User guide

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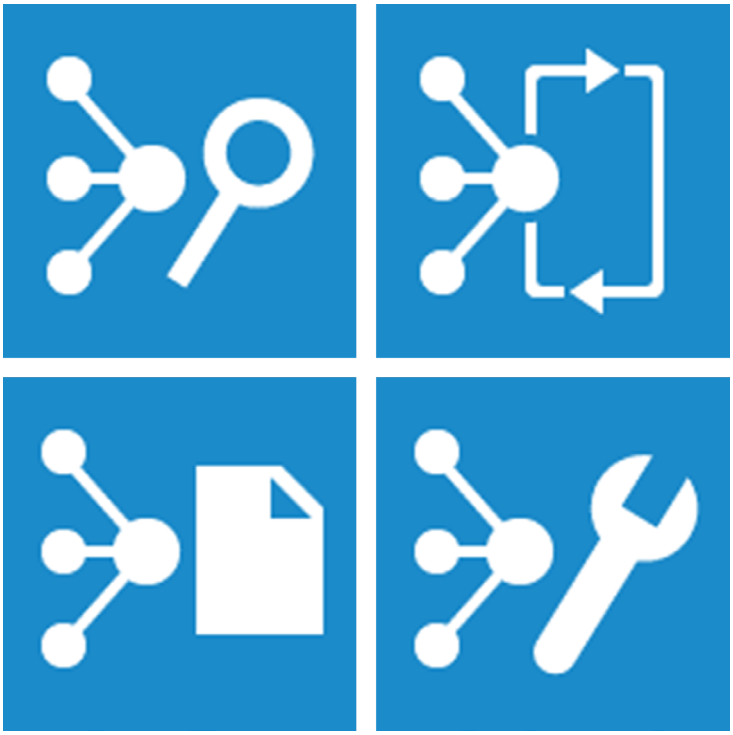
DataHUB



www.renishaw.com/additivemanufacturing

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Contents

1 Legal notices

1.1 Terms and conditions and warranty

Unless you and Renishaw have agreed and signed a separate written agreement, the equipment and/or software are sold subject to the Renishaw Standard Terms and Conditions supplied with such equipment and/or software, or available on request from your local Renishaw office.

Renishaw warrants its equipment and software for a limited period (as set out in the Standard Terms and Conditions), provided that they are installed and used exactly as defined in associated Renishaw documentation. You should consult these Standard Terms and Conditions to find out the full details of your warranty.

Equipment and/or software purchased by you from a third-party supplier is subject to separate terms and conditions supplied with such equipment and/or software. You should contact your third-party supplier for details.

1.2 Patents

Features of Renishaw's additive manufacturing systems, and other similar systems, are the subject of one or more of the following patents and/or patent applications:

1.2.1 RenAM 500 series

CA 2738618	EP 2331232	IN WO2014/125258	US 10335901
CA 2738619	EP 2875855	IN WO2014/125280	US 10493562
	EP 2956261	IN WO2014/199134	US 10500641
CN 102186554	EP 2956262		US 10639879
CN 105102160	EP 3007879	JP 6482476	US 10933620
CN 105228775	EP 3221073	JP 6571638	US 10974184
CN 105492188	EP 3221075		US 11033968
CN 107107193	EP 3299110		US 11040414
CN 107206494	EP 3323534		US 11104121
CN 107921659	EP 3325240		US 11267052
CN 108189390	EP 3357606		US 11305354
CN 108349005	EP 3377252		US 11478856
CN 108515182	EP 3377253		US 11565346
CN 109177153	EP 3566798		US 8753105
	EP 3689507		US 8794263
	EP 4023387		US 9114478
			US 9669583
			US 9849543
			US 2020-0023463
			US 2021-0354197
			US 2022-0203451
			US 2023-0122273

1.2.2 DataHUB

CN 109937101	EP 3482855	US 11167497	WO 2020/099852
CN 111315512	EP 3538295	US 2020-0276669	
CN 112996615	EP 3880391	US 2021-0394272	

1.2.3 InfiniAM Spectral

CN 105745060	EP 3049235	US 10850326	WO 2020/099852
CN 108349005	EP 3377252	US 11305354	WO 2020/174240
CN 109937101	EP 3482855	US 11040414	
CN 110026554	EP 3482909	US 2020-0276669	
CN 111315512	EP 3538295	US 2021-0039167	
CN 111491777	EP 3880391	US 2021-0394272	
CN 112996615	EP 3930999	US 2022-0168813	
CN 115943048	EP 2020-174240	US 2022-0203451	

1.3 REACH

Information required by Article 33(1) of Regulation (EC) No. 1907/2006 (“REACH”) relating to products containing substances of very high concern (SVHCs) is available at:
Product Environmental Compliance – Additive manufacturing (renishaw.com)

1.4 Control of pollution, applicable in the People’s Republic of China

Renishaw has prepared a table in accordance with the provisions of SJ/T 11364. This is available on request from Renishaw.

1.5 China RoHS

For more information on China RoHS, visit:
Product compliance – Additive manufacturing (renishaw.com)

1.6 Changes to equipment

Renishaw reserves the right to change equipment specifications without notice.

2 Introduction

DataHUB is a suite of software that allows data that has been captured using the CameraVIEW™, MeltVIEW™, and/or LaserVIEW™ hardware to be processed, either into a visual form viewed using InfiniAM®, or through a novel analyser implemented using the DataHUB plug-in system. DataHUB may optionally connect to Renishaw Central, onto which DataHUB can upload alerts, analysis results, and time series.

This user guide is designed to help you navigate and utilise the DataHUB software suite effectively. Whether you are a new or an experienced user, this guide will provide you with the necessary information to make the most of DataHUB's features and functionalities.

2.1 Intended use

DataHUB software serves as a centralised data management system that collects, stores, and organises the data generated during the Renishaw additive manufacturing (AM) process. It provides a secure and reliable means to access and retrieve AM data, supporting the seamless transfer of information between the RenAM system and the viewing PC.

2.2 Applicability

DataHUB supports the RenAM 500 series models: 500, 500 Ultra, and 500 Flex. Earlier Renishaw AM platforms are not supported. For further information regarding the suitability of your system, contact Renishaw.

NOTE: DataHUB does not support the RenAM 500M AM system.

2.3 Reference documentation

In addition to this user guide, refer to the following documents for additional information about other aspects of the InfiniAM system, DataHUB and the RenAM 500 series.

- RenAM 500 series additive manufacturing system installation guide (Renishaw part no. H-5800-3692)
- RenAM 500 series additive manufacturing system user guide (Renishaw part no. H-5800-3693)
- InfiniAM and DataHUB software installation guide (Renishaw part no. H-5800-4349)
- InfiniAM Spectral user guide (Renishaw part no. H-5800-3919)
- InfiniAM Camera user guide (Renishaw part no. H-5800-4675)
- DataHUB developer manual (Renishaw part no. H-5800-4762)

2.4 Critical information in this guide

Within this user guide additional information that is important to read and understand is presented as a warning, caution or note. The definition of each of these and an example of each is given below.

2.4.1 Warning

An example of a warning is as follows:

WARNING: A warning is to tell the end user that there is a possibility of injury to themselves or other people in the vicinity if the described course of action is not followed.

2.4.2 Caution

An example of a caution is as follows:

CAUTION: A caution is to tell the end user that there is a possibility of damage to the equipment if the described course of action is not followed.

2.4.3 Note

An example of a note is as follows:

NOTE: A note is to advise the end user of important information that is related to, or will assist them in the task or activity they are carrying out.

3 Safety

WARNING: All safety information is in accordance with the applicable Renishaw AM system user guide and Renishaw AM system installation guide – unless otherwise stated within this document.

WARNING: Ensure that a blanking plate or the MeltVIEW hardware module is fitted to the laser aperture before turning on the AM system laser.

WARNING: The MeltVIEW hardware module is not interlocked to the laser safety circuit. If the MeltVIEW hardware module is removed and the laser is fired, harmful laser light will be emitted from the laser aperture on the AM system

3.1 DataHUB Generator specific laser and warning labels

There are no additional safety or warning labels fitted to the AM system as a result of installing DataHUB Generator.

4 Scope of supply

DataHUB is delivered as a set of four background services:

- **DataHUB Automation** (service), which automatically begins processing jobs when a build is started.
- **DataHUB Central** (optional), which manages communication between DataHUB and Renishaw Central.
- **DataHUB Service**, which schedules and performs the actual processing.
- **DataHUB Notification**, which sends email notifications via an SMTP server.

In addition, there are three applications associated with DataHUB:

- **DataHUB Automation** (front end), which configures the automation system.
- **DataHUB Generator**, which manually begins processing jobs.
- **DataHUB Monitor**, which displays the health of DataHUB and the progress of any work it is performing.

Typically, DataHUB runs on a machine known as a Data Collector PC (DCPC). This machine receives AMPM data directly from one or more RenAM machines in real time, and holds it for processing and/or later archiving.

5 Spare parts

There are no user-serviceable parts within DataHUB. In the event that DataHUB fails, then it should be repaired by re-installing and configuring the software.

NOTE: For the contact details of your local Renishaw office or to arrange a service visit, see section 10, “Customer support”.

The InfiniAM and DataHUB software will be periodically updated. All subscription users will be entitled to download the latest software release from their **MyRenishaw** account.

6 Processing data in DataHUB

DataHUB is a suite of software that runs on a Data Collection PC and allows a user to process raw AMPM data collected from a RenAM machine into a form that is viewable using InfiniAM.

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- **DataHUB Automation** (front end), which configures the automation system.
- **DataHUB Generator**, which manually begins processing jobs.
- **DataHUB Monitor**, which displays the health of DataHUB and the progress of any work it is performing.

NOTE: A single Data Collection PC can accommodate up to six AM systems on either a 1 Gigabit or a 10 Gigabit Ethernet.

DataHUB Generator gathers the necessary information to initiate a processing job and registers it with DataHUB Service for background processing. It can process data from both in-progress and completed builds. During in-progress build, DataHUB will pause or resume data processing when the build is paused or resumed. DataHUB Monitor displays the progress of data processing for each job that has been initiated using DataHUB Generator.

6.1 DataHUB Generator

DataHUB Generator is used to manually configure the processing of a build using DataHUB.

1 **About**

Click the icon to view the details about the application.

2 **Navigation bar**

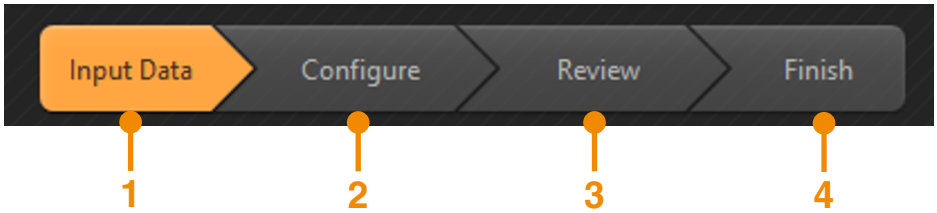
It allows you to navigate between the stages.

3 **Current stage**

Displays the currently selected stage.

6.1.1 Navigation bar

The navigation bar at the bottom of the screen allows the user to progress through the stages to generate a build job.



1 **Input Data**

Allows you to navigate to the ‘Build Information’ stage.

2 **Configure**

Allows you to navigate to the ‘Configure Pipelines’ stage.

3 Review

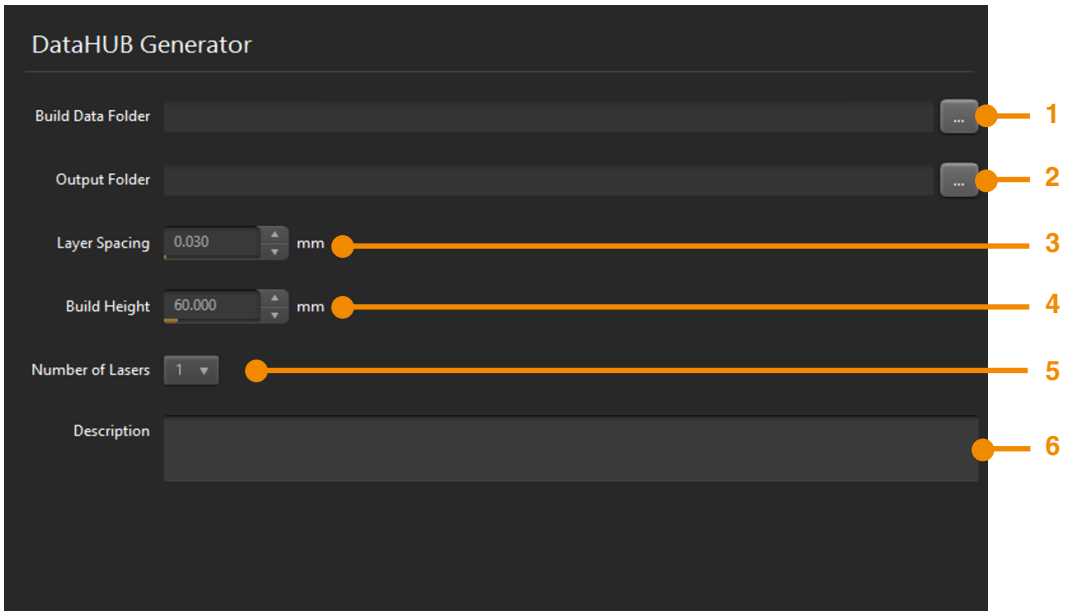
Allows you to navigate to the ‘Review’ stage.

4 Finish

This stage will be selected when you navigate to the ‘End’ screen by clicking the ‘Start’ button on the ‘Review’ stage.

6.1.1.1 Build information stage

This stage collects information common to all data sources. Initially only two fields will be enabled.



1 Build Data Folder

Specify the location of the input AMPM data. Data for all modalities collected during a single build will be transferred into a single folder. The name of this folder will contain the *.mtt filename as well as the time the build was started. Click the ‘Browse’ button to open a dialog box that allows navigation through the file system to locate an input folder.

NOTE: It is important that you select this top-level folder – DataHUB explicitly expects CameraVIEW data to be in sub-folders of the Build Data Folder.

NOTE: Once the ‘Build Data Folder’ has been selected, DataHUB Generator will read information about the build and populate the remaining fields. If DataHUB Generator cannot find the build information, the following fields must be configured manually.

2 Output Folder

Specify the folder to which DataHUB should write output. Click the ‘Browse’ button to open a dialog box that allows navigation through the file system to locate an output folder.

3 **Layer Spacing**

Enter the space between each layer (in mm).

NOTE: DataHUB only supports a uniform layer spacing. It is possible to process a build that uses variable layer spacing by providing a single layer spacing, however the output may not represent the relationship between layers correctly.

4 **Build Height**

Enter the height of the completed build (in mm). The build height must be a multiple of the layer spacing.

5 **Number of Lasers**

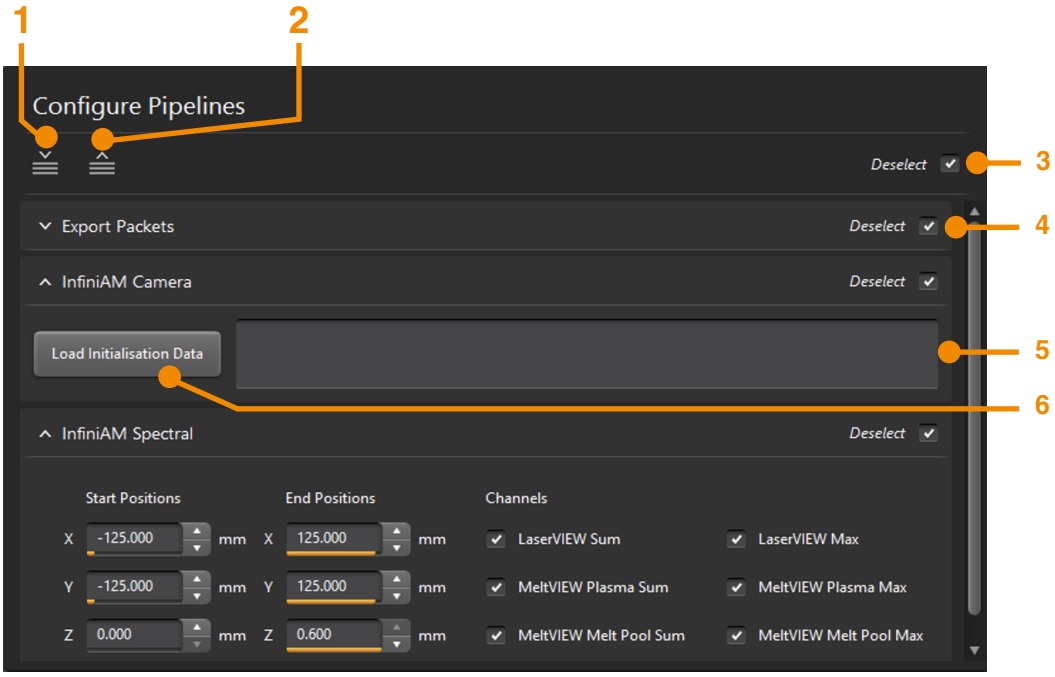
Enter the number of lasers installed on the RenAM machine.

6 **Description**

Enter a textual description by which the build can be identified. This text will be displayed in DataHUB Monitor to allow you to identify the related processing job, among other places.

6.1.1.2 Configure Pipelines stage

This stage is used to configure the specific pipelines through which a build will be processed, as well as any parameters required by those pipelines.



1 **Expand All**

Click the button to expand all pipelines.

2 **Collapse All**

Click the button to collapse all pipelines.

3 Select All checkbox

Tick the checkbox to select all pipelines.

4 Select checkbox

Tick the checkbox to select the corresponding pipeline.

NOTE: If a pipeline is unavailable, either because it is not licensed or because the build does not contain data of the appropriate modality, the checkbox will be disabled for selection.

5 Initialisation Data field

Some pipelines are configured using initialisation data conforming to a JavaScript Object Notation (JSON) schema. Use this field to enter initialisation data text conforming to a JSON schema. If the file with pre-prepared parameters is available on your system, use the 'Load Initialisation Data' button to select it.

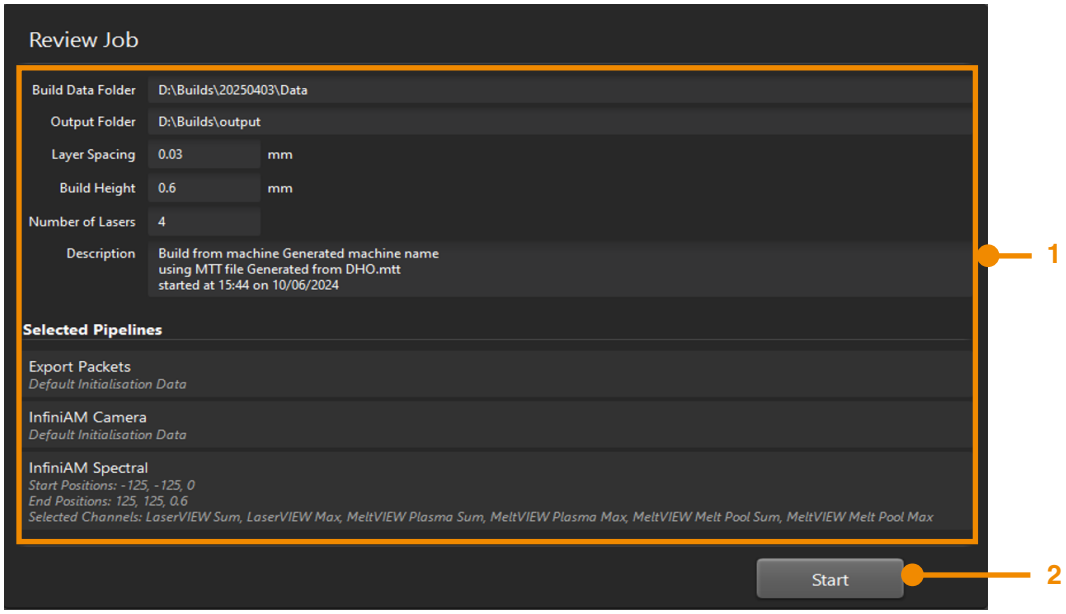
6 Load Initialisation Data

Click the associated 'Load Initialisation Data' button to open a dialog box that allows navigation through the file system to locate a file containing pre-prepared parameters.

Each pipeline can be individually configured. If a pipeline has been configured incorrectly, DataHUB Generator will display a warning; if an incorrectly configured pipeline has been selected, DataHUB Generator cannot proceed to the review stage.

6.1.1.3 Review stage

This stage displays a summary of the selected configuration and provides the option to start the job.



1 **Review Job**

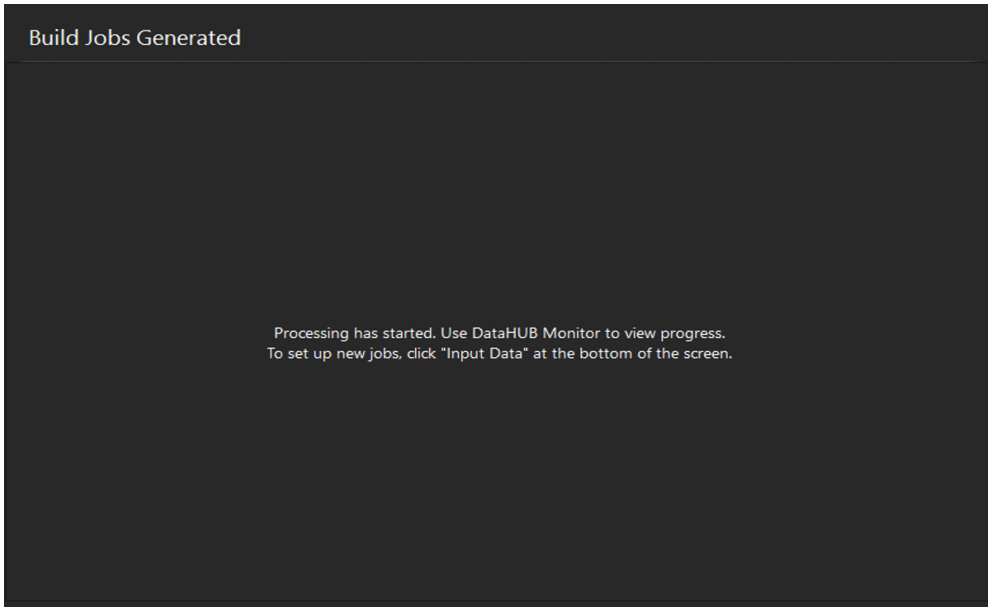
The information contained under this header allows you to review the pipelines selected and the configured parameters. You can also verify that the input build data and output folder are correctly configured. If any details require changes, you can navigate to the previous stages to modify them.

2 **Start**

Once the configuration is reviewed and verified, click this button to start the jobs.

6.1.1.4 Build Jobs Generated stage

This stage in the DataHUB Generator indicates whether the jobs have started successfully.



The ‘Build Jobs Generated’ stage reports whether DataHUB was able to start the jobs. Use the navigation bar to return to ‘Input Data’ stage and begin a new set of jobs.

NOTE: DataHUB Generator does not provide any feedback on the progress of a job. Progress can be monitored using DataHUB Monitor.

6.2 Processing LaserVIEW and MeltVIEW data via plug-ins

DataHUB comes with one plug-in always installed and licensed, known as Export Packets. Export Packets will convert the LaserVIEW and MeltVIEW source files into a tabular form, similar to a '.csv' file. It will contain rows (separated by a 'new line' character) and columns (separated by a 'TAB' character) for each packet. For additional information about Export Packets, refer to the DataHUB Developer manual (Renishaw part no. H-5800-4762).

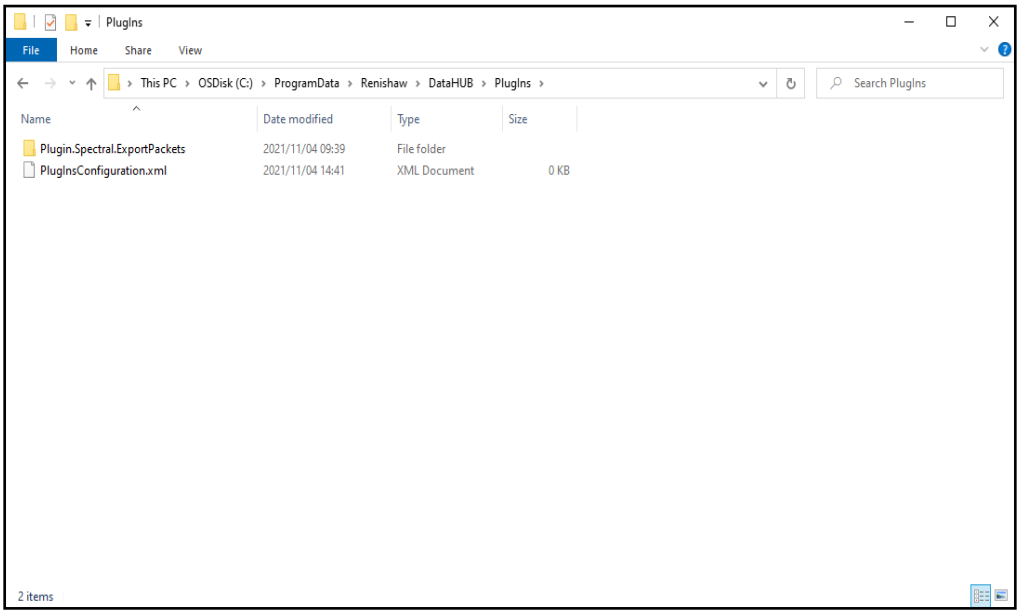
If DataHUB has the "LaserVIEW/MeltVIEW Pluggability" feature licensed, it will also run any other plug-ins that have been installed.

6.2.1 Installing and updating a custom plug-in

NOTE: The following describes the basic procedure for installing a custom plug-in. A custom plug-in may require additional steps to function correctly. Please ensure you have read all attendant documentation provided with the custom plug-in when installing it.

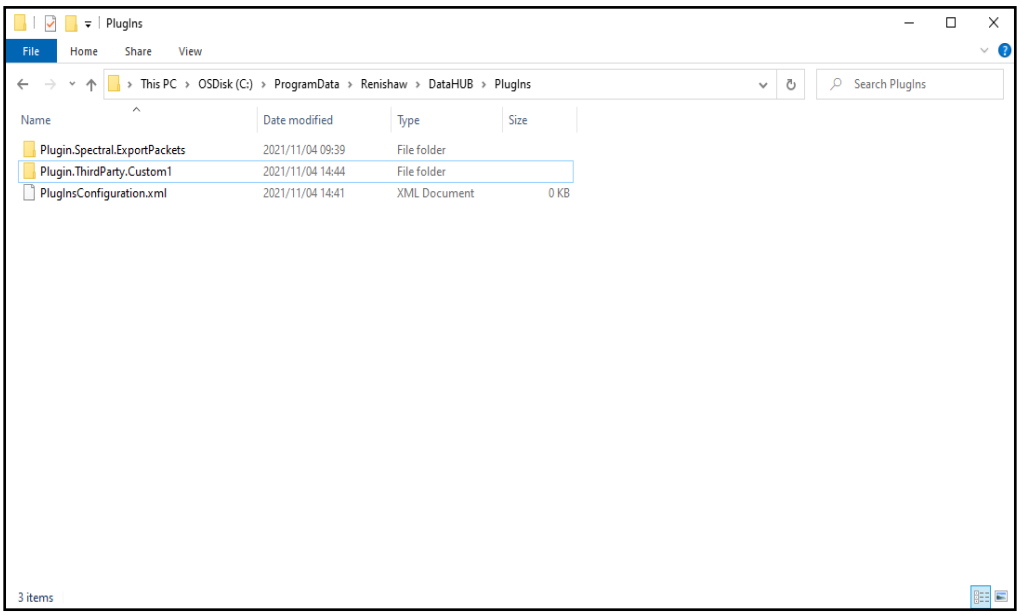
1. If you are updating an existing plug-in, ensure DataHUB Service has been stopped before progressing further. For more information see, section 9, "Troubleshooting".

2. Navigate to "%PROGRAMDATA%\Renishaw\DataHUB\PlugIns" in Windows Explorer.



3. Copy the plug-in into this location.

NOTE: All plug-ins should be contained in a distinct sub-folder of the ‘PlugIns’ folder.

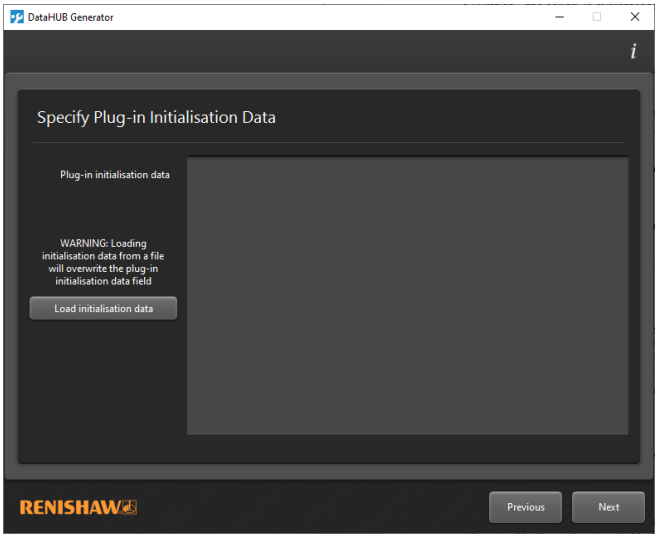


4. Restart DataHUB Service. DataHUB Service loads plug-ins on start-up so will not discover new plug-ins until it has been restarted. For more information see, section 9, “Troubleshooting”.

6.2.1.1 Workflow

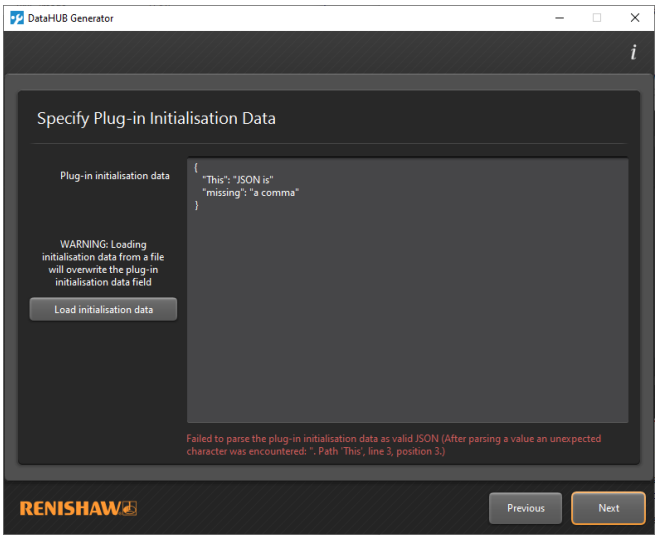
The first screen on the LaserVIEW and MeltVIEW plug-ins workflow captures plug-in parameters for each plug-in. A plug-in may need additional parameters to function correctly; this screen allows you to enter those parameters, encoded as JSON. All plug-ins will be sent the contents of this string on initialisation, and it is up to you to provide appropriate data in the form each installed plug-in expects. If no installed plug-in requires any additional parameters, it is safe to leave this screen empty.

NOTE: The Export Packet plug-in does not require any additional parameters.

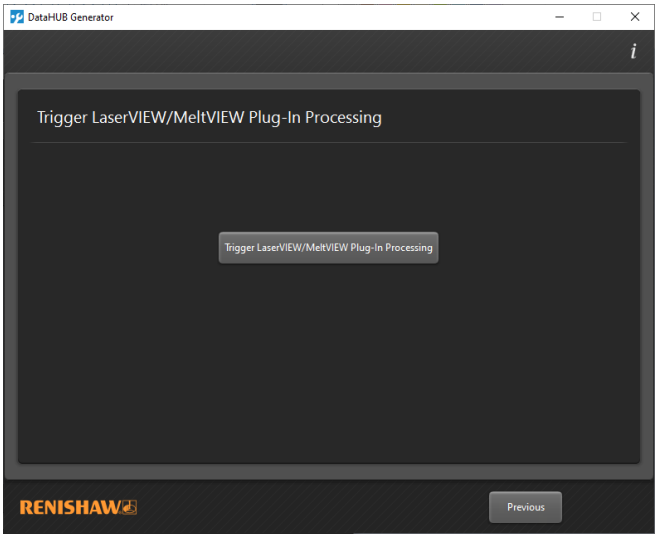


Frequently run builds may use an identical set of parameters each time. To avoid having to enter them every time, you may instead click the ‘Load initialisation data’ button to load prepared JSON from a file.

When you click the ‘Next’ button, the data you have entered is validated. If it is not valid JSON, you will not proceed to the next screen, but instead be presented with an error.

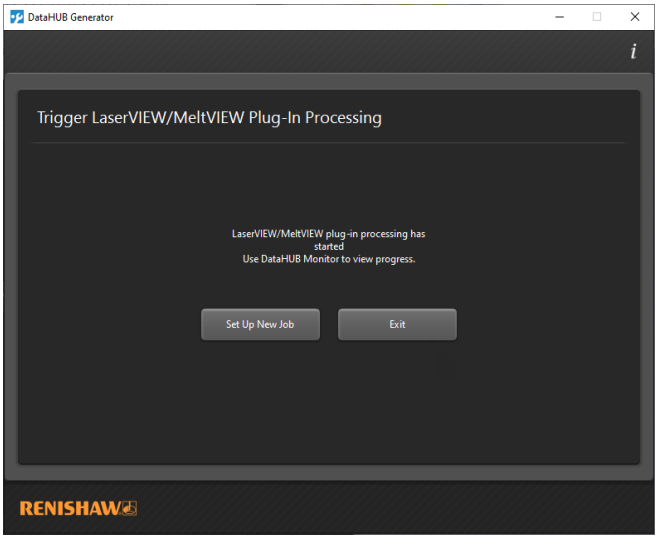


The final screen allows you to confirm the details you have provided and trigger the start of the processing job.



Once you have triggered the start of the build, you can return to the start of the process and set up a new processing job or close the application.

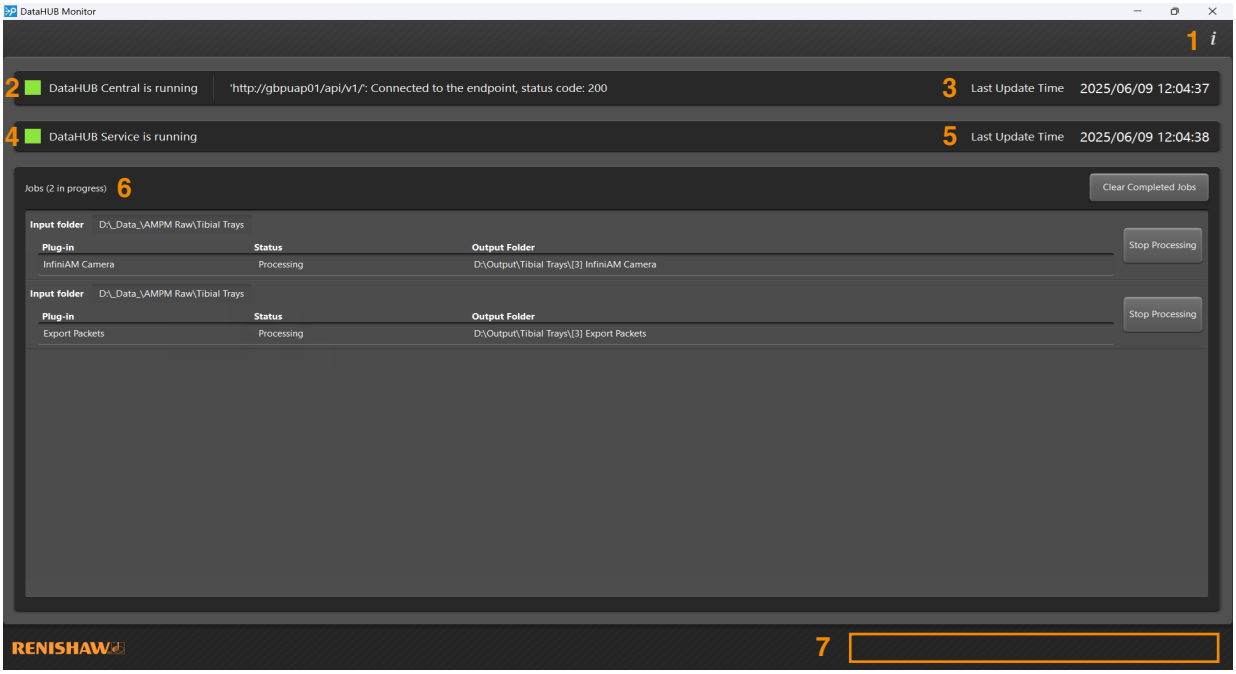
NOTE: DataHUB Generator does not provide any feedback on plug-in progress. Progress can be monitored via DataHUB Monitor.



6.3 DataHUB Monitor

6.3.1 Monitoring the processing AMPM data

The user interface displays the following information:



1 About

Click the icon to view the details about the application.

2 DataHUB Central's status

Displays the status of DataHUB Central (whether it is installed, whether it is running, and whether it is connected).

3 Last Update Time

Displays the last update time for DataHUB Central Service status.

4 DataHUB Service's status

Displays the status of DataHUB Service (whether it is installed, and whether it is running).

5 Last Update Time

Displays the last update time for DataHUB Service status.

6 Jobs

Displays the number of jobs being processed.

7 Alerts

Displays any errors which may have occurred whilst running DataHUB.

NOTE: There may be a significant pause before a job appears in the list on the DataHUB Monitor. This occurs when many data files are being validated.

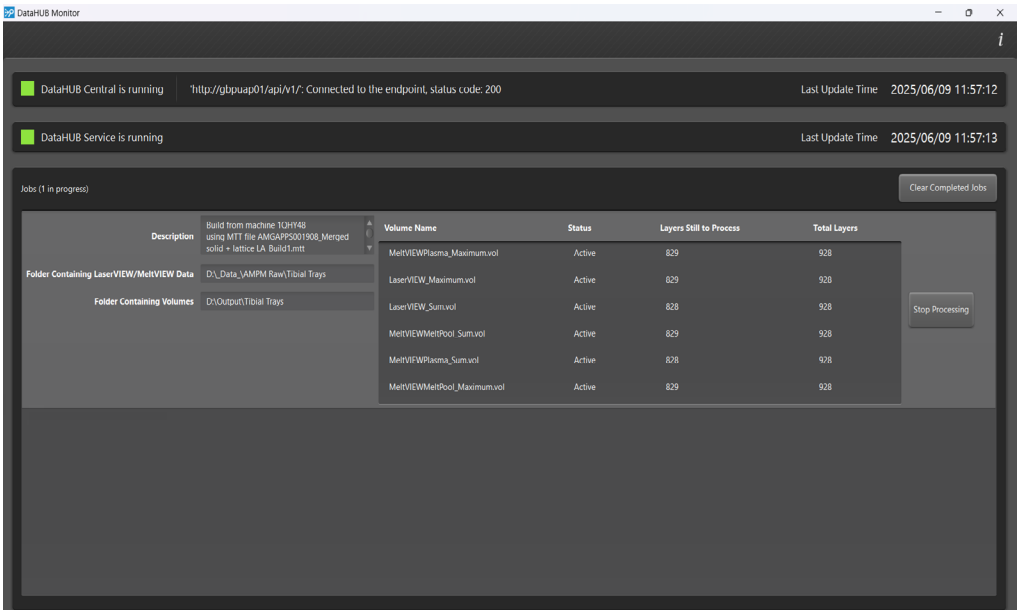
6.3.2 Spectral pipelines

For each Spectral job, the following information is displayed:

- A description of the job.
- The folder containing the data captured by the MeltVIEW and LaserVIEW hardware.
- The folder containing the output volumes.
- Information about the volumes being processed.

For each volume, the following information is displayed:

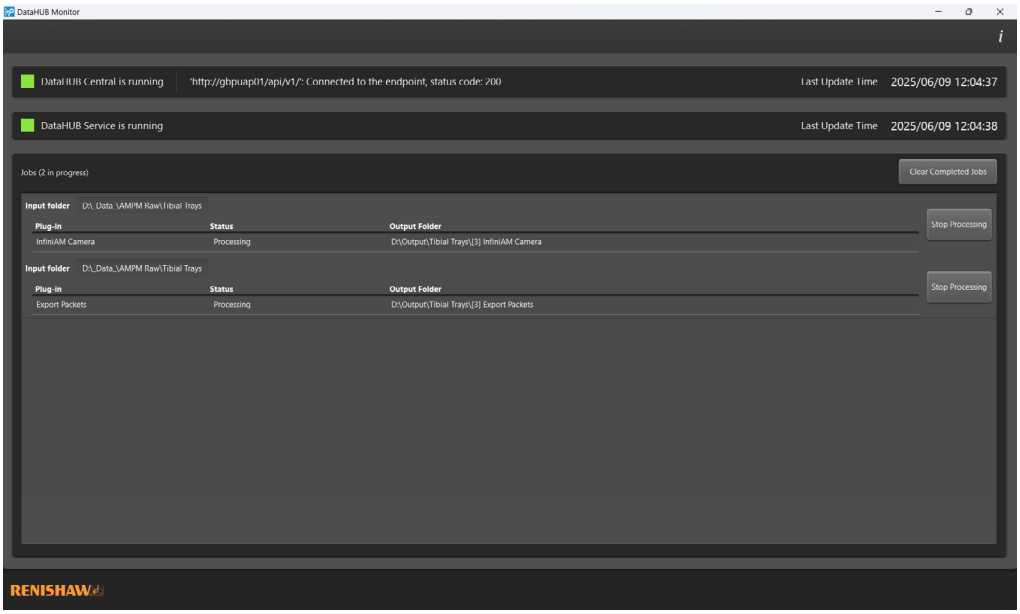
- The volume name.
- The volume status (active, waiting for data, finished, error or cancelled).
- The number of layers still to be processed.
- The total number of layers.



6.3.3 Plug-in pipelines

For each plug-in job, the folder that contains the build is displayed. For each plug-in instance that DataHUB is running, the following is displayed:

- The display name of the plug-in, as reported by the plug-in's "DisplayName" property.
- The status of the plug-in.
- The file path to the folder where output from this plug-in will be written to.



6.3.4 Cancelling a job

The 'Stop processing' button is used to send signals to DataHUB Service that it should stop processing data for that job immediately, regardless of how much unprocessed data is available. This is useful if an error has been made in setting up a job, or if it is desirable for data processing to cease for any other reason.

6.3.5 Error

If a task status is shown as 'Error', a catastrophic error has occurred, which means no further processing can take place. For example, this could happen if a partially completed volume is deleted during processing.

6.3.6 Housekeeping

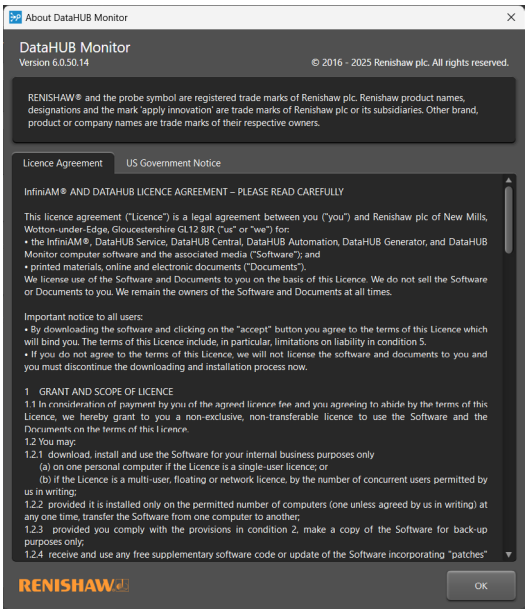
The 'Clear Completed Jobs' button is used to clear all jobs that are not in progress, specifically those with task statuses of finished, cancelled, or in error.

6.3.7 About

The ‘About’ window provides information on the following:

- The version of the software.
- The copyright information.

It also displays a copy of the full licence agreement.



6.4 Communicating with Renishaw Central

Provided it has been configured on installation, DataHUB Central manages communication between DataHUB and Renishaw Central. Once configured, this does not require any user intervention.

NOTE: Not all legacy data is supported. DataHUB can only send outputs from builds produced by a machine running MSS v1.4.0 or higher to Renishaw Central.

7 Automating DataHUB

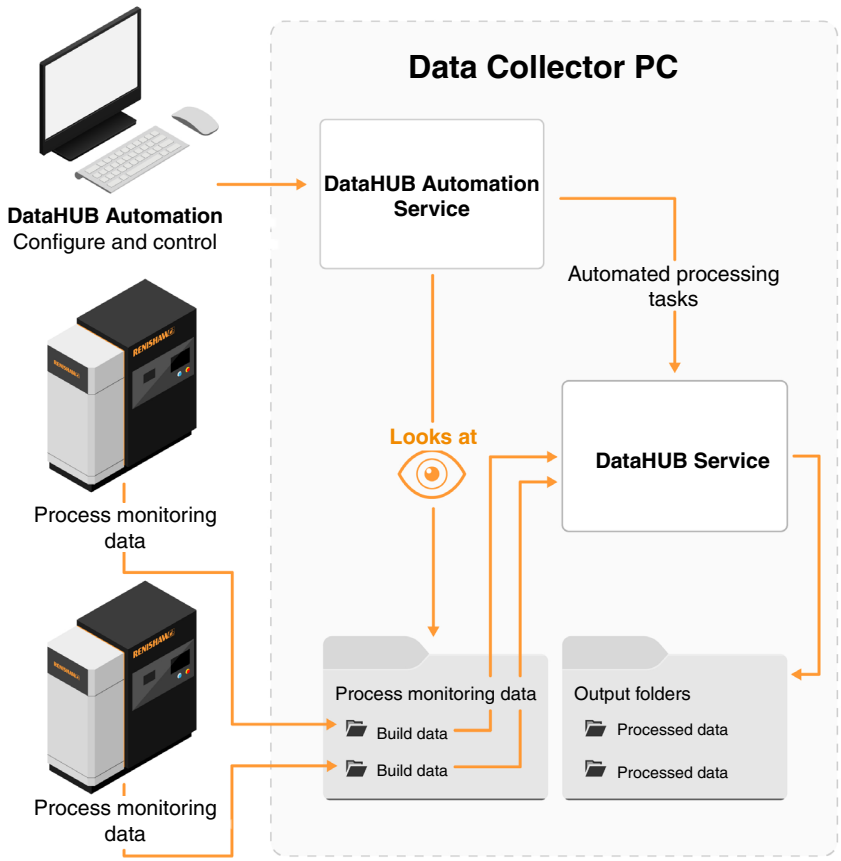
DataHUB Automation automates the handling of process monitoring data collected on a Data Collection PC (DCPC). After configuration, process monitoring data is processed without further user intervention to produce data for InfiniAM, plug-in analysis results, and other data visualisers.

The automation system provides a comprehensive and flexible apparatus to streamline process monitoring data handling, given the wide variety of builds, materials, and other process variables. For example, a build in titanium may require a particular range of plug-in parameter values, while a build in steel may need a different set of values. A build of a certain part on any machine may require no automatic data processing, whilst all builds by a specific machine may not require CameraVIEW data processing. All such process monitoring goals may be achieved with a suitably configured DataHUB Automation system.

The automation system comprises two components:

- The DataHUB Automation front end, used to configure the processing tasks that should be performed when builds start.
- The DataHUB Automation Service that monitors for new builds and initiates the configured processing tasks.

The principal interactions between the automation system and the AM system are illustrated below:



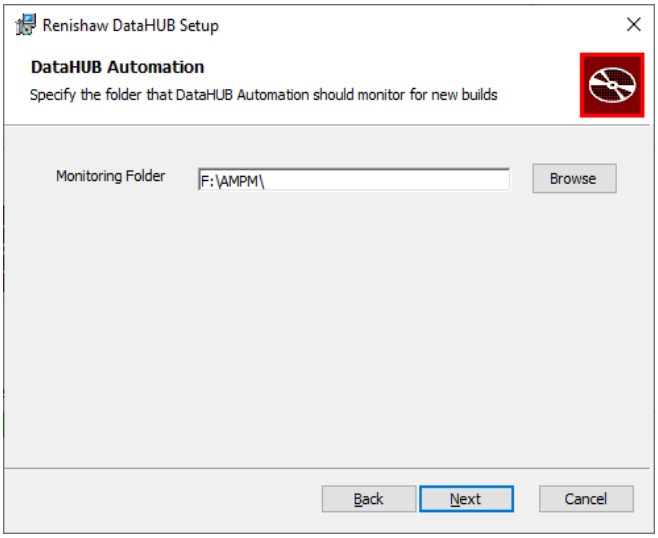
Renishaw AM machines transfer process monitoring data to a DCPC hosting the DataHUB software suite. The DataHUB Automation Service monitors for new builds and, when one is detected, tests various details of the build against a list of “matching rules”, each specifying a number of processing tasks. If the build details satisfy a matching rule, the automation service instructs the DataHUB Service to begin the associated processing tasks.

The matching rules are defined using the DataHUB Automation front end. In this application, rules are added, refined, and reordered so that processing tasks relevant to machines, materials, parts and so on are triggered automatically as soon as process monitoring data is available.

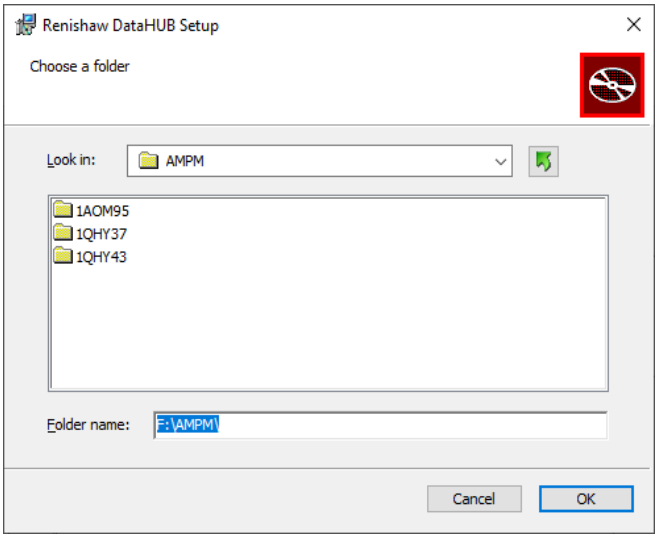
7.1 Installation

DataHUB Automation is installed with all other DataHUB services and applications on a DCPC when ‘Renishaw DataHUB Set-up.exe’ is run.

During installation, DataHUB Automation must be instructed where on the DCPC it should monitor for builds. This should be the physical path on the DCPC chosen when configuring the FTP site for the DTS service – please refer to the InfiniAM and DataHUB software installation guide (Renishaw part no. H-5800-4349) for full details on this commissioning activity.



Clicking the ‘Browse’ button launches a folder browser dialog box which allows you to select the folder to monitor.



7.2 DataHUB Automation front end

The DataHUB Automation front end configures how DataHUB Automation determines if processing should be performed for a new build and, if so, what processing should be performed.

The application has two modes of operation: configuring the matching rules and exercising the matching rules.

7.2.1 Matchers

DataHUB Automation uses a list of matching rules – matchers – to determine what to do when a new build is detected. Each matcher defines:

- Criteria that a build must satisfy to be a “match”.
- The processing that should then be performed.

When DataHUB Automation detects a new build, it tests that build against each matcher in order. If a match is found, DataHUB Automation ceases testing any further matchers: a build can match at most one matcher.

If a build does not match any matchers, DataHUB Automation does not initiate any processing for that build. Processing may be started manually using DataHUB Generator, if desired.

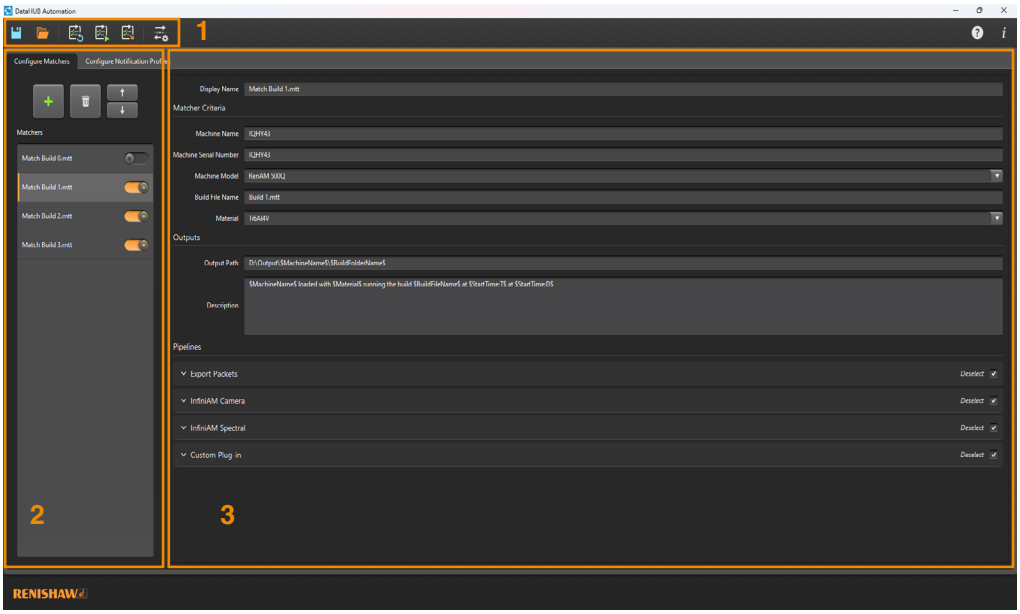
When the application starts, the current automation configuration is displayed.

7.2.2 Parameters and substitution

Each individual build contains values – the total build height, the machine producing the build, and so on – that are useful when configuring the automation system. Such parameters are integrated into the matchers: parameters are used as placeholders when defining a matcher and are substituted with the real values defined by a particular build.

7.2.3 Configuring matchers

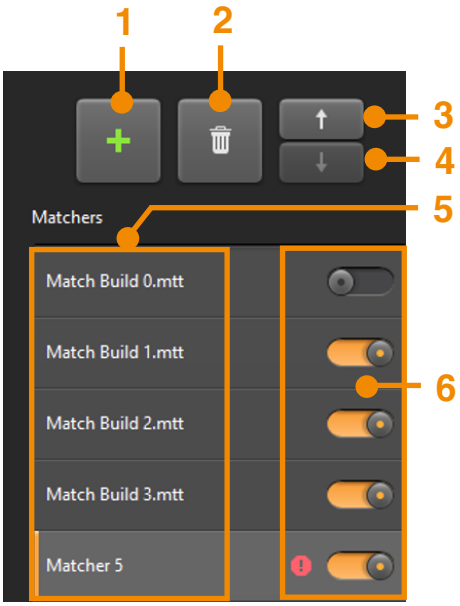
There are three main elements to the ‘Configure Matchers’ mode:



1. The menu bar
2. The list of matchers
3. Configuring the selected matcher

7.2.3.1 The list of matchers

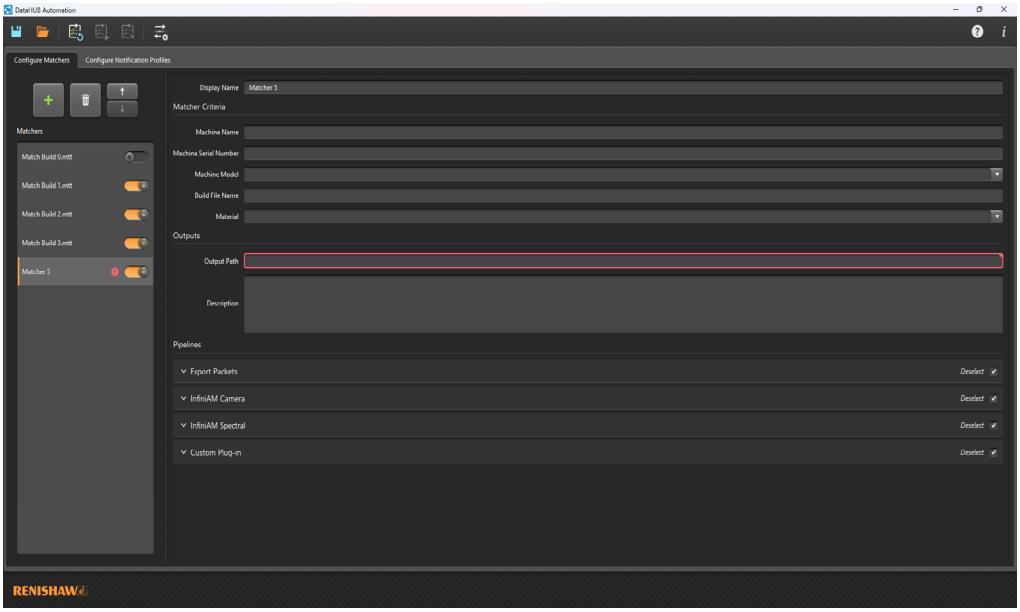
The left-hand panel provides functions to manage the list of matchers.



1. The ‘Add a new matcher’ button
2. The ‘Delete the selected matcher’ button
3. The ‘Move the selected matcher up’ button
4. The ‘Move the selected matcher down’ button
5. The list of matchers
6. The ‘Enable/disable matcher’ toggle

Adding a matcher

Clicking the ‘Add a new matcher’ button adds a new matcher to the end of the list with default values and selects it.



Selecting a matcher

Clicking on a matcher in the list of matchers displays its current configuration in the right-hand panel. The selected matcher may be removed, reordered, or modified.

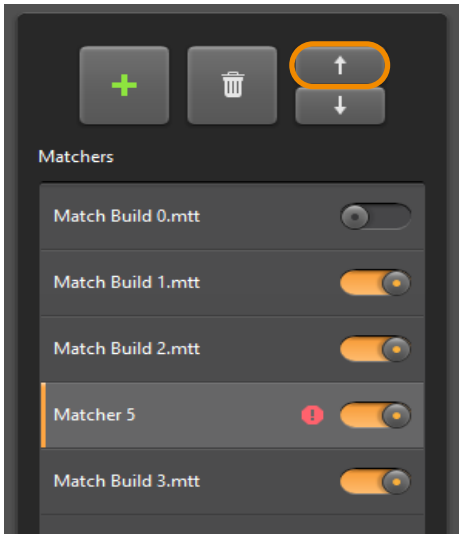
Reordering matchers

The matcher order displayed on the UI is the order in which the matchers are tested by DataHUB Automation.

When DataHUB Automation detects a build, it compares it against each matcher in turn until it finds a match.

NOTE: If the build could match more than one matcher in the list of matchers, only the first matcher is matched, and DataHUB Automation will start only one set of processing actions.

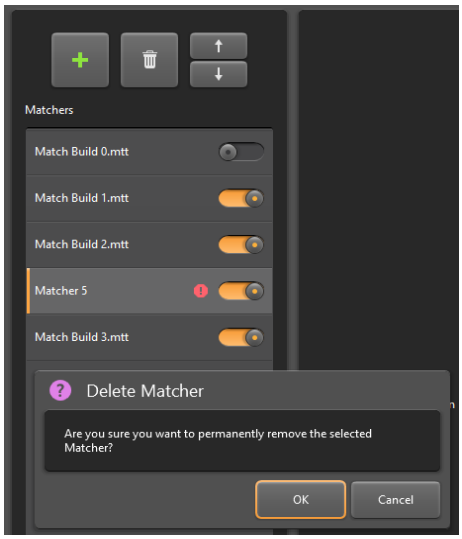
Click the ‘Move the selected matcher up’ button or the ‘Move the selected matcher down’ button to move the selected matcher one place in the respective direction.



Deleting a matcher

Click the ‘Delete the selected matcher’ button to permanently remove the selected matcher from the list.

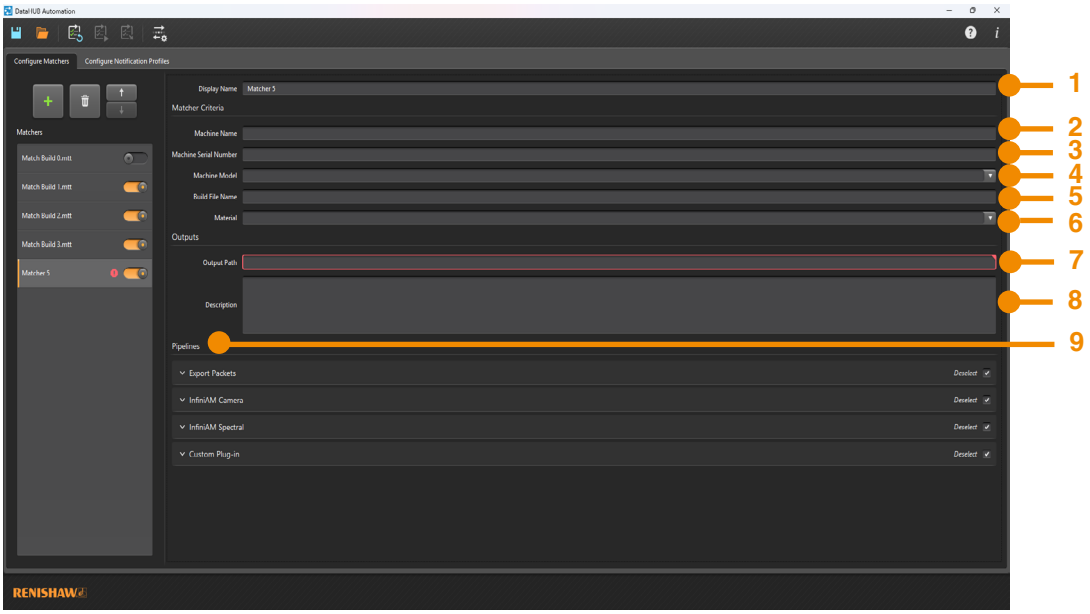
NOTE: This action cannot be undone so, to prevent accidental loss of data, the deletion must be confirmed.



Enabling/disabling matchers

Clicking the ‘Enable/disable matcher’ toggle of a matcher toggles between an enabled (orange) and disabled (grey) state. Disabled matchers are not considered by the DataHUB Automation service; disabling matchers may be preferred over permanent deletion.

7.2.3.2 Configuring the selected matcher



The right-hand panel provides functions to configure the selected matcher.

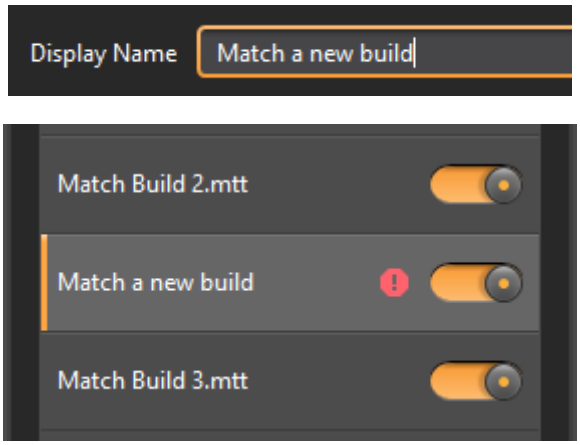
1. The ‘Display name’ field
2. The ‘Matching criteria for Machine Name’ field
3. The ‘Matching criteria for Machine Serial Number’ field
4. The ‘Matching criteria for Machine Model’ field
5. The ‘Matching criteria for Build File Name’ field

6. The ‘Matching criteria for Material’ field
7. The ‘Output Path’ field
8. The ‘Description’ field
9. The ‘Pipelines’ currently installed and available to DataHUB on the DCPC

There are two tasks when configuring a matcher:

1. Defining what builds a matcher will match
2. Defining what processing should be performed on a match

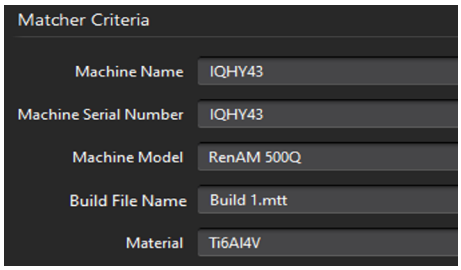
In addition, the ‘Display name’ field provides a user-friendly name to identify a particular matcher from the list of matchers:



Defining a matching build

There are five properties of a build that a matcher can test:

- The name of the machine that produced the build
- The serial number of the machine that produced the build
- The model of the machine that produced the build
- The name of the MTT file used by the build
- The material used by the build



The matcher tests each of a build's properties against the patterns of the corresponding fields. An empty field indicates the property should not be tested. To match, the build property must either:

- exactly match the value in the field, or
- make a partial match using the wildcard character "*"

A wildcard matches zero or more characters. For example, "abc*" matches any value that starts with the characters "abc" regardless of what follows, so would match "abc", "abcd", or "abc123", and so on.

All pattern matches are case-sensitive except for the Build file name (which follows the convention for Windows file paths in being case-insensitive).

In addition, in real data the 'Machine Model' field and 'Material' field are often taken from a common list of values. By clicking the down arrow, typical values available for these fields may be seen.

The list of standard materials is:

- Aluminium: 'AlSi10Mg'
- Cobalt-Chrome: 'CoCr-2LC'
- Inconel 625: 'In 625'
- Inconel 718: 'In 718'
- Maraging Steel: 'Maraging Steel'
- 316L Stainless Steel: 'SS 316L'
- 17-4 PH Stainless Steel: '17-4PH Steel'
- Titanium: 'Ti6Al4V'

This list represents the most common materials processed by the RenAM 500 series. However, Renishaw provides official support for various materials outside this list, and experimentation with novel materials is supported by QuantAM Material Editor.

For materials outside the standard list, a custom matcher can be specified by the user that reflects the material name.

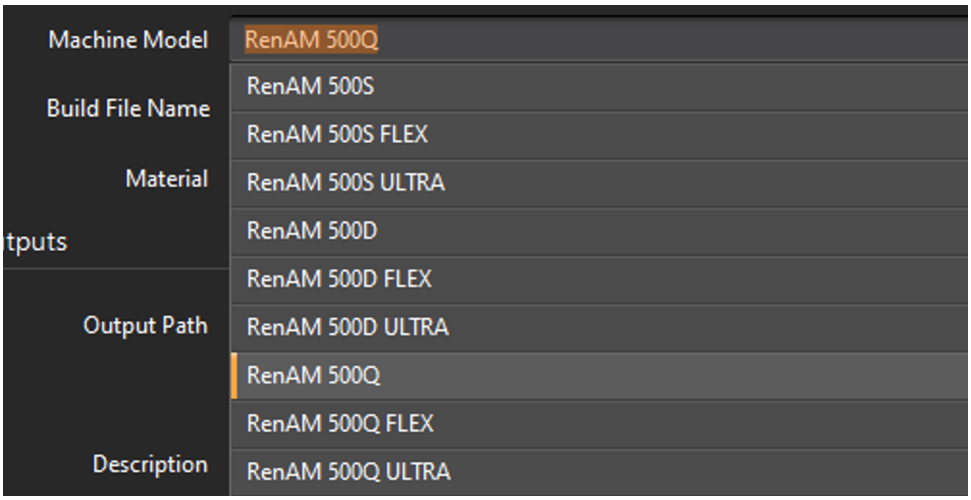
NOTE: For more information about the materials supported by the RenAM 500 series, including material property data, see **www.renishaw.com/metalpowders**.

The machine models are made up of the following components:

- A standard model is RenAM 500(number of lasers), with a powder recirculation system, reusing powder from the overflow hopper
  - ‘RenAM 500S’ – Single laser
  - ‘RenAM 500D’ – Dual laser
  - ‘RenAM 500Q’ – Quad laser
- ‘RenAM 500S/D/Q FLEX’ – the machine is a Flex total powder loss variant, replacing the overflow hopper powder recirculation
- ‘RenAM 500S/D/Q ULTRA’ – A standard model with the optional TEMPUS and AMPM modules

This leads to a total of nine possible combinations:

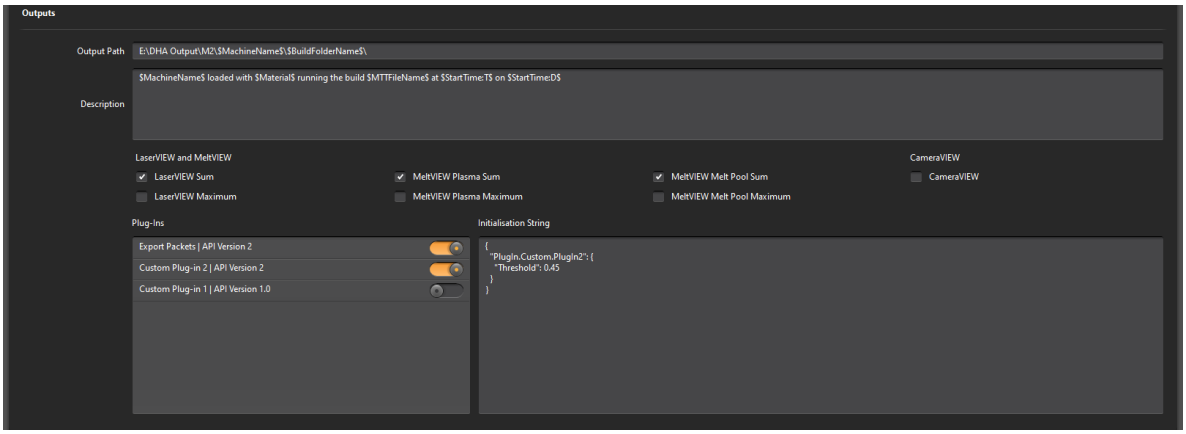
- ‘RenAM 500S’
- ‘RenAM 500S Flex’
- ‘RenAM 500S Ultra’
- ‘RenAM 500D’
- ‘RenAM 500D Flex’
- ‘RenAM 500D Ultra’
- ‘RenAM 500Q’
- ‘RenAM 500Q Flex’
- ‘RenAM 500Q Ultra’



7.2.3.3 Result processing

The three key pieces of information DataHUB Automation needs are:

1. What processing should be performed
2. What parameters they should be processed with
3. Where the output of the processing should be stored



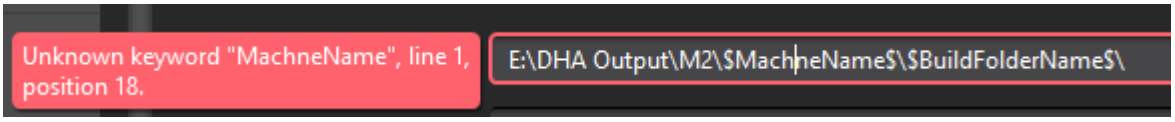
Output path

The ‘Output Path’ field describes the folder path that should be used as the root output folder for all processing tasks. For example, with an output path of “`C:\Output`”, the ***LaserVIEW Maximum*** InfiniAM dataset will be stored at the location <`C:\Output\LaserVIEW_Maximum.vol`>.

The ‘Output Path’ field supports parameters and must be a valid path. For more information, see section 7.2.3.5, “Parameterisation”.

NOTE: A matcher is applied to ALL builds that are matched to it. It is particularly important to ensure that ‘Output path’ resolves to a unique value for every build – using parameters can help guarantee this. For more information, see section 7.2.3.5, “Parameterisation”.

If the ‘Output Path’ is not valid, or contains unknown or malformed parameters, an error message is reported next to the field.

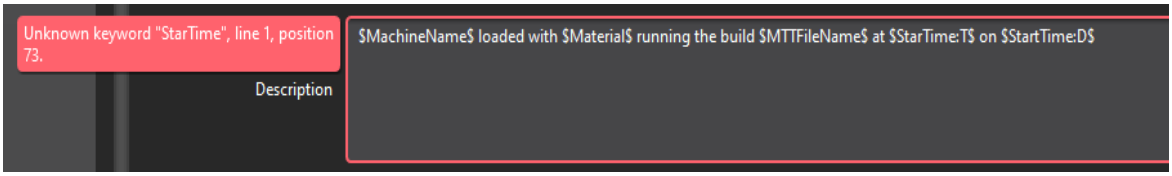


Description

The ‘Description‘ field generates a description used in the processing outputs to help identify the nature of the data. The field supports parameters.

NOTE: If no ‘Description’ is required, this field can be left blank.

If the ‘Description’ field contains unknown or malformed parameters, an error message is reported next to the field.



7.2.3.4 Pipelines

You can select the pipelines required to process any matched builds and the specific parameters required by those pipelines. Each pipeline can be individually configured. For more information, see section 6.1.1.2, “Configure Pipelines stage”.

Some pipelines are configured using initialisation data that conforms to a JSON schema. DataHUB will ensure that any text entered in the ‘Initialisation Data’ field is a valid JSON, however, it will not validate it against the schema required by the associated plug-in. Clicking the associated ‘Load Initialisation Data’ button will open a file browser, allowing you to load a file containing pre-prepared parameters.

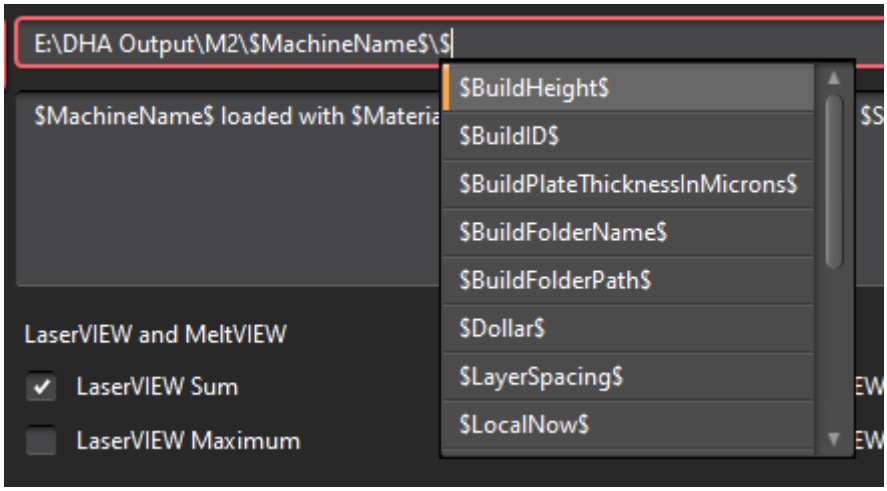
NOTE: If no ‘Initialisation Data’ is required, this field can be left blank.

The InfiniAM Camera pipeline allows you to select from the available notification profiles. All selected notification profiles will be used to generate notifications. For more information, see section 7.2.4, “Notification profiles”.

7.2.3.5 Parameterisation

Most jobs require tailoring to the needs of the build – consequently, output fields support parameters that are resolved at the point that DataHUB Automation detects that a build has started. For example, the parameter ‘$MachineName$’ is replaced by the actual machine name of the matched build.

To assist with parameterisation on any of the ‘Output path’, ‘Description’, or ‘Initialisation String’ fields, typing a ‘$’ opens a list of supported parameters:



A parameter may be selected using the up and down cursor keys and then inserted into the relevant field by pressing Enter, the Tab key or the spacebar. You can also insert any parameter by clicking on it in the list.

Supported parameters

The following are the parameters recognised by DataHUB Automation:

- `$BuildHeight$`: in millimetres
- `$BuildID$`: a unique identifier for the build as an 8-digit code
- `$BuildPlateThicknessInMicrons$`: as defined for a build
- `$BuildFolderName$`: the name of the folder that contains the build process monitoring data
- `$BuildFolderPath$`: the full folder path that contains the build process monitoring data
- `$Dollar$:` an escape sequence for the literal character '$'
- `$LayerSpacing$`: in millimetres
- `$LocalNow$`: the local time at which DataHUB Automation detected the build, in the format "yyyy-MM-dd HH-mm-ss"
- `$MachineModel$`: as defined for a build
- `$MachineMSSVersion$`: as defined for a build
- `$MachineName$`: as defined for a build
- `$MachineSerialNumber$`: as defined for a build
- `$Material$`: as defined for a build
- `$MTTFileName$`: as defined for a build
- `$StartTime$`: as defined for a build, in the format "yyyy-MM-dd HH-mm-ss"

When a build is processed by DataHUB Automation, these parameters are replaced with the corresponding build values. For example, the value `$MachineSerialNumber$` is replaced by the serial number of the Renishaw AM machine conducting the build.

NOTE: Parameters are case-sensitive.

Formatting

All numeric and date/time parameters may be formatted to suit. If no format is specified, a default formatting is used. There are a great many ways to format numbers and dates; for examples, refer to the online documentation at **C# string formatting**. All formats described there are supported.

A format specifier is defined in a string after the parameter, separated by a colon character ':'. For example, `$BuildHeight:0.00$` presents the build height formatted to two decimal places, and a date/time formatted as `$LocalNow:D$` presents the current date/time formatted as a long date/time, for example, "Tuesday, 26 July, 2022".

Examples

A new build is detected in a folder <`C:\Data\Q64\Build_1_mtt`>, from machine Q64, at 10:30:23 2022/06/23, and is assigned a BuildID of "A1B2C3D4":

Path with no parameters

Output path "`C:\Output`"

All processed data (for every build) writes to the same single folder <`C:\Output`>

Path with one parameter only

Output path "`$BuildFolderPath$`"

All processed data for this build is written to the folder <`C:\Data\Q64\Build_1_mtt`>

Path with one parameter and further definition

Output path "`$BuildFolderPath$\Output`"

All processed data for this build is written to the folder <`C:\Data\Q64\Build_1_mtt\Output`>

Path with two parameters

Output path "$BuildFolderPath$\Output $BuildID$"

All processed data for this build is written to the folder <`C:\Data\Q64\Build_1_mtt\Output A1B2C3D4`>

Path using $

Output path "`$BuildFolderPath$\Output $Dollar$$BuildID$$Dollar$`"

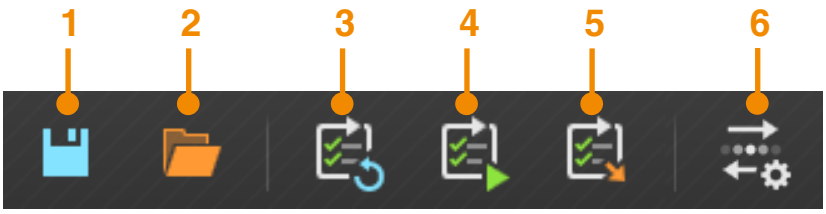
All processed data for this build is written to the folder <`C:\Data\Q64\Build_1_mtt\Output $A1B2C3D4$`>

Path with several parameters

Output path "`F:\AMPM Outputs\$MachineSerialNumber$\$BuildFolderName$\$LocalNow$`"

All processed data for this build is written to the folder <`F:\AMPM Outputs\Q64\Build_1_mtt\2022-06-23 10-30-23`>

7.2.3.6 The menu bar



The menu bar provides functions to save and restore the current session, change to the ‘Exercise Matchers’ mode, and upload the matchers to the live system.

1. The ‘Save the current session’ button
2. The ‘Open a saved session’ button
3. The ‘Import from a back-up’ button
4. The ‘Exercise the matchers’ button. This changes the screen to the ‘Exercise Matchers’ mode (available when all matchers are valid). For more information see, “Exercising the behaviour of a set of matchers”.
5. The ‘Upload the matchers to DataHUB Automation’ button
6. The ‘Configure SMTP credentials’ button

Saving and restoring the session

Clicking the ‘Save the current session’ button displays a ‘Save’ dialog box to navigate to a save location for in-progress work. This will **not** alter the live system.

A saved session may be restored by clicking the ‘Open a saved session’ button, displaying a file browser to select a saved session. If the session is successfully loaded, the complete list of matchers and all their details are replaced by those contained in the loaded session. If the load fails for any reason, the existing session is preserved.

Exercise the matchers

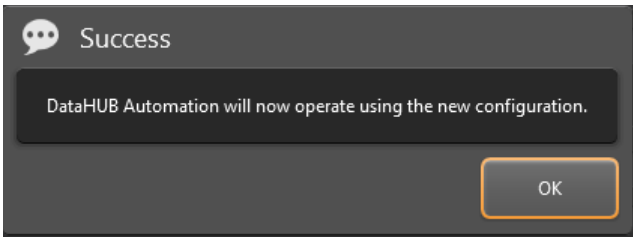
Before uploading the matchers to the live automation system, it is advisable to first test the new matcher configuration against some example builds, to prove the overall behaviour of the system. The ‘Exercise the matchers’ button switches the application into a test and diagnose mode. For more information, see “Exercising the behaviour of a set of matchers”.

Uploading the automation configuration to DataHUB Automation

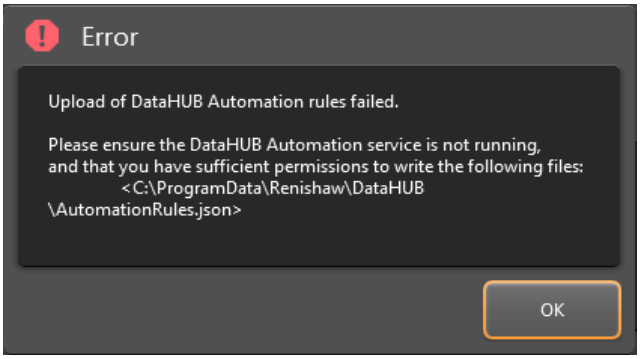
Clicking the ‘Upload the matchers to DataHUB Automation’ button uploads the matchers into the live system, replacing the previous configuration. It is possible to upload the matchers only if there is at least one matcher, and all matchers are valid.

The upload must be confirmed, and to prevent accidental loss of data, the current live configuration is automatically backed up. For more information, see “Automation configuration back-up”.

If the upload was a success, a confirmation dialog box is displayed:



If the uploaded failed, a dialog box is shown detailing the failure, for example:



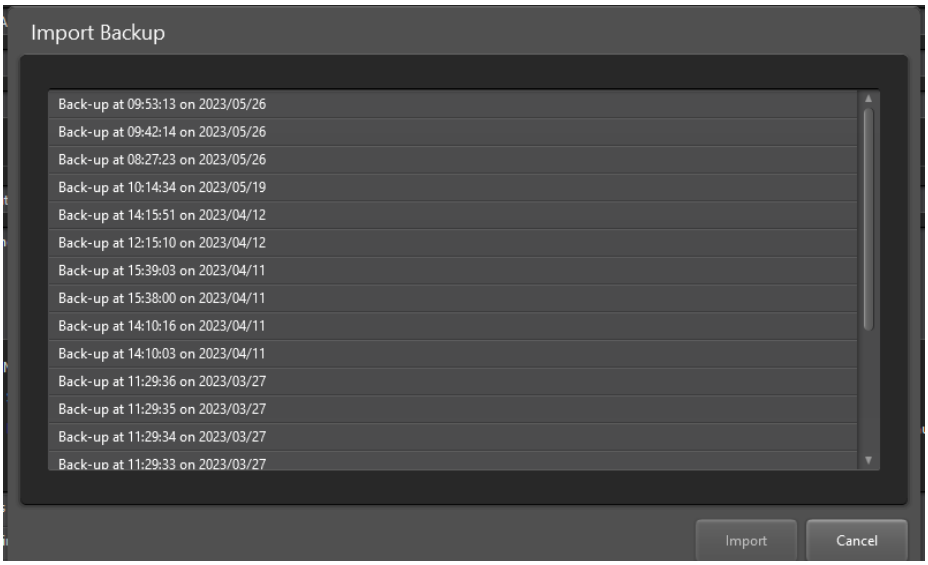
Automation configuration back-up

The previous automation configuration is lost when a new configuration is uploaded to the live system. To ensure there is a recovery point in case there is an issue with the new configuration, the previous configuration is backed up and marked with the time the back-up occurred.

If the back-up fails for any reason, the failures are displayed, and the option is offered to either continue with or cancel the upload; continuing overwrites the automation configuration with the risk of being unable to restore the configuration if desired.

Restoring an automation configuration back-up

Clicking the ‘Import from a back-up’ button displays a dialog box containing a list of all the back-ups made on this machine.

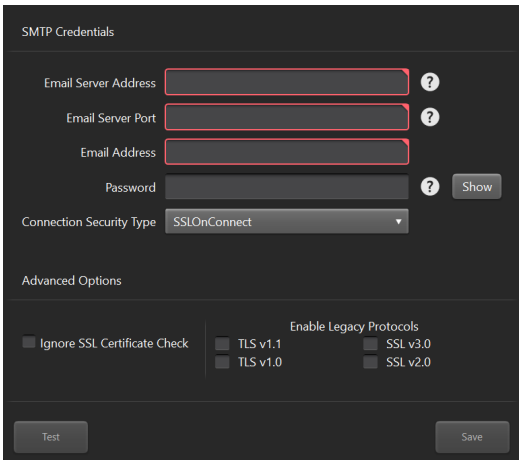


Back-ups are identified by the date and time the back-up was performed. Select the desired back-up to restore, and click the ‘Import’ button. This loads the backed-up configuration into the application, but not the live system. Uploading the loaded configuration to the live system restores the live system to the imported state.

If there is an issue loading the back-up, or if it is cancelled, the current configuration is not altered.

Configuring notifications

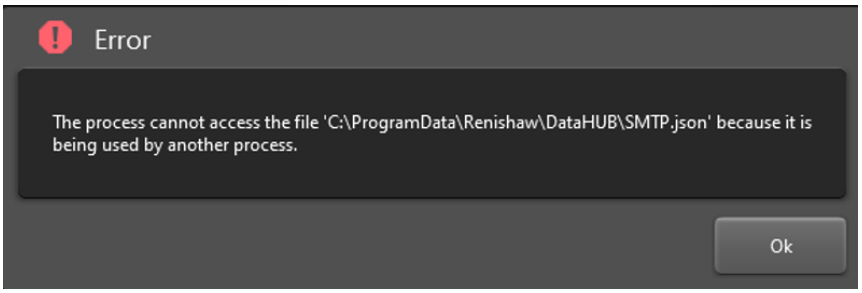
The ‘Configure SMTP Protocols’ button allows you to set up the credentials needed for an SMTP server to send emails using the automation application.



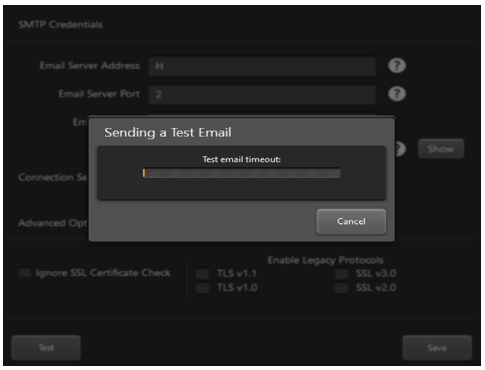
The fields are populated with the persisted SMTP credentials, which are initially blank. Before the credentials can be saved or tested, they must adhere to the following rules:

- Host Address must not be blank.
- Port Number must be a positive integer.
- Sender Address must not be blank.

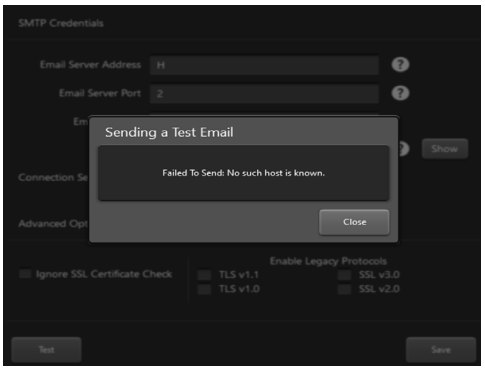
If any field contains invalid SMTP credentials, the system will prevent the file from being saved and display the following error message.



When all fields are valid, the SMTP credentials can be tested by clicking the ‘Test’ button. During testing, a dialog box will appear, indicating that a test email is being sent to the provided address using the specified details.



The result of sending the test email will be shown in the dialog box. To confirm everything is working, check your inbox for the test email. If the email service is unable to connect, particularly with a new server address, it might take a while or display a message indicating that the email has failed to send.



7.2.4 Notification profiles

Notification profiles allows you to control the timing and recipients for notifications generated by the CameraVIEW Anomaly Detection plug-in. The plug-in is capable of supporting multiple notification profiles. Each profile includes three components:

- The recipient of the notification.
- The interval at which the notification is sent.
- Whether to send a notification when DataHUB completes a build processing, regardless of the configured interval.

Each notification profile can be triggered at one of four intervals:

- Layers: Notifications are generated after a fixed number of layers has elapsed.
- Layers with anomalies: Notifications are generated after a fixed number of layers has elapsed, provided that period includes at least one anomaly.

- Minutes: Notifications are generated after a fixed number of minutes has elapsed.
- Minutes with anomalies: Notifications are generated after a fixed number of minutes has elapsed, provided that time period includes at least one anomaly.

If a profile is configured with multiple types of intervals, they will be prioritised in the following order: ‘Layers’, ‘Minutes’, ‘Layers with anomalies’, and then ‘Minutes with anomalies’.

NOTE: The minimum configurable time-based interval is 1 minute.

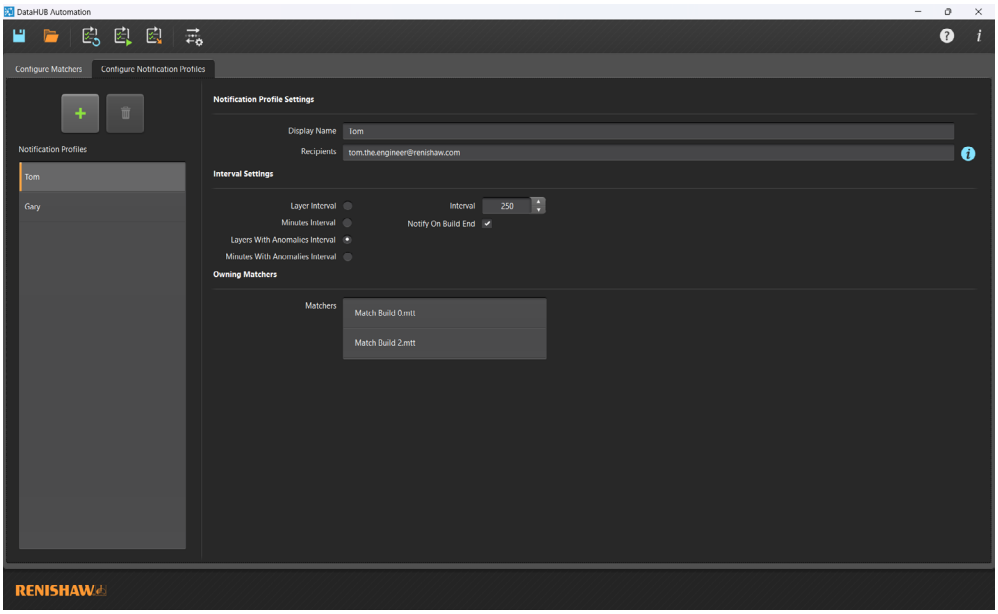
NOTE: Notifications will only be generated for layers on and after the StartAnomalyDetectionOnLayer parameter. For more information, see section “Tuning the anomaly detection performance”.

7.2.4.1 Configuring notification profiles

The following procedure outline the steps to configure the notification profile.

1. Open DataHUB Automation.
2. Navigate to the ‘Configure Notification Profiles’ tab.
3. Add or select the matcher from the left-hand panel to configure the notification profile.

NOTE: It is possible to add multiple recipients. Recipients should be separated by commas.



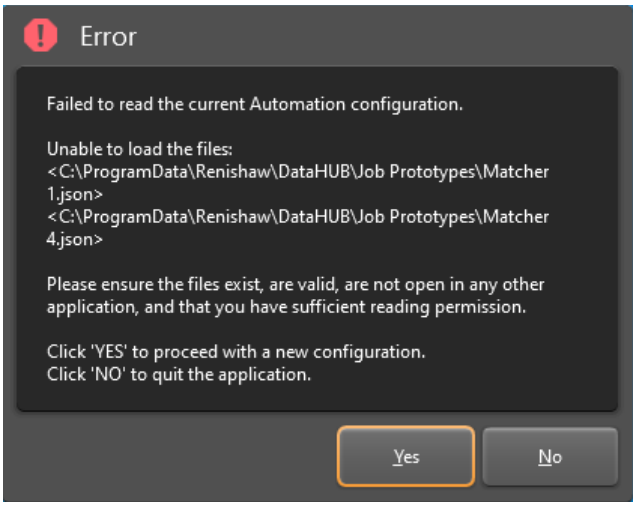
To save the notification profiles, you can choose one of the following methods:

- Save the automation session and load it the next time you enter DataHUB Automation.
- Upload the automation configuration, and it will be automatically loaded on start-up of automation.

NOTE: If you restore a previous automation configuration, the profiles from the time of that upload will be restored.

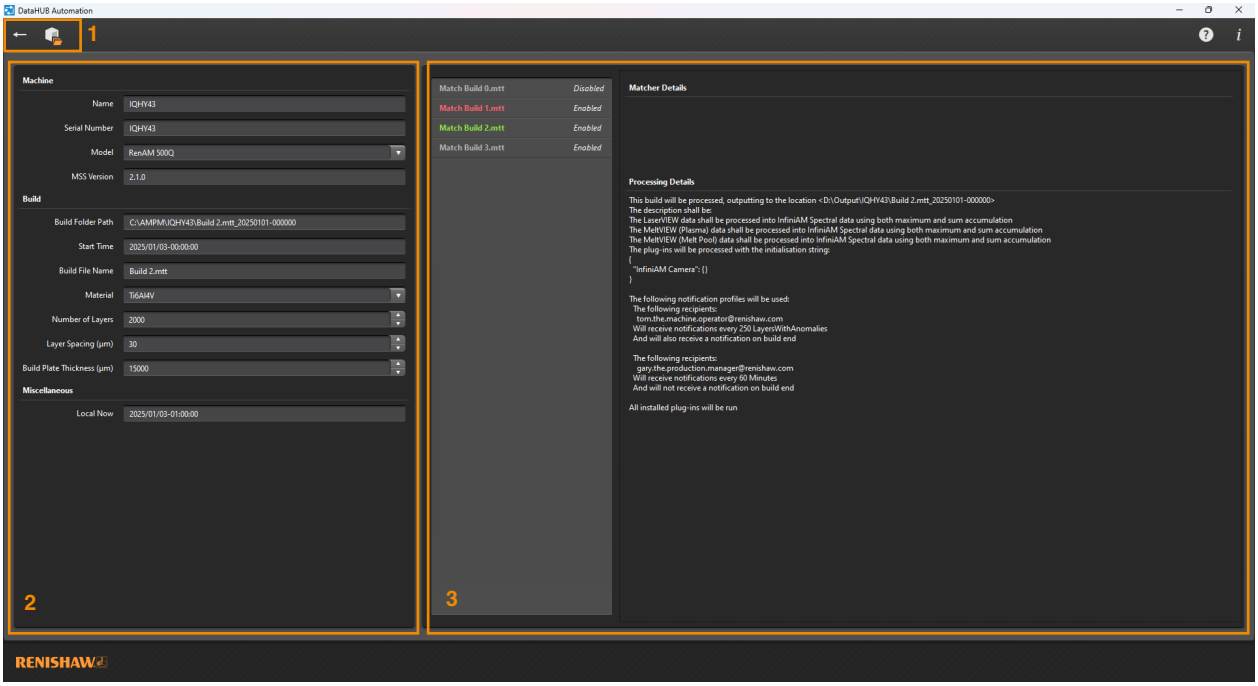
7.2.5 Recovery from corrupt configurations

Should the application fail to load the current configuration, an error is displayed. The choice is offered to continue to configure DataHUB Automation from a blank slate, or to quit the application to preserve the state of the system for diagnosis.



7.2.6 Exercising the behaviour of a set of matchers

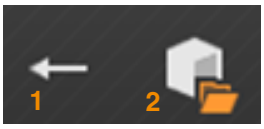
Before uploading the matchers into the live system, it is advisable to confirm the new matchers behave as expected.



There are three main elements to the Exercise Matchers mode:

1. The menu bar.
2. Entering the (test) build details.
3. The result of running the test build details through the matchers.

The menu bar provides functions to change to the Configure Matchers mode and load test data from a real build.

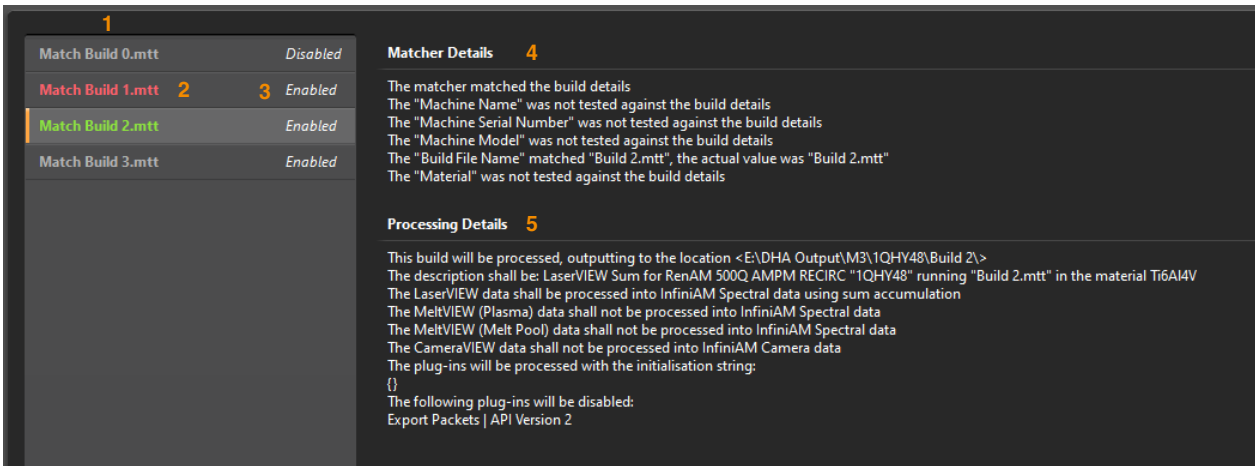


1. The “Return to configure matchers” button
2. The “Load test data from a build” button

The left-hand panel provides functions that define the “build details”, that is the test data to be run through the matchers.

1. The “Machine name” field
2. The “Machine serial number” field
3. The “Machine model” field
4. The “MSS version” field
5. The “Build folder path” field
6. The “Start time” field
7. The “Build file name” field
8. The “Material” field
9. The “Number of layers” up-down
10. The “Layer spacing” up-down
11. The “Build plate thickness” up-down
12. The “Local now” field

The right-hand panel displays the results of running the “build details” through the matchers.



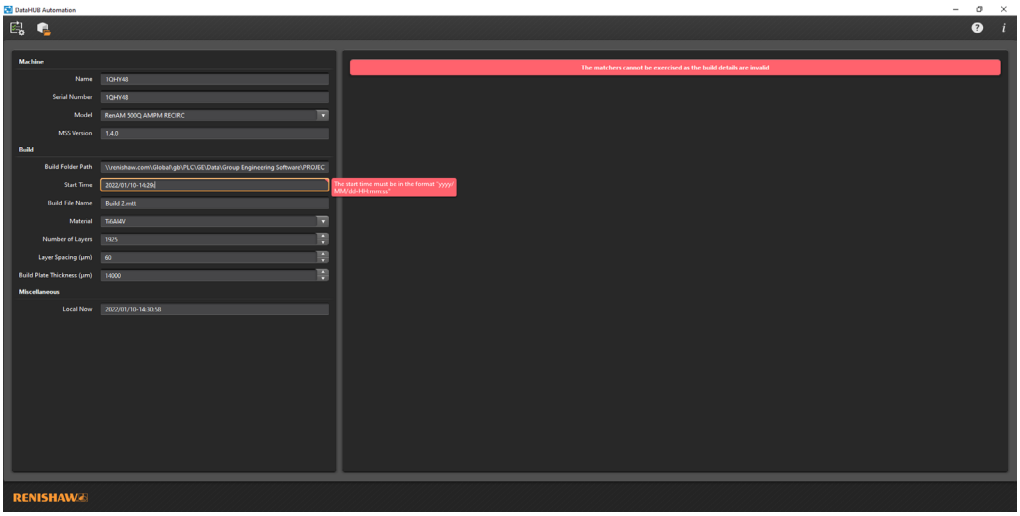
1. The list of matchers
2. The name of the matcher
3. The enabled state of the matcher
4. The matcher details
5. The processing details

7.2.6.1 Entering build details

To exercise a set of matchers, valid test build data is required. Each field that can be tested against or substituted into the output must be entered. Some of these fields must conform to additional criteria to be valid:

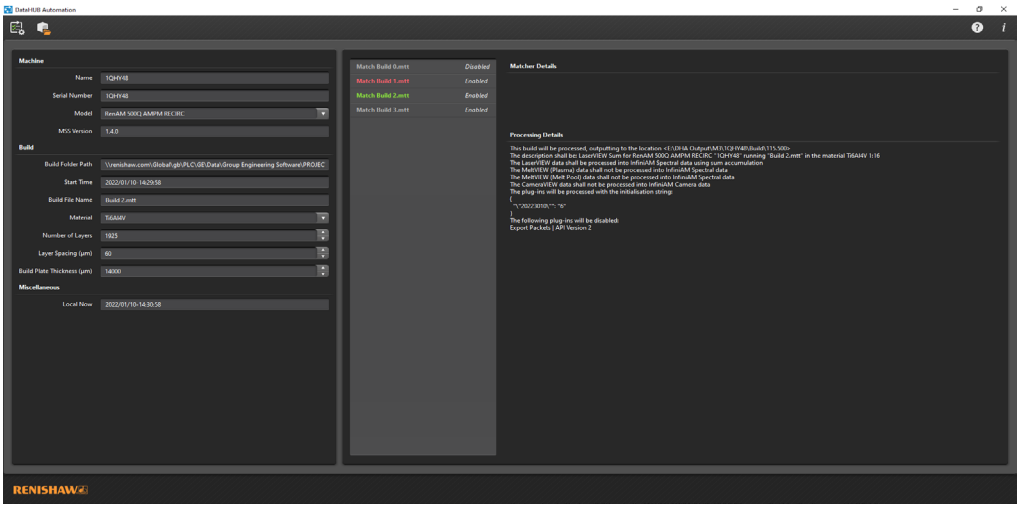
- ‘Start Time’ and ‘Local Now’ must be valid date-times, in the format identified by the watermark.
- ‘Build File Name’ must be a valid file name.
- ‘Build Folder Path’ must be a valid path.

If any field is invalid, an error identifying the issue with the data is displayed next to it and no results are displayed.



In addition, in real data the ‘Machine Model’ field and ‘Material’ field are often taken from a common list of values. By clicking the down arrow, typical values available for these fields may be seen.

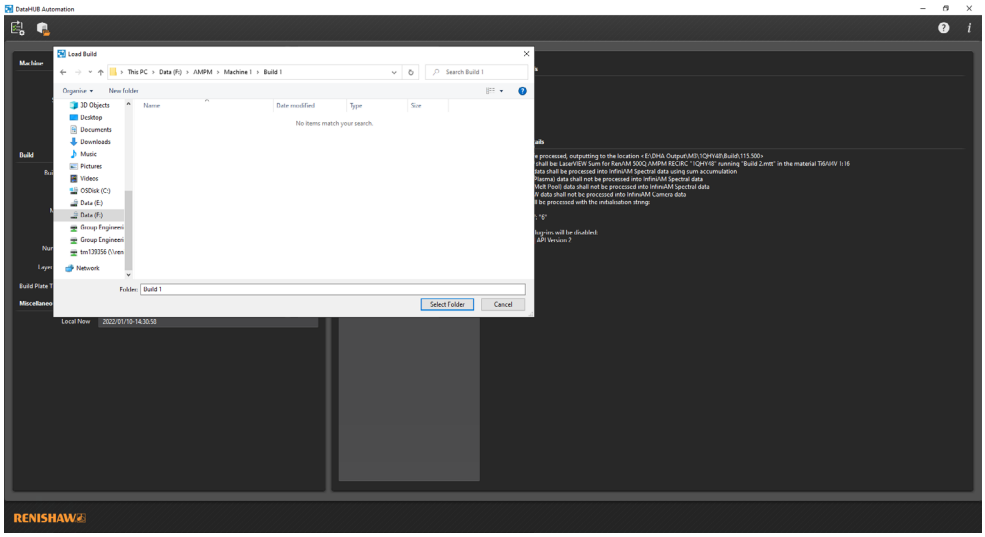
If all the fields are valid, the test data is run through the set of matchers and the results of the test are displayed to the right of the screen.



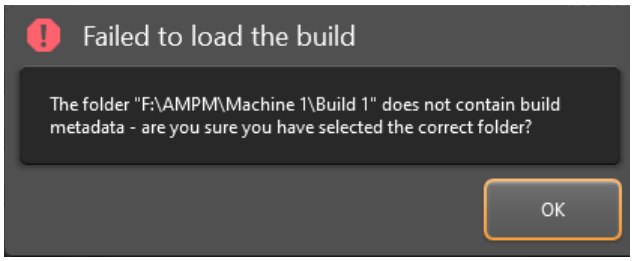
If any field is modified, assuming it is valid, the new data is run through the set of matchers and the results are updated.

7.2.6.2 Loading a build

As a convenience, or to reproduce an interaction from the live system, the data from a real build can be loaded directly into DataHUB Automation. Clicking the ‘Load test data from a build’ button in the menu bar displays an ‘Open Folder’ dialog box. Navigate to a folder that contains process monitoring data.



DataHUB Automation updates the fields using the data contained in that build. If the build cannot be loaded for any reason, the fields are left unmodified.



Once the data has be loaded it may be altered, as necessary.

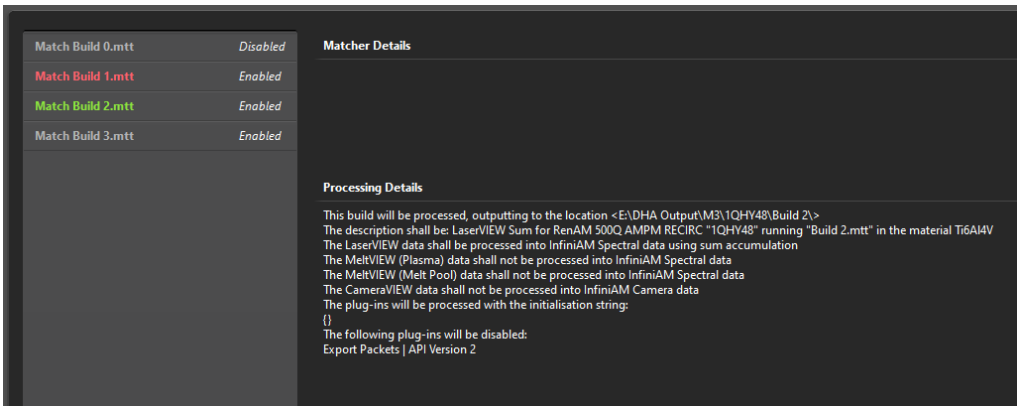
NOTE: Not all legacy data is supported. Only builds produced by a machine running MSS v1.4.0 or higher can be loaded.

7.2.6.3 Understanding the results

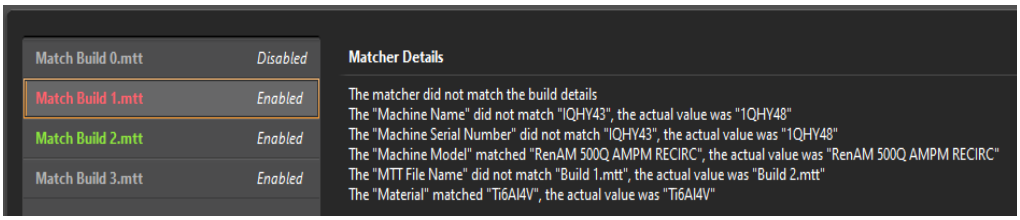
An overview of the result is displayed as a list. Each matcher has a colour-coded name indicating what happened during the tests:

- Grey: not run (either because it was explicitly disabled, or because a previous matcher matched)
- Red: was run but did not match the test data
- Green: was run and matched the test data

The following example displays the results when the data matches the third matcher ‘Match Build 2.mtt’.

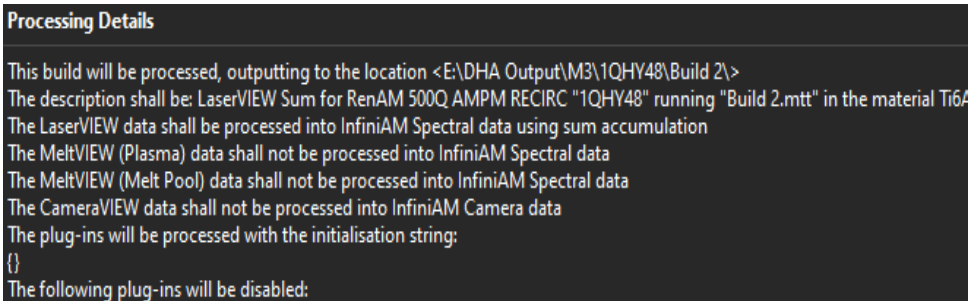


Selecting a matcher displays details about why that matcher passed, failed, or did not run against the test data.



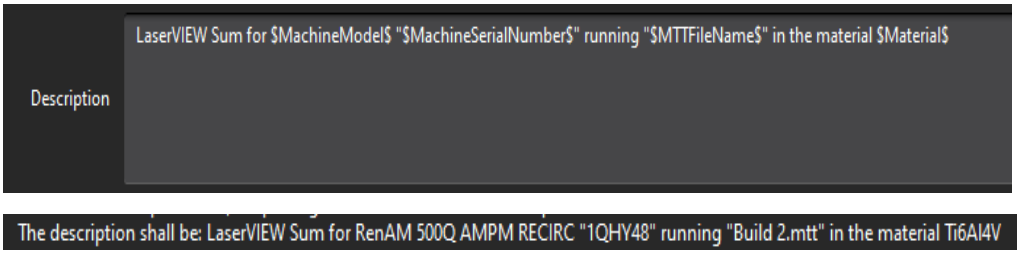
The processing (if any) that would be performed by DataHUB Automation is displayed underneath.

The following example displays the processing that would be started if an identical build was generated in the live system.



The results resolve any parameters in the ‘Output Path’, ‘Description’ or ‘Plug-in Initialisation String’ fields of the matched matcher using the test data.

The following example displays how parameters (shown in ‘Configure Matchers’) are resolved with the test build details



7.2.6.4 Further configuring matchers

After evaluating the matchers, it may be apparent they do not behave as expected and require modification. Alternatively, testing may have proven they behave as expected and should be deployed to the live system. In either case, clicking the ‘Configure the matchers’ button returns to the previous mode.

8 Process Monitoring Data Processing

8.1 InfiniAM Spectral

If DataHUB has the 'LaserVIEW/MeltVIEW Processing' feature licensed and the selected build has LaserVIEW/MeltVIEW data available, you will be able to process the build with the 'InfiniAM Spectral' pipeline. The 'InfiniAM Spectral' pipeline converts LaserVIEW and MeltVIEW data into a format that can be viewed in InfiniAM.

Each of the three channels, LaserVIEW, MeltVIEW (Melt Pool), and MeltVIEW (Plasma) can be processed using two accumulation methods: 'Maximum' and/or 'Sum'. This means that DataHUB can produce up to six artefacts for each build. Regardless of the accumulation method selected, the 3D data will have an X, Y, and Z resolution (voxel size) of 240 µm (0.009 in).

When processed using the 'Maximum' accumulation method, the 2D data will have an X and Y resolution (pixel size) of 150 µm (0.006 in). Both pixel and voxel values are calculated using the maximum photodiode signal that falls within the area/volume they encompass. These volumes are useful for seeing overall trends in the build and highlighting areas that have unexpectedly high signals.

When processed using the 'Sum' accumulation method, the 2D data will have a pixel size of 40 µm (0.0015 in). Both pixel and voxel values are calculated using a scaled sum of the signals that fall within them. These volumes show the fine detail of the actual hatch lines, showing what energy has been put into and fed back from the build and where.

File type	Pixel size in 2D view	Voxel size in 3D view
Sum	40 µm (0.0015 in)	240 µm (0.009 in)
Maximum	150 µm (0.006 in)	240 µm (0.009 in)

When configuring InfiniAM Spectral using DataHUB Generator, you can adjust the sub-region of the build volume that DataHUB should process. This allows you to reduce the amount of work, and therefore processing time, if you are only interested in a specific feature of the build. By default, and when configured using DataHUB Automation, the entire build volume is selected.

- X start and end positions – the bounds of the region to process from the leftmost point (in mm) to the rightmost point (in mm) relative to the build plate.
- Y start and end positions – the bounds of the region to process from the frontmost point (in mm) to the backmost point (in mm) relative to the build plate.
- Z start and end positions – the bounds of the region to process from the bottommost point (in mm) to the topmost point (in mm) relative to the build plate.

NOTE: The origin in X and Y is the centre of the build plate and a full layer extends from (–125 mm, –125 mm) to (125 mm, 125 mm). The origin in Z is the top of the build plate and extends from 0 mm to the build height.

NOTE: Many builds will not cover the full build plate. In such cases, it is recommended that the X and Y start and end positions are reduced to contain just the area of the build plate used.

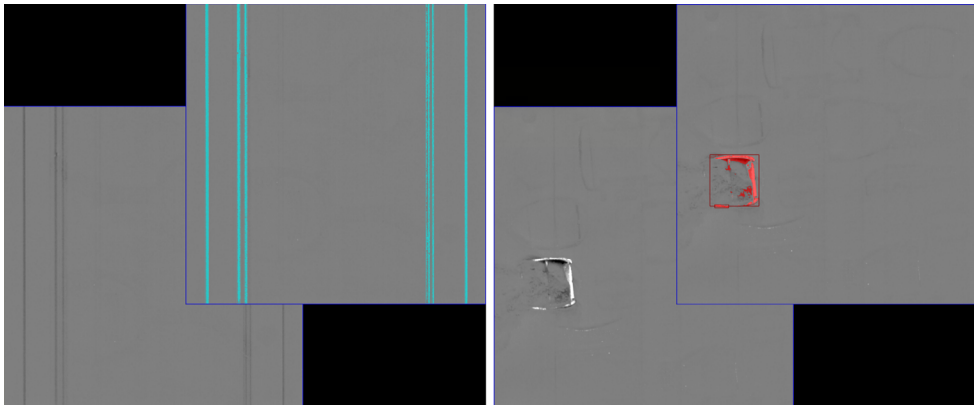
8.2 InfiniAM Camera

If DataHUB has the ‘CameraVIEW Processing’ feature licensed and the selected build has CameraVIEW data available, then you will be able to process the build with the ‘InfiniAM Camera’ pipeline.

The InfiniAM Camera pipeline converts CameraVIEW data into an InfiniAM Camera dataset that may be viewed in InfiniAM. Optionally, it can generate reports on detected anomalies.

8.2.1 CameraVIEW anomaly detection

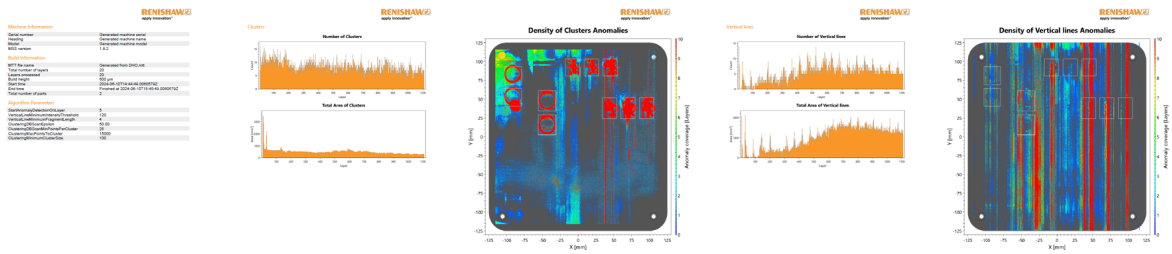
CameraVIEW powder bed images are searched for anomalous features that may indicate problems with a build. The detected anomalous features are: stripes and clusters. Stripes observed in the powder bed may result from issues with the wiper blade, while clusters could suggest inadequate powder coverage due to various factors.



All detected features are added to the analysis charts in InfiniAM as both a count and total area per layer. The same charts, plus heatmaps for stripes and clusters, are added to a series of PDF reports and can be emailed to registered addresses.

8.2.2 Anomaly reports

With appropriate configuration in DataHUB Automation, PDF reports are generated that summarise detected anomalies during the build. Each report details the build, includes the detection parameter values, and presents various charts illustrating the current detections.



8.2.3 Tuning the anomaly detection performance

The performance anomaly detection is governed by the values of several parameters. Altering these will change parameters such as detection sensitivity, the minimum size of reported anomalies etc.

The values of these parameters may be specified in the plug-in initialisation data. An example is given below for reference.

StartAnomalyDetectionOnLayer

Range: 1 or greater

Default value: 20

Effect: Analyse layer images from the specified layer onwards.

Notes: The build plate often is visible in the early layer images and to prevent anomaly detection producing many false positive results, the first 20 (default) layers are ignored. Some builds may need to extend the range of ignored layers, in which case a higher value should be specified.

StripeMinimumIntensityThreshold

Range: 0 to 255

Default value: 120

Effect: Exclude from stripe detection all pixels with a intensity brighter than this value.

Notes: Anomalous stripes are distinguished from, for example, lines of visible part material by their low pixel intensity, that is, they appear as dark lines in the powder. To include brighter pixels in stripe detection, a higher value may be specified, or to limit stripe detection to the darkest lines, a lower value. The brightest possible pixel intensity is 255 and the lowest is 0.

StripeMinimumFragmentLength

Range: 1 or greater

Default value: 4

Effect: Exclude from stripe detection all line fragments with a length shorter than this value.

Notes: The pixels potentially forming a stripe are often separated and fragmented by uninteresting pixels. When searching for stripes, these line fragments, ignoring any deemed too short, are joined together to form the full anomaly. Reducing or increasing this value adjusts the minimum length of fragments to be included in the search.

ClusteringMinimumClusterSize

Range: 1 or greater

Default value: 100

Effect: Exclude small clusters.

Notes: Clustering will find many small (and therefore, uninteresting) clusters, so tuning this value defines the size a cluster must exceed for it to be reported. The two-dimensional nature of clusters means the default size of 100 can be thought of as a 10×10 patch of anomalous pixels, a value of 625 as 25×25 patch of anomalous pixels, and so on.

ClusteringDBScanEpsilon

Range: 0.0 or greater

Default value: 50.0

Effect: The distance (in pixels) between points such that they are included in the same cluster.

Notes: Tuning this value will change the number and size of reported clusters. A higher value typically produces fewer, larger clusters. A CameraVIEW image size is 2000×2000 pixels covering a powder bed of 250×250 mm; a pixel is therefore 0.125 mm on each side and the default value equates to 6.25 mm.

ClusteringDBScanMinPointsPerCluster

Range: 0 or greater

Default value: 25

Effect: The number of neighbours a point must have to be included in a cluster.

Notes: Tuning this value will change the number and size of reported clusters. A higher value typically produces fewer, larger clusters.

ClusteringMaxPointsToCluster

Range: 0 or greater

Default value: 15000

Effect: The threshold at which clustering assumes all anomalous points are to be labelled as a single, large cluster.

Notes: Finding clusters takes a lot of computing power, and how long it takes depends on how many anomalous pixels there are – some images have thousands. When this happens, running the full clustering search can take too long and cause the plug-in to time out. So, in those cases, it's better to skip clustering and treat all anomalous pixels as a single large cluster.

8.2.3.1 Sample initialisation data


```
{
    “InfiniAM Camera”: {
        “AlgorithmParameters”: {
            “StartAnomalyDetectionOnLayer”: 20,
            “StripeMinimumIntensityThreshold”: 80,
            “StripeMinimumFragmentLength”: 5,
            “ClusteringMinimumClusterSize”: 625,
            “ClusteringDBScanEpsilon”: 170,
            “ClusteringDBScanMinPointsPerCluster”: 15,
            “ClusteringMaxPointsToCluster”: 10000
        },
    }
}
```


8.3 Export packets

If the selected build has LaserVIEW/MeltVIEW data available, then you will be able to process the build with the ‘Export Packets’ feature installed with DataHUB.

The ‘Export Packets’ feature exports the data from the raw optical AMPM data files into user comprehensible tabular data stored in a ‘TAB-separated values’ format. This format (as opposed to the more common ‘Comma-separated values’ format) has been chosen to reduce errors caused by culture-specific separators.

The ‘Export Packets’ pipeline will produce one output file per laser, per layer of the build. This output file will contain a row (separated by a ‘new line’ character) for each packet and columns (separated by a ‘TAB’ character) as follows:

- Start time – the offset, measured in microseconds, from the start of the layer to the start of the packet.
- Duration – the time, measured in microseconds, that the laser spent on positioning and firing.
- Demand X – the Cartesian X component, measured in millimetres from the centre of the build plate, indicating the position at which the laser was instructed to melt during this packet.
- Demand Y – the Cartesian Y component, measured in millimetres from the centre of the build plate, indicating the position at which the laser was instructed to melt during this packet.

- Demand focus – The focal point of the laser, in millimetres, relative to the surface of the powder substrate along the beam path.
- Demand laser power (mean) – The mean power at which the laser was instructed to operate during the duration of the packet, measured in watts.
- MeltVIEW plasma (mean) – The mean value of all samples captured by the MeltVIEW Plasma (700 - 1050 nm) sensor throughout the duration of the packet.
- MeltVIEW melt pool (mean) – The mean value of all samples captured by the MeltVIEW Melt Pool (1100 nm – 1700 nm) sensor throughout the duration of the packet.
- LaserVIEW (mean) – The mean value of all samples captured by the LaserVIEW sensor throughout the duration of the packet.
- Laser back reflection (mean) – The mean value of all samples captured by the in-laser back reflection sensor throughout the duration of the packet.
- Laser output power (mean) – The mean value of all samples captured by the in-laser output power throughout the duration of the packet.
- Demand laser power (median) – The median power at which the laser was instructed to operate over the duration of the packet, measured in watts.
- MeltVIEW plasma (median) – The median value of all samples captured by the MeltVIEW Plasma (700 nm – 1050 nm) sensor throughout the duration of the packet.
- MeltVIEW melt pool (median) – The median value of all samples captured the MeltVIEW Melt Pool (1100 nm – 1700 nm) sensor throughout the duration of the packet.
- LaserVIEW (median) – The median value of all samples captured by the LaserVIEW sensor throughout the duration of the packet.
- Laser back reflection (median) – The median value of all samples captured by the in-laser back reflection sensor throughout the duration of the packet.
- Laser output power (median) – The median value of all samples captured by the in-laser output power sensor throughout the duration of the packet.

NOTE: All mean values are rounded to the nearest integer, with midpoints rounded up.

8.4 Custom plug-ins

If DataHUB has the 'LaserVIEW/MeltVIEW Pluggability' feature licensed and the selected build has LaserVIEW/MeltVIEW data available, then you will be able to process the build with any pipelines installed through the plug-in system.

Please refer to documentation provided by the supplier for any further details needed to configure their plug-in.

9 Troubleshooting

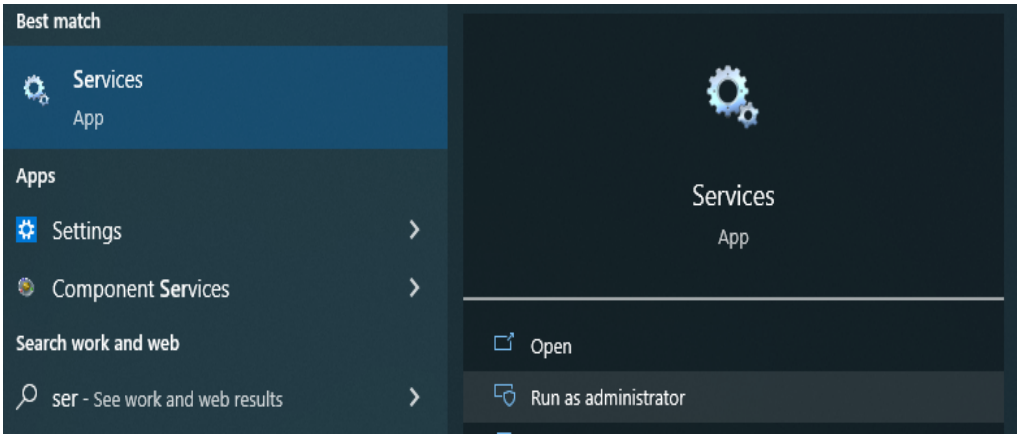
Should you encounter any difficulties while operating or configuring DataHUB, contact Renishaw for assistance using the contact information provided in section 10, “Customer support”.

9.1 Stopping, starting and restarting a Windows service

DataHUB’s primary operations are performed by a selection of Windows services that run in the background at all times. When a critical error occurs, or when performing some maintenance operations, it may be necessary to administer these services. This can be done with the standard tools provided by Windows.

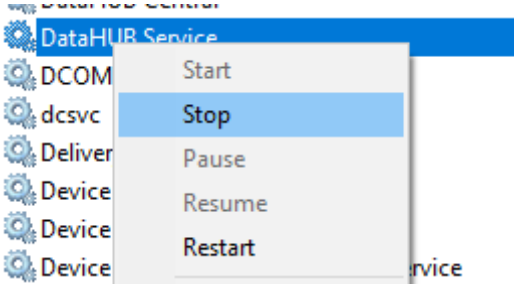
For convenience, a few of the common operations are documented here; administering Windows services requires a user account that has access to administrator permissions.

1. Open “Services” as an administrator.

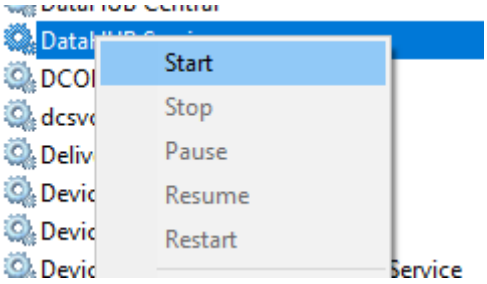


2. Navigate to the service you wish to administer. Under normal circumstances, DataHUB Automation and DataHUB Service should have a status of “Running”. Depending on whether the connection to Renishaw Central has been configured or not, DataHUB Central may or may not have a status of “Running”.

3. Right-click on the service to bring up the context menu. If the service is currently running, it can be stopped or restarted by clicking the appropriate option.



If the service is stopped, it can be started:



10 Customer support

If you experience an issue with your system or software, or if you need advice, contact Renishaw.

10.1 Contact details

Contact details for Renishaw are below:

Phone number:		**+44 (0) 1453 524524** Hours of work: Monday to Friday 08:00 to 17:00 (UTC, subject to DST changes)
Email:	**For quotes and orders related to consumables, parts, and contracts**	**ampd.sales@renishaw.com**
	For scheduled maintenance visits, machine breakdowns or any machine operating queries	**am.support@renishaw.com**
	For any guidance or issues related to build file preparation, general machine operation, machine training, post build testing and analysis	**am_applications@renishaw.com**
	For any QuantAM licence issues or queries	**quantam.support@renishaw.com**
Service address:		Renishaw plc New Mills Wotton-under-Edge Gloucestershire GL12 8JR United Kingdom

1. System type	
2. System serial number	
3. InfiniAM hardware (MeltVIEW/ CameraVIEW module) serial number	
4. InfiniAM software version	
5. DataHUB software version	

Please quote the details above. The system serial number plate can be found on the rear of the system.

Additional support can be sought by contacting your local Renishaw office. See: **www.renishaw.com/contact**

11 Abbreviations

The following abbreviations are used throughout this guide:

Term	Definition
AM	Additive Manufacturing
AMPM	Additive Manufacturing Process Monitoring
DNS	Domain Name System
DCPC	Data Collection PC
FTP	File Transfer Protocol
GPU	Graphics Processing Unit
HMI	Human Machine Interface (touch screen)
IIS	Internet Information Services
IP	Internet Protocol
IT	Information technology
OEM	Original equipment manufacturer
PC	Personal Computer
PLC	Programmable Logic Controller
SMTP	Simple Mail Transfer Protocol
SSL	Secure Sockets Layer

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