User guide
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RENISHAW
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Renishaw QuantAM CLI implementation

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Contents

1 Types of CLI file 1
2 Opening a CLI file 1
2.1 Selecting CLI file type 1
2.2 Opening a CLI file with a material file already applied 2
2.3 Opening a CLI file with another CLI file already open 2
2.4 Opening multiple CLI files 3
3 Material file selection for CLI files 3
4 Material Viewer for CLI files 4
5 Support stage operations for CLI files 4
5.1 Display Slices for Slice CLI files 4
5.2 Import CLI supports for Slice CLI files 5
6 Build style selection for Scan Path CLI files 6
7 Scan path generation for CLI files 7
7.1 Slice CLI files 7
7.2 Scan Path CLI files 8
8 Appendix A: CLI import definition for QuantAM 9
8.1 CLI import restrictions 9
8.2 Non-standard interpretation of Scan Path CLI files 9
9 Appendix B: RenExposures in CLI files. 12
9.1 What is CLI RenExposure data? 12
9.2 RenExposure command description 12
9.2.1 ASCII Slice CLI file 12
9.2.2 Binary Slice CLI File 13
9.2.3 Size of Binary command description 13
9.3 Slice generation for CLI files with RenExposures 14
9.4 Restrictions on usage of RenExposures 14

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1 Types of CLI file

There are two types of CLI file supported in QuantAM:

1. **Slice CLI file:** each Slice CLI file can contain information for more than one part. It contains layer-wise slices for all the parts in the file.

2. **Scan Path CLI file:** each Scan Path CLI file contains information for only one part. The file contains layer-wise scan path data for that part. Each layer contains points co-ordinates for all the scan sections present in that layer. These sections can be either hatches or polygons.

2 Opening a CLI file

This section describes how to open or import a CLI file in QuantAM.

2.1 Selecting CLI file type

On importing a CLI file, you must specify the type of CLI file.

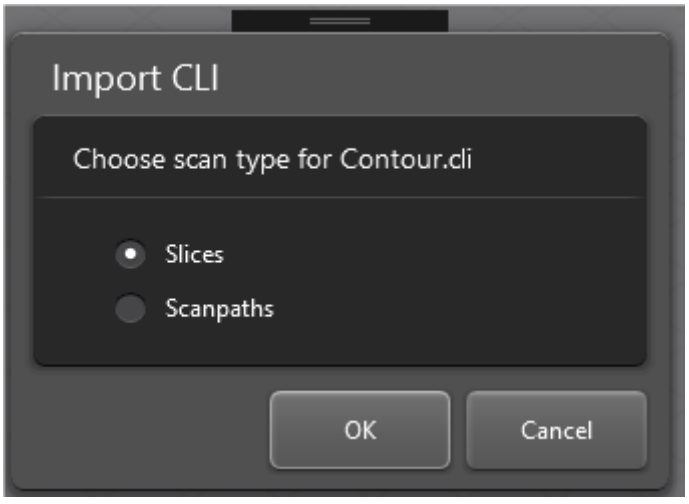

Figure 1 Selecting CLI file type

Once you specify the type and click OK, the file is opened in the layout stage.

If you click Cancel, the import operation is cancelled and the application stays in the same state.

2.2 Opening a CLI file with a material file already applied

If a material file is already applied to the layout and you want to import a CLI file, the CLI layer thickness must be the same as, or a multiple of, the applied material thickness.

If you attempt to import a CLI file which has a layer thickness which is not the same as (or a multiple of) the applied material file, a warning message is displayed:

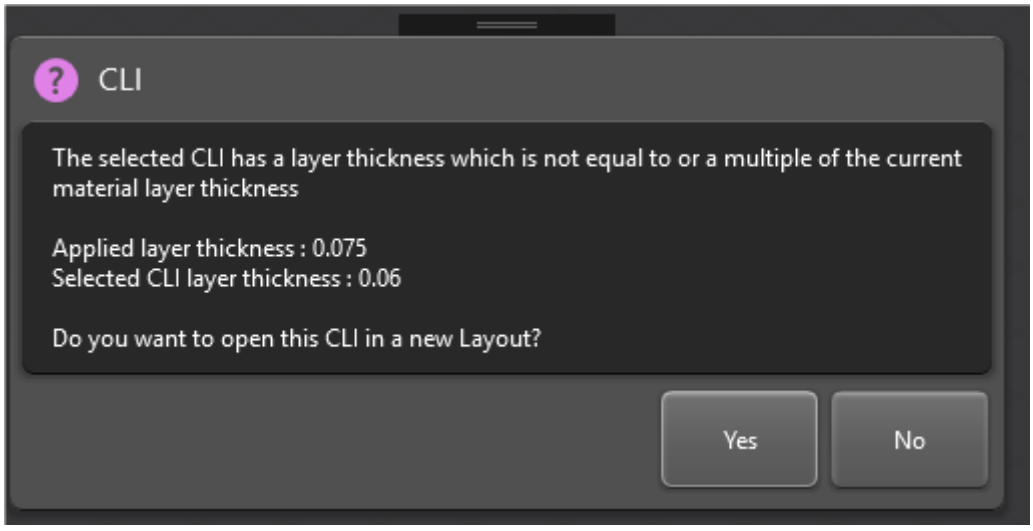

Figure 2 Import CLI file with material already applied

If you click Yes, a new layout is created and the CLI part is opened in this new layout. If you click No, the CLI part-opening operation is cancelled.

2.3 Opening a CLI file with another CLI file already open

If a CLI file is already open in a layout and you want to import another CLI file, the new CLI file layer thickness must be the same as, or a multiple of, the currently opened CLI file.

If you attempt to import a CLI file which has a layer thickness which is not the same as (or a multiple of) the already loaded CLI file, a warning message is displayed:

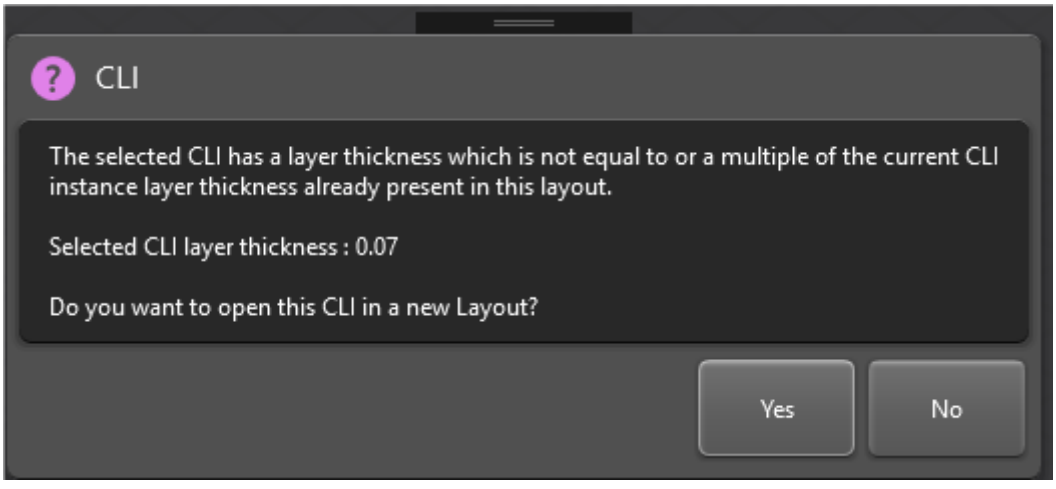

Figure 3 Import CLI file with another CLI file already open

If you click Yes, a new layout is created and the CLI part is opened in this new layout. If you click No, the CLI part-opening operation is cancelled.

2.4 Opening multiple CLI files

You can select multiple CLI files to import at once.

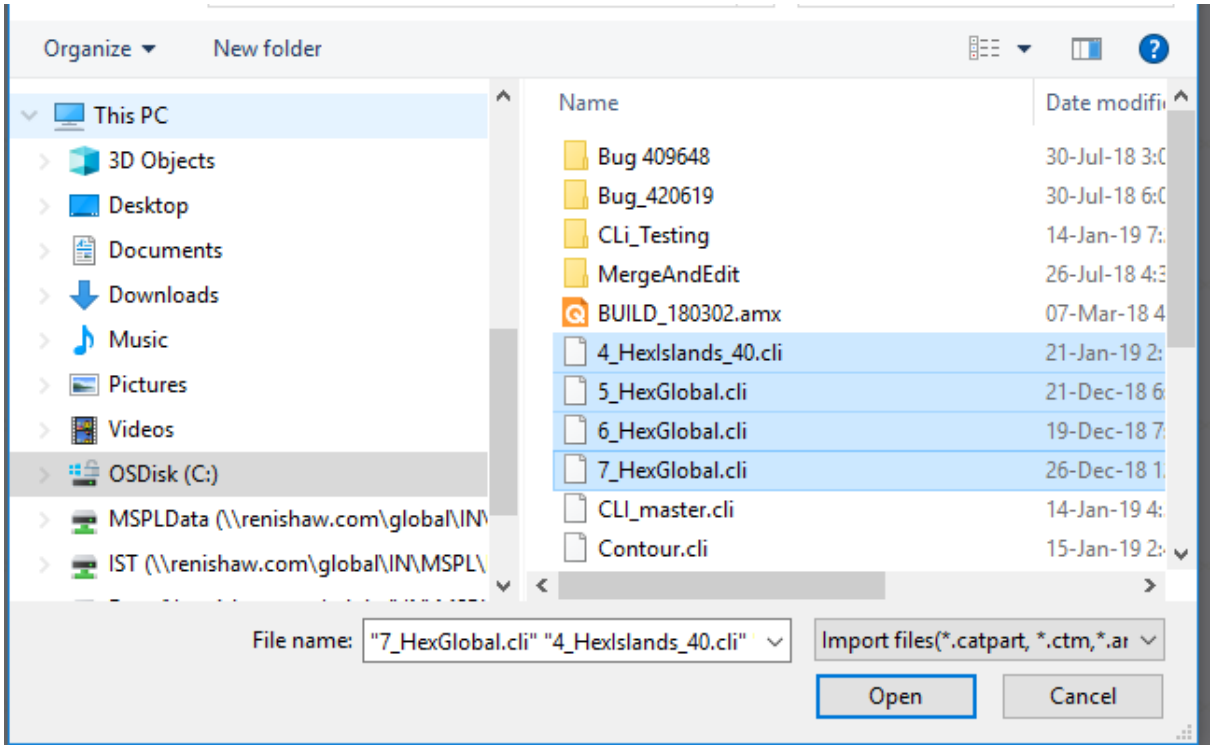

Figure 4 Importing multiple CLI files

3 Material file selection for CLI files

Once a CLI file is imported, the material list in the Material Editor window is filtered according to the layer thickness of the imported CLI part. Consequently, only material files with layers equal to the CLI layer thickness can be applied. All the other material files will be disabled. If multiple CLI files are open in a given layout, the material list is filtered according to the minimum layer thickness of these CLI files.

4 Material Viewer for CLI files

For Slice CLI files, Material Viewer behaves the same as it does for an STL file.

However, for Scan Path CLI files, the values on the Strategy, Control, Volume, Upskin and Downskin tabs are displayed as N\A, as these values are not used for scan path generation. For all other tabs, the behaviour is the same as that for an STL file.

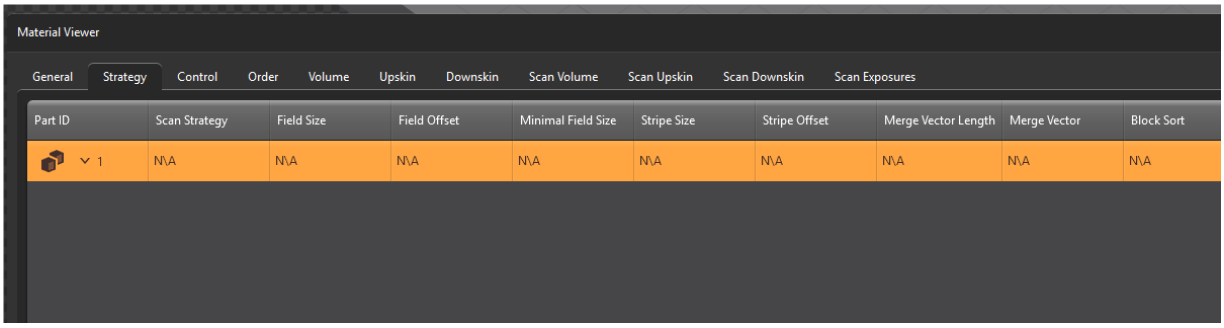

Figure 5 Material Viewer for Scan Path CLI files

5 Support stage operations for CLI files

If the imported CLI file is of the Scan Path type, all the options in the support stage are disabled.

For Slice CLI files, two options are enabled: Display Slices and Import Supports.

5.1 Display Slices for Slice CLI files

You can generate and view the slices for Slice CLI files by clicking on the Display Slices button in the support stage.

If a material file has not already been applied, you first need to apply a material file (see "Material file selection for CLI files").

5.2 Import CLI supports for Slice CLI files

You can import CLI supports for Slice CLI files by clicking the Import Supports button. Only CLI files can be imported as supports. The support CLI and part CLI files must have the same layer thickness, otherwise an error message will be displayed. CLI supports can contain open profiles.

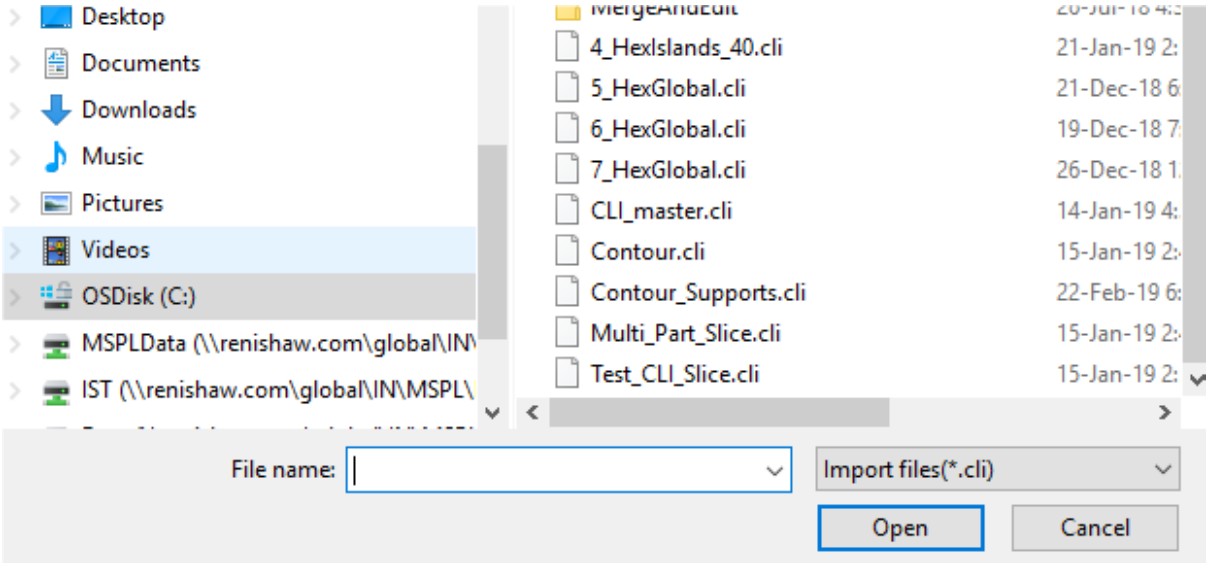

Figure 6 Browse support files for Slice CLI files

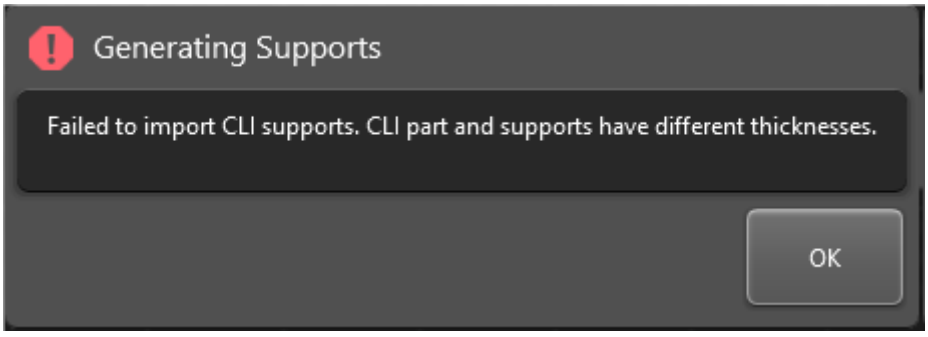

Figure 7 Error on CLI support import

6 Build style selection for Scan Path CLI files

When you import a Scan Path CLI file, you need to assign build style types to all the build style IDs which are present in the file (see "Appendix A: CLI import definition for QuantAM" for details on build style ID definition in CLI files).

You can do this using the Build Style selection dialog box in the layout stage Properties window.

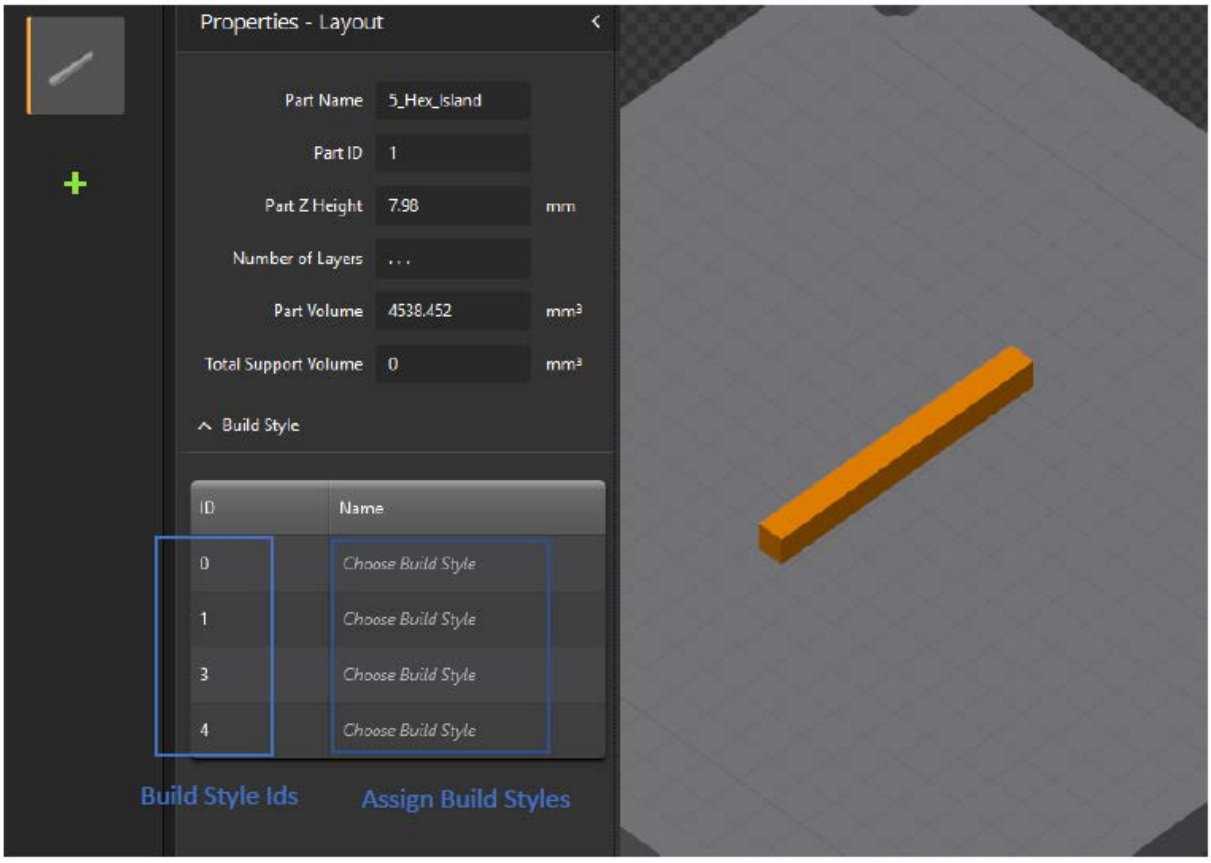

Figure 8 Build style selection for Scan Path CLI files

The build style list is filtered according to the section type the ID represents in the CLI file. For example, in the above figure, if ID 0 represents a hatch section in the CLI file, the build style list will contain only the hatch build style types.

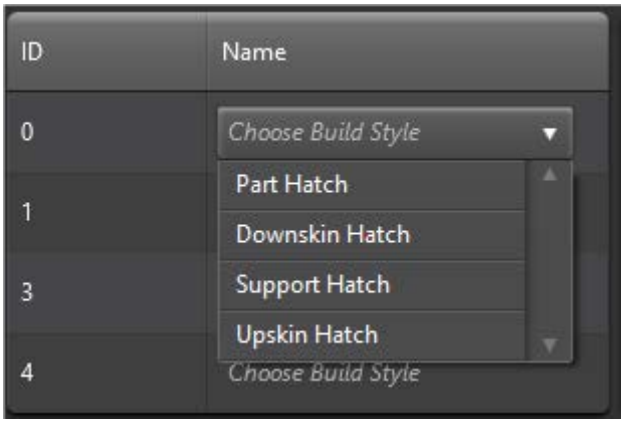

Figure 9 Hatch build style types for CLI

Similarly, if ID 3 represents a polygon section in the file, the list will contain only polygon build style types.

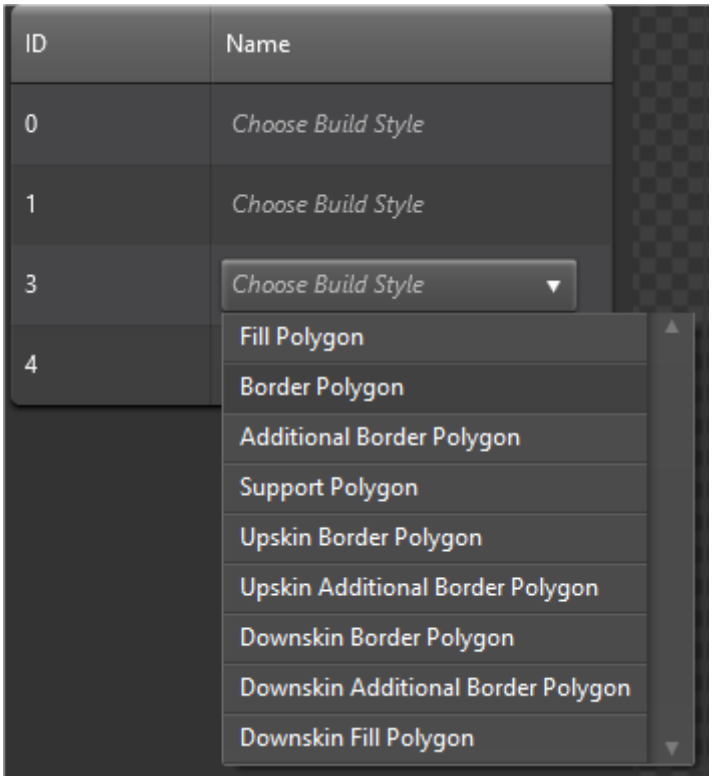

Figure 10 Polygon build style types for CLI

7 Scan path generation for CLI files

7.1 Slice CLI files

Once you have applied a material file, you can switch to the review stage to generate scan paths for Slice CLI files.

7.2 Scan Path CLI files

To generate scan paths for Scan Path CLI files, you need to fulfil two prerequisites.

1. Apply a material file.

2. Assign build style types to all the build style IDs present in the Scan Path CLI. If you switch to the review stage without assigning all build styles, a warning message is displayed.

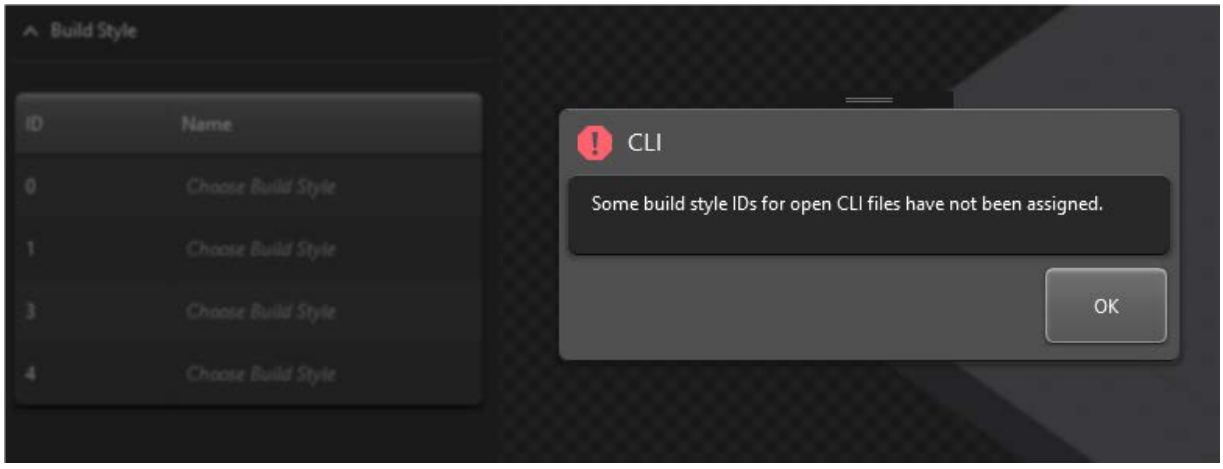

Figure 11 Error if build styles have not been assigned

Once you have assigned all the build styles, you can switch to the review stage to view Scan Paths.

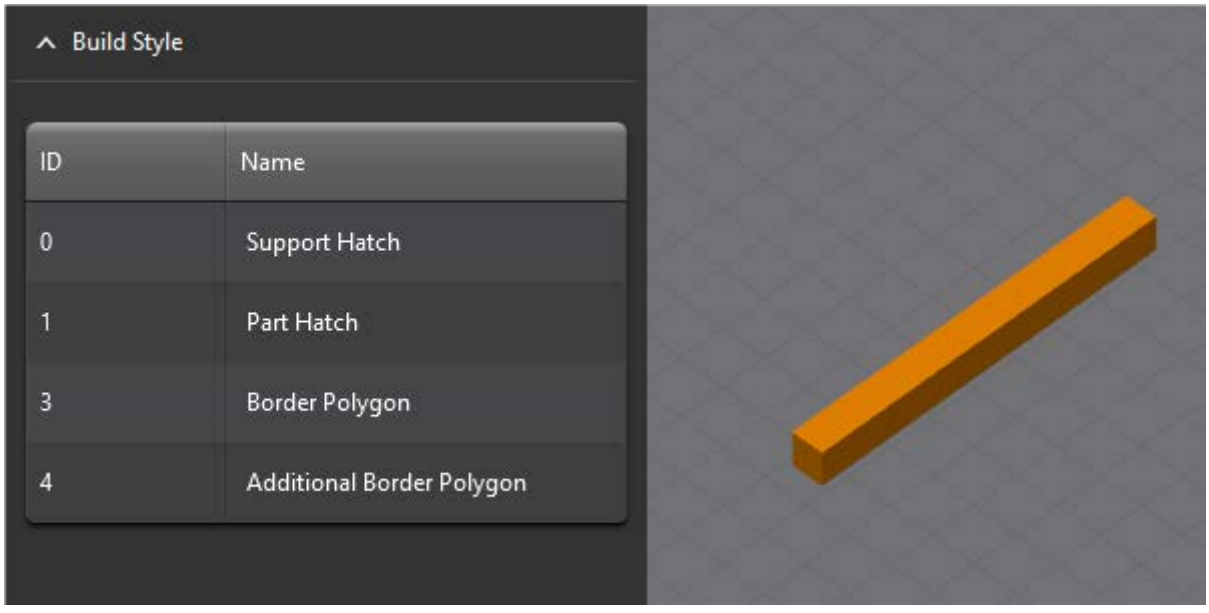

Figure 12 Scan Path generation for Scan Path CLI files

8 Appendix A: CLI import definition for QuantAM

8.1 CLI import restrictions

There are a few restrictions which must be respected to allow successful import of CLI files in QuantAM. These restrictions apply to both Slice and Scan Path CLI files.

- The layer thickness in the CLI file must be consistent. Currently, we do not support variable layer thickness for CLI files in QuantAM.
- The starting Z for any model in the CLI file must be either 0 or a multiple of the layer thickness.
- If the first layer in the CLI file is at height 0, it should not contain any profiles, i.e. it should be an empty layer.
- For ASCII CLI files, the line endings (new line character) must be CRLF or “\r\n” (2 bytes). QuantAM does not support ASCII CLI files with LF or “\n” line endings (1 byte). Note that certain text editors (e.g. Notepad++) can convert line endings from LF to CRLF.
- The following sections must be present in the header section of the CLI file to be imported:
    - $$ASCII
    - $$UNITS
    - $$VERSION

8.2 Non-standard interpretation of Scan Path CLI files

Below is a simple excerpt from a Scan Path CLI file showing some hatch profiles for a layer at height 0.06 mm.

$$HEADERSTART
$$ASCII
$$UNITS/1
$$VERSION/200
$$LABEL/0,5_Hex_Island
$$DATE/030518
$$DIMENSION/-40,-0.00377999991178513,0,40,7.19999980926514,8
$$LAYERS/133
$$HEADEREND
$$GEOMETRYSTART
$$LAYER/0.06
$$HATCHES/0,6,36.904501342773,7.149999809265,36.904501342773,0.057519999985,36.999…….
$$HATCHES/0,6,35.574501342773,7.149999809265,35.574501342773,0.057519999985,35.669…….
$$HATCHES/0,5,34.339501342773,0.057519999985,34.339501342773,7.149999809265,34.434…….
$$HATCHES/0,5,33.009501342773,0.057519999985,33.009501342773,7.149999809265,33.104…….
$$HATCHES/0,5,31.679501342773,0.057519999985,31.679501342773,7.149999809265,31.774…….

Standard interpretation

The standard CLI specification defines the following syntax for the start hatches command:

$$HATCHES/id, n, p1sx, p1sy, p1ex, p1ey, ...pnex, pney

With the following parameter definition:

id	INTEGER, identifier to allow more than one model information in one file. id refers to the parameter id of command $$LABEL (HEADER-section)
n	INTEGER, number of hatches (n × 4 = number of coordinates)
p1sx...pney	REAL, coordinates of the hatches 1...n. 4 parameters for every hatch (startx,starty,endx,endy)

According to the standard, the 0 (highlighted on the previous page), which follows each $$HATCHES command, corresponds to the 'model ID'. Effectively, this means that if a Scan Path CLI file has multiple models, we can use this identifier to ascertain which hatch profiles belong to which model.

Interpretation in QuantAM v5

The standard interpretation posed a significant limitation when we tried to align it with the QuantAM Scan Path generation methodology.

In QuantAM, we support several kinds of build style. For hatches, we can have volume hatch, downskin hatch or upskin hatch. For polygons, we also support multiple build styles including border, additional border, upskin border, downskin border etc.

In QuantAM, the way we differentiate between these build styles is that each is assigned a unique ID. These build style IDs are then used to read the corresponding laser parameters from the material file.

To replicate the build style behaviour for Scan Path CLI files, we needed some way to attach a build style ID to every $$HATCHES command, to enable us to say whether a particular $$HATCHES command represents a volume hatch or a downskin hatch etc. The same applies to every $$POLYLINE command.

The standard CLI specification does not expose a parameter to specify build style IDs. This means that if we use the standard interpretation, we will have no way to enable different hatch and polygon styles in a scan path CLI.

Consequently, to support the import of Scan Paths CLIs in QuantAM, we repurposed the parameter 'model ID'. While importing the Scan Path CLI in QuantAM, 'model ID' is used to specify the build style type. This has the side effect that the 'model ID' cannot be used to identify which part the CLI command belongs to, and therefore **Scan Path CLIs imported into QuantAM can only contain one model per CLI file**.

When you import a Scan Path CLI in QuantAM, we read all these integer IDs and ask you to assign build styles from the material file to them.

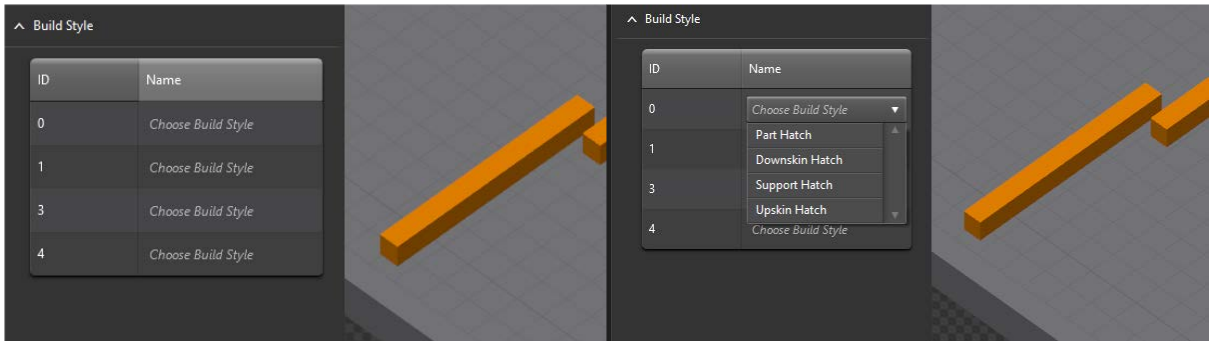

Figure 13 Build style assignment for Scan Path CLIs

URL for standard specification

http://www.hmilch.net/downloads/cli_format.html

9 Appendix B: RenExposures in CLI files

9.1 What is CLI RenExposure data?

The standard CLI specification gives us the ability to represent polygon and hatch data in a CLI file. For ASCII CLI files we can use the command parameters $$POLYLINE and $$HATCHES respectively. Similarly, we have designated command IDs to represent polygon and hatch data in a binary CLI file.

In addition to this, some users want the ability to represent point exposure data in a CLI file. Since there is no command for point exposures in the standard CLI specification, the following modifications were introduced to the QuantAM interpretation of CLI files:

- For ASCII CLI files, the $$RENEXPOSURES command was introduced.
- For binary CLI files, the RenExposure Command Ids 133 and 134 were introduced.

NOTE: RenExposures are only supported in Slice CLI files.

9.2 RenExposure command description

9.2.1 ASCII Slice CLI file

Below is the syntax for representing point exposures in an ASCII Slice CLI file.

$$RENEXPOSURES/ Id, N, E_{1x}, E_{1y}, E_{2x}, E_{2y}, ...

$$RENEXPOSURES	Indicates that this is point exposure data.
Id	Refers to the id of the model to which this point exposure data belongs.
N	Total number of exposure points.
E_{1x}, E_{1y}, E_{2x}, E_{2y}, ...	X-Y co-ordinates for point exposure data. The number of points should be (N × 2).

Example

$$RENEXPOSURES/ 1,5,24.999998,24.999998,14.999999,5.000000,10.000000,10.000000, 0.000000, 0.000000,20.000000,10.000000

9.2.2 Binary Slice CLI File

Below is the syntax for representing point exposures in a binary Slice CLI file.

CommandID,Id,N, E_{1x}, E_{1y}, E_{2x}, E_{2y}, ...

CommandID	Refers to command id to be used for point exposure data.
Id	Refers to the id of the model to which this point exposure data belongs.
N	Total number of exposure points.
E_{1x}, E_{1y}, E_{2x}, E_{2y}, ...	X-Y co-ordinates for point exposure data. The number of points should be N × 2).

NOTE: There are no separators in the binary format between the Command Id and the parameters, nor within the parameters themselves – the comma is added in the above description just to make the different parameters more distinct.

9.2.3 Size of binary command description

Based on which command ID is used, the size in bytes of the parameters differs.

The CommandID is always 2 bytes in size.

The table below gives the size of the parameters.

CommandID	Parameter	Size (in bytes)
133	Id	2 (unsigned short)
	N	2 (unsigned short)
	E_{1x}, E_{1y}, E_{2x}, E_{2y}, ...	2 (each co-ordinate point, unsigned short)
134	Id	4 (unsigned integer)
	N	4 (unsigned integer)
	E_{1x}, E_{1y}, E_{2x}, E_{2y}, ...	4 (each co-ordinate point, float)

9.3 Slice generation for CLI files with RenExposures

Once you have imported a Slice CLI file containing point exposure data in QuantAM, you can move to the support stage and generate slices. Exposure points are displayed in cyan and contours are displayed in yellow.

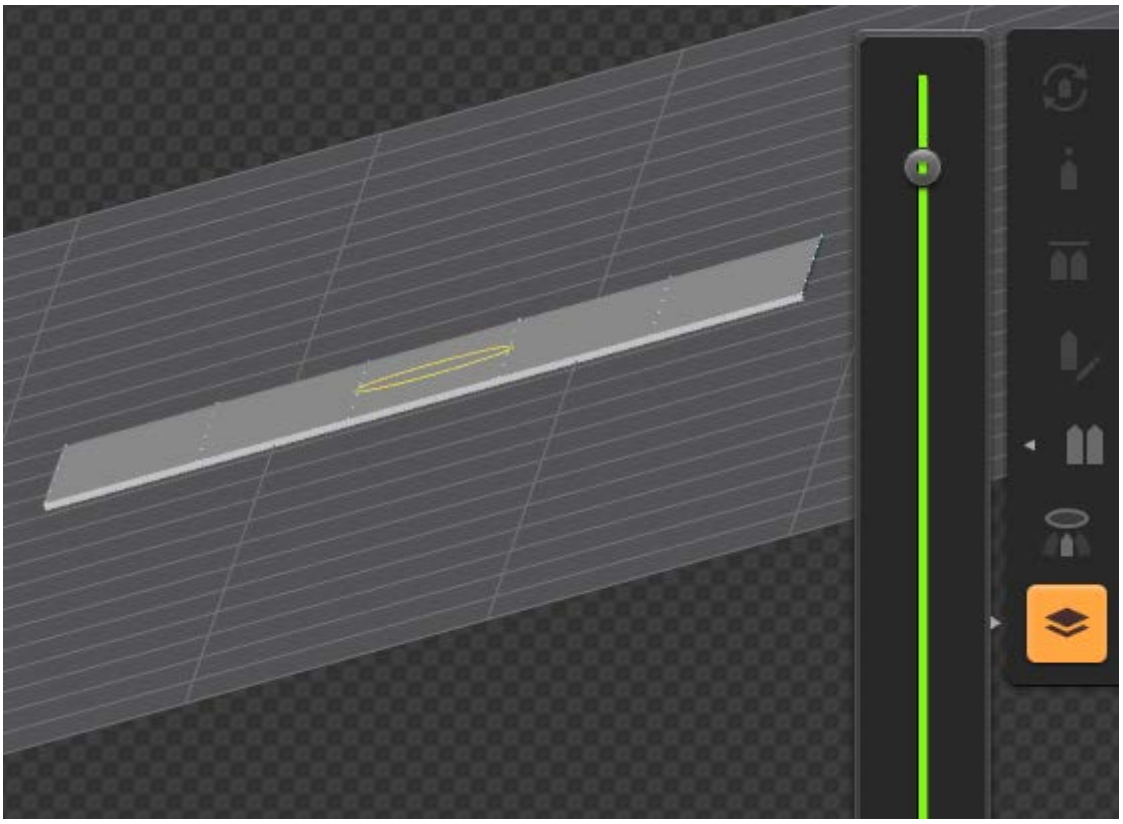

Figure 14 RenExposures CLI with point exposures and contours

9.4 Restrictions on usage of RenExposures

The following restrictions apply to Slice CLI files with RenExposures.

1. A part with only RenExposures and no slice on all its layers is invalid. So, if any of the parts in a Slice CLI file contains only point data, the file will be considered invalid and will not be imported.

2. The difference between the Z heights of the first two exposure layers must be equal to the CLI slice thickness. For example, in a Slice CLI file with a layer thickness of 0.06 mm, if the first RenExposures layer is at z = 0.300, then the layer at z = 0.360 or z=0.240 must have a RenExposures command. If there are no point exposures for the layer, the command can be added with no points as **$$RENEXPOSURES/1,0,**

3. RenExposures cannot be imported separately – they must be present in the same CLI file.

4. RenExposures are only supported within Slice CLI files.

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