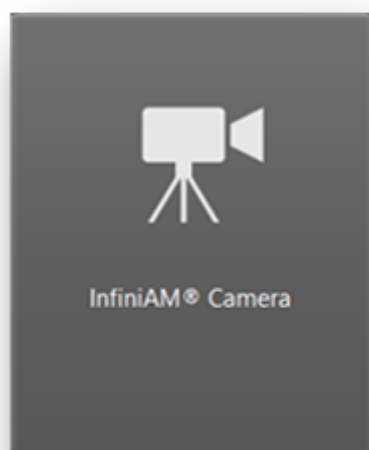


InfiniAM® Camera



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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](https://www.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](https://www.renishaw.com))

1.6 Changes to equipment

Renishaw reserves the right to change equipment specifications without notice.

2 Introduction

Renishaw has developed InfiniAM software (InfiniAM Camera mode) to process the images captured by CameraVIEW hardware monitor and provide feedback on the optical emissions from the Additive Manufacturing (AM) process. This feedback helps in understanding component build quality before and after the build is completed, and in monitoring laser input characteristics and beampath spectral emissions.

InfiniAM Camera mode assists in identifying build anomalies by analysing powder dose images. It compares pairs of neighbouring images and highlights significant visual differences. These differences may indicate areas that require further investigation of the build, including a review of other process monitoring data collected by the InfiniAM system. During an ongoing build, the most recent images and analysis can be monitored in real time.

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

2.1 Intended use

InfiniAM Camera is an advanced monitoring software module within the InfiniAM suite, designed to deliver real-time insights into Renishaw's AM process. It primarily functions to analyse and visualise high-resolution images and videos of the build environment, enabling detailed observation and analysis of each layer. InfiniAM Camera integrates seamlessly with Renishaw's existing AM hardware and software, ensuring a cohesive workflow and precise data acquisition.

2.2 Applicability

InfiniAM Camera 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: InfiniAM Camera 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)
- DataHUB user guide (Renishaw part no. H-5800-4761)
- 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.

3.1 InfiniAM Camera system specific warning labels

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

4 Scope of supply

The scope of supply for the InfiniAM Camera system is as follows:

4.1 Standard equipment (Renishaw-supplied)

1. CameraVIEW hardware – to generate visual records of every layer of a build as it is being built on a Renishaw AM system. Installed during the AM system manufacturing process.
2. DataHUB software suite – runs on the Data Collection PC and converts visual data into files for viewing.
3. InfiniAM software – runs on the viewing PC and enables viewing of visual records.
4. User licence for the Renishaw DataHUB suite of software.
5. User licence for the Renishaw InfiniAM Camera software.

4.2 Standard equipment (externally-sourced)

1. InfiniAM Camera viewing PC – not supplied, but a specification is included within this document.
2. Data Collection PC – not supplied, but a specification is included within this document.

5 Spare parts

Our equipment is sold subject to the terms and conditions of sale supplied with your purchase of the system, or available on request from your local Renishaw office: www.renishaw.com/contact.

All components and sub-assemblies are subject to rigorous quality control. Components purchased from sub-suppliers, such as ball bearings, electric motors or hydraulic cylinders, are supplied in accordance with Renishaw specifications. Renishaw will not honour any warranty claims where faults arise due to non-OEM replacement parts being fitted.

When ordering spare parts, please quote the following:

- Description of the spare part and its part number, if known
- Equipment name and model
- Serial number
- Year of manufacture

Details of the AM system can be found on the serial number plate on the rear of the system. Details of the CameraVIEW hardware can be found on the sticker situated on the rear of the camera. The CameraVIEW hardware can be found behind a cover above the chamber.

There are no user-serviceable parts within the InfiniAM system. In the event that the InfiniAM system fails, repair is by exchange of the affected module with a serviceable module from Renishaw. The replacement module will be installed, commissioned and tested by a Renishaw Service engineer.

NOTE: For the contact details of your local Renishaw office or to arrange a service visit, see section 11, “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 Software set-up

Technical specifications may change from time to time. Renishaw reserves the right to change any technical specification at any time. Any specification not listed in the table below is available upon request. For details of your local Renishaw office, see section 11, “Customer support”.

For the Renishaw AM system installation guide or user guide, contact your local Renishaw office.

6.1 Hardware specification

6.1.1 Data Collection PC for a CameraVIEW and Spectral system hardware specification (customer-supplied)

Processor	Intel i7 quad core (or equivalent)
Graphics card (minimum)	NVIDIA card with: At least 10 GB RAM At least 3500 CUDA cores Compute capability 6.1 or higher (e.g. GeForce GTX 1080 Ti, GeForce RTX 3080)
RAM	32 GB DDR4
Solid state drive	4 TB
Hard disk drive	10 TB
Ethernet	1 × 10 Gigabit Ethernet port

6.1.2 Data Collection PC for a CameraVIEW-only system hardware specification (customer-supplied)

Processor	Intel i5 quad core (or equivalent)
RAM	8 GB DDR4
Solid state drive	500 GB
Hard disk drive	4 TB
Ethernet	1 × 10 Gigabit Ethernet port

6.1.3 InfiniAM viewing PC specification (customer-supplied)

Processor	Minimum	Intel i7 quad core (or equivalent)
Graphics card	Minimum	NVIDIA card with at least 4 GB RAM (e.g. GeForce GTX 1050 Ti, GeForce GTX 1650)
	Recommended	NVIDIA card with at least 8 GB RAM (e.g. GeForce GTX 1080, GeForce RTX 3070)
RAM	32 GB DDR4	
Solid state drive	Recommended	> 1 TB
Hard disk drive	Recommended	> 10 TB

6.1.4 Data storage/back-up server (customer-supplied)

Storage memory	To suit customer storage requirements
----------------	---------------------------------------

6.2 InfiniAM Camera software pre-installation questionnaire

Customer-supplied equipment							
1.1	Is a 1 Gigabit or 10 Gigabit Ethernet with Cat6 cabling available?		<input type="checkbox"/> Yes				
1.2	For DataHUB on a Camera and Spectral system, is a Data Collection PC available to the following specification:		<input type="checkbox"/> Yes				
	Processor	Intel i7 quad core (or equivalent)					
	Graphics card	NVIDIA card with: At least 10 GB RAM At least 3500 CUDA cores Compute capability 6.1 or higher (e.g. GeForce GTX 1080 Ti, GeForce RTX 3080)					
	RAM	32 GB DDR4					
	Solid state drive	4 TB					
	Hard disk drive	10 TB					
	Ethernet	1 × 10 Gigabit Ethernet port					
1.3	For DataHUB on a Camera only system, is a Data Collection PC available to the following specification:		<input type="checkbox"/> Yes				
	Processor	Intel i5 quad core (or equivalent)					
	RAM	8 GB DDR4					
	Solid state drive	500 GB					
	Hard disk drive	4 TB					
	Ethernet	1 × 10 Gigabit Ethernet port					
1.4	Is a viewing PC available to the following specification:		<input type="checkbox"/> Yes				
	Processor	Intel i7 quad core (or equivalent)					
	Graphics card	<table border="1"> <tr> <td>Minimum</td> <td>NVIDIA card with at least 4 GB RAM (e.g. GeForce GTX 1050 Ti, GeForce GTX 1650)</td> </tr> <tr> <td>Recommended</td> <td>NVIDIA card with at least 8 GB RAM (e.g. GeForce GTX 1080, GeForce RTX 3070)</td> </tr> </table>	Minimum	NVIDIA card with at least 4 GB RAM (e.g. GeForce GTX 1050 Ti, GeForce GTX 1650)	Recommended	NVIDIA card with at least 8 GB RAM (e.g. GeForce GTX 1080, GeForce RTX 3070)	
Minimum	NVIDIA card with at least 4 GB RAM (e.g. GeForce GTX 1050 Ti, GeForce GTX 1650)						
Recommended	NVIDIA card with at least 8 GB RAM (e.g. GeForce GTX 1080, GeForce RTX 3070)						
	RAM	32 GB DDR4					
	Solid state drive	> 1 TB (recommended)					
	Hard disk drive	> 10 TB (recommended)					
1.5	Is a file storage area available? The space required is to suit customer requirements.		<input type="checkbox"/> Yes				

Data Collection PC requirements		
2.1	Is the Data Collection PC configured with an FTP server that can be accessed from the Ethernet location of the AM system PC?	<input type="checkbox"/> Yes
2.2	Is Ethernet communication possible between the AM system and the Data Collection PC?	<input type="checkbox"/> Yes
2.3	Is Microsoft IIS available on the Data Collection PC?	<input type="checkbox"/> Yes
2.4	Is administrator access available for the Data Collection PC?	<input type="checkbox"/> Yes
2.5	Is a static IP address available for the Data Collection PC or a domain name so that the Data Collection PC can be accessed by the AM system?	<input type="checkbox"/> Yes

NOTE: Renishaw will not be able to install and run the software effectively if the Data Collection PC does not meet this specification.

NOTE: The Data Collection PC does not need to be a desktop machine with a monitor – it can be accessed through remote desktop connection if needed.

6.3 InfiniAM Camera installation and activation

1. When you order InfiniAM and DataHUB, your sales representative will request an email address. Entitlement IDs for InfiniAM and DataHUB will be sent to this email address.
2. Along with the installation bundles for InfiniAM and DataHUB, you will also receive an installer for the Renishaw Licence Manager.
3. Follow the instructions in the Renishaw Licence Manager user guide for details on how to set up the floating licence server and activate your entitlements.
4. Install InfiniAM and DataHUB in accordance with the InfiniAM and DataHUB software installation guide (Renishaw part no. H-5800-4349). Contact your nearest Renishaw office using the details in section 11, “Customer support”, for a copy of this document.

7 Commissioning and decommissioning

7.1 Commissioning

The InfiniAM system will be commissioned by a Renishaw Service engineer. See section 11, “Customer support”, for the contact details of your local Renishaw office.

WARNING: The AM system must be electrically isolated before any work is carried out. Isolate it at the mains power supply by moving the main switch to the 0 or OFF position and locking it with a personal padlock. Attach a visible warning sign to indicate that the system is isolated. Carry out safe isolation procedure checks in accordance with IEE standards.

7.2 Decommissioning

The InfiniAM system will be decommissioned by a Renishaw Service engineer. See section 11, “Customer support”, for the contact details of your local Renishaw office.

WARNING: The AM system must be electrically isolated before any work is carried out. Isolate it at the mains power supply by moving the main switch to the 0 or OFF position and locking it with a personal padlock. Attach a visible warning sign to indicate that the system is isolated. Carry out safe isolation procedure checks in accordance with IEE standards.

8 System description

The Renishaw AM process creates homogeneous solid metal components, using high-powered laser energy to melt fine powder, manufacturing parts directly from 3D CAD data.

The aim of this document is to describe to a Renishaw AM system user how to use the Renishaw InfiniAM system, including hardware and software. This will include a description of how to operate the InfiniAM Camera software and also describe any procedures that are unique to the InfiniAM system.

This user guide has been written based on the assumption that the Renishaw AM system has been fitted with the appropriate hardware (CameraVIEW), the InfiniAM software and DataHUB software have been installed, the Data Collection PC has been set up and all system hardware and software has been commissioned and tested by a Renishaw Service engineer.

Renishaw has developed the InfiniAM system to monitor and provide feedback on the optical emissions from the AM process. This feedback is essential in understanding component build quality before and after the build has completed, monitoring laser input characteristics and beampath spectral emissions.

8.1 CameraVIEW module

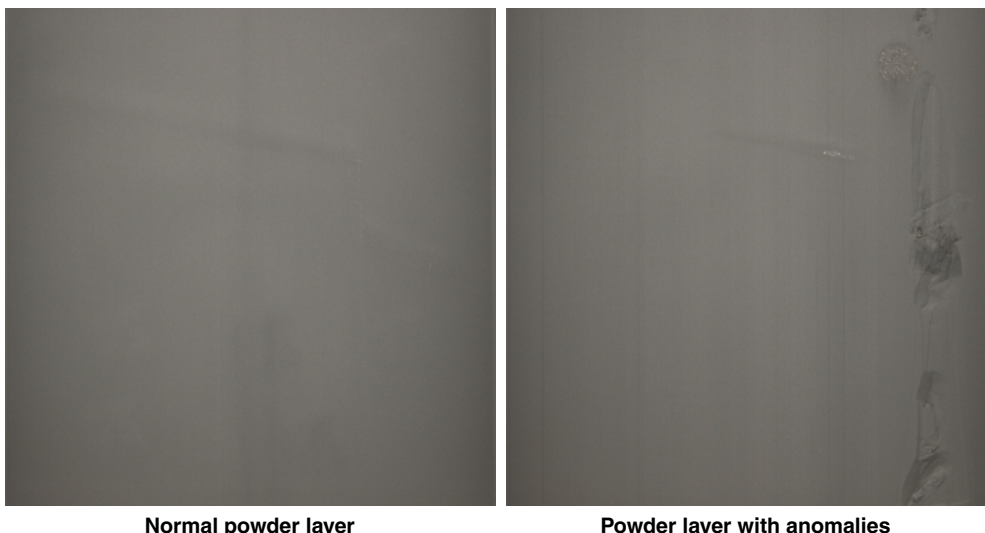
RenAM systems fitted with the CameraVIEW module capture images of the powder bed at set points in each layer. The first image shows the powder bed after dosing and the second shows the powder bed after melting. These are referred to as “Powder” and “Melted” images respectively.

NOTE: As TEMPUS technology changes the fundamental nature of the powdering/melting cycle, the images may contain laser sparks at the highest productivity settings. For a clear image, build files need to use the “Increased Camera Visibility” TEMPUS configuration. At the highest productivity settings, it may not be feasible to generate CameraVIEW images while operating a build while using TEMPUS technology.

Failure modes can be detected in CameraVIEW images, and the InfiniAM system provides tools to access these features.

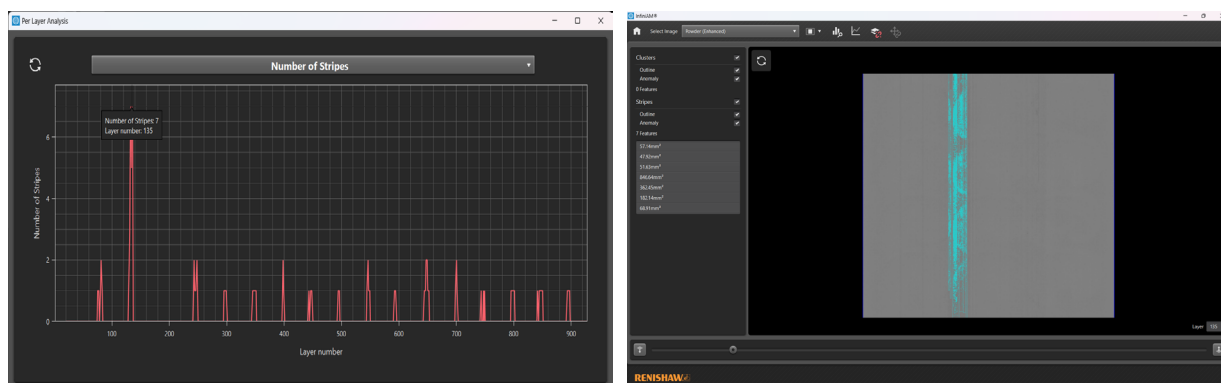
8.2 Understanding InfiniAM Camera datasets

The CameraVIEW module captures two images for each layer, one after the recoater has spread powder across the layer (Powder), one after the lasers have finished firing (Melted). The Powder images are highly valuable for determining if a build has encountered a failure mode. This is because, under normal operating conditions, Powder images should be similar – a broadly uniform square of powder. Where there is a marked deviation from this standard, it indicates a defect may be present on the layer.



A full build can be quite large, making it impractical to manually review the entire build for data anomalies. To assist with this, DataHUB detects deviations in Powder images by comparing them with a standard uniform powder bed, which may indicate potential defects. Anomalies are then categorised as either “Stripes” or “Clusters”. InfiniAM highlights the locations in each layer where such anomalies are detected.

The first task is to identify where in the build defects may have occurred. The peaks and troughs in the “Per Layer Analysis” series can help you to identify the number and size of anomalies. An increased density of anomalies may indicate faults in specific layers. Click on the point of interest to display the corresponding layer.



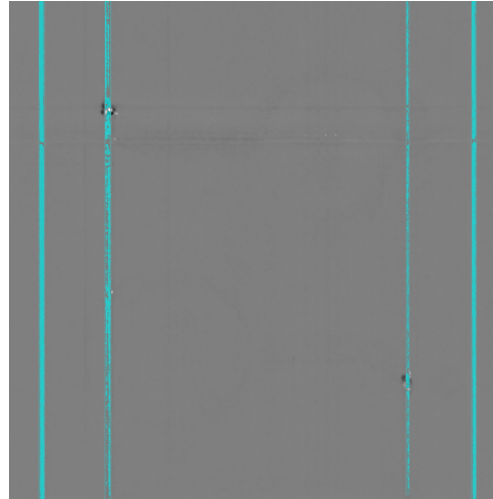
Clicking a point in the layer series to navigate to a layer of interest

Once you discover a region of interest within the build, you can review the data, layer by layer. By comparing the location of detected anomalies to the underlying data, the Powder and the Melted images, and between layers, you can understand what has happened in the layers of concern. If the build is still in progress, you can decide if you need to intervene with the build.

“Stripe” anomalies usually indicate a fault related to the recoater. Damage to the recoater often appears as a raised embankment running vertically in the direction of the recoater. However, a vertical furrow across the powder may indicate that the recoater has picked up condensate and is dragging it across the powder bed. Both of these failure modes are detected as “Stripe” anomalies and may be preceded by a “Cluster” anomaly related to the cause of the recoater fault.

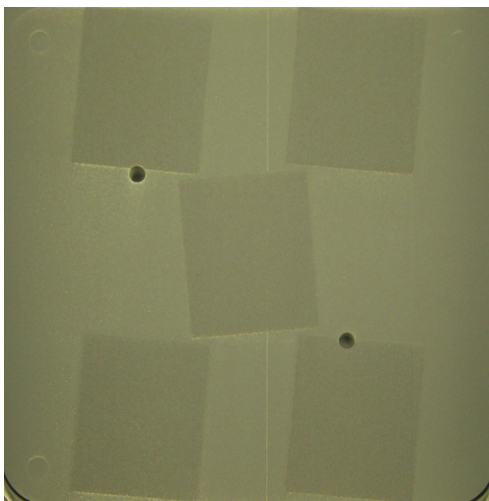


Raw powder layer

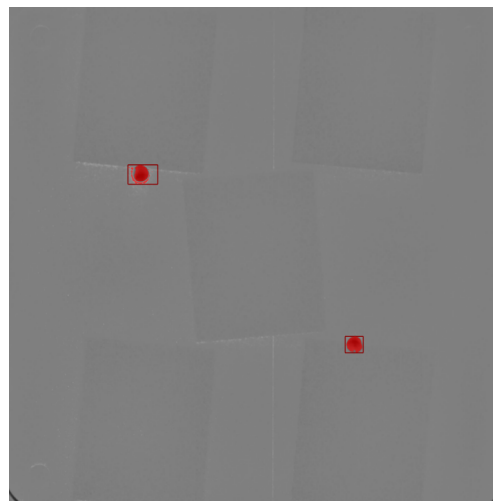


Powder layer with stripe anomalies

“Cluster” anomalies usually indicate that the bare metal is visible through the powder. However, they may also result from smoke, condensate on the powder bed, or even damage or marks on the chamber window. When you review the Powder images, it should be fairly clear which of the above it is. Bare metal is visible primarily where short dosing has failed to completely cover the previous layer in the powder bed or where a de-lamination has caused a segment of the part to protrude above the powder surface. Condensate is expected and not usually concerning in itself, but significant levels of condensate could provoke failures later in the build.



Raw powder layer



Powder layer with cluster anomalies

The anomalies detected depend on a set of variables configured for automated detection, and their sensitivity can be tuned. These anomalies do not necessarily mean defects and an experienced user must review them to determine whether the detected anomalies are defects or not. While Renishaw has calibrated DataHUB to produce reasonable results for general use, you can tune the detection algorithms to improve their quality when dealing with specific features of a build and/or material.

NOTE: DataHUB excludes the first 20 layers from the detection algorithms because the build plate's reflective surface is visible until enough powder accumulates.

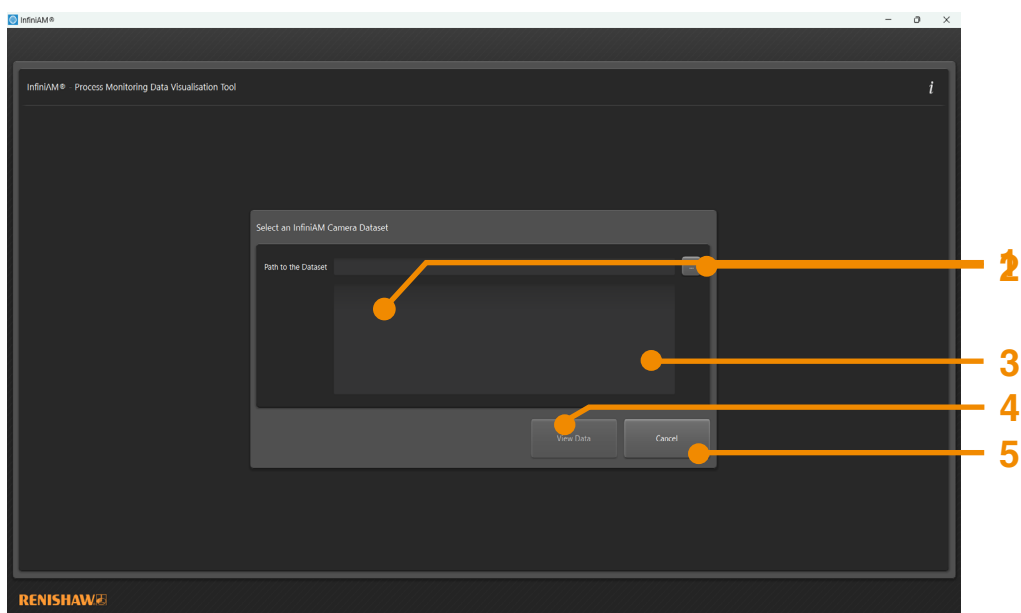
9 Operation

9.1 Select a build to view

NOTE: Although camera images are accessible directly from the AM system using FTP, during installation, software on the machine will be installed that automatically transfers the images to the Data Collection PC and sorts them by layer number.

NOTE: It is necessary to process the images with DataHUB to be able to view them with InfiniAM Camera.

9.1.1 Screen layout



1 Path to the Dataset

Displays the path of the currently selected folder containing the InfiniAM Camera dataset. Initially, no folder will be selected.

2 Browse

Click the 'Browse' button to open a dialog box that allows navigation through the file system to locate a folder containing the InfiniAM Camera dataset.

3 Description

Displays the report details of the loading process and the loaded InfiniAM Camera dataset folder.

4 View Data/Retry

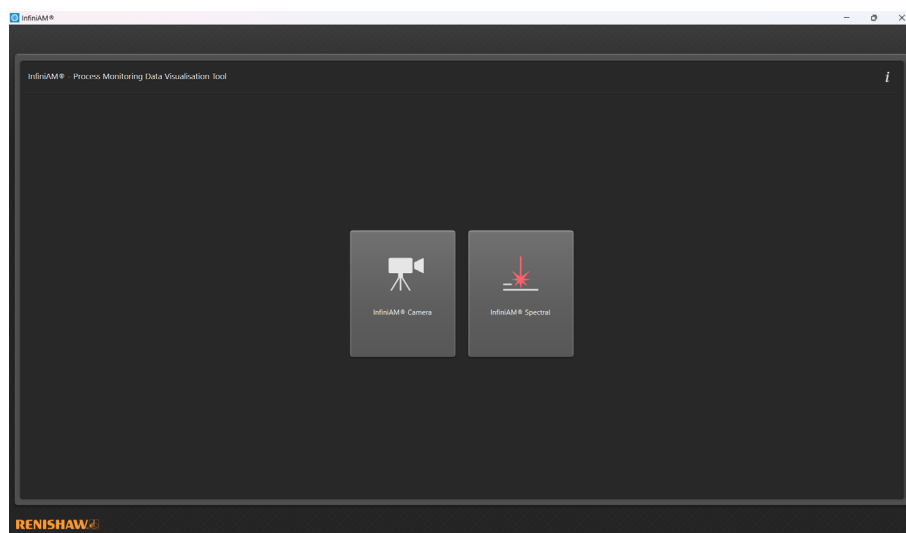
This will be enabled when the loading operation has finished. If the dataset is successfully loaded, click the 'View' button to enter the 'InfiniAM Camera' screen with the selected dataset. If the dataset fails to load, click the 'Retry' button to attempt to load the dataset again.

5 Cancel

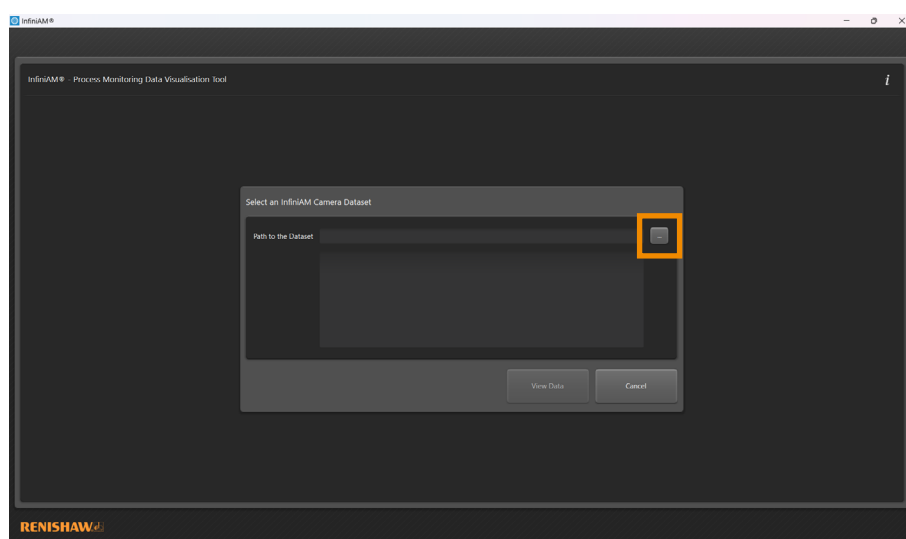
Returns you to the home screen.

9.2 Loading InfiniAM Camera dataset

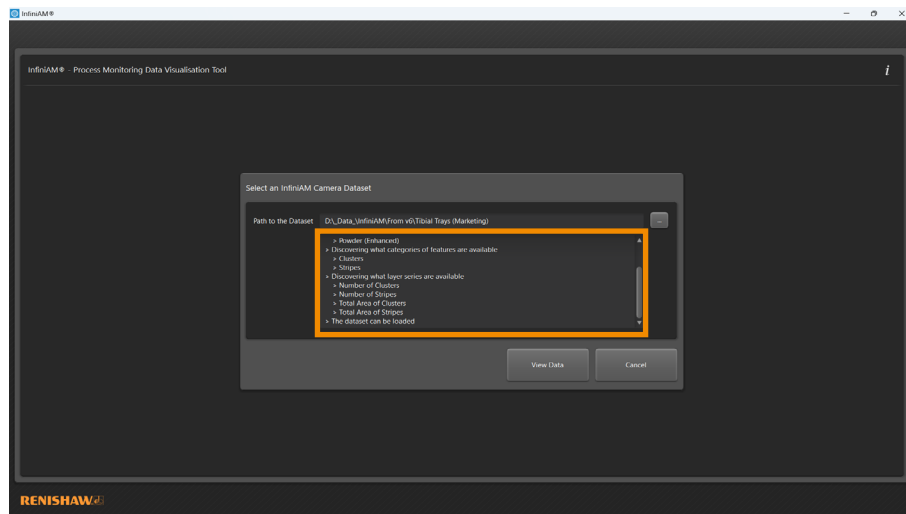
1. Open the 'InfiniAM' software application by clicking on its icon on the desktop or by navigating through the Windows start menu.
2. Click the 'InfiniAM Camera' button from the InfiniAM home screen.



3. From the 'Select build' dialog box, click the 'Browse' button to open a dialog box that allows navigation through the file system to locate the desired build data folder.



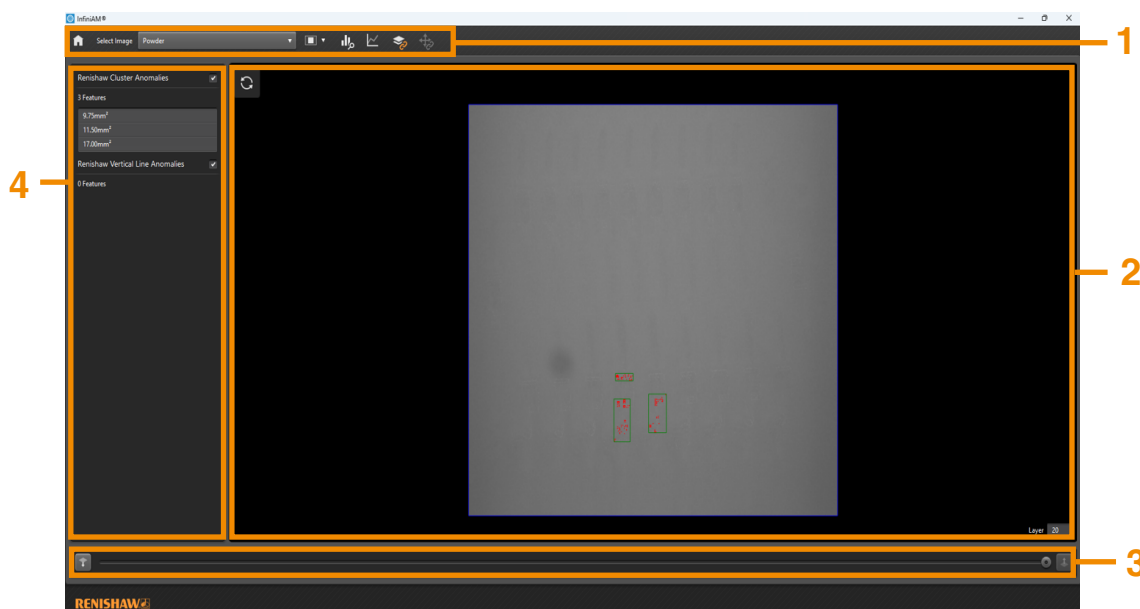
4. If the selected folder contains a valid camera image dataset, a description of the build will be displayed in the 'Build Information' box. Click 'OK' to view the build.



9.3 Analysing InfiniAM Camera dataset

9.3.1 Screen layout

The InfiniAM Camera screen is divided into four views.



1 Toolbar controls

Provides the control to visualise and analyse the InfiniAM Camera dataset. For more information, see section 9.3.3, “InfiniAM Camera toolbar controls”.

2 Preview window

Displays the layer data of the selected InfiniAM Camera dataset. For more information, see section 9.3.4, “Preview window”.

3 Navigation bar

Provides the control to navigate through the layers of the selected dataset. For more information, see section 9.3.5, “Navigation bar”.

4 Feature groups

Displays the list of all features on the current layer, organised by type. For more information, see section 9.3.6, “Feature groups”.

9.3.2 InfiniAM Camera basic navigation controls

Use the following mouse controls for navigating the image views:

- **Pan:** Select and drag using the right mouse button.
- **Zoom:** Hold down the middle mouse button, drag forwards to zoom in and backwards to zoom out; or scroll the middle mouse wheel forwards to zoom in and backwards to zoom out.

The images may be synchronised so that panning or zooming any view will set the other views to show the same region of their layer image. For more information, see section 9.3.3, “InfiniAM Camera toolbar controls”.

9.3.3 InfiniAM Camera toolbar controls

The InfiniAM camera toolbar contains the following controls.



1



Home

This opens the 'Home' page.

2

Select Image

Use the drop-down list to display a list of all available image sources in the dataset. Click on any one of these image sources to display the images for that source.

3

Display Layout

Select the desired layout from the drop-down list to view different data presentations in InfiniAM Camera. Clicking on a layout will update the screen to display the data accordingly. For more information, see section 9.3.3.1, "Changing display layout and comparing layers".

The available layouts are:

3a



Display Only the Current Layer

The preview window displays the current layer.

3b



Display the Current Layer and the Surrounding Layers

The preview window displays three sequential layers, with the current layer in the centre.

3c



Display the Current Layer as Emphasised and the Surrounding Layers

The preview window displays the current layer enlarged on the left, with the preceding layer in the upper right and the succeeding layer in the lower right.

4



Control Displayed Data

This will open the 'Control Displayed Data' tool. For more information, see section 9.3.3.2, "Control displayed data tool window".

5



Per Layer Analysis

This will open the 'Per Layer Analysis' tool window. For more information, see section 9.3.3.5, "Per layer analysis tool window".

6



Lock/Unlock to the Latest Layer

Use this button to toggle whether InfiniAM should automatically display any new layer upon arrival. If you navigate away from the latest layer, InfiniAM will unlock from the latest layer. Click the button to return to the latest layer.

7



Synchronise/Unsynchronise Navigation

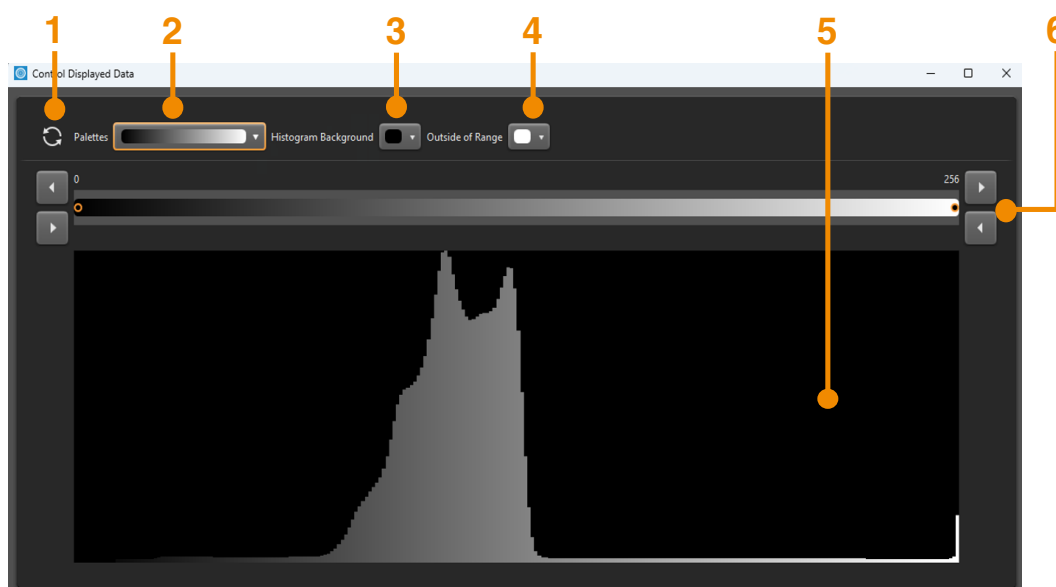
Toggle this button to link or unlink navigation changes between views. It remains disabled if 'Display Only the Current Layer' is selected in 'Display Layout'.

9.3.3.1 Changing display layout and comparing layers

Changing display layout can be useful to cross-reference between multiple sequential layers. By default, InfiniAM displays one layer at a time to maximise the screen space dedicated to it. However, you can customise the view to display up to three sequential layers centred around a selected layer using the drop-down list next to the 'Display Layout' tool. This allows you to cross-reference features in all three layers and see if they are present across the layers or even change (for better or worse) as the build progresses.

9.3.3.2 Control displayed data tool window

The 'Control Displayed Data' tool window offers additional controls to customise the visualisation of data. The toolbar contains the following controls:



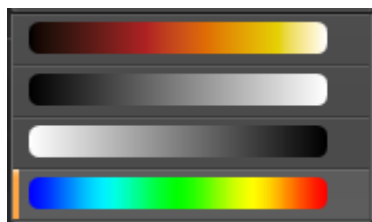
1

Reset Range

This button will select the full range of the histogram.

2 Palettes

By changing the palette, the colour scheme used to represent the histogram can be changed. This is useful for visualising data according to personal preference.



3 Histogram Background

The histogram background colour may need to be adjusted depending on the colour scheme selected. This only affects the histogram view.

4 Outside of Range

This assigns a colour to the data outside of the selected range in the histogram graph. Renishaw recommends using a colour not used to represent data in the histogram. This only affects the histogram view.

5 Histogram Graph

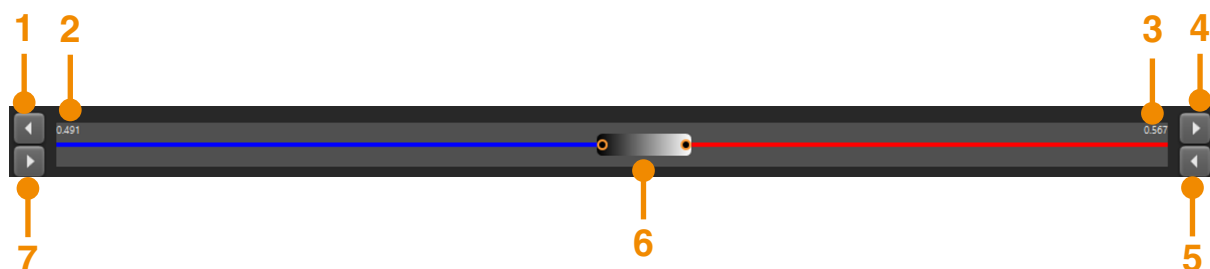
This displays a histogram representing the distribution of values across all layers within the selected volume. The Y axis represents the complete range of potential values within the data, while the X axis indicates the frequency of each value's occurrence. Consequently, the height of each column corresponds to the number of times that particular value appears in the dataset. The histogram is colour-coded in accordance with the selected palette and range settings, reflecting how each value will be displayed.

6 Selected Data Range

The specific set of data points that are chosen for analysis during the monitoring process.

9.3.3.3 Selecting data range in control displayed data tool

The interactive selected data range control in the 'Control Displayed Data' tool window allows you to input specific start and end values to define the range.



1 Increment Minimum

Increase the minimum by 0.001, to a maximum of 0.001 below the maximum, or 0.995, whichever is lower.

2 Minimum

Displays the current minimum values of the range.

3 **Maximum**

Displays the current maximum values of the range.

4 **Increment Maximum**

Increase the maximum by 0.001, to a maximum of one.

5 **Decrement Maximum**

Reduce the maximum by 0.001, to a minimum of 0.001 above the minimum, or 0.005, whichever is higher.

6 **Range Slider**

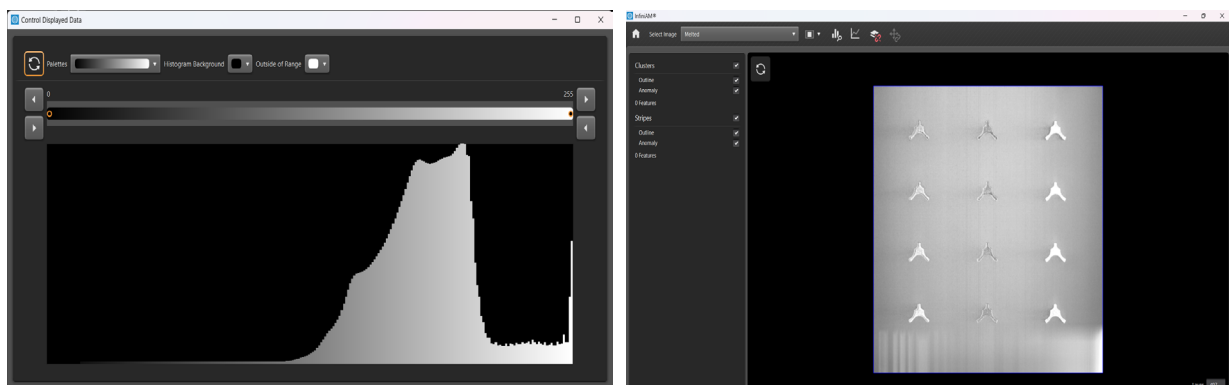
Click and drag the range slider to move the centre point of the range.

7 **Decrement Minimum**

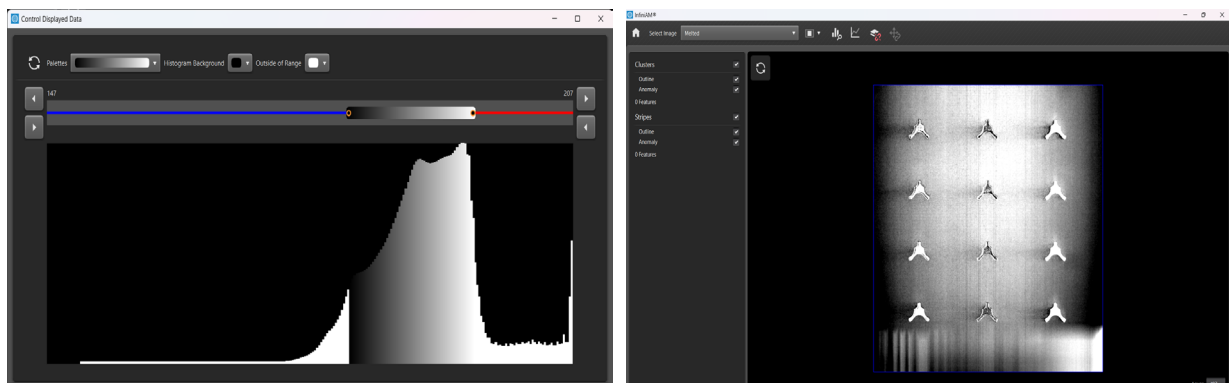
Reduce the minimum by 0.001, to a minimum of zero.

9.3.3.4 **Visualising data using control displayed data tool**

The 'Control Displayed Data' tool window allows you to centrally modify the presented data. By default, InfiniAM Camera displays all data, but you can select a subset of the data defined between a minimum value and a maximum value, ignoring all data outside of that range. The tool evenly distributes the data inside that range across a colour palette.



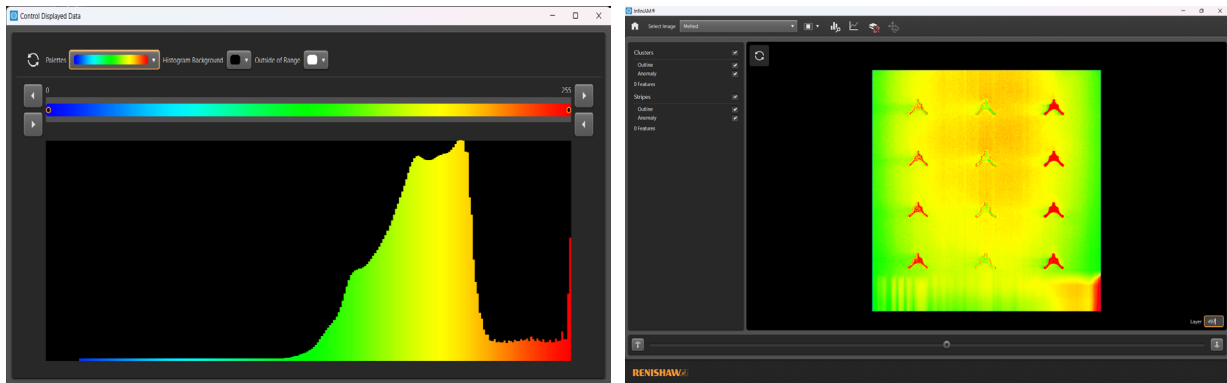
All data displayed



Reducing the displayed data to increase the contrast

The selected range is aligned with a histogram of the prevalence of data values across every layer in the current image source. In such a histogram, peaks usually correspond to similar data in the images – for example, the contrast between bright, melted metal and dull, unmelted powder can represent distinct peaks in the histogram. This can be used to isolate “interesting” data from the complete set.

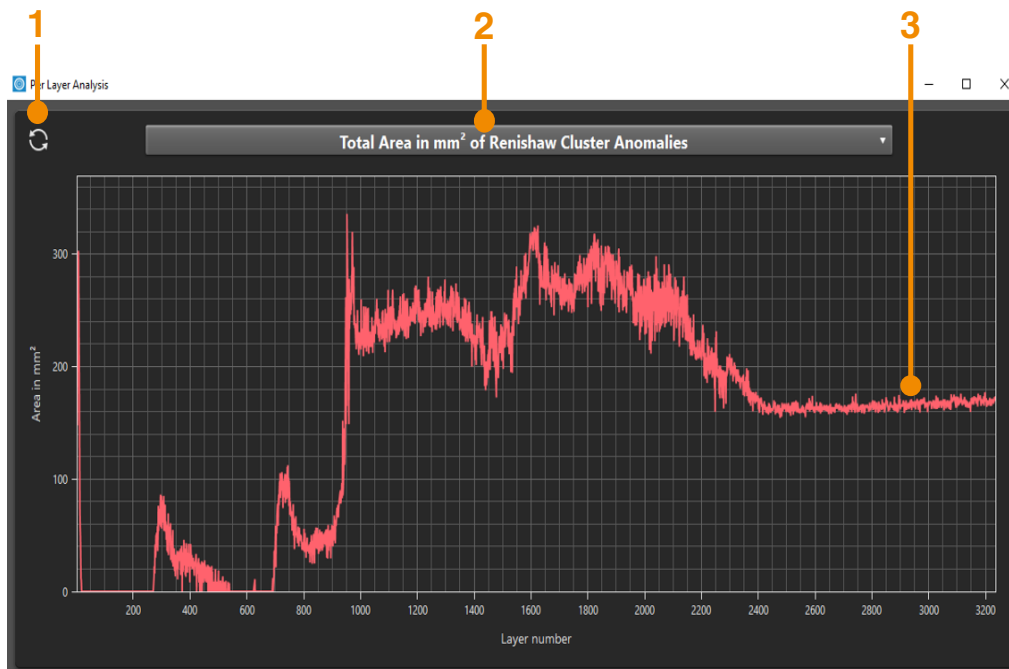
Different palettes are useful in different situations. Typically, when the histogram displays a single broad peak, a grey scale or similar palette is more suitable. Alternatively, in cases where there are multiple distinct peaks, a full colour palette tends to be more effective.



Any updates made in this tool window will be reflected in the main display in real time. This allows you to react to and tune how the data is displayed.

9.3.3.5 Per layer analysis tool window

The ‘Per Layer Analysis’ tool window displays data that summarises a trend across the entire build.



1 Reset

Reset the currently displayed graph to its default pan and zoom.

2 Select Layer Series

Use the drop-down list to display a list of all available layer series in the dataset. Click on any one of these layer series to view it.

3 Layer Series Graph

Displays the currently selected layer series as a line series. Each layer series describes some metric “per layer”.

Use the following mouse controls for navigating around the graph in the ‘Per Layer Analysis tool window’.

- **Pan:** Select and drag using the right mouse button.
- **Zoom:** Hold down the middle mouse button, drag forwards to zoom in and backwards to zoom out; or scroll the middle mouse wheel forwards to zoom in and backwards to zoom out.
- **Display values:** Click with the left mouse button to show the X and Y axis values at that point on the line and display the corresponding layer in the “Primary” view of the InfiniAM Camera screen.

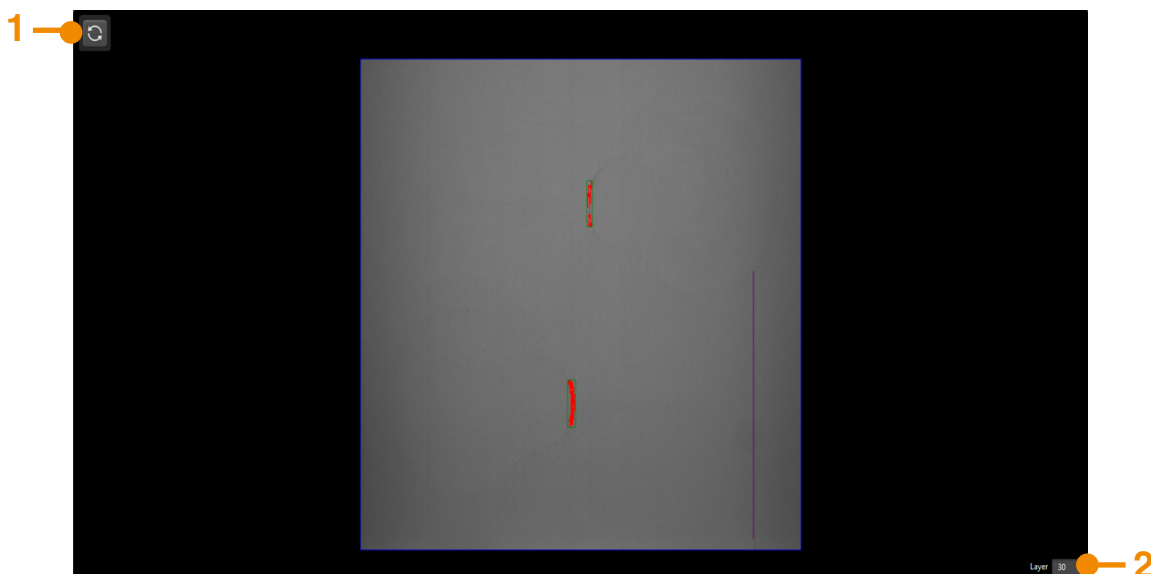
9.3.4 Preview window

The preview window displays the image of the selected layer from the selected image source in the different views. Use the following mouse controls for navigating around the different views:

- **Pan:** Select and drag using the right mouse button.
- **Zoom:** Hold down the middle mouse button, drag forwards to zoom in and backwards to zoom out; or scroll the middle mouse wheel forwards to zoom in and backwards to zoom out.

9.3.4.1 Primary view

The primary view is always displayed, regardless of the selected display layout. It shows an image of the selected layer from the designated image source. If there are features on that layer, it will overlay “Renishaw stripe anomalies” in light blue and “Renishaw cluster anomalies” in red.



1 Reset

Reset the pan and zoom of the image to fill the available space.

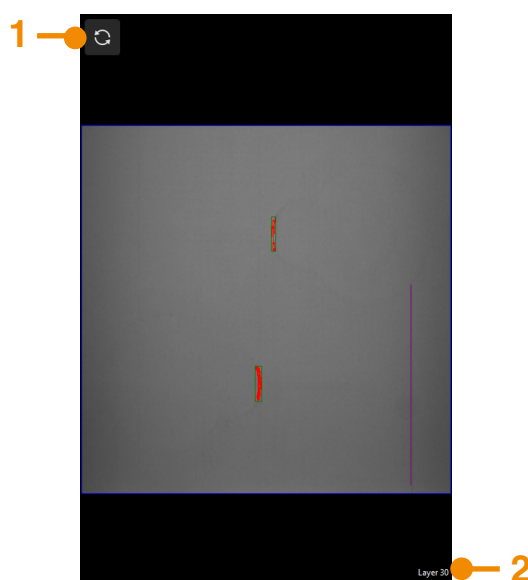
2 Layer

The 'Layer' text box displays the layer number of the displayed or selected layer. Enter a value into the text box to change the selected layer, then press Enter on the keyboard..

9.3.4.2 Secondary view

The secondary views are displayed only in certain display layouts. These views shows an image of a layer obtained from the selected image source, and if features are detected on that layer, they will overlay "Renishaw stripe anomalies" in light blue and "Renishaw cluster anomalies" in red.

NOTE: If the selected layer doesn't have an appropriate preceding or following layer, the secondary view will be blank.



1 Reset

Reset the pan and zoom of the image to fill the available space.

2 Layer



The 'Layer' label displays the layer number of the displayed or selected layer.

NOTE: By default, anomaly detection does not run on the first 10 layers of a build; however, this setting can be configured. As a result, a dataset may not include features for the initial run of layers.

9.3.5 Navigation bar

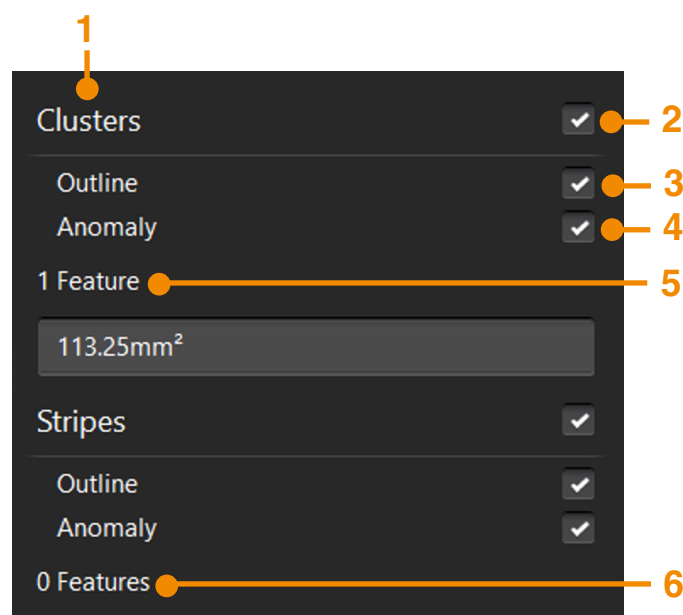
The navigation bar is designed to facilitate the selection of required layers within a dataset.



- | | | |
|---|--|--|
| 1 |  | <p>Go to Previous Layer</p> <p>Display the previous layer in the section. Click and hold the button to navigate down multiple layers.</p> |
| 2 | | <p>Layer Slider Bar</p> <p>Select and drag the slider to view a particular layer in the build.</p> |
| 3 |  | <p>Go to Next Layer</p> <p>Display the next layer in the section. Click and hold the button to navigate up multiple layers.</p> |

9.3.6 Feature groups

Feature groups contains a list of all the features on the current layer, grouped according to type. Each group is identified by its “Group name”. All the feature groups present in the build will be displayed even if the current layer does not contain features of that type.



1 Group Name

Each group available in the selected dataset is identified by its group name.

2 Show/Hide Feature

Enable the checkbox to ensure that the features within the selected group are displayed in the views.

3 Show/Hide Outlines

Enable the checkbox to ensure that the features within the selected group are displayed with outlines in the views.

4 Show/Hide Anomaly

Enable the checkbox to ensure that the features within the selected group are displayed with anomalies in the views.

5 Number of Features

Displays the number of the features available in the selected dataset.

6 Features

The features list shows the name of each feature in the group on the selected layer. It will only include features from the selected layer – even if the chosen display layout shows multiple layers, features from other layers will not be shown. Click on a feature to select it. This will automatically adjust the view, displaying the selected feature for better examination by panning and zooming in or out of the visible surfaces.

9.4 In-process analysis

InfiniAM Camera views data from a build while it is in process. As the RenAM machine and DataHUB process the build, InfiniAM Camera will access more layers. If the selected layer is unavailable because it has not yet been processed, InfiniAM Camera will inform you. Once that layer is processed and available, InfiniAM Camera will automatically refresh and display it.

9.5 Legacy datasets

InfiniAM Version 6 does not support datasets produced by older versions of InfiniAM Camera. To view an older InfiniAM Camera dataset, install an older version of InfiniAM. You can install InfiniAM version 6 alongside any previous version of InfiniAM.

10 Maintenance

10.1 Maintenance schedule

Calibration should be carried out every six months.

WARNING: All user maintenance on the Renishaw AM system is as specified in the relevant user guide. All service engineer maintenance on the Renishaw AM system is as specified in the relevant AM system maintenance manual.

WARNING: The AM system must be electrically isolated before any work is carried out. Isolate it at the mains power supply by moving the main switch to the 0 or OFF position and locking it with a personal padlock. Attach a visible warning sign to indicate that the system is isolated. Carry out safe isolation procedure checks in accordance with IEE standards.

10.2 Maintenance tasks

10.2.1 Calibration

The CameraVIEW hardware module must be calibrated by a Renishaw Service engineer. There are no user-serviceable parts within the CameraVIEW hardware module.

See section 11, “Customer support”, for details of your local Renishaw office and to arrange a service visit.

11 Customer support

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

11.1 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 (CameraVIEW hardware) 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. Details of the CameraVIEW hardware can be found on the sticker situated on the rear of the camera. The CameraVIEW hardware can be found behind a cover above the chamber.

Additional support can be sought by contacting your local Renishaw office. See:

www.renishaw.com/contact

12 Abbreviations

The following abbreviations are used throughout this guide:

Term	Definition
AM	Additive Manufacturing
AMPM	Additive Manufacturing Process Monitoring
DNS	Domain Name System
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
SSL	Secure Sockets Layer

www.renishaw.com/contact



#renishaw

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