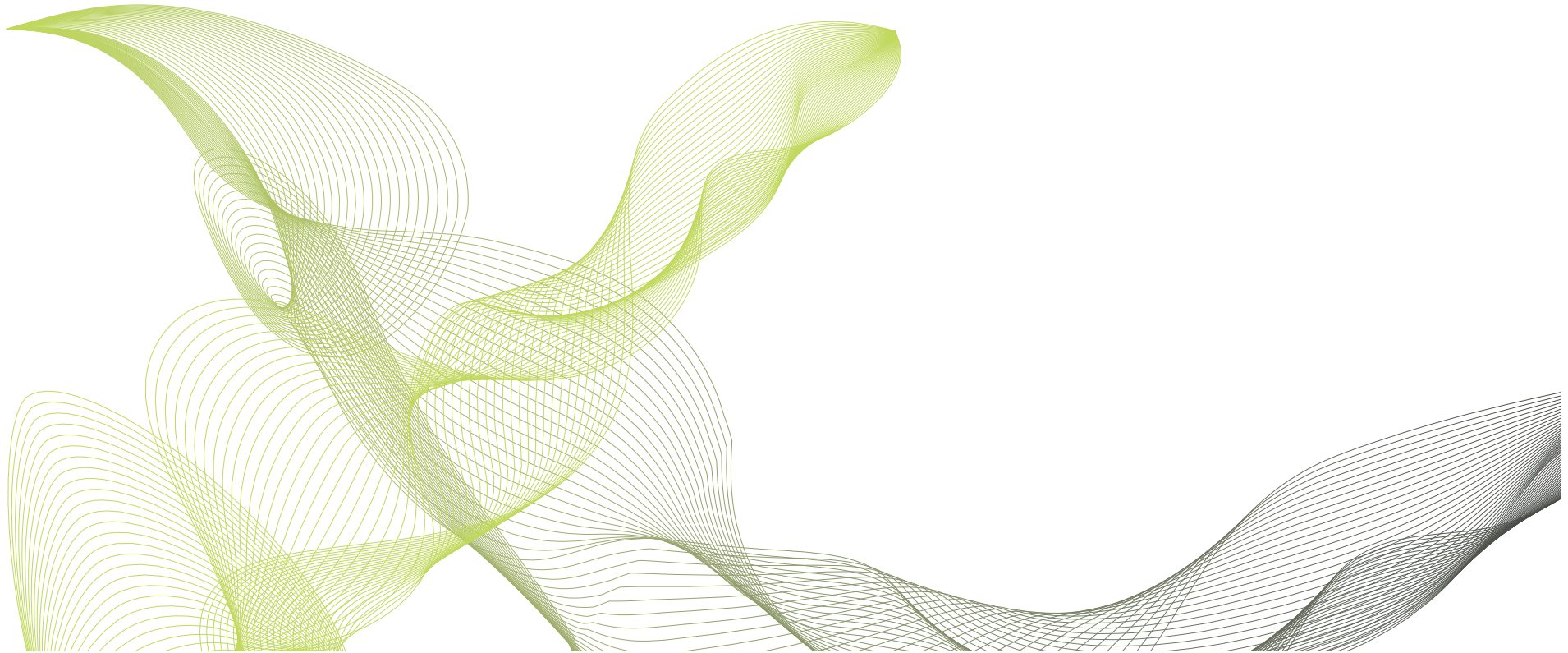


# CARTO Explore



[www.renishaw.com/carto](http://www.renishaw.com/carto)

 #renishaw



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## Legal information

### 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.

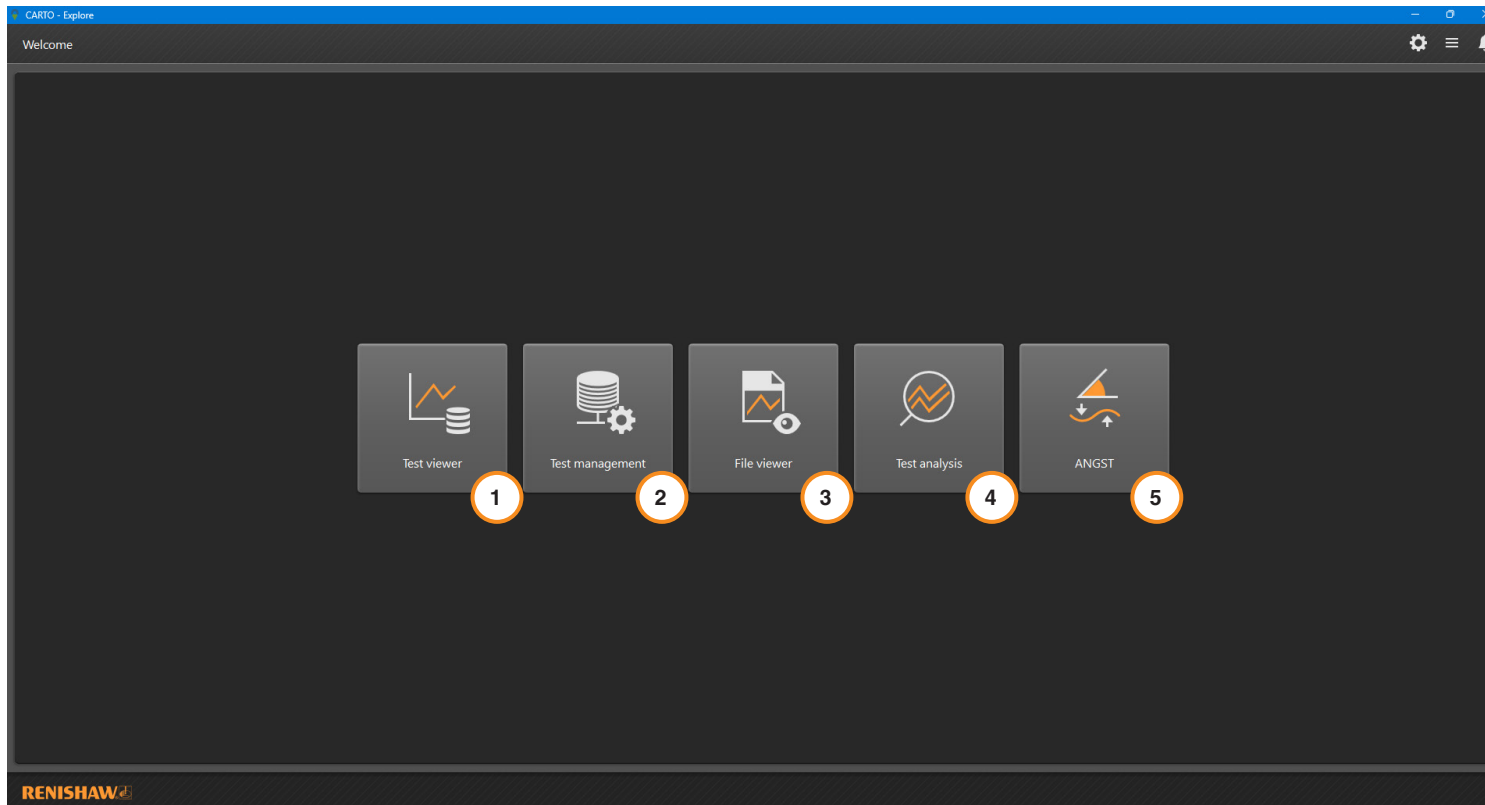
### Safety

Before using the laser system, consult the *XL laser safety* information booklet (Renishaw part no. M-9908-0363) or the *XM laser safety* information booklet (Renishaw part no. M-9921-0202).



## Home screen

The home screen allows you to view individual measurement files, import legacy data or open the test viewer displaying all the tests in the test database. To return to the home screen at any point, select the 'Home' icon on the top left of the screen.



|   |                                    |
|---|------------------------------------|
| 1 | Test viewer                        |
| 2 | Test management                    |
| 3 | File viewer                        |
| 4 | Test analysis                      |
| 5 | ANGST<br>(Angular to straightness) |



## 1 Test viewer

Select the 'Test viewer' icon to view and display all the tests in the database and options for filtering the available tests. You can manage tests through this view; exporting, importing, tagging, and deleting of previously run tests. You can select individual tests and expand them for in-depth analysis or comparison.

## 2 Test management

The 'Test management' icon on the home screen imports supported file types into the CARTO database. This functionality enables you to transfer legacy files from LaserXL or RotaryXL software to the CARTO suite.

## 3 File viewer

Using the 'File viewer' icon on the home screen, you can view legacy file types in CARTO. The following file types are compatible:

- Ballbar analysis (.b5r files)
- Dynamic (.rtx and .rtd files)
- Flatness moody and grid: (.rtn files)

## 4 Test analysis

Using the 'Test analysis' icon on the home screen, you can load two tests from the CARTO database. The following types of analysis can be performed:

- Linear parallelism analysis
- Rotational parallelism analysis
- Squareness analysis

## 5 ANGST

The ANGST icon allows you to convert an angular data file into a straightness file to give an indication of the form of axis straightness error.



## Test viewer screen

The following image highlights the main areas of the Explore interface.

The screenshot shows the CARTO Explore interface with the following components highlighted by numbered callouts:

- 1**: Home icon
- 2**: Search bar
- 3**: Filter tags section
- 4**: Displayed tests table
- 5**: Import transfer file button
- 6**: Export all tests, Export to transfer file, Export tests, Export to CSV buttons
- 7**: Error heatmap button
- 8**: Compare view button
- 9**: Combined report button
- 10**: Data stitch button
- 11**: Settings button
- 12**: More (Help and about) button
- 13**: Notification tab button
- 14**: Refresh button
- 15**: Delete button

| Test title            | Machine name | Serial number | Axis | Operator | Date                         |
|-----------------------|--------------|---------------|------|----------|------------------------------|
| Stitched              | Machine      | -             | X    | sk       | Tuesday 2025/09/09 12:02 PM  |
| stitch 100mm gap      | Fanum        | -             | X    | mc       | Monday 2025/04/07 03:55 PM   |
| stitch 500mm gap      | Fanum        | -             | X    | mc       | Monday 2025/04/07 03:52 PM   |
| test 4 1200-2250      | Fanum        | -             | X    | mc139304 | Monday 2025/04/07 03:33 PM   |
| stitch 3 750 - 2250   | Fanum        | -             | X    | mc139304 | Monday 2025/04/07 03:33 PM   |
| stitch 2 250-1300     | Fanum        | -             | X    | mc139304 | Monday 2025/04/07 03:18 PM   |
| stitch 1 - 250-1750   | Fanum        | -             | X    | mc139304 | Monday 2025/04/07 03:09 PM   |
| baseline fanum x - nm | Fanum        | -             | X    | mc139304 | Monday 2025/04/07 02:56 PM   |
| DMC_1000-600          | Machine      | -             | X    | jm142059 | Monday 2022/09/26 03:31 PM   |
| DMC_0-1000            | Machine      | -             | X    | jm142059 | Monday 2022/09/26 02:56 PM   |
| DMC_0-600             | Machine      | -             | X    | jm142059 | Monday 2022/09/26 02:48 PM   |
| DMC_700-1000          | Machine      | -             | X    | jm142059 | Monday 2022/09/26 02:40 PM   |
| DMC_400-700           | Machine      | -             | X    | jm142059 | Monday 2022/09/26 02:34 PM   |
| DMC_0-400             | Machine      | -             | X    | jm142059 | Monday 2022/09/26 02:27 PM   |
| pa3                   | -            | -             | -    | Renishaw | Friday 2022/08/19 02:40 PM   |
| 2pntpara3             | -            | -             | -    | Renishaw | Thursday 2022/08/11 05:14 PM |
| heakpara2             | -            | -             | -    | Renishaw | Thursday 2022/08/11 03:25 PM |
| heakpara2             | -            | -             | -    | Renishaw | Thursday 2022/08/11 03:25 PM |
| heakpara1             | -            | -             | -    | Renishaw | Thursday 2022/08/11 03:03 PM |



## Test viewer

The 'Test viewer' is an area used for handling and selecting results. Browse through the tests saved in the database and open them for analysis or export them.

1

### Home

Return to the home screen

2

### Search

**Quick** – for a quick way to filter test results.

**Advanced** – expand the search area to use the advanced search. You can filter results based on multiple criteria at the same time.

3

### Filter tags

4

### Displayed tests

Select a category (test title, axis, etc.) to organise the tests based on the chosen category. You can then toggle between ascending and descending order by selecting again. For fast loading time, long lists of test records are split up into pages. You can adjust the number of test records per page in the settings.

5

### Importing transfer file

6

### Exporting files

The following options are found in the drop-down menu at the top right of the screen:

**Export all tests** – to export all database records to a single .CARTO file, select the 'Export all tests' icon.

The .CARTO file can then be transferred to a different computer, and imported to the new CARTO database by selecting the 'Import transfer file' icon.

**Export to transfer file** – to transfer test records to a CARTO database on a different computer, highlight the required test records and select the 'Export to transfer file' icon.

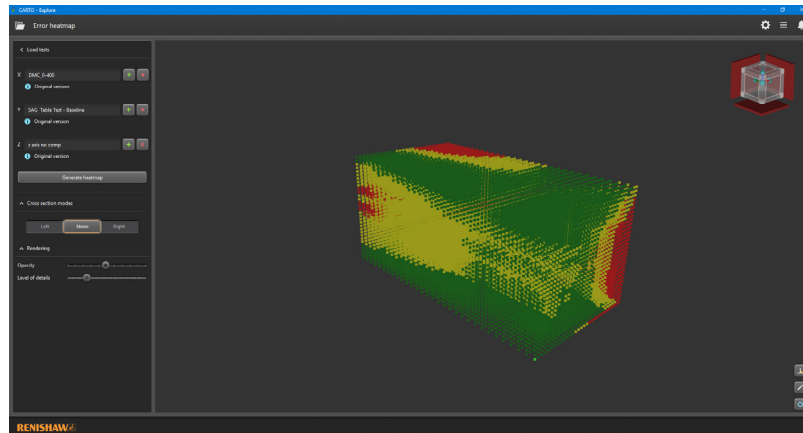
**Export tests** – export test records to RTL, RTA, and ST\* files by highlighting a test or a group of tests and then selecting the 'Export tests' icon. Exported files are compatible with Renishaw XCal-View software. To export files that are compatible with older file formats, go to 'Settings' > 'Application' and tick 'Use full legacy format'.

**Export to CSV** – select one or multiple tests from the database and export the tests to a comma-separated values (.csv) file. This function exports all test information, including the raw laser readings.



## 7 Error heatmap plug-in

Select the 'Error heatmap' icon for a 3D visualisation of machine errors. For XM-60/600 data only.



## 8 Compare view

More information is on **page 18**.

## 9 Combined report

More information is on **page 22**.

## 10 Data stitch

More information is on **page 17**.

## 11 Settings

The 'Settings' window automatically opens the first time Explore is used and can be accessed at any time by selecting the 'Settings' icon. To save any changes made, use the 'Apply' button. Further information are over page.

## 12 Help improve CARTO

Choose whether to share technical information to help improve CARTO.

## 13 Notifications

Software notifications, such as 'Check for updates', are displayed here.

## 14 Refresh results

When tests are saved in Capture while the 'Test viewer' is open, the new tests are not shown until the next time Explore is opened, or the 'Refresh' icon is selected.

## 15 Delete

Highlight a test record and select the 'Delete' icon at the bottom right of the screen. Deleted test records can be restored from the home screen.



## Other features

### View selected test

Open a test record by double-clicking the desired test.

### Tagging

Tags are added by selecting a test record or group of test records and typing in the 'Add tags' field, then pressing enter. You can remove the association between the test record and a tag name by holding the cursor over the tag name and selecting the 'Remove tag' icon.

## Settings

There are eleven tabs that can be used to specify preferences.

### General

**Language** – change the language used in the software. The default language is listed as 'System', which reflects the settings of your device.

**Theme** – choose whether Explore has a 'light' or 'dark' appearance.

### Application

This tab shows all options for the application.

**24 hours format** – switches the displayed time between 12 and 24 hour time formats.

**Records per page** – the number of records displayed per page in the test viewer, from 25 to 100.

**Channel names** – switches between error channels. Displays either ISO 230-1 standard or the VDI 2617 standard by default.

### Error compensation:

**Legacy format** – uses the LaserXL error compensation format.

**Show overwrite warning** – either shows or hides a warning when an output file has the same name as a previous file and the old file will be overwritten.

**LEC output path** – set the default folder location when generating LEC files.

### Export file:

**File name attributes** – select the file name attributes while exporting to files. Include or remove machine names, serial numbers, and test titles from the exported file.

**Legacy LaserXL precision** – use the legacy LaserXL precision settings while exporting to files.

**Full legacy format** – use full legacy format while exporting to files.

### Advanced configuration:

**File encoding** – select from a range of encoding types.

### Edit test errors - password authentication:

**Lock edit test errors function** – secures the file with a password. This option allows you to lock error editing functionality on tests and is not related to securing a complete test.



## Units

This tab shows the units and decimal places for the error and environmental data that is displayed in the analysis graphs.

**Linear and straightness units** – assign units for linear and straightness error and for target.

**Angular units** – assign units for angular error and for target.

**Squareness units** – assign units for squareness error.

**Environment units** – assign units for temperature, expansion coefficient, pressure, and humidity.

## Angular

**Apply average to all runs** – average angular results at each position across all runs.

**Analysis standards configuration** – options to include or exclude standards; ASME, GB/T, ISO, JIS, Renishaw and VDI.

## Linear

**Apply average to all runs** – average linear results at each position across all runs.

**Analysis standards configuration** – options to include or exclude standards; ASME, GB/T, ISO, JIS, Renishaw and VDI.

## Straightness

**Apply average to all runs** – display average straightness results at each position across all runs.

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**NOTE:** This option only performs averaging on data in the 'Raw', 'Renishaw straightness 2012', and 'Compare' graphs. Straightness averaged data can be seen in ISO 10791-1 2015 analysis as well along with RAW and Renishaw 2012.

---

**Show data slope value on graph** – displays the slope value when slope removal is applied to the captured data.

**Enable slope removal for raw and compare views**

**Method** – select the averaging method: End point fit or Least squares fit.

**Averaging type** – run by run, average runs per direction, average all runs.

**Run by run** – slope is calculated for each individual run to perform detrending on each individual runs with the slope.

**Averaging runs per direction** – slopes are calculated for all averaged forward and reverse runs separately to perform detrending on each individual runs with the corresponding slope values.

**Averaging all** – slope is calculated for all averaged data to perform detrending on each individual runs with the slope.

**Analysis standards configuration** – options to include or exclude standards; ASME, ISO, Renishaw and VDI.



## Squareness

**Prism error (arcsecs)** – define the specified prism error.

## Axis configuration

**Add new axis under test** – option to add new axes for both linear and rotary measurements.

## Report

This tab configures the PDF report output.

**Language** – change the language used when generating a report.

**Font** – allows selection of the report font.

**Logo** – browse and add a personalised logo to a report. Personalised logos appear in the top right of PDF and printed test reports.

---

**NOTE:** The size of the logo in reports will be 200 × 50 pixels. If the logo is not this size, the software automatically scales the chosen logo to fit on the report.

---

**Local date format** – the ISO date format (YYYY-MM-DD) is used as default in PDF reports.

**Show environmental conditions table** – environmental data captured from the XC is included when generating a report. The laser measurements remain fully environmentally compensated.

## Graph configuration

This tab configures graph layout and output.

**Exponential scale** – an option to express axis values as a base multiplied by a power of 10, making it easier to display larger or smaller values.

**Legend** – displays the run identifications on the right-hand side of the plot.

**Grid** – displays a 'Background grid' on the plot relative to the scale.

**Line thickness** – adjusts the thickness of the data plot lines displayed in the graph.

### RAW and Renishaw graph plots:

**Marker style** – a drop-down menu with many visual options for the data plot markers.

### Stitched graph plots:

**Stitched regions** – highlights the portion of the data that has been stitched.



## Test management screen

The screenshot shows the 'Test management' screen in the CARTO Explore application. The interface includes a left sidebar with a search bar, a 'Tags' section, and a list of tags. The main area displays a table of test records. At the bottom right, there are three icons for refreshing, restoring, and clearing trash.

| Test title                         | Machine name | Serial number | Axis | Operator | Date                       |
|------------------------------------|--------------|---------------|------|----------|----------------------------|
| Verification - 2023-04-17 11_09_24 | New machine  | 0000          | Y    |          | Monday 2023/04/17 11:09 AM |
| Calibration - 2023-04-17 11_05_54  | New machine  | 0000          | Y    |          | Monday 2023/04/17 11:05 AM |

Showing 1 to 2 tests out of 2

- |   |              |
|---|--------------|
| 1 | Importer tab |
| 2 | Restore tab  |
| 3 | Refresh      |
| 4 | Restore      |
| 5 | Clear trash  |

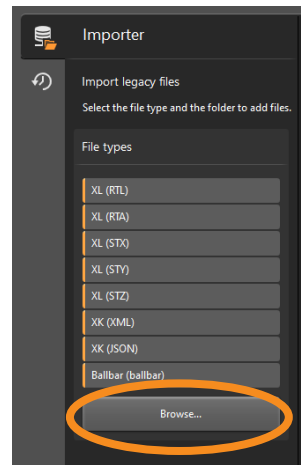


## 1 Importer tab

| XL-80                           | Ballbar           | XK10 and XK20             |
|---------------------------------|-------------------|---------------------------|
| RTL<br>RTA<br>STX<br>STY<br>STZ | Ballbar (ballbar) | XML (XK10)<br>JSON (XK20) |

Selecting the 'Browse' button on the left-hand side prompts you to define the location folder of the test being imported.

For any axis missing, 'Axis under test' is highlighted in red until edited by you. Select 'Edit test' at the bottom right of the screen and select the relevant letter in the drop-down list under 'Axis under test'. Tags are added during the importing process, as described in the **'tagging' section**. Use the 'Show imported tests' toggle to show or hide tests that are already been imported.



## 2 Restore tab

Displays records that are deleted from the database.

## 3 Refresh

Reload the list of records

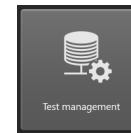
## 4 Restore

Highlight a test record and restore the test.

## 5 Clear trash

Highlight a test record and clear the test.

## Migrate from LaserXL to CARTO



The 'Test management' function allows simple migration from LaserXL and RotaryXL software applications to the CARTO software suite.

It allows Laser 10, LaserXL, and RotaryXL test data and test methods to be imported providing data in a single database location. Importing test data allows existing machine part programs to be used. The 'How to' video features instructions to carry out the migration process.

The video is on the CARTO support page: [www.renishaw.com/carto-support](http://www.renishaw.com/carto-support).



## Data review and analysis

### Test viewer



The 'Test viewer' panel, found on the left-hand side of the software when a test is open, contains details regarding the open test. This example shows an XM-60 test.

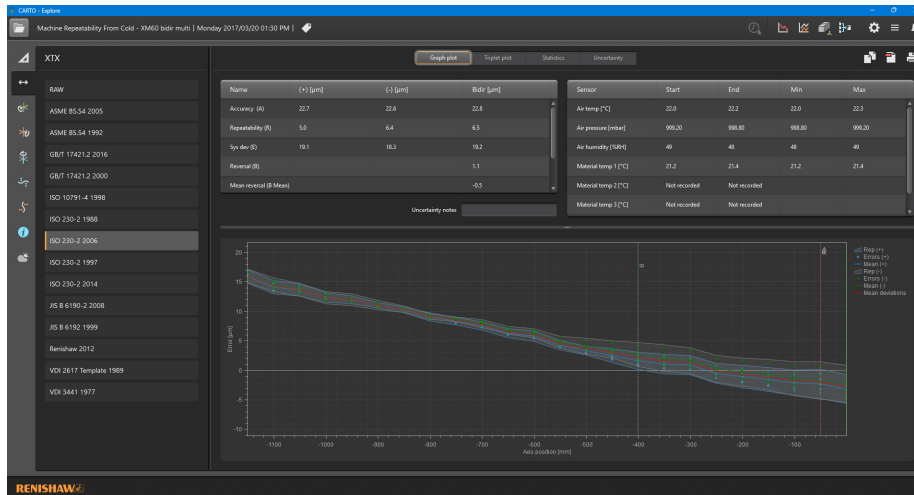
**Measurements** – displays the 'Graph plot' and 'Raw data' table for the selected test. When viewing the 'raw' graph of an error channel, there is a multi-switch at the top of graph.

**Test information** – contains details of the selected test. You can edit the title, operator, notes, machine name, and serial number of a test record. To edit the text, select the field, type the new text and select the 'Save' icon in the top right.

**Environmental conditions** – the 'Environmental conditions' tab summarises the data captured by the environmental compensation unit during the test (when connected). Clicking on a graph gives more information and allows printing or creation of a PDF file.



## Analysis



**Supported analysis standards** – ASME 5.54 1992, ASME B5.54 2005, GB/T 17421.2 2000, GB/T 17421.2 2016, GB/T 17421.2 2023, ISO 230-2 1988, ISO 230-2 1997, ISO 230-2 2006, ISO 230-2, 2014, JIS B 6192 1999, ISO 10791-1 2015, ISO 10791-4 1998, JIS B 6190-2 2008, Renishaw 2012, VDI 3441 1977, VDI 2617 Template 1989.

**Switching the data view** – data is viewed in various formats using the tabs at the top of the data plot. The format options vary depending on the analysis standard selected.

## Analysis feature highlights

Select from different analysis standards next to the graph plot to display them on the graph.

**Opening a standard** – when a test is open, you can view the data using one of the international analysis standards supported within Explore. The analysis standards are in the column on the left-hand side.



## Graph interaction

When analysing a test within Explore, the following options are available to customise the graph:

### ‘Zoom’ in and out on the cursor:

- Position the cursor over the graph and use the scroll wheel to zoom.
- Press and hold the control key (ctrl), and press the + or – key to zoom in or out.

**‘Zoom’ the axis scale** – position the cursor over the required axis, select it and then use the scroll wheel to zoom.

### ‘Zoom’ to a manually selected area:

- Hold the scroll wheel and drag to select an area to zoom.
- Press and hold the control key (ctrl), select and hold the right mouse button and drag to select the area to zoom.

### ‘Pan’ the axis scale up and down:

- Position the cursor over the required axis, select and hold the right mouse button, and drag the axis.

### ‘Pan’ the graph plot:

- Position the cursor over the graph, select and hold the right mouse button and drag.
- Position the cursor over the graph and select it. Press and hold the control key (ctrl) and use the arrow keys.

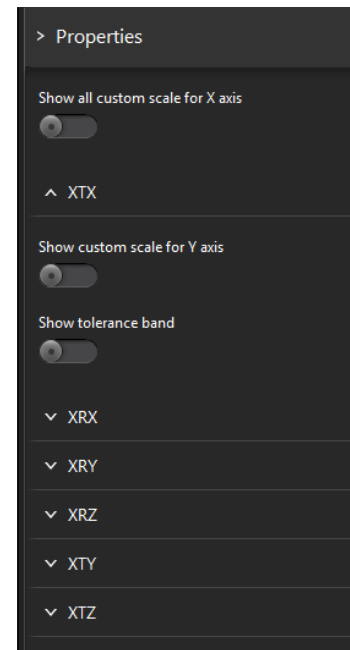
### ‘View’ point co-ordinates and series details:

- Position the cursor over a capture point on the graph and hold the left mouse button to view information.

### ‘Revert’ to default settings:

- Position the cursor over the graph and double-click the scroll wheel.
- Position the cursor over the graph, press the control key (ctrl) and double-click the right mouse button.
- Position the cursor over the graph and select the ‘Home’ icon.

## Properties pane



On the right-hand side of the measurements screen, the properties pane allows you to customise the X and Y axes of the displayed graph(s). You can set a custom scale with a minimum and maximum range.

Custom tolerance bands can be applied to the graph(s). This allows you to add in a visual guide to the graph(s), to highlight data that meets their tolerance requirements.



## Data stitch



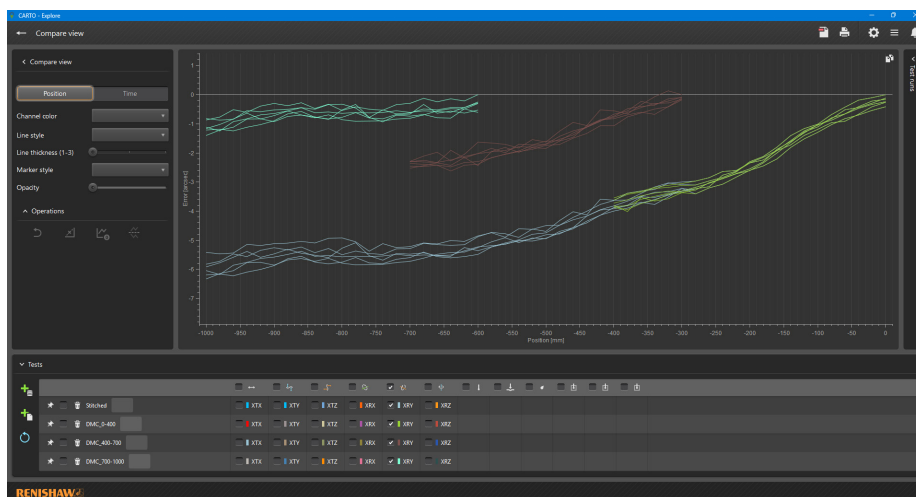
Stitching data together allows you to capture a measurement axis in multiple sections before using the data stitch function to create a single measurement record. This allows measurement of axes that are greater in length than the specification of the laser system. Alternatively, it offers the ability to break down measurements of axes captured in noisy measurement environments into smaller sections.

### To stitch tests:

1. Select 'Data stitch' in the bar towards the top right of the screen.
2. Select the measurement type, machine name, and axis from the drop-down menus. This filters the database when selecting the tests to be stitched.
3. Select add tests and select the tests to be stitched.
4. Each test section is displayed as an individual test in the view window.
5. Select 'Stitch test' to stitch the tests together. This creates a preview and highlights the overlapping section.
6. Enter a 'Test name' and 'Operator' details before selecting 'Save' to add the new test to the database.
7. To open the next test from Data stitch, select 'Open'.



## Compare



Comparing test records can be useful for applications such as comparing data before and after error compensation or viewing the effects of angular error for linear positioning. While in compare view, zero point offset, slope removal, and graph inversion can be applied to the data.

### To compare files:

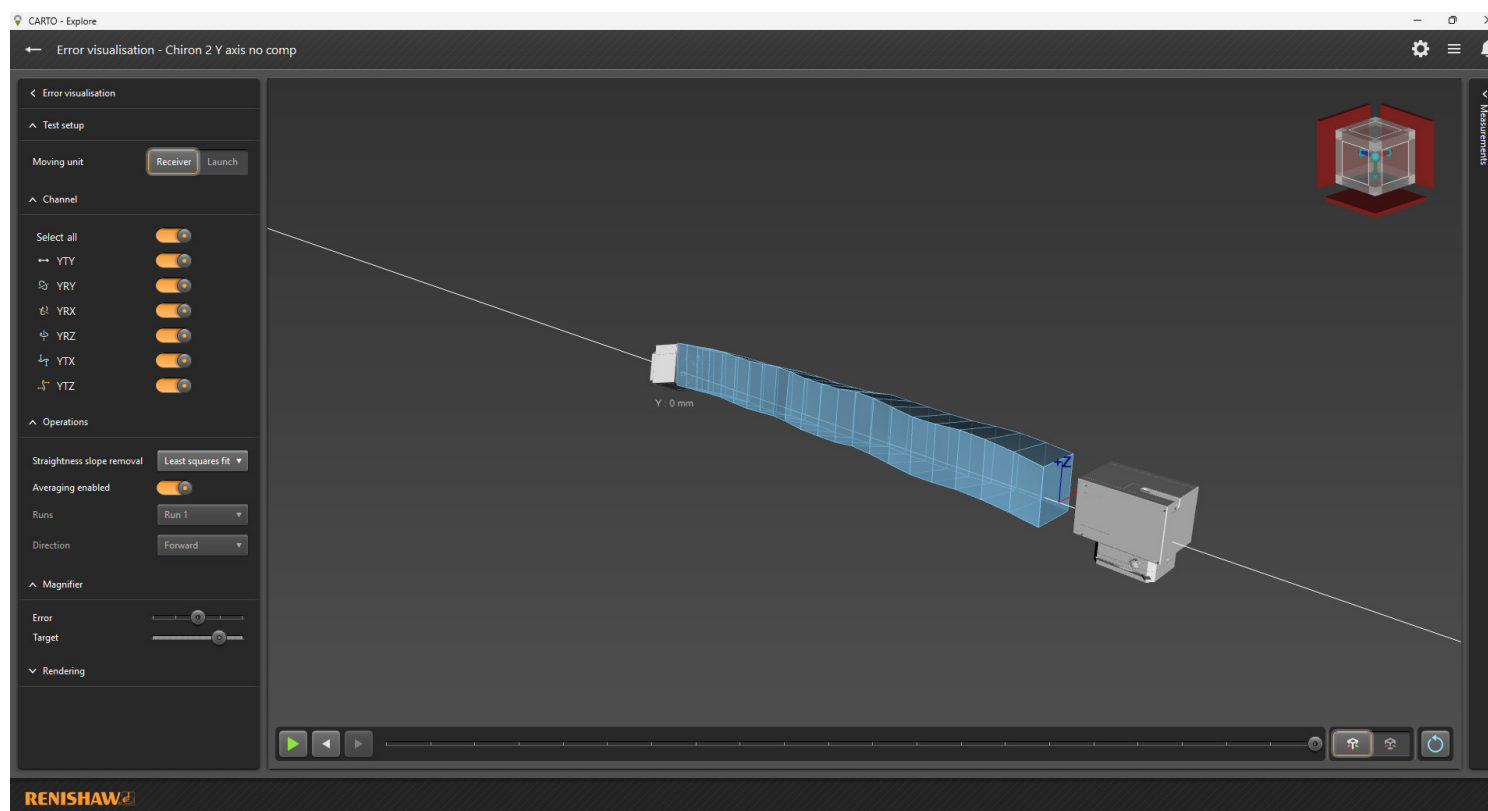
1. Go to the test viewer.
2. Select one or more test records.
3. Select 'Compare' in the bar towards the top right of the screen.
4. In the table at the bottom of the page, tick the boxes of the error channels of interest.
  - Select 'Add' to add extra test records to the table.
  - Select 'Remove' in front of each test record to remove individual records.
  - Select the 'Reset' button on the left of the table to reset the Compare view to the default state.
  - To edit how an error channel is displayed, select the error channel in the table and make adjustments using the panel on the left.



## Error visualisation (XM tests only)



Selecting error visualisation allows you to view a training animation of the captured measurement. This highlights the relationship between each individual degree of freedom and the effect that they have on the axis being measured. Operations, magnifiers, and rendering options are available. It is located at the top right of the measurement viewer screen.





## Data modifiers



|   |                       |
|---|-----------------------|
| 1 | Offset reading        |
| 2 | Zero point offset     |
| 3 | Average all runs      |
| 4 | Apply slope removal   |
| 5 | Data clipping options |



### 1 Offset readings (XM tests only)

Select 'Offset reading' to offset all six error channels from the XM measurement to a different point of interest. This allows you to see the effect of different offset values on the measurement values.

### 2 Zero point offset

'Zero point offset' enables the data to be offset so the displayed and effective '0' position is different from that set at the time of data capture. This can be useful for error compensation of rotary axes.

To apply the 'Zero point offset', select the 'Zero point offset' to display the 'Zero point offset' dialog box. Configure the 'Zero point offset' as required.

Toggle the 'Apply modifier' option in the Zero point offset window to revert to the original settings.

### 3 Average all runs

Selecting 'Average all runs' calculates the mean value across all calibration runs to find a single representative data set.

This can be removed at any time by toggling the 'Apply modifier' option.

### 4 Apply slope removal

Slope removal helps remove unwanted linear trend, so the remaining data represents the true error. In CARTO Explore, there are two methods for this:

- **End point fitting** – a straight line is drawn between the first and last end point and subtracts it from the dataset.
- **Least squares fit** – Calculates the best fit straight line through all the data points using the least squares approach, and then removes it.

### 5 Data clipping options

Selecting 'Data clipping options' to display and edit the maximum and minimum values for the X axis.

Runs can be removed from a multi-run test using the 'Data clipping modifier'.

These can be removed at any time to return the full range of the X axis by toggling the 'Apply modifier' option.



## Creating reports

Reports can be created using the following methods:

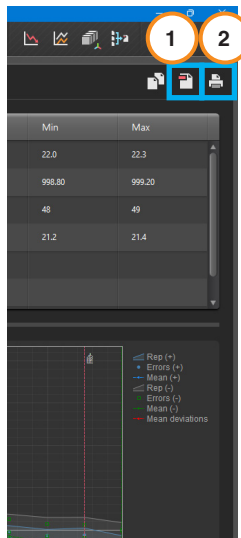
- Copying and pasting the relevant data into another application for editing.
- Creating a formatted PDF from within Explore.

**NOTE:** Adobe® Reader or a similar program must be installed on the device to view PDF reports.

## Copy and paste

Data within the software can be copied from any page where the 'Copy' icon appears.

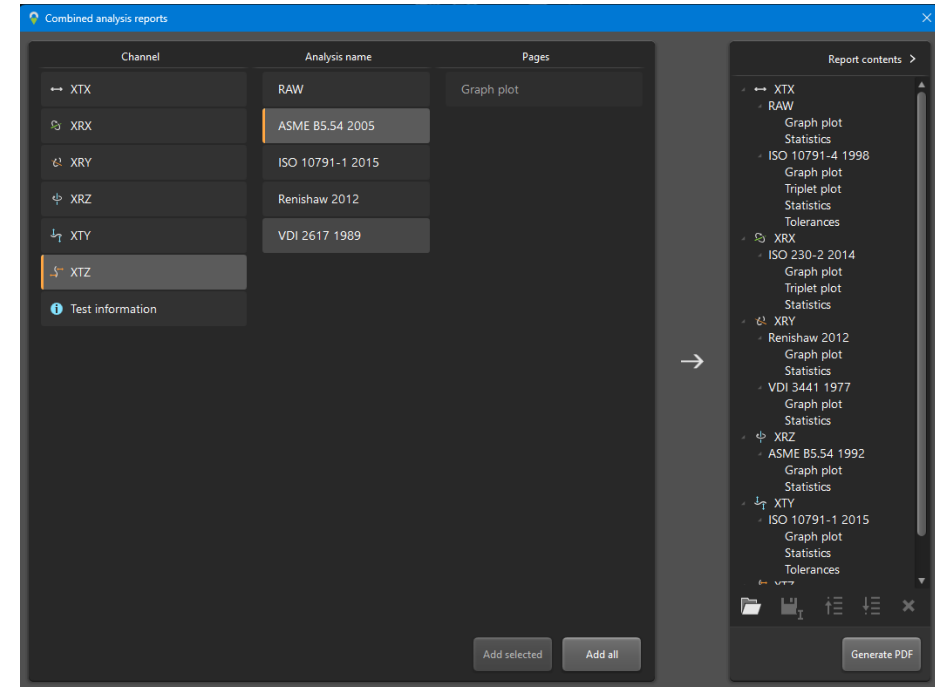
## Create a PDF



A PDF report can be generated from any analysis screen by selecting the 'Adobe®' icon. This allows selection of further Adobe® options, such as 'Save' and 'Print.' Alternatively, select the 'Print' icon to go directly to printing.

|   |             |
|---|-------------|
| 1 | Adobe® icon |
| 2 | Print       |

## Combined report

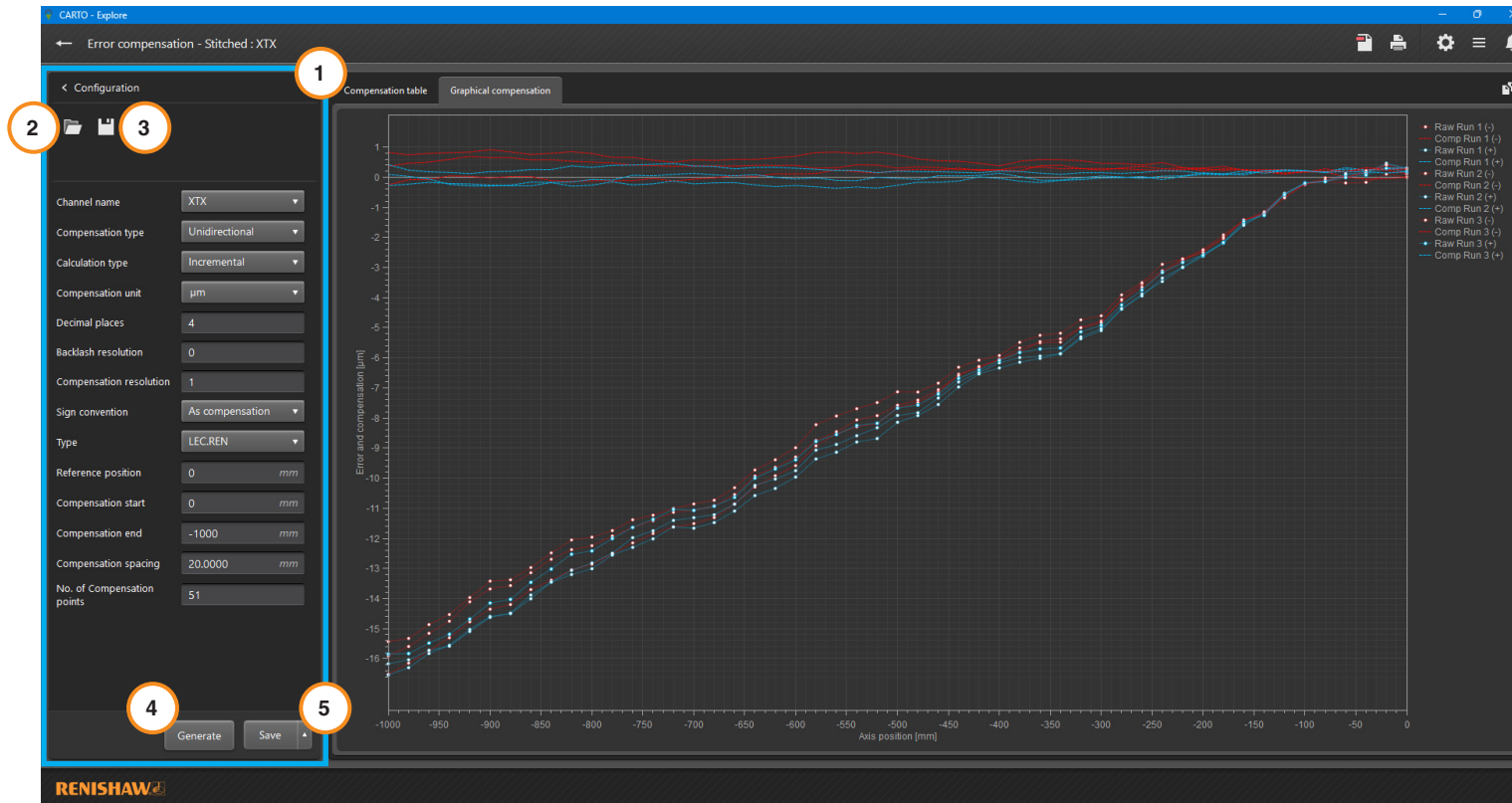


A single PDF report can be created for a single or multiple tests, displaying all six error channels in one report.

1. Select the 'Combined report' icon in the bar towards the top right of the screen. (The combined report functionality is also accessed from the 'Test viewer' screen).
2. Use the combined report window to create and generate a combined report for information of the required error channels. For example; RAW plot, RAW stats, and GB/T 17421.2 2016.



## Error compensation



|   |                                             |
|---|---------------------------------------------|
| 1 | Configuration panel                         |
| 2 | Save configuration settings                 |
| 3 | Load configuration settings                 |
| 4 | Generate<br>(View error compensation files) |
| 5 | Save error compensation file                |

When a test is open, the 'Error compensation' icon is at the top right of the Measurements screen.



## 1 Configuration panel

**Channel name** – select a channel to compensate.

### Compensation type:

- Unidirectional – one table of compensation values with a backlash value.
- Bidirectional – separate values for forward and reverse directions.

### Calculation type:

- Incremental – this gives values calculated with respect to the previous compensation point.
- Absolute – this gives values calculated at user-defined points with respect to the reference position.

**Compensation units** – assign the units for compensation values.

**Decimal places** – enter the number of decimal places for the compensation values.

**Backlash resolution** – the resolution of backlash values produced.

**Compensation resolution** – the resolution of compensation values produced.

**Sign convention** – configures the output values to either ‘as errors’ or ‘as compensation’. Inverts the sign of compensation values produced.

### Type:

There are two error compensation formats available: LEC.REN and LEC2.REN.

Choose a format which best suits the requirements for the relevant machine controller.

**Reference position** – the axis position where the zero point of compensation is applied.

**Compensation start** – the start position on the axis where compensation is applied.

**Compensation end** – the end position on the axis where compensation is applied.

**Compensation spacing** – the spacing between each compensation point.

**No. of compensation points** – instead of specifying the compensation spacing, the number of compensation points can be specified.

## 2 Saving configuration settings

If the configuration settings are required for future use, they can be saved by selecting the ‘Save’ icon.

## 3 Loading configuration settings

Select the ‘Load configuration’ icon to load a previously saved compensation configuration.



#### 4 Viewing error compensation files within Explore

When the configuration settings are complete, select the 'Generate' icon.

The error compensation data can be viewed in 'Compensation table' format or 'Graphical compensation' format.

In the graphical compensation view, the plot displayed will show the initial captured data results and the 'Predicted machine performance after compensation'.

#### 5 Saving the error compensation file

When the error compensation is generated, select 'Save' to save the compensation file. Select a location to save the compensation table.

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 #renishaw

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