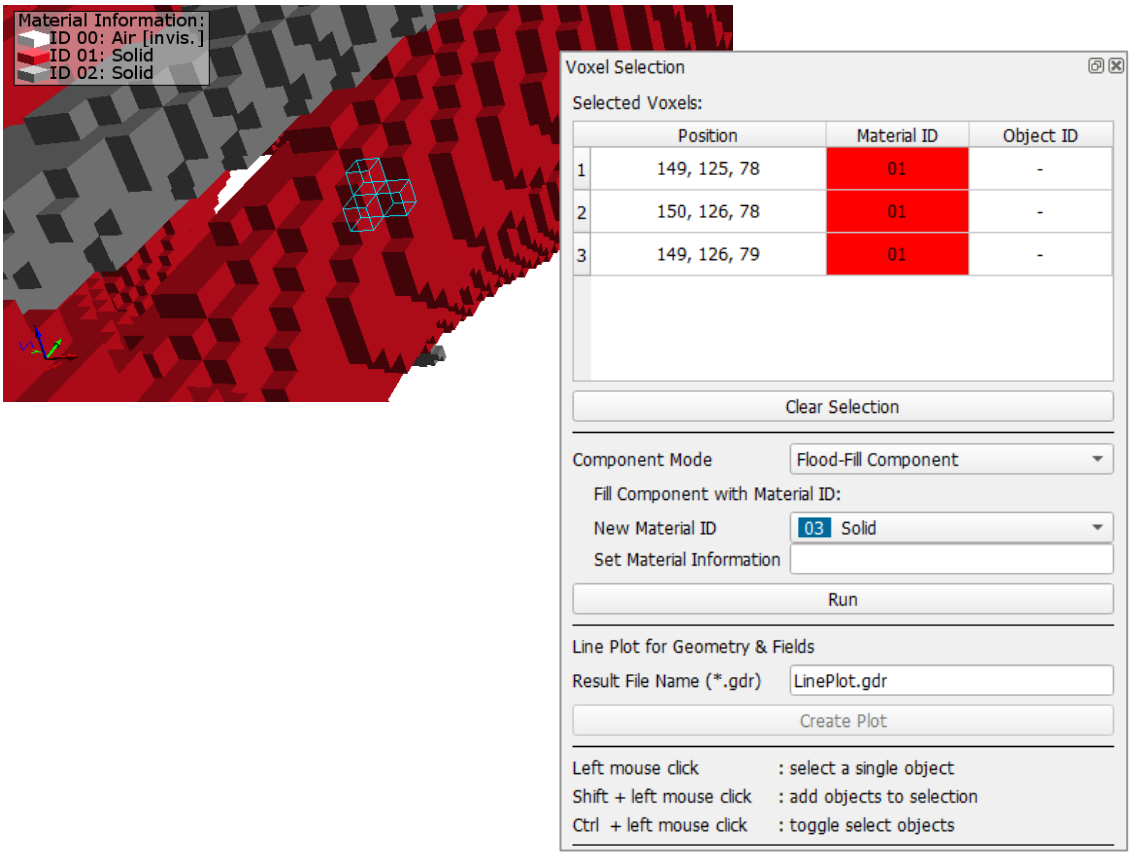
The voxels forming a fiber in the structure model are edited in 2D Cross Section (SEM) view or in 3D Rendering, as follows:

1. Select voxels:
   a. Zoom into the structure by pressing and holding the right mouse button while moving the mouse back and forth or scroll the mouse wheel.
   b. To enter the **Voxel Selection** mouse mode, click the  icon in the toolbar. This also opens the **Voxel Selection** dialog from the GUI sidebar.





c. Click on a voxel to select it. For several voxels, press and hold the Shift key on the keyboard while clicking the voxels. A cyan-colored frame appears at the edges of the selected voxel(s). At the same time, the parameters defining the voxel(s) (Position as X, Y, Z coordinates and Material ID) appear in a table in the **Voxel Selection** dialog.

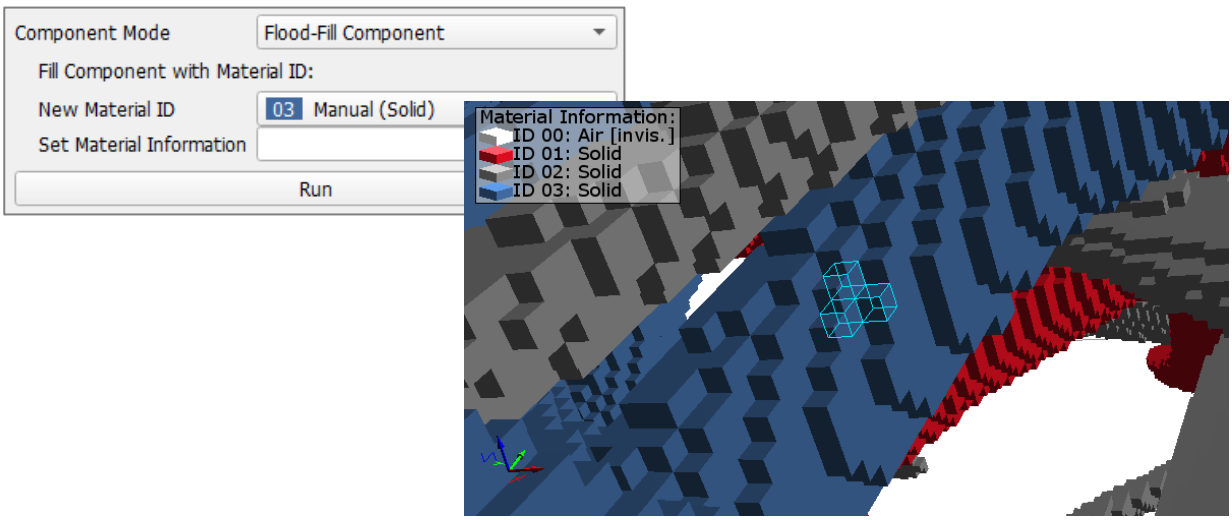


d. If a voxel is mistakenly selected, hold Ctrl and click again on that voxel.

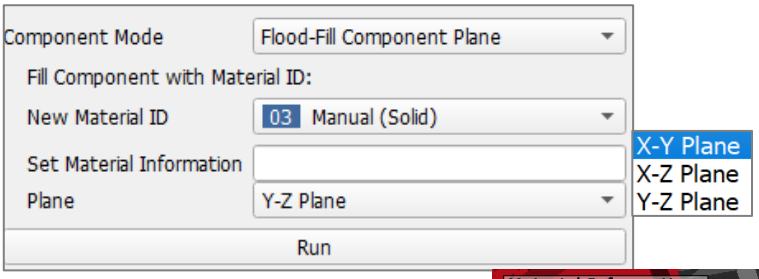
e. Clicking **Clear Selection** in the **Voxel Selection** dialog removes all voxels from the selection.

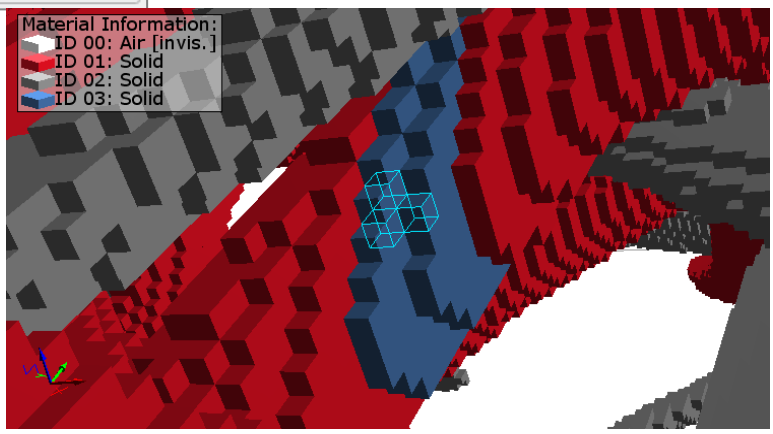
2. Edit voxels by selecting one of the **Component Mode** commands and clicking **Run**:

a. **Flood-Fill Component**: Fill the selected voxels and the components connected to them (see page 29) with a **New Material ID** chosen from the pull-down menu.

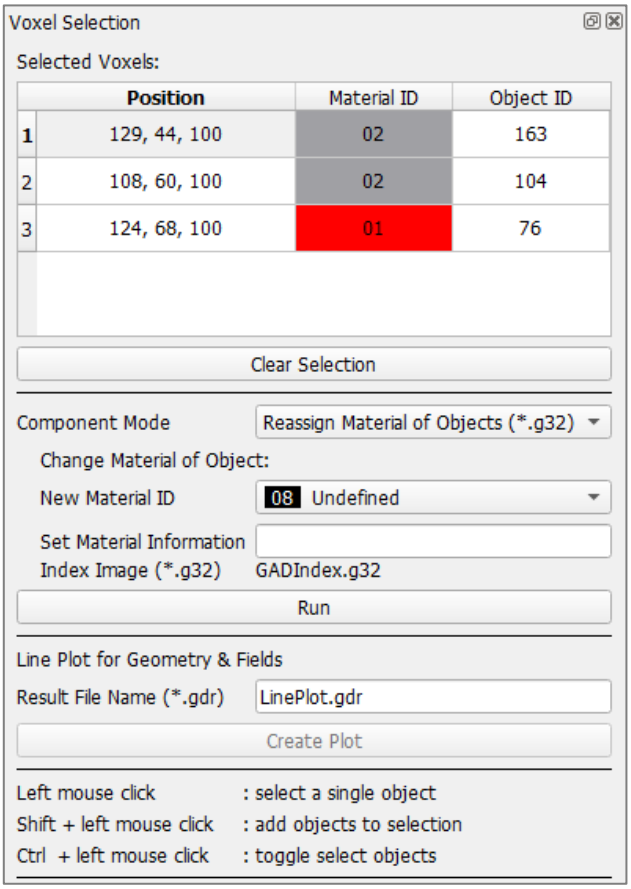


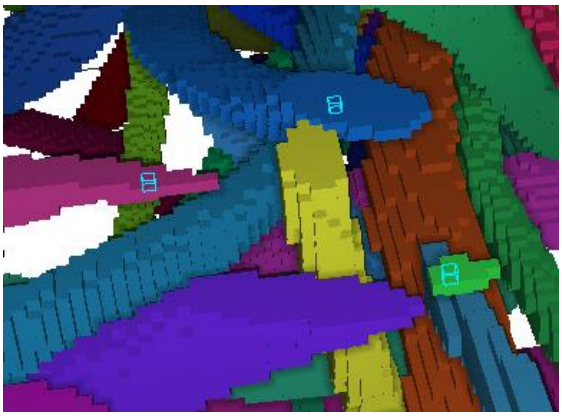
b. **Flood-Fill Component Plane**: Fill the selected voxels and the components connected to them with a **New Material ID** only in the **Plane** chosen from the pull-down menu.

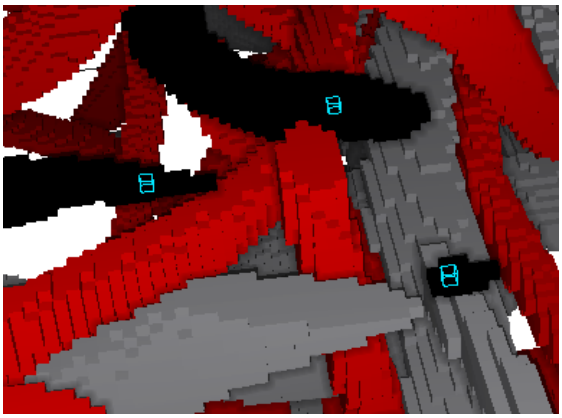




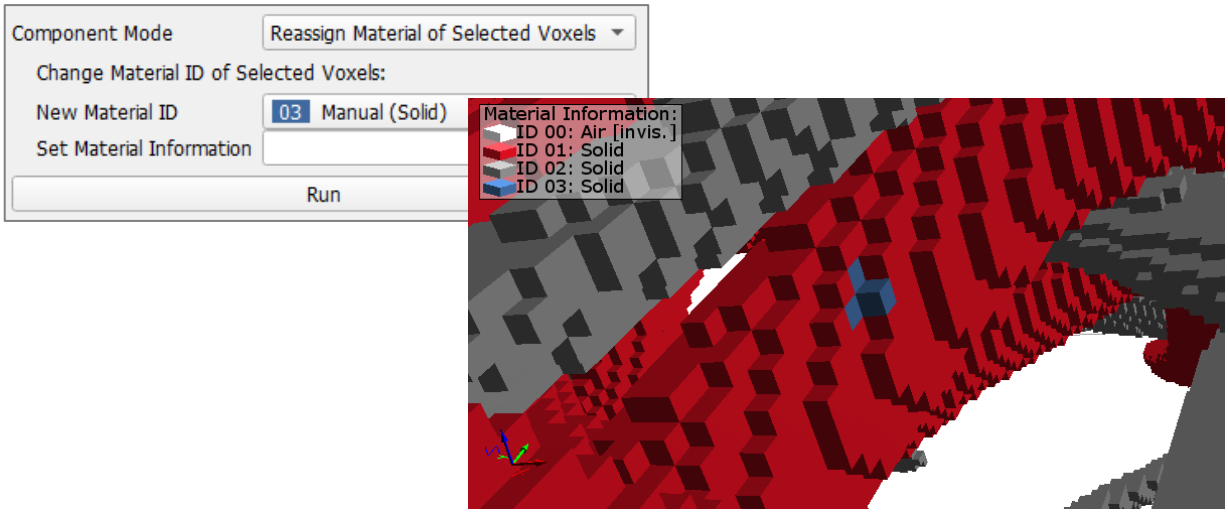
c. **Reassign Material of Objects (*.g32):** If a *.g32 file with object indices is loaded in the GeoDict GUI (e.g., created by right clicking on GAD Objects in the Project Status Section and selecting Create GAD Index Image, see page 46), the Object ID is additionally shown for each voxel selected. Select a **New Material ID** and click **Run**, to assign the new material to all voxels that belong to the same Object ID as the voxels selected (here Object IDs 76, 104 and 163).



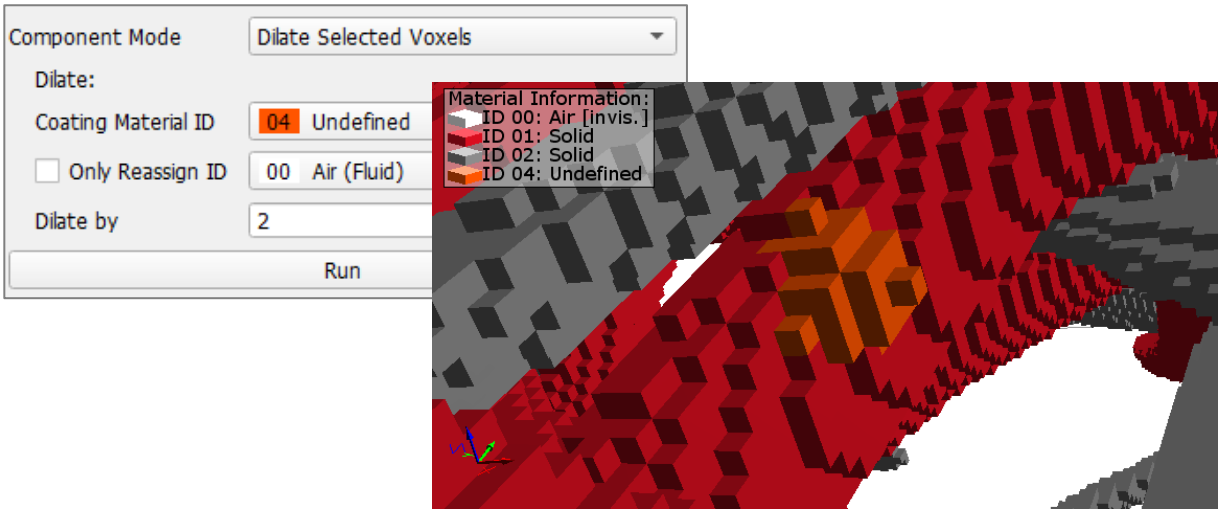




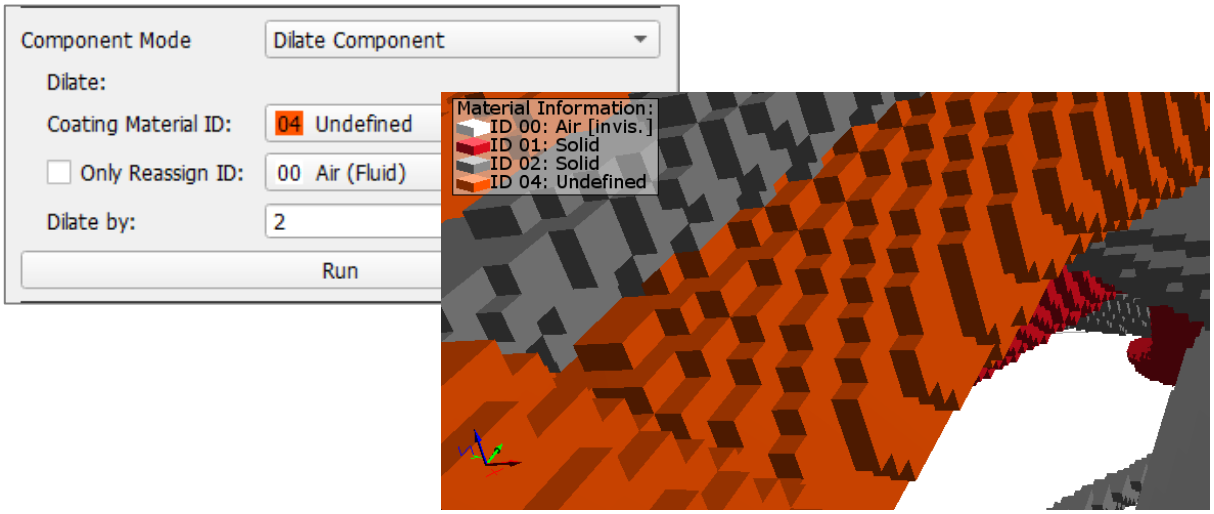
d. **Reassign Material of Selected Voxels**: The material ID of the selected voxels can be changed by selecting a **New Material ID** from the pull-down menu.



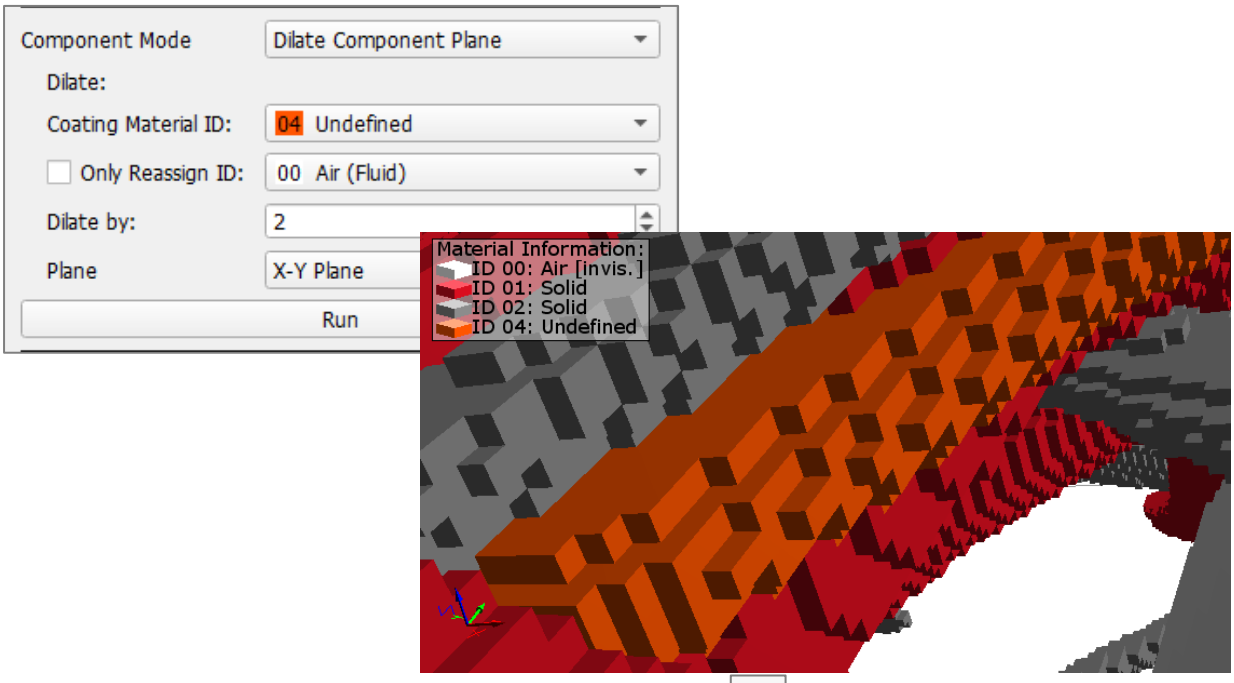
e. **Dilate Selected Voxels**: It is possible to dilate the voxels by coating them with another material chosen from the **Coating Material ID** pull-down menu by a certain number of voxels (**Dilate by**). An explanation for the dilate command can be found in the ProcessGeo handbook.



f. **Dilate Component**: Also possible is to dilate the selected voxels and the components connected to them with the **Coating Material ID** by a certain number of voxels (**Dilate by**).

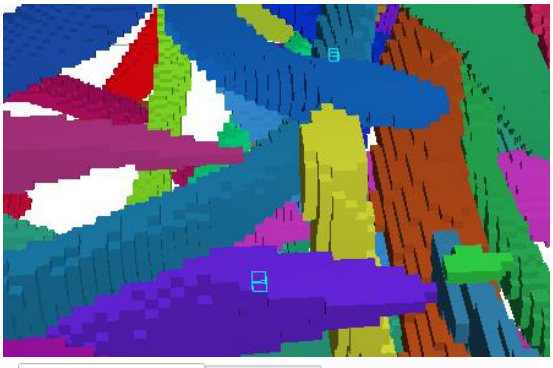


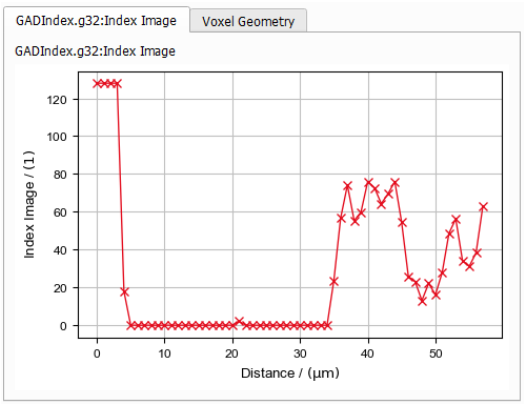
g. **Dilate Component Plane**: Dilate the selected voxels and the components connected to them only in the **Plane** chosen from the pull-down menu with the **Coating Material ID** by a certain number of voxels (**Dilate by**).

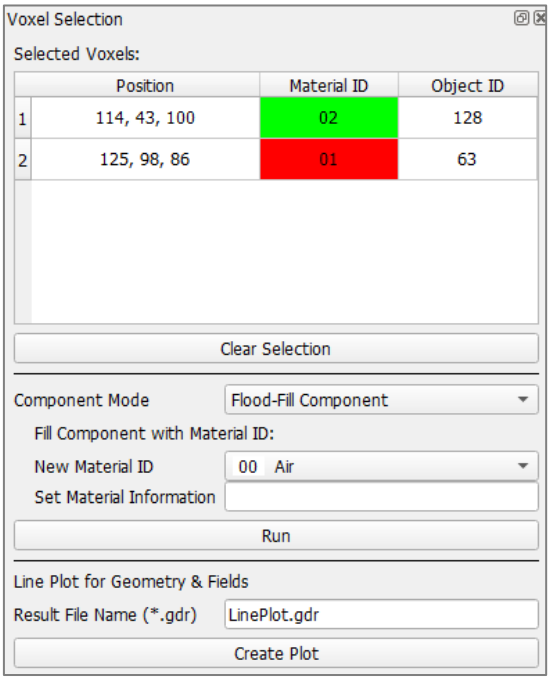


All these operations can be undone by clicking the  icon in the toolbar or CTRL+Z.

3. Select exactly two voxels to create a **Line Plot for Geometry & Fields**. This will gather information on the structure along the straight line between the two selected points. After entering a **Result File Name**, click on **Create Plot**. Then, the Result Viewer opens and shows in the Report tab the start and end point of the line in X-, Y- and Z-coordinates as well as the length of the line. For each loaded volume field the minimal, maximal and mean value on the line is stated. In the Plots tab, the Material IDs along the line are plotted over the distance from the starting point in the **Voxel Geometry** subtab. Each volume field has its own subtab with a plot of the field values on the line over the distance.

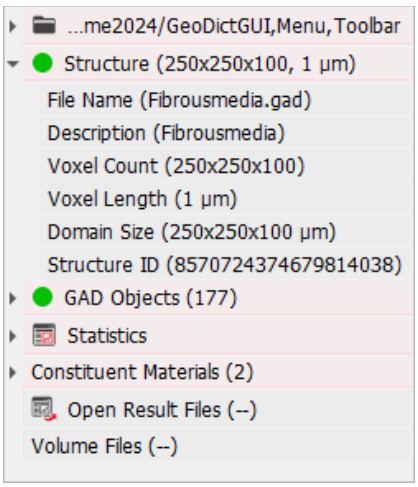






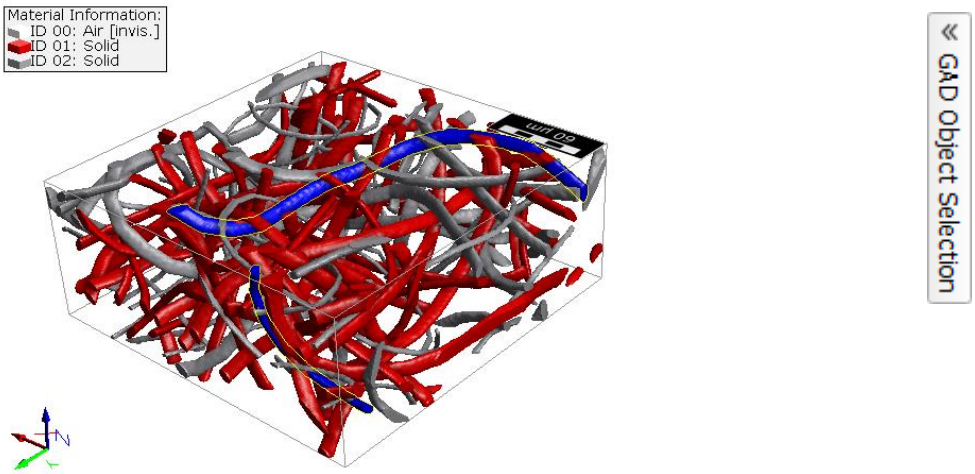
GAD Object Selection

The same fibrous media model as in the section above is edited, but now the analytic objects are modified. This is possible if a structure in GAD format is loaded, or a structure in GDT file format with analytic object information contained in the GDT file. The information that appears in both cases in the **project status** section, is equivalent.



In contrast to editing the voxel structure, editing the analytic objects preserves the analytic object information in the file.

The analytic objects (fibers) in this fibrous structure model can be edited, while visualizing the material model in 2D Cross Section (SEM) view or in 3D Rendering, as follows:



1. Select analytic objects:
   a. To enter the **GAD Object Selection** mouse mode, click the icon in the toolbar. This also opens the **GAD Object Selection** dialog from the GUI sidebar.
   b. Click on a GAD object to select it. For several objects, press and hold the Shift key on the keyboard while clicking the objects. The selected object(s) appear(s) highlighted.
   c. The table in the **GAD Object Selection** dialog shows the **ID** number and the **Object Type** of the selected GAD object.

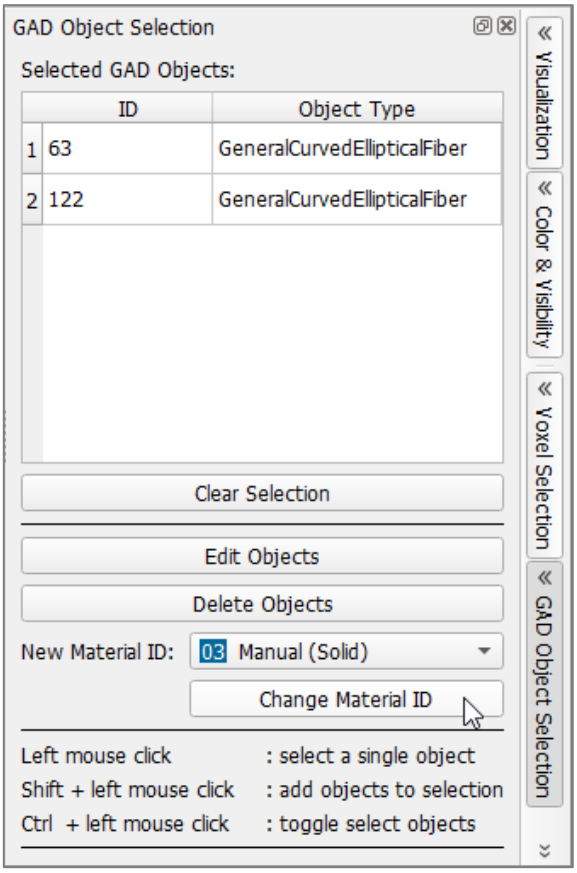
d. If an object is mistakenly selected, press and hold the CTRL key and click on the object again.

f. Clicking **Clear Selection** in the **GAD Object Selection** dialog removes all objects from the selection.

2. Edit analytic objects:

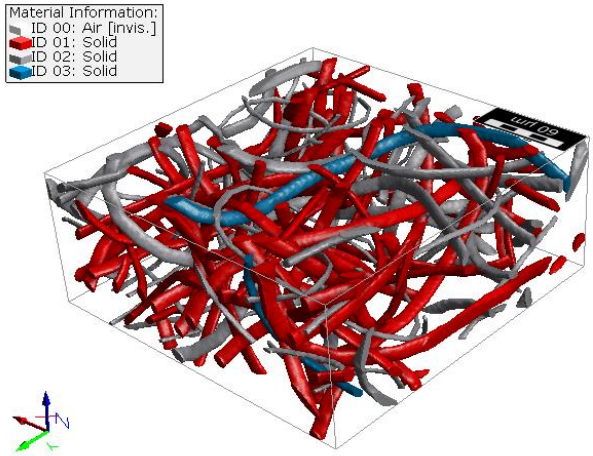
a. When clicking **Delete Objects**, all selected fibers, which are listed in the table, are deleted and taken out from the structure model.

b. **Change Material ID:** The material ID of the selected objects can be changed by selecting a new material ID from the pull-down menu and clicking **Change Material ID**.



The selected fiber(s) still appear(s) highlighted (and perhaps makes it difficult to see the change in the material) until the user clicks **Clear Selection**.

Now the fibrous structure model contains fibers of three different materials.



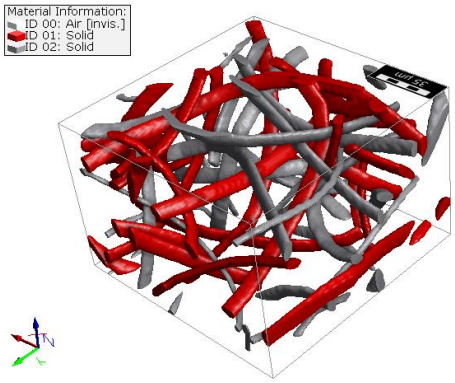
It is also possible to **Edit Objects** in a dialog which looks similar to the GadGeo **Edit GAD Objects** dialog, but it contains only the chosen GAD Objects. With a double click or right click on one of the selected objects in the table the Edit menu for only this object can be opened. The GadGeo handbook describes how the GAD Objects can be edited.

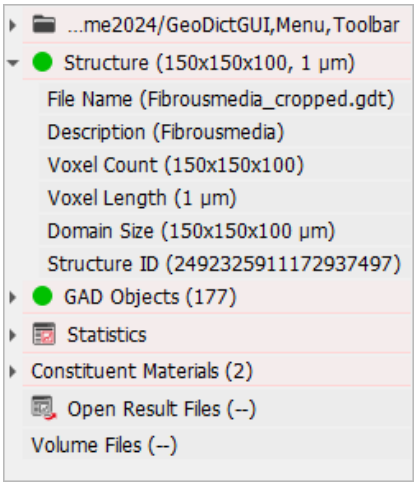
PAINT

The **Paint Mode** editing works in a way similar to the Windows standard editor **Paint**. Editing is always done in 2D (View → 2D Cross-Section (SEM)) and the effects can be seen later in 2D as well as in 3D (View → 3D Rendering).

The **Paint Mode** places GAD Objects with the shape chosen in Brush Mode into the structure. After painting, these GAD objects can be modified, e.g. as shown before on page 74. Thus, using the paint mode on a structure with analytic object information changes the analytic data. After editing in the paint mode, the changed structure must be saved to store the modifications.

As an example, a fibrous media model is edited with **Paint Mode**.





The **Paint** mode is used as follows:

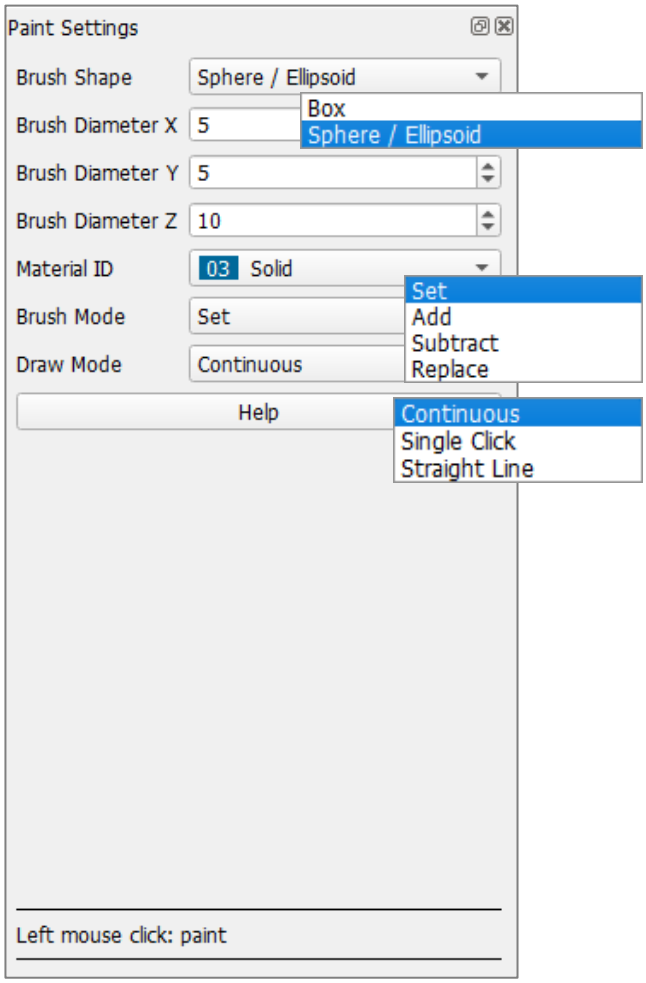
1. Select **View** → **2D Cross-Section (SEM)** in the menu bar or click the 2D icon in the toolbar.

   In the Visualization panel, above the Visualization area, click the Camera (Y, Z) tab and use the **Direction** pull-down menu and the **Slice** slider to navigate to the location where the editing should take place. Here, direction Z and slice 90 is selected.

2. Click the **Paint** tab on the GUI sidebar to open the **Paint Settings** dialog. The Paint mouse mode is activated with the  icon from the toolbar, which also opens the paint settings dialog. The **Paint** tab is greyed out and not accessible when the structure is viewed in 3D rendering.

3. In the opening **Paint Settings** dialog, editing is done using the cursor as a brush. Make sure, that the  icon is selected, so that the brush is active! The shape of the brush is set in the **Brush Shape** pull-down menu and the size in the **Brush Length (Diameter) X**, **Brush Length (Diameter) Y** and **Brush Length (Diameter) Z** boxes. The brush size is given in voxels.

   The brush shape can be a **Box**, with the side lengths entered in Brush Length X, Y, and Z, or a **Sphere** / **Ellipsoid** with the diameters entered in Brush Diameter X, Y, and Z. The shape and size of the brush will be the shape and size of the GAD objects that you paint in the structure.

   The Material ID of the material to draw with is chosen from the **Material ID** pull-down menu.

   The choice of **Brush Mode** in the pull-down menu determines the working technique for the brush. With **Set**, the original material ID of the painted voxels is replaced by the selected material ID. With **Add** and **Subtract**, the chosen material ID is bit-wise added to or subtracted from the original material ID. Use **Replace**, to select a **Replace ID**. Only the Replace ID is changed to the new material ID. Read more on the brush modes below on page 80 ff.).

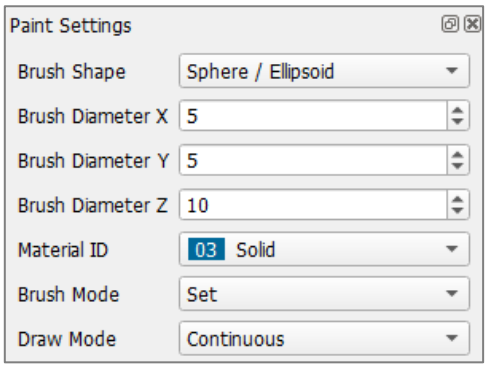
   The Draw Mode defines whether the brush stroke is applied for **Continuous** drawing, for a **Single Click** or for drawing a **Straight Line**.

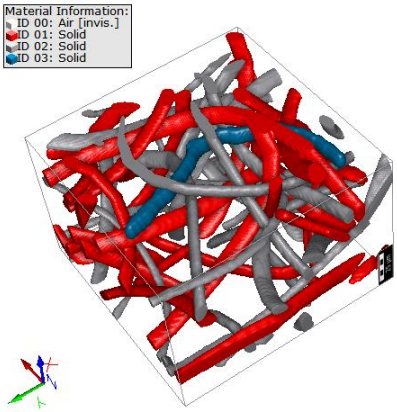
4. The brush strokes, in the selected shape, size, and Material ID (here Sphere (Ellipsoid), diameter 5 x 5 x 10 voxels, Material ID 03), are applied by pressing and moving (for **Continuous Drawing** and **Drawing Straight Lines**) and by clicking (for **Single Click Drawing**) with the left mouse button in the desired position.

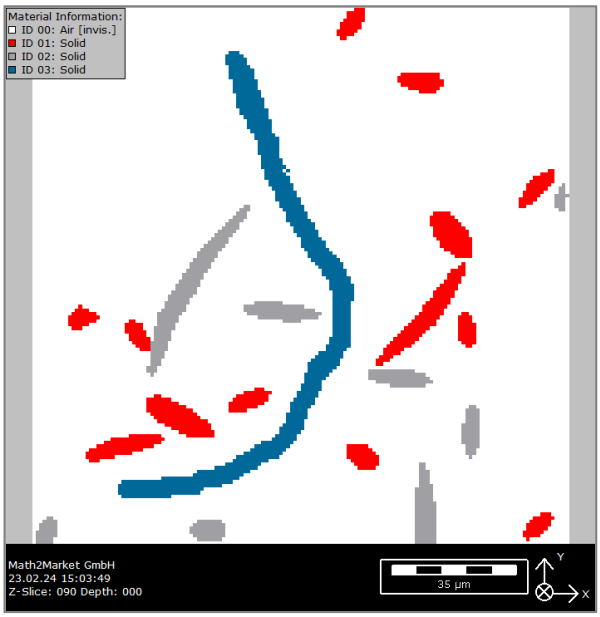
   Paint at different spatial locations by selecting a different **Direction** (X, Y, or Z) and/or a different **Slice** in the View Controls panel, above the Visualization area.

Draw Modes

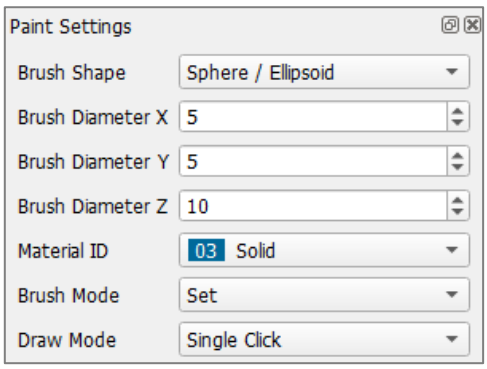
For **Draw Mode Continuous**, press the **left mouse button** while dragging the mouse.

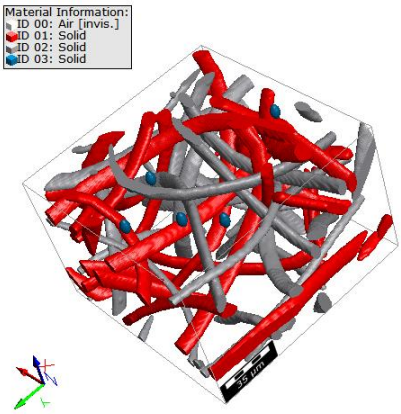


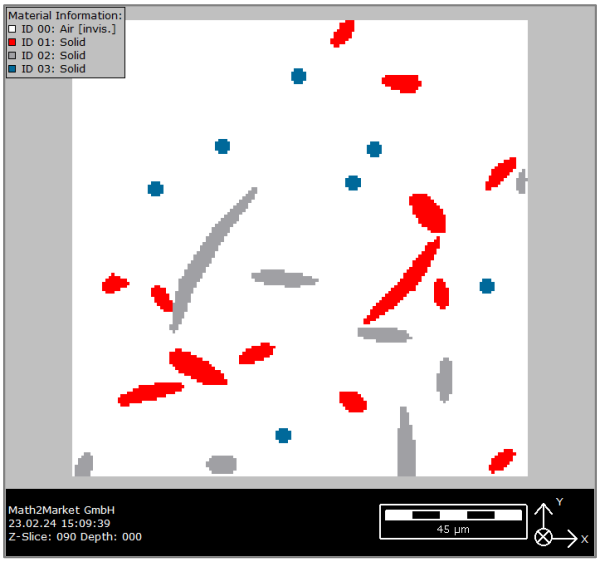




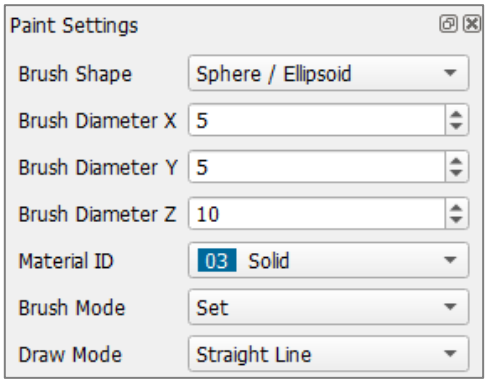
Use **Draw Mode Single Click** by clicking the left mouse button in different locations of the 2D view of the structure model. The effects of editing (in 2D view) are observed as soon as the left mouse button is released. You can also switch to 3D rendering to see and control the changes made.

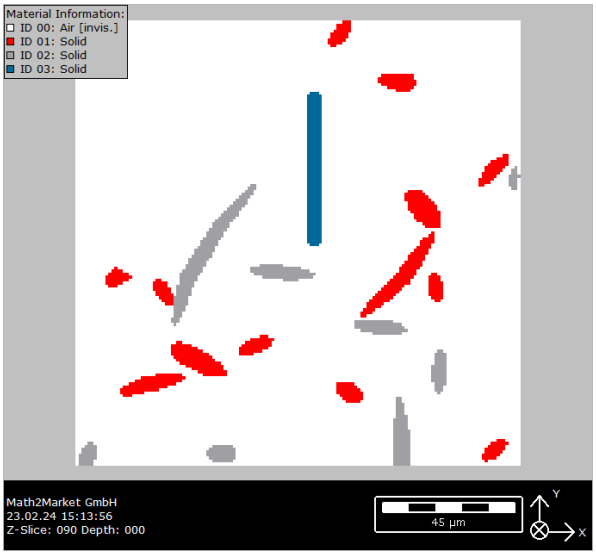


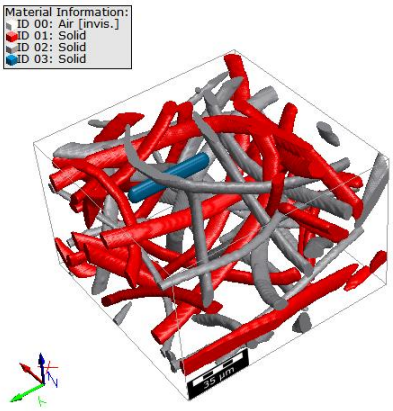




Use **Draw Mode Straight Line** by clicking the left mouse button and drawing the line to the desired end point while holding the mouse button clicked.



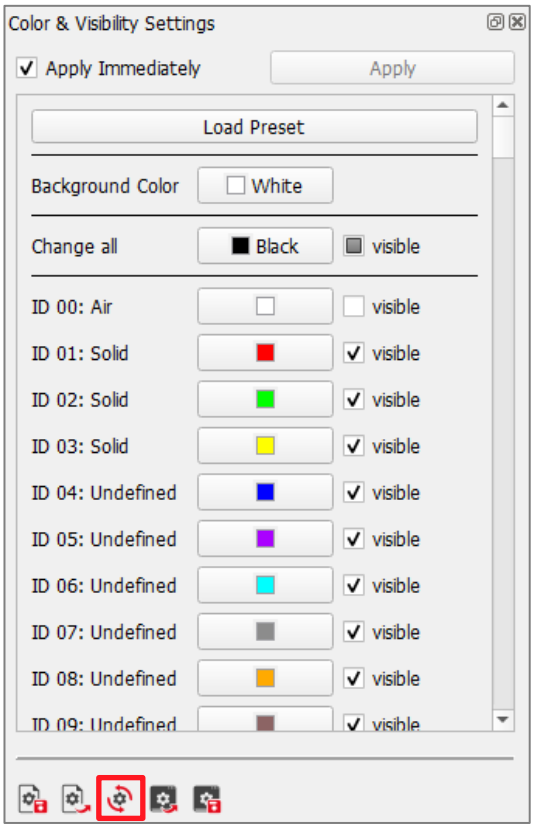




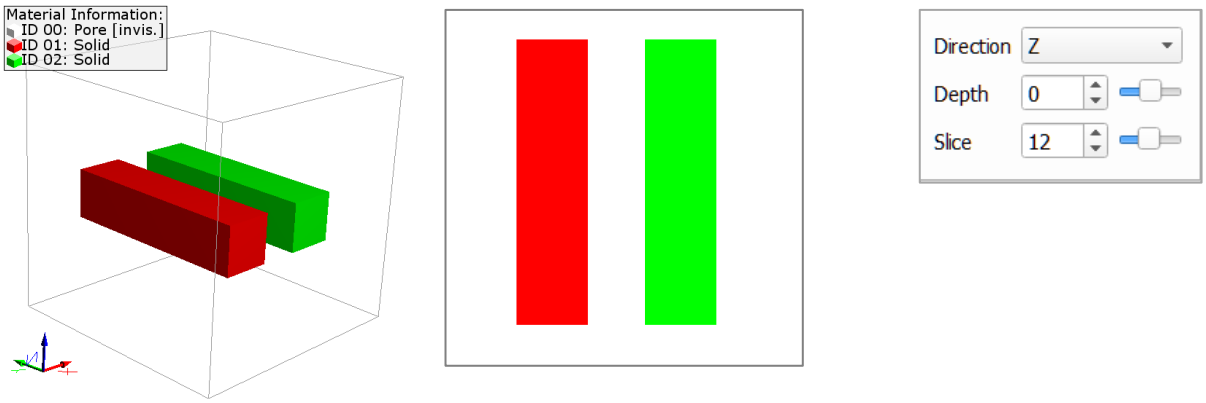
Brush Modes

While painting in the structure different material intersections occur, where the material ID is changed in different ways. This is shown in the next example. To better observe material intersections, the GeoDict built-in red-green-yellow-blue color scheme is used.

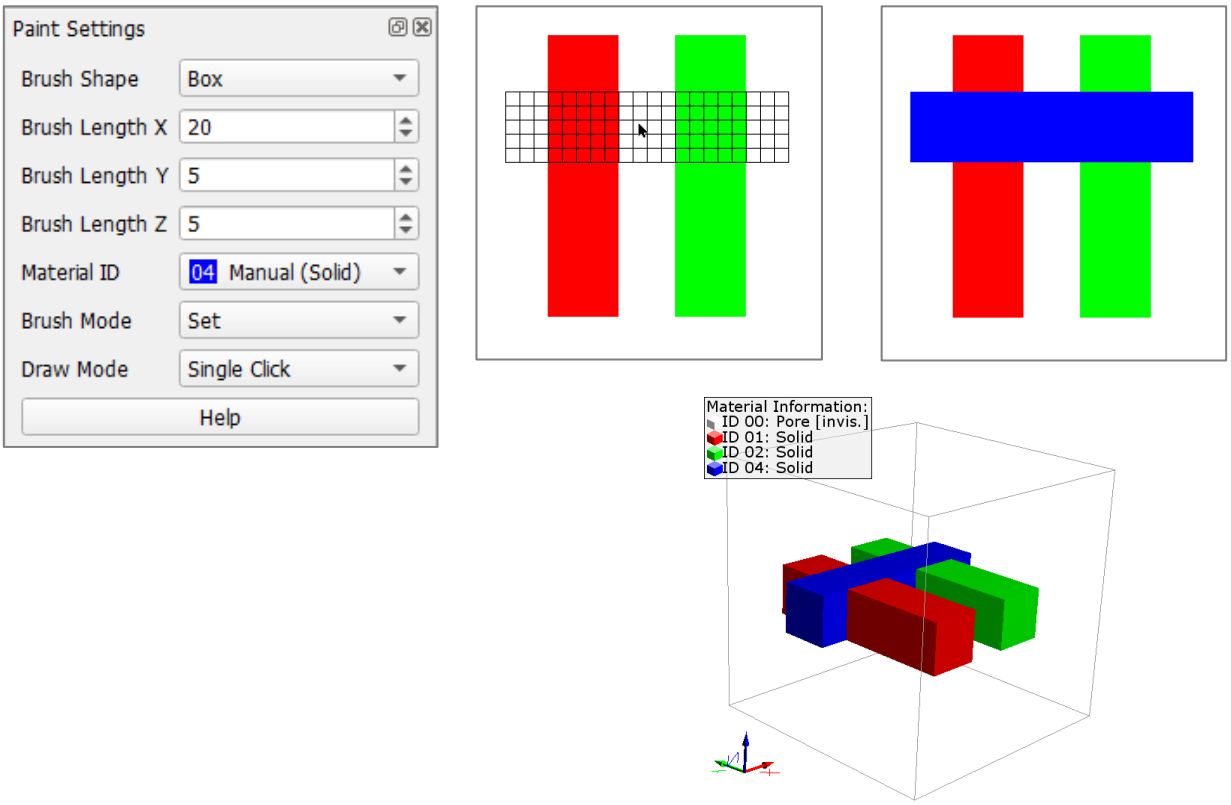
This color scheme is obtained by selecting **Settings → Color & Visibility Settings...** and clicking the  icon at the bottom of the dialog (**Load built-in default settings**).



For this example, two slabs were created with 5x20x5 voxels each. The painting is done in the X-Y-plane on slice 12.

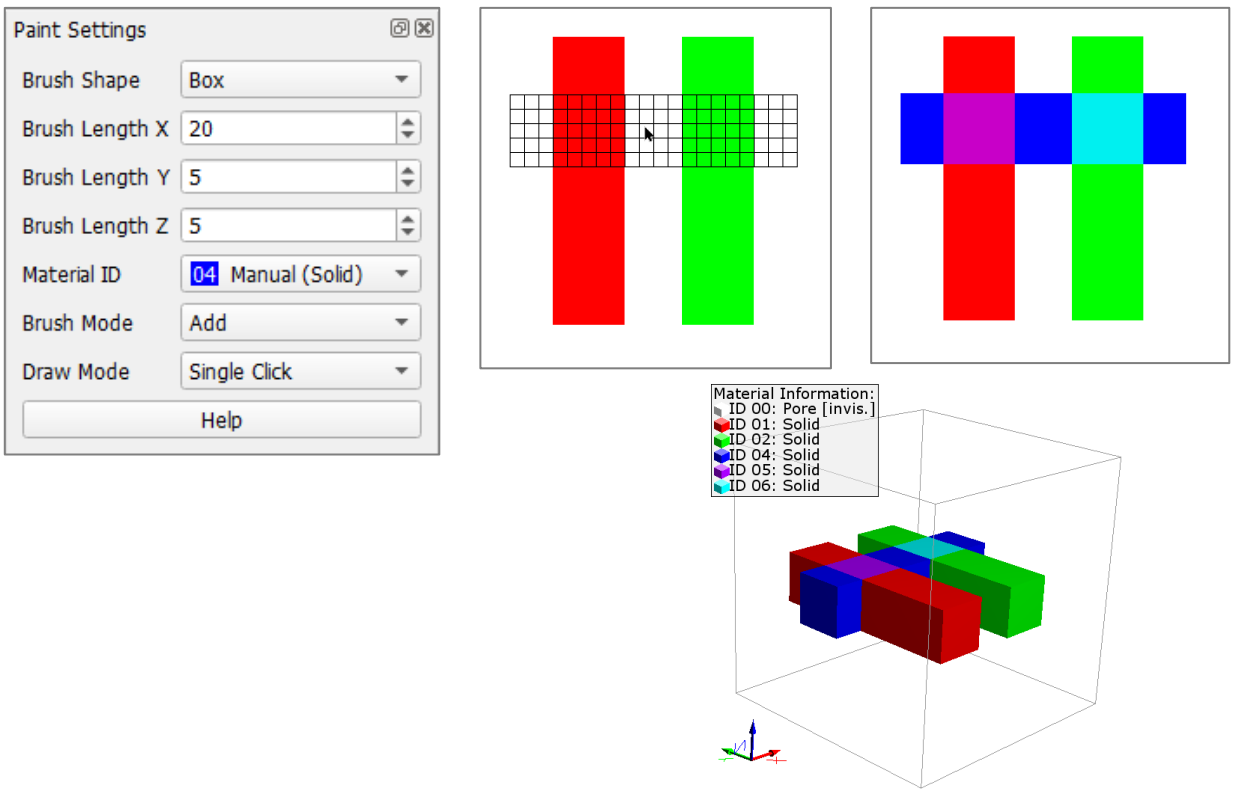


In **Set** mode, all original material IDs are set to the chosen Material ID. The replacement of material is clearly seen in 3D rendering:

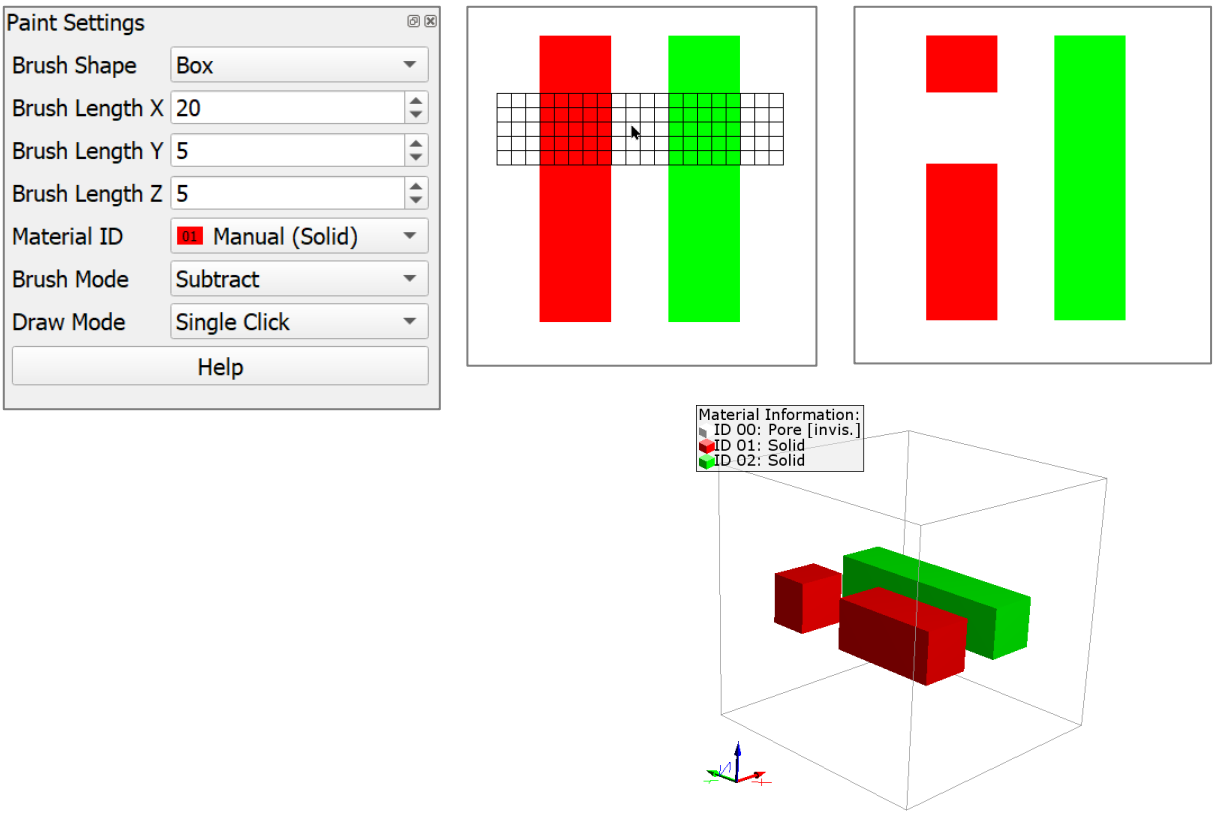


In **Add** mode, the selected Material ID does not replace the original material ID of the painted voxels, but an intersecting material is built. The new material ID is determined by bitwise adding the paint material ID to the material ID of the painted voxels.

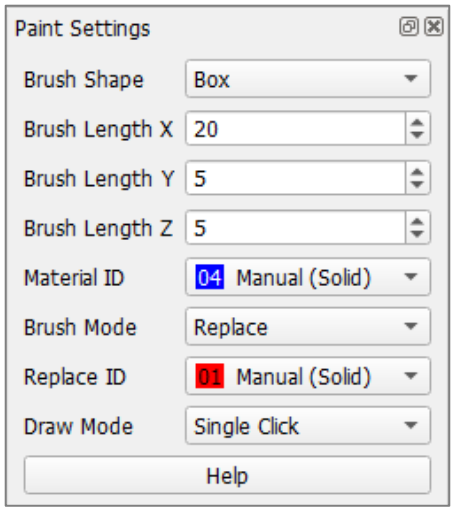
According to GeoDict's rules on defining new material IDs for intersecting materials (see below on page 83), adding voxels of material ID 04 (blue) to material ID 01 (red) results in intersected voxels of material ID 05 (violet-colored). Material ID 04 added to material ID 02 (green) results in intersected voxels of material ID 06 (cyan-colored). And Material ID 04 added to Material ID 00 (porous space) results in Material ID 04. The intersecting materials are also shown below in 3D rendering.

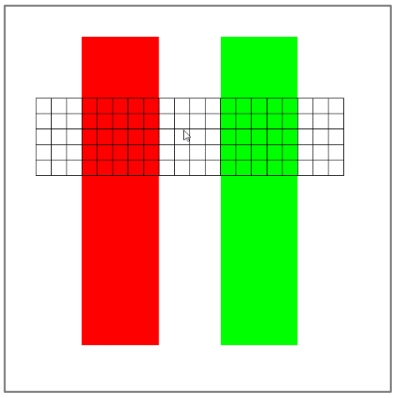


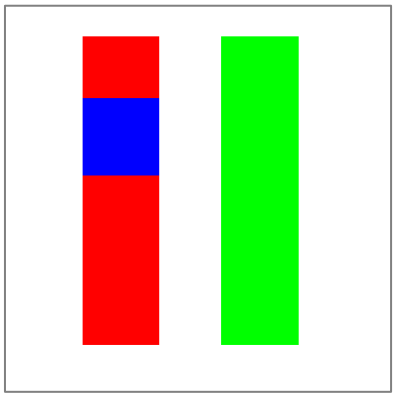
In **Subtract** mode, the selected Material ID is bit-wise subtracted from the existing structure where the brush is applied (see below page 83).

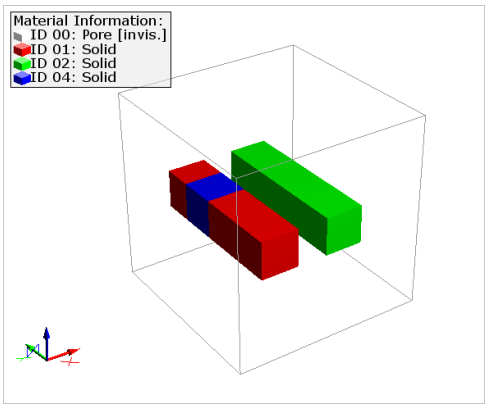


In **Replace** mode, the selected Material ID replaces only voxels with the Replace ID. Other Material IDs are unaffected by the modification. With the settings shown only voxel of material ID 01 replaced by material ID 04.









Intersecting Material IDs for Add and Subtract Modes

With the GeoDict built-in color settings, 256 Material IDs are available.

In **Add** and in **Subtract** edit mode, when two materials are added or subtracted, the Material ID of the addition or the subtraction is given by adding or subtracting the binary codes corresponding to the Material IDs. The used calculation rules are shown below.

Binary addition rules				
1	+	1	=	1
1	+	0	=	1
0	+	1	=	1
0	+	0	=	0

Binary subtraction rules				
1	-	1	=	0
1	-	0	=	1
0	-	1	=	0
0	-	0	=	0

The addition or subtraction of Material IDs is done column-wise, as follows:

0	0	0	1	01
+	+	+	+	+
0	0	1	1	03
=	=	=	=	=
0	0	1	1	03

0	0	0	1	01
-	-	-	-	-
0	0	1	1	03
=	=	=	=	=
0	0	0	0	00

Examples of Material ID and binary codes of intersection materials obtained by **adding**:

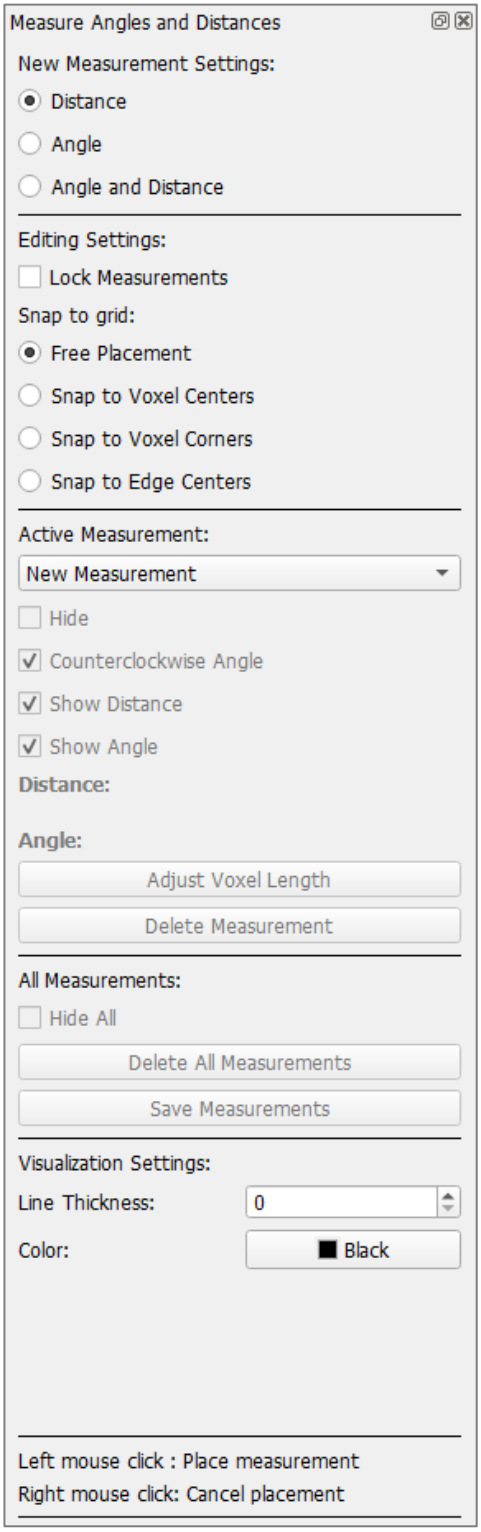
First material		Second material		Intersection material	
Material ID	Binary code	Material ID	Binary code	Material ID	Binary Code
02	0010	04	0100	06	0010 + 0100 = 0110
03	0011	04	0100	07	0011 + 0100 = 0111
03	0011	05	0101	07	0011 + 0101 = 0111
05	0101	01	0001	05	0101 + 0001 = 0101

Examples of Material ID and binary codes of intersection materials obtained by **subtracting** are:

First material		Second material		Intersection material	
Material ID	Binary code	Material ID	Binary code	Material ID	Binary code
01	0001	01	0001	00	0001 – 0001 = 0000
05	0101	02	0010	05	0101 - 0010 = 0101
02	0010	01	0001	02	0010 - 0001 = 0010
04	0100	01	0001	04	0100 – 0001 = 0100

METROLOGY

With the **Metrology** functionality, distances and angles can be measured in the 2D View of a structure.



Select **View** → **2D Cross Section (SEM)** in the menu bar. Click the **Metrology** tab on the GUI sidebar to open the **Measure Angles and Distances** dialog. The measurement mouse mode is activated with the icon from the toolbar, which also opens the Measure Angles and Distances dialog. The **Metrology** tab is greyed out and not accessible when the structure is viewed in 3D rendering.

In the **Camera** tab of the View Control panel, choose the **Direction** (**X**, **Y** or **Z**) and the **Slice** of the structure for the measurement.

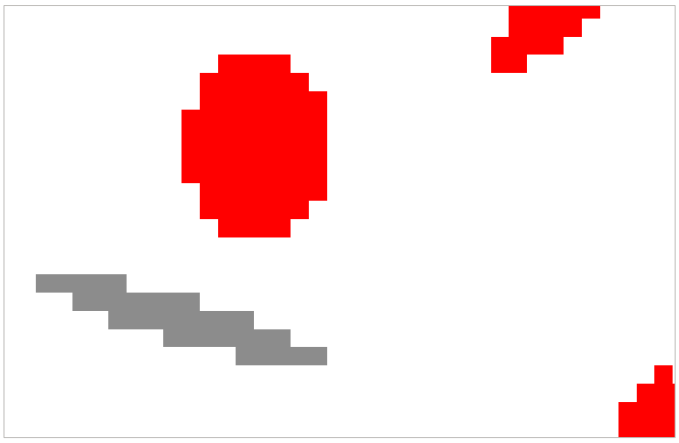
To start a new measurement, first select from the **New Measurement Settings** if a **Distance**, an **Angle** or **Angle and Distance** should be measured.

In the **Editing Settings** part of the panel, choose **Lock Measurements** to move the whole line of a measured distance and/or angle to another location. If **Lock Measurements** is unchecked, the end point of a measurement can be modified.

Next, in **Snap to grid**, define if points should be selected freely in the structure (**Free Placement**), or be snapped to the nearest **Voxel Centers**, **Voxel Corners**, or **Edge Centers**. This means that when you click into the structure the nearest voxel center, voxel corner, or edge center (depending on the selection) is set as starting point for the measurement.

In the **Visualization Settings**, choose the **Line Thickness** and **Color** for the visualization of the measurement. This can also be done after the measurements were conducted and it applies to all measurements. The font size of the measurements can be changed in the visualization settings sidebar.

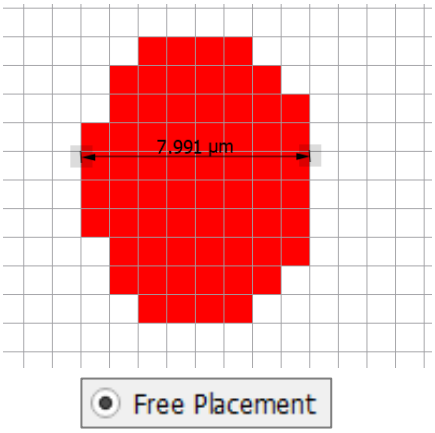
To start measuring, click with the left mouse button at the position where the measurement should be started and left-click again at the desired end point. If the measurement should be canceled, just click the right mouse button.

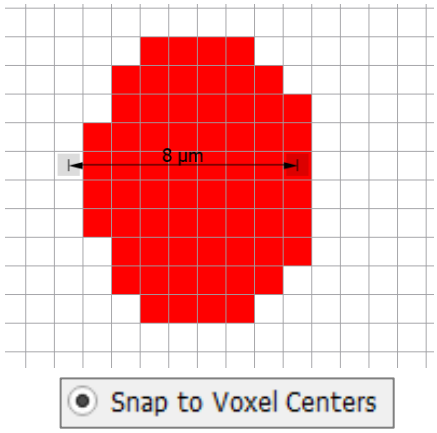


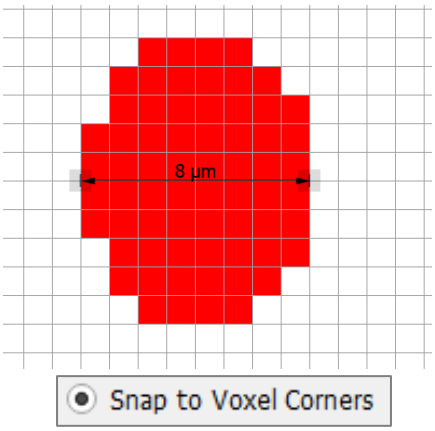
In the example shown here, the diameter of the red fiber in X-direction is measured.

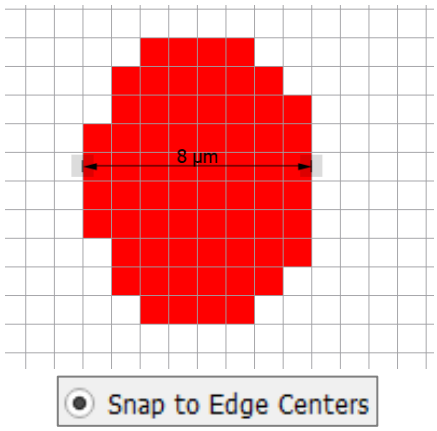
The differences between the snap options can be observed if the visibility of the grid is turned on.

Look at the start or end points of the measurements to detect the difference. If a Snap mode is active the measurements are more precise than placing the points by hand (Free Placement).





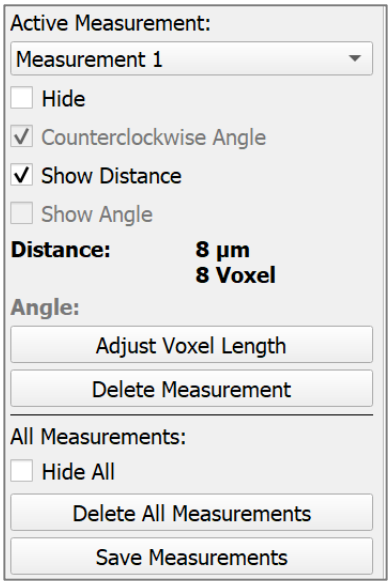




Each measurement gets a number and all of them are listed in the drop-down menu under **Active Measurement**. The last measurement is usually the active one, but you can choose a previous measurement from the list or by clicking on the endpoints of the measurement in the visualization area.

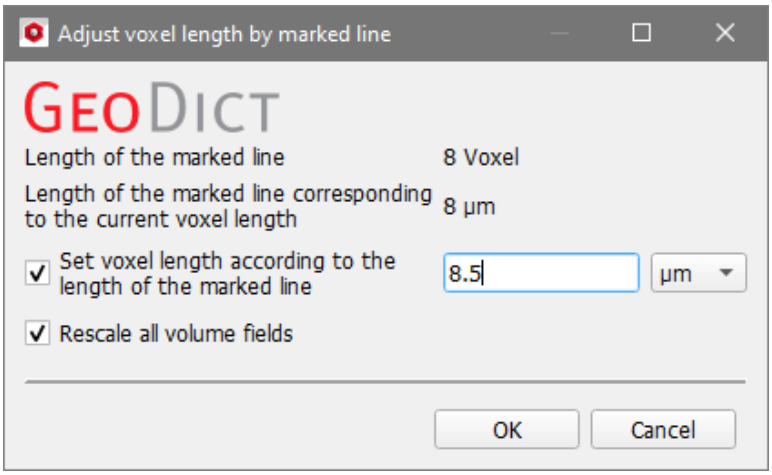
Below, the measured distance and/or measured angle is shown.

Check **Hide** to hide the measurement and the text in the visualization area, uncheck **Show Distance** to hide only the text of distance measurement, or uncheck **Show Angle** to hide the text of the measured angle. The angle is measured and shown counterclockwise, when **Counterclockwise Angle** is checked. Uncheck to switch measuring and visualization to **Clockwise**, there is no need to redo the measurement.



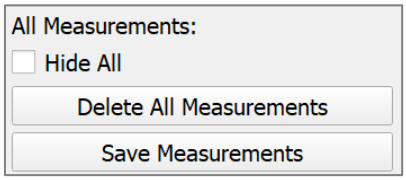
With **Delete Measurement**, the currently active measurement is deleted from the panel.

Clicking **Adjust Voxel Length** opens a dialog to change the voxel length of the structure accordingly to the measured distance. Enter the desired length of the measured line (in the example 8.5 µm instead of the 8 µm measured in Measurement 1) and click **OK**. The voxel length of the whole structure is rescaled to match the desired length. Check **Rescale all volume fields**, to rescale also the volume fields to the new voxel length.

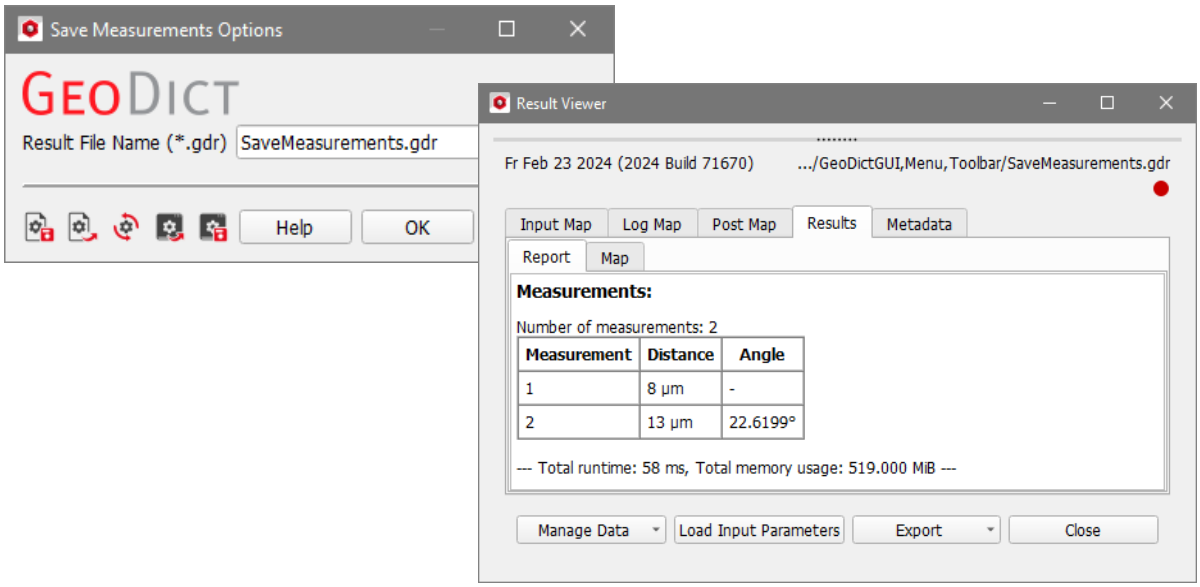


The old measurements remain in the structure and their metrical position is maintained. But due to the adjusted voxel length, the voxel position of the measurement changes.

In the **All Measurements** part of the panel, all available measurements can be hidden by checking **Hide All** or deleted with **Delete All Measurements**.

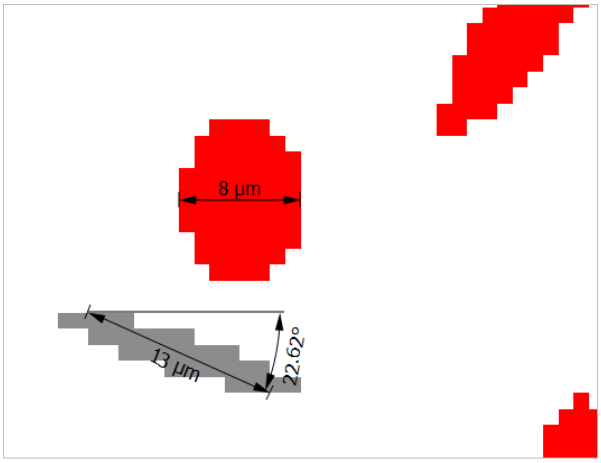


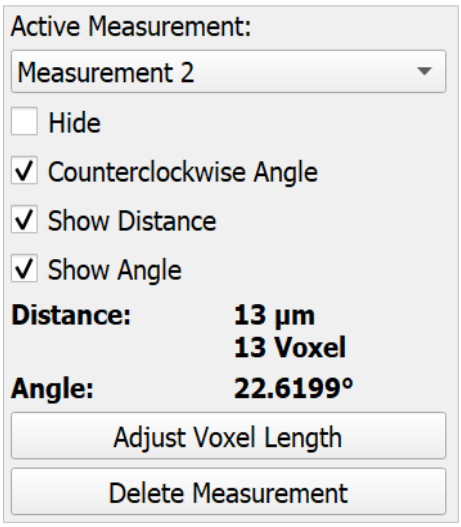
The measurements can also be saved in a *.gdr file by clicking **Save Measurements**. A dialog opens, where you enter the desired result file name.



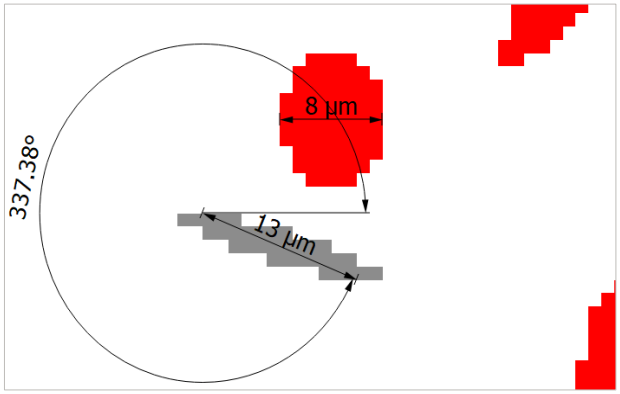
For the example we create a second measurement, this time measuring the length of the gray fiber segment and its angle to the X-axis. For this, set the options for this new measurement to **Angle and Distance**. As snap mode **Snap to Voxel Corners** was chosen.

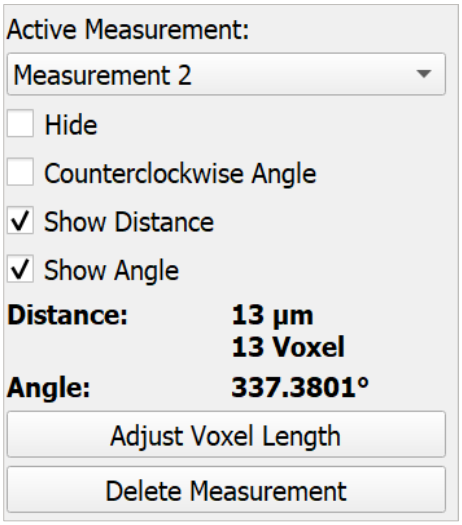
First, the desired distance is measured, then this measure line is taken as first angle leg, and the angle can be measured with a third click.



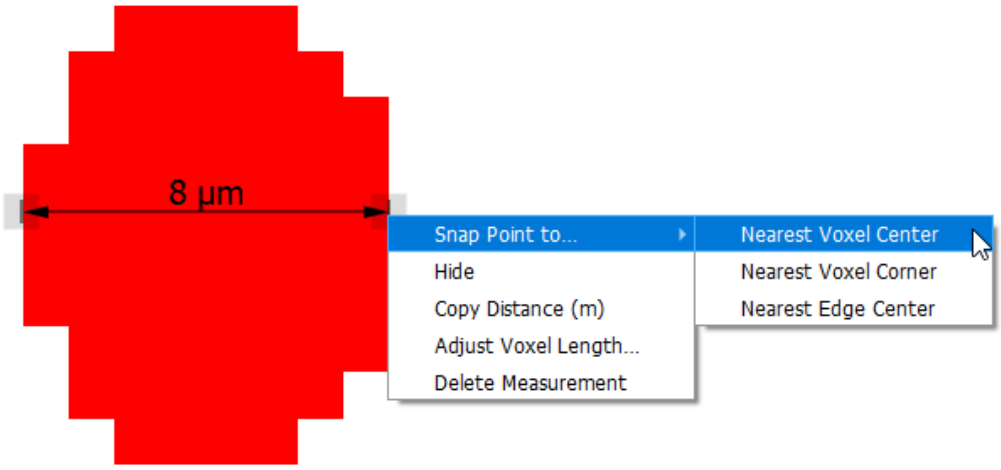


Unchecking **Counterclockwise Angle** changes the visualization and value of the measured angle.





Edit a selected measurement with a right click on one of the endpoints. The selected point can be snapped to the grid as explained above. The measured distance is adapted accordingly. The options Hide, Adjust Voxel Length, and Delete Measurement are the same as explained above. If needed, you can **Copy** the **Distance** in meters to the clipboard.

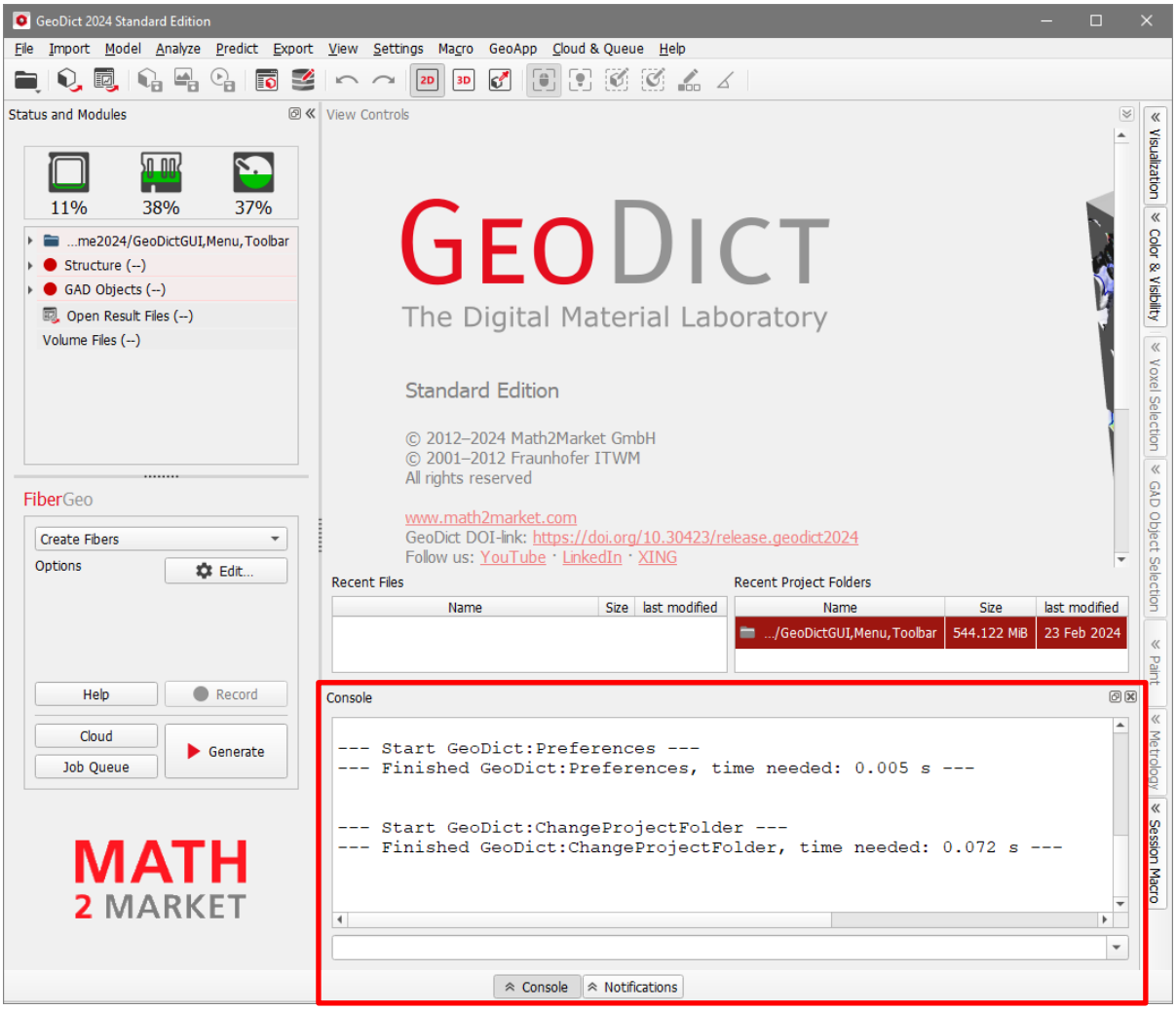

8 µm
Snap Point to...
Hide
Copy Distance (m)
Adjust Voxel Length...
Delete Measurement
Nearest Voxel Center
Nearest Voxel Corner
Nearest Edge Center

Console and Notifications

The console and notifications panels are located at the bottom of the GUI, under the visualization area. The **Console** panel is a textual GUI window and log viewer. The console allows you to read the system logs, help find certain ones, monitor them, and filter their contents. Additionally, you can enter and execute python commands directly in the console. For more details, see the GeoPy Scripting handbook.

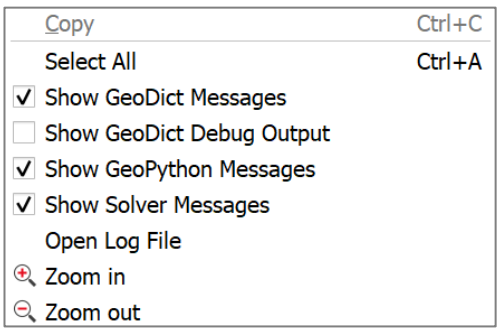
The console panel can be folded and unfolded by clicking on the Console icon.

When expanded, the panel can be un-docked and turned into a dialog that can move around. Undocking is done by clicking the icon, located at the top right after expanding. The console can also be closed by clicking on .



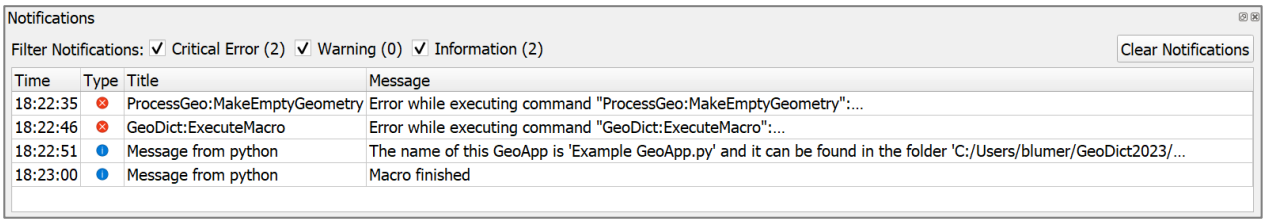
The **Notifications** panel can be opened and closed in the same way by clicking on the Notifications icon.

A right click in the console panel provides further options to filter and read the information displayed. Text in the console can be marked with the cursor and exported to another program by using **Copy**. With **Select All** the whole text in the console is marked.



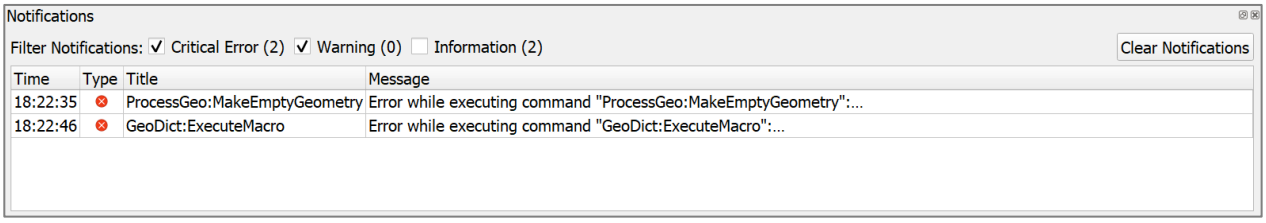
Check the boxes to **Show GeoDict Messages**, **Show GeoDict Output**, **Show GeoPython Messages** and **Show Solver Messages**. During each GeoDict session a log file, that contains all outputs from the console, is written and saved in %username&/geodict2024/log (Windows) or %username%/.geodict2024/log (Linux). With **Open Log File** it is opened in the chosen text editor (see page 26 ff.). Use **Zoom in** and **Zoom out** to enlarge or reduce the font size of the console.

Messages from GeoDict, which are shown in the console, are also shown in the **Notifications** panel.



The list shows the **Time**, when a message was raised, the icon shows the **Type** of the message, also the **Title** and the **Message** itself are given. The message is fully displayed in the tooltip, which opens when resting with the cursor over the message. With a right click in the corresponding field the title and the message text can be copied to the clipboard to save them e.g. in a text editor. This is helpful, when a message box was closed, and the user wants to re-read the message. Another advantage is, that you do not have to scroll through the console, where other output from GeoDict is listed.

With the filter options it is possible to show only **Critical Errors**, **Warnings** and/or **Information**. Click on **Clear Notifications** to delete all messages from the list.



https://doi.org/10.30423/userguide.geodict

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