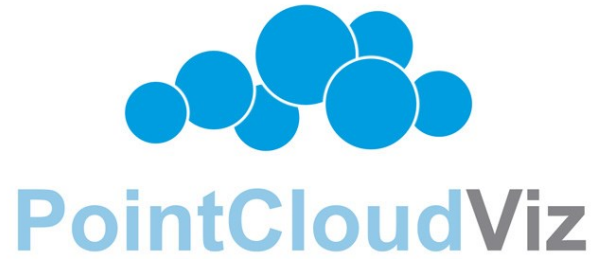

Large point cloud visualization for Petrel

User Guide

Version 1.0

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Mirage Technologies S.L.

www.mirage-tech.com

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About this User Guide

This guide provides a reference to using the PointCloudViz v1.0 plug-in for Petrel 2013.X. Please download a higher version of PointCloudViz for later Petrel releases.

For a description of the supported platforms, licensing issues and installation instructions please refer to the PointCloudViz Installation Guide.

Most of the material included in this document can be found in the plug-in help, accessible from the Petrel application in the **Help/plug-in help** menu.

Typestyle Conventions

The following conventions are observed throughout this guide:

- **Bold** text is used to designate literal file and folder names, dialog titles, names of buttons, icons, and menus, and terms that are objects of a user selection.
- *Italic* text is used for word emphasis, defined terms, manual titles and variables representing files or paths.
- Monospace text (`Courier`) is used to show literal text as you would enter it, or as it would appear onscreen.

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Introduction to LiDAR and other large point cloud datasets

What is LiDAR?

LiDAR stands for "Light Detection and Ranging" or "Laser Imaging Detection and Ranging". It is a sensor technology that uses laser scanning to get a large amount of 3D points from the environment surfaces that reflect the laser light. Typically, sensor providers offer software to attach to each 3D point its geographic coordinates, reflected intensity, color and even material classification.

Other laser-based technologies can provide similar data, like LADAR or simple 3D laser scanners. Special sensors have also been designed to provide information about aerosols and biochemical compounds by using spectral information.

3D point cloud data can be collected from airborne sensors (in airplanes, helicopters or drones) to cover a wide area, from surface vehicles on streets, highways and railways, or from fixed ground locations.

Because laser light can penetrate media like tree canopies and water, LiDAR can be used to get multiple reflections and 'see through' the vegetation and water masses.

Why are point clouds useful?

Typical point cloud data uses are:

- Extraction of terrain topography for visualization and surface analysis (structural, risk).
- Extraction of baseline, change tracking and certification of construction projects.
- Asset inventory and management.
- Infrastructure safety inspection and maintenance (railway and highway corridors, industrial plants, power lines, harbors).

In addition, specific laser sensors are used to detect airborne or waterborne particles:

- Contaminant aerosols and plumes.
- Oil and gas spills and leaks.

How to get LiDAR or 3D point cloud data?

There are three basic options:

- Use data collected or distributed by governmental mapping agencies. Some web sites offer search engines to find out what data is available, like data.gov or Earth Explorer. These datasets will normally cover a wide-area with low-resolution data.
- Use a LiDAR data provider. Most companies which traditionally offer cartography now provide LiDAR data as well. Some online magazines include a directory of companies providing these services.
- If you have in-house GIS or topography experts, you can buy or rent a LiDAR sensor, standalone or vehicle-mounted, and collect the data on your own.

If you need sample data to test PointCloudViz, you can find LiDAR datasets at Open Topography and the libLAS samples page.

PointCloudViz plugin features

At version 1.0, PointCloudViz features include:

- Loading LiDAR and point cloud data in the most common formats: .LAS, .LAZ and .XYZ (plain text point list).
- Point clouds are automatically processed so that it can be viewed interactively regardless of the original size. Sizes up to a billion points have been tested.
- Seamless visualization of LiDAR data, together with any other Petrel-supported data, in 2D and 3D windows.
- Projection from any coordinate reference system supported by Petrel.
- Multiple display options: single color, color per point, intensity per point, color multiplied by intensity, and classification. The available options depend on the point data attributes.
- Integrated into Petrel data exploration tools like intersection planes and picking.

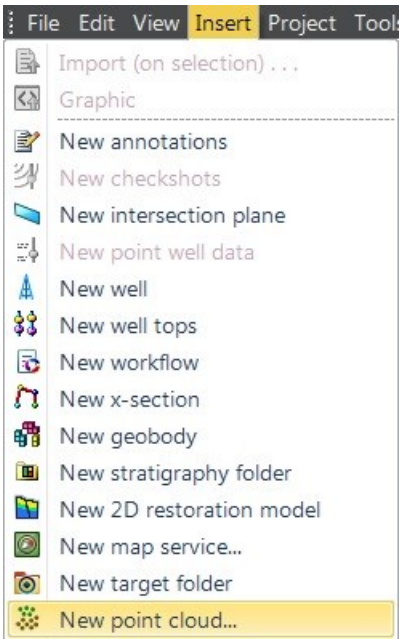
Next versions of PointCloudViz will include analysis tools to better integrate point cloud data into exploration, drilling and production workflows.

If you are interested in specific features regarding point clouds or other massive data, contact us at mirage@mirage-tech.com.

Adding point cloud data

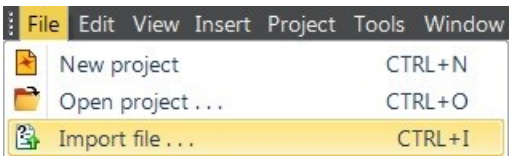
Once PointCloudViz plug-in is installed (see *Installation Guide*), you will find two ways to add point cloud data to Petrel:

- The **Insert / New point cloud...** menu command.

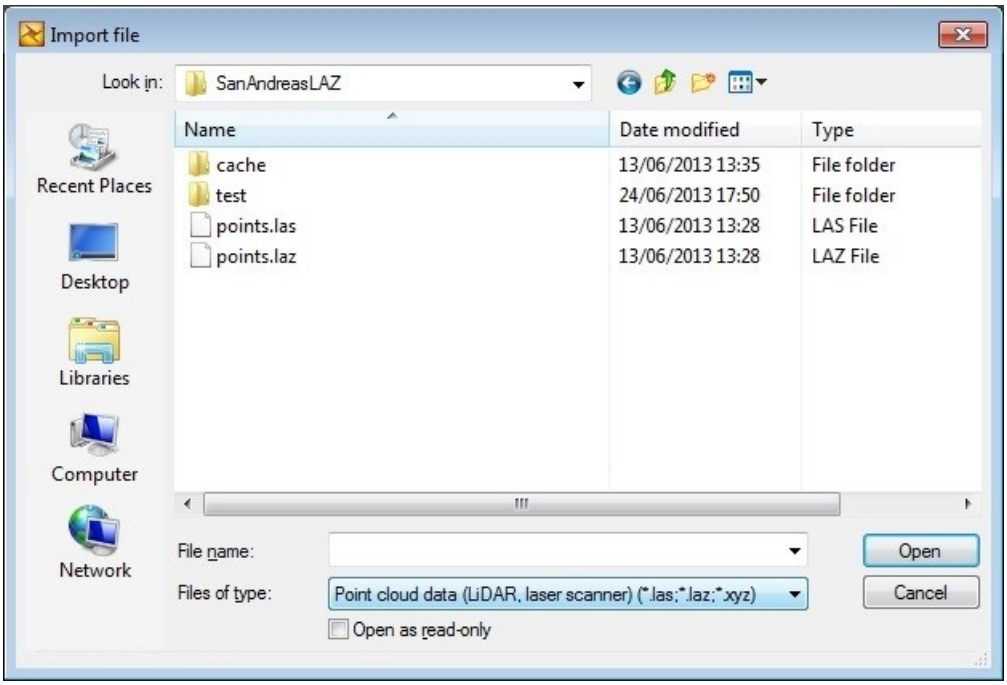


  After using this command, the **Insert point cloud wizard** will open automatically.

- The **File / Import file...** menu command.



In the file browser that opens, select the **Point cloud data...** filter and browse for your local data.



You can select one or multiple files of the same or adjacent sites, but *do not select multiple files if they come from locations which are far from each other*. In that case, import these files separately.

After selecting the files, the **Insert point cloud wizard** will open automatically.

The *Insert point cloud* wizard

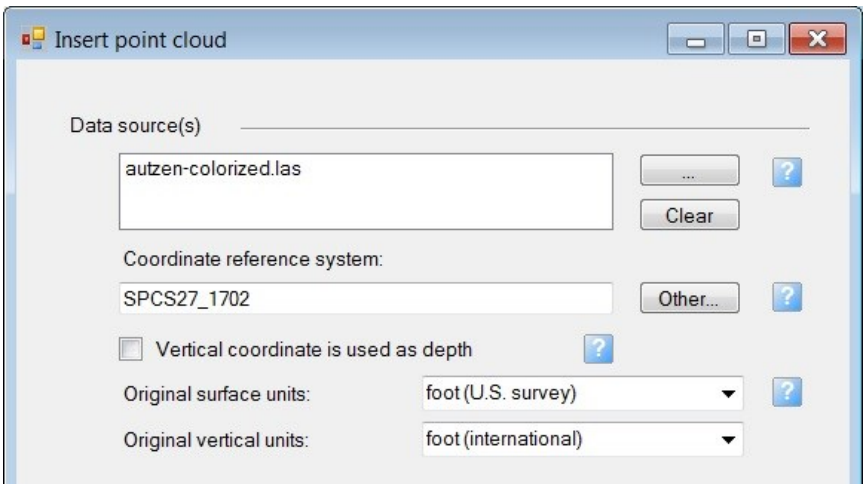
This wizard will open automatically when the **Insert/New point cloud** or **File/Import file** commands are used. The goal of the wizard is to guide you through the selection of some properties that will make easier to load and display the point cloud data.

If you place the cursor over the help hotspots, you can get information and tips about each information field.

Input/output settings

This page has two sections. The first section is used to specify the original point cloud data sources to be displayed in Petrel. The second section is used to select the location where a processed version of the data (*point data pyramid*) is stored to handle large datasets smoothly.

Data source(s) section



Input files

This section contains a list of input point cloud files. The background of the list box will remain colored in pink until valid files are selected.

If the **Import file** command has been used, the selected files are automatically added to the list box. Otherwise, the browsing button to the right (marked with '**...**') must be used to browse and select the files.

You can add to the list multiple point cloud files of the same or adjacent sites, but do not add multiple files if they come from locations which are far from each other. In that case, import these files separately.

Coordinate reference system

If we want to combine the point cloud datasets with other Petrel-supported objects, we must make sure they are in the same coordinate reference system (CRS), or they are projected to the same CRS when loaded in the project.

In this field we must specify the original CRS of the point cloud data files we selected for import. This information will be known by the data provider and usually distributed with a metadata file which accompanies the data itself.

By default, the original data CRS will be set to the current Petrel project's CRS (it will be empty if the project has no CRS assigned). If you know that the CRS of the input point data is different, set it by using the browse button (marked with '**...**') to the right, which will open the standard Petrel CRS selector.

Vertical coordinate as depth

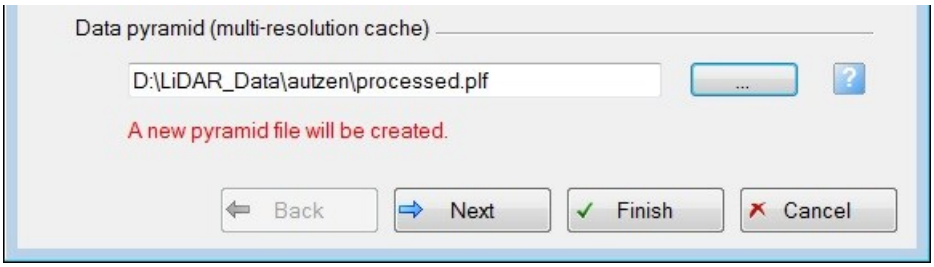
If this option is not checked, the Z values of the points are interpreted as elevation measured from the sea level, which is the normal interpretation for geographic information. Check this option if the Z values in your input data must be interpreted as depth measured from a reference ground plane, as it is common in the geophysics domain.

Surface and vertical units

Use these dropdown lists to select the units of your input data, for surface (X, Y) as well as vertical (Z) coordinates. The default units will be those of the selected CRS.

Notice that later adjustment of vertical offset and scale are possible for visualization purposes in the display settings of the point cloud object.

Data pyramid section

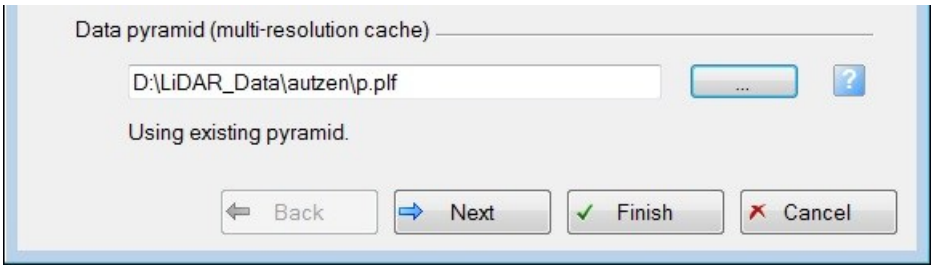


In this text field you must enter the location and name of the point cloud data pyramid (.plf) file. This data pyramid file is required to achieve interactive visualization of large point cloud datasets.

It is strongly recommended that you *place this .plf file inside a folder that is specific to your dataset*, so you can easily remove later the file and its matching pyramid subfolders (named 0, 1, etc.) if you no longer need them.

If the data pyramid file does not exist yet (e.g. when you first add the point cloud data to the project), it will be automatically created by processing the input data after the wizard is closed. This process will take some time, depending on the data size.

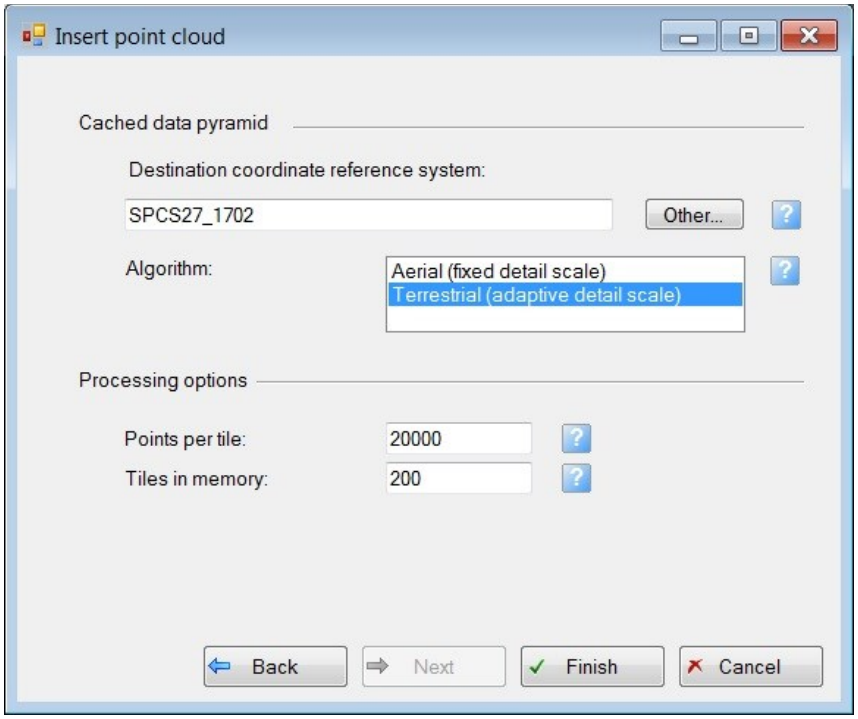
If you want to use the same point cloud data in different projects, you can select a .plf file that you have already created. In this case, you will see a message at the bottom of the wizard page informing you that the cache already exists and will be used.



If a project is loaded with a reference to a pyramid file which no longer exists, PointCloudViz will automatically process again the data and create the pyramid file, as long as it has permissions to write in the referenced disk location.

Data pyramid process settings (advanced)

This wizard page is enabled when the point cloud data pyramid (.plf) file does not exist yet and has to be processed. In most cases, you can just *accept the defaults* and click on **Finish** to close the wizard.



This page has two sections. In the first section, you select some options of the data pyramid. The second section is used to change some processing options affecting the memory usage.

Cached pyramid section

Destination coordinate reference system

This text field must contain the CRS for the data stored in the cached pyramid. This CRS should ideally be the same as the CRS of the projects in which you plan to display the point cloud. In this way, it will not be necessary to project the point data as it is loaded and visualization will be smoother.

Pyramid processing algorithm

Select the algorithm used to create the multiresolution pyramid cache. The 'aerial' algorithm provides better visualization for point clouds with homogeneous density, like those captured from aerial LiDAR, but 'terrestrial' works well in all cases, especially for variable density point clouds like those captured at ground level.

Processing options section

It is not recommended to change the values in this section unless you experience memory and performance problems.

Number of points per tile

This is the maximum number of points to be stored in each tile of the data pyramid cache. A higher number will speed up the processing, but may slow down visualization.

Number of tiles in memory

This is the number of tiles to be kept in memory during the generation of the pyramid cache. A higher number will speed up data processing, but consume more memory (watch the memory usage figure below).

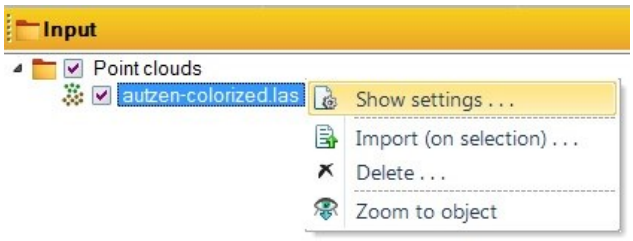
Processing the data

When the wizard is closed, if the data pyramid has to be processed, a new background task will appear in the Petrel **Task Manager**.

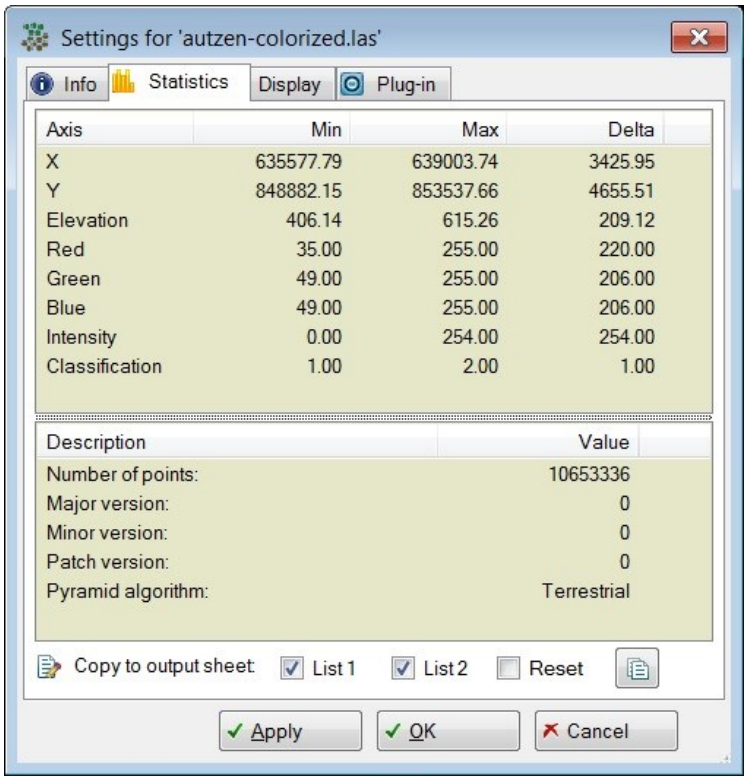
You should wait until the processing task is complete before trying to display the data or change its settings. If you try to set the point cloud object visible in a window, the visibility checkbox will turn grey. In that case, wait until the processing is complete and turn the object off and on again. It should display fine then.

Displaying point cloud data statistics

After adding point cloud data to Petrel, it is important to verify its statistics. To do so, you can use the **Show settings...** option in the Point Cloud object context menu.



Then select the **Statistics** tab in the settings dialog.



The contents of the *axis section* in this page are:

- Ranges of the original *X, Y and elevation* coordinates.

  We can use these ranges to verify that the data is located where it should.

- Ranges of **color** components, from 0 to 255 for Red, Green and Blue.

  If the delta values are zeros, it means the point data does not come with colors. In this case, the 'color per point' display mode will not be available.

- Range of point *intensity* values.

  If intensity values are provided, this range may go from 0 to 255, or sometimes as high as 5,000 or 65,000. Sometimes the maximum value is an invalid value, which means we should probably use a smaller range when displaying the intensity (see the *Display settings* section).

  If intensity values other than zeros are not present, the 'intensity' and 'color x intensity' display modes will not be available.

- Range of *classification* indices.

  These are the minimum and maximum values assigned to points as material classification (see the *standard LiDAR classification* section).

  If classification values are not present (all values are the same), the 'classification' display mode will not be available.

In addition, the page offers information on some dataset properties:

- The original *number of points* in the dataset.

  This number can be in the order of millions without causing problems to PointCloudViz. Not all the points will be displayed simultaneously, but they will be selected depending on each window's view point.

- *Version* numbers for the data pyramid cache.

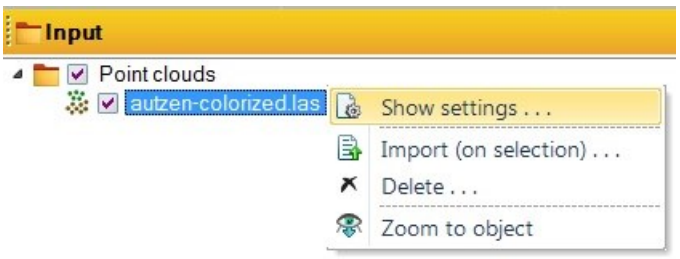
  If you experience problems with the data cache, we might request this information from you for debugging purposes.

- *Algorithm* used to process the data pyramid.

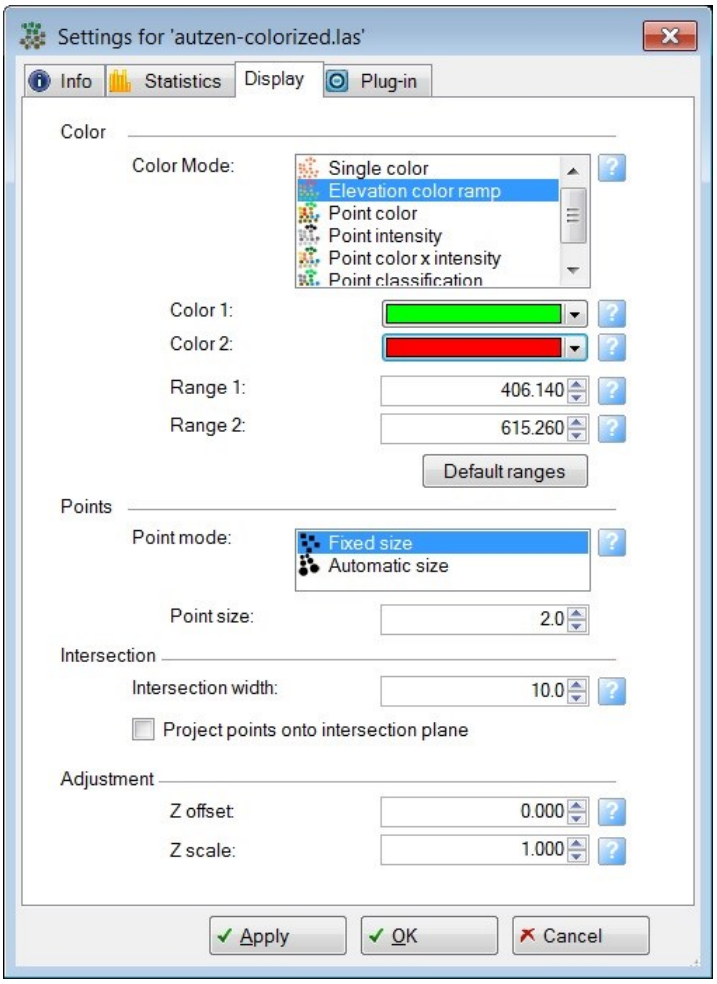
  This was selected when adding the point cloud to Petrel. The 'aerial' algorithm provides better visualization for point clouds with homogeneous density, like those captured from aerial LiDAR, but 'terrestrial' works well in all cases, especially for variable density point clouds like those captured at ground level.

Setting display options

After adding point cloud data to Petrel, you can change the way it is displayed in 2D and 3D windows. To do so, you can use the **Show settings...** option in the Point Cloud object context menu.



Then select the **Display** tab in the settings dialog.



Notice that the changes performed in the page will not have an effect in the visualization until the **Apply** or **Ok** buttons are pressed.

Color options

Color mode

This section lists all the options to assign colors to the points. Depending on the available point attributes (RGB color, intensity, classification) some options will be enabled or disabled (see the LiDAR data statistics).

Note that colors in the 'classification' mode are automatically assigned to those material values defined by the standard such as buildings, ground, water and vegetation. A grey color is used for buildings, brown for ground, blue for water and different shades of green for the three types of vegetation.

The color mode can also be changed easily by using the **PointCloudViz toolbar**.

Colors 1 and 2

Color 1 is used for all points in the dataset when 'single color' mode is selected, and used as color of low elevation points when 'elevation color ramp' mode is selected. It is disabled for other color modes.

Color 2 is used as color of high elevation points when 'elevation color ramp' mode is selected. It is disabled for other color modes.

Ranges 1 and 2

When 'elevation ramp' is selected as color mode, range 1 is the elevation where Color 1 is applied (minimum elevation), and range 2 the elevation where Color 2 is applied (maximum elevation).

When 'intensity' color mode is used, range 1 is the intensity value colored with the maximum light (white color). If the whole point cloud looks very dark when displayed in intensity mode, try lowering this range value. Notice that the maximum intensity value is also used in the 'color x intensity' mode.

Use the **Default ranges** button to reset the range values to the maximum and minimum values in the dataset.

Point options

Point mode

Select the option to assign a size to points when displayed on the window. When the 'automatic size' option is selected, the points are round and their size depends on the distance to the observer.

Notice that the 'automatic size' option will make point cloud drawing slower.

Point size

Use this field to change the overall point size. When the 'automatic size' option is used, this value multiplies the calculated sizes.

Intersection options

These options apply when the *intersection with planes* is activated (see section on working with intersection planes).

Intersection width

This parameter defines the size of the data area displayed when using intersection planes. The points shown will be those closer to the intersection plane than the specified distance in meters.

Point projection option

If this option is checked, the points closest to the intersection plane(s) will be shown on the plane itself (useful to create cross sections). Otherwise, they will be seen in their original locations.

Adjustment options

These options are used to shift or scale the point cloud data in the Z coordinate (elevation, depth) when it is displayed. In this way, it is easier to compare different datasets and surfaces. However, this transformation does not change the point heights when used for other purposes (for instance, the values shown when picking).

Z offset

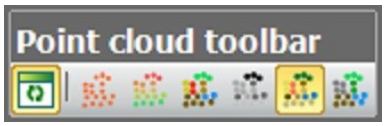
This value is added to the point elevation, moving the point cloud up and down for display purposes.

Z scale

This value multiplies the elevation of the point cloud, only for display purposes.

The PointCloudViz toolbar

This toolbar is a convenient way to change the display options of point cloud datasets.



Notice that when more than one point cloud object has been added to Petrel, the toolbar actions will affect the object that is selected in the Input tree (the *active point cloud*).

Automatic window refresh

The left-most tool is active by default. It enables the automatic window refresh needed to display detailed point data as it is loaded from the pyramid cache.

Click on the tool to disable the automatic refresh if you do not want to update the visualization periodically. However, the point cloud detail will still change when you navigate in the window.

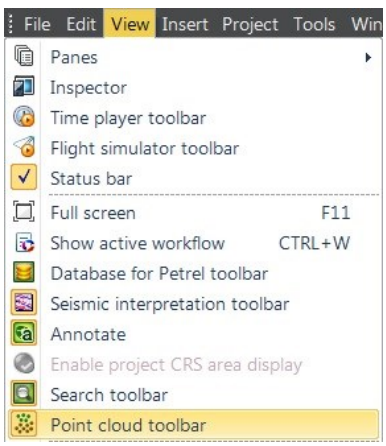
Quick color mode change

The other tools in the toolbar can be used to quickly change the color mode. Those modes which are not available for the current dataset will be disabled.

Refer to the display settings section for more details on color modes and how to change their parameters.

Showing and hiding the toolbar

Use the **View/point cloud toolbar** menu toggle button to make the PointCloudViz toolbar visible or invisible.

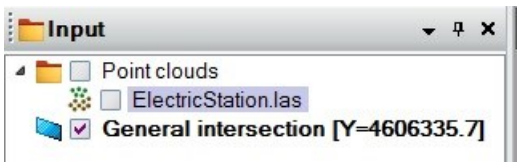


Using intersection planes with point cloud data

The ability to use intersection planes to create dynamic cross sections of data is a very useful data exploration tool included in Petrel.

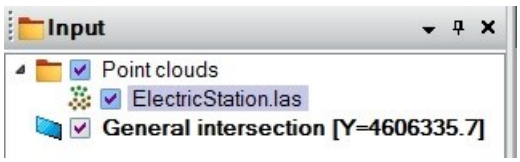
Search "general intersection" in the Petrel help system to find out how to create, manipulate and animate intersection planes.

After you create and/or select a general intersection plane, make the point cloud object *invisible* in the **Input tree** of the Petrel Explorer,

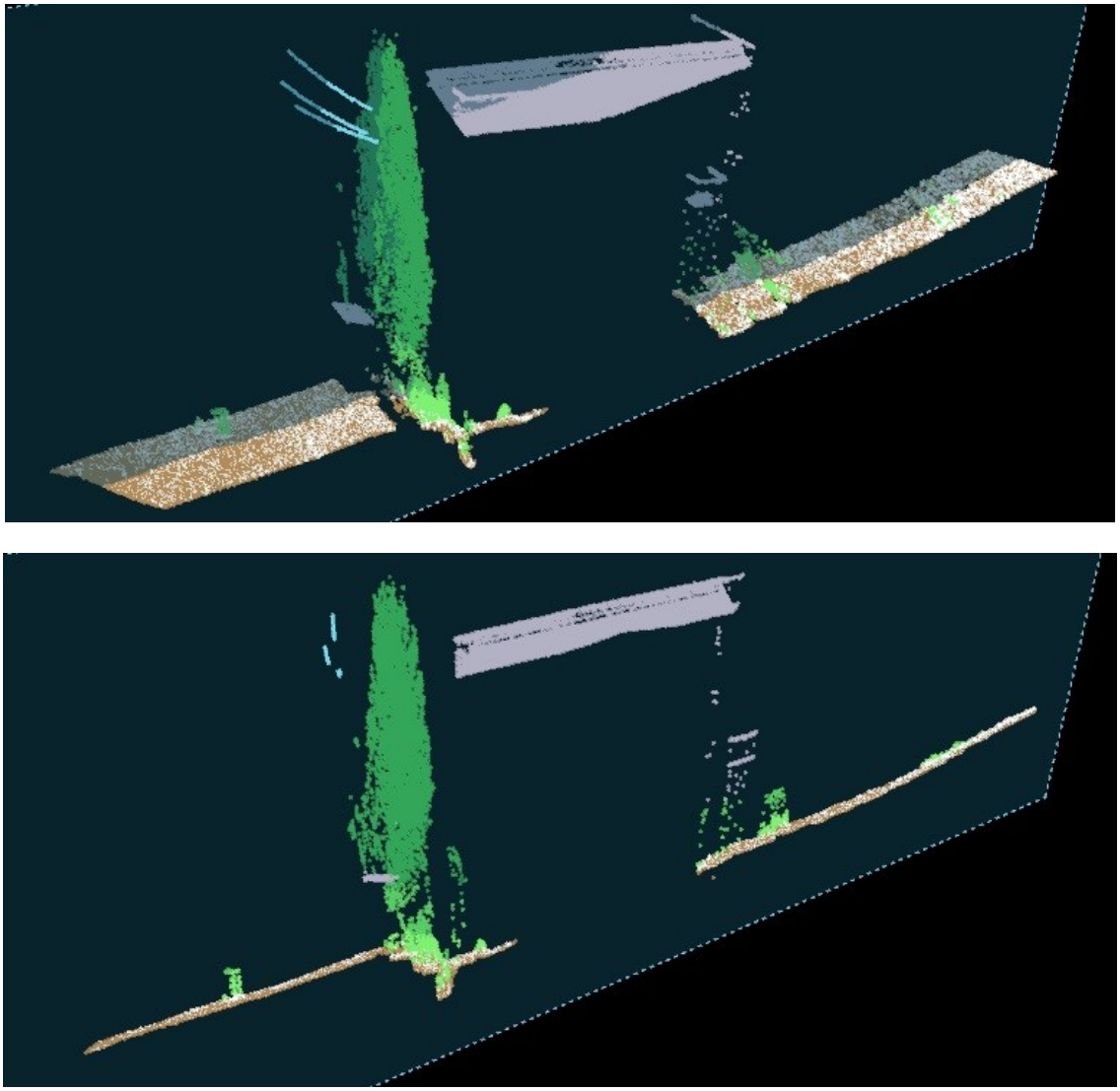


Then select the *intersection visibility mode* by using the left-most tool in the **general intersection toolbar**.

And check the point cloud as visible in the **Input tree**, when its checkbox area is colored in blue.



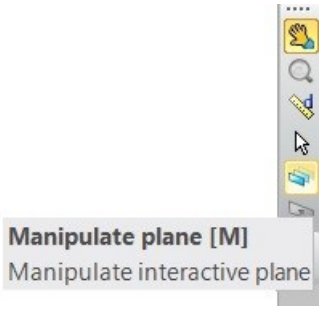
The display settings page of the point cloud includes options to change the width of the intersection area and to project the points on the intersection plane:



The intersection mode activated for a point cloud: without projection on plane (above) and with projection on plane (below)

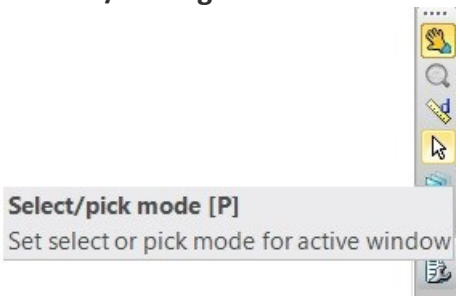
The picking tool, color mode and other display settings also work in the intersection visualization mode.

You can make the intersection plane move by *manipulating* it (see below), or by using the *animation tools* in the **general intersection toolbar**.



Using picking with point cloud data

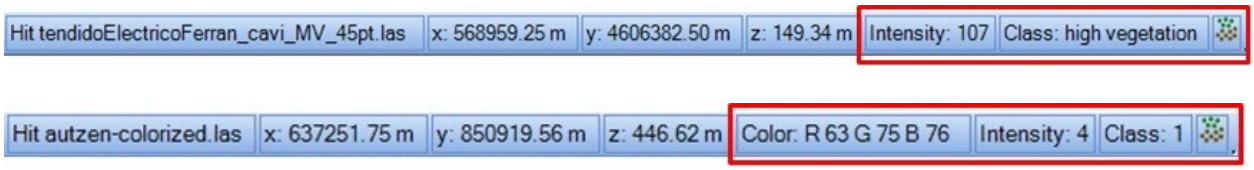
PointCloudViz extends the Petrel support for getting precise information about the domain objects by using the **Select/Picking** *tool*:



This tool can be used on point cloud data in both the normal and intersection visualization modes.

Information returned by the picking tool

Depending on the attributes associated with LiDAR data, the information provided in the bottom status bar of Petrel will include more fields and their values, in addition to the geographical coordinates of the selected point.



Moving point cloud data

After adding point clouds to Petrel and saving the project, the project file will store the point cloud properties and references to the original point cloud data file as well as the pyramid cache. The point cloud data itself is not embedded in the Petrel project file (that would duplicate the required disk space).

Those references to original and processed point cloud data are stored as absolute paths. This means that, if you move the Petrel project file to a different location, the point cloud visualization will work fine *as long as the pyramid cache data is still accessible in the location where it was first created.*

However, if you change the location of the pyramid cache files, or this disk location is not accessible from the Petrel application, this will happen:

- First, PointCloudViz will try to recreate the pyramid cache from the original point cloud data, in the location stored as reference in the project. If this succeeds, the data will display and there will be no need to update the project file.
- If the pyramid can't be recreated (because the original data is no longer available in the stored location, or because the destination folder for the pyramid data can't be created), the caching process will fail and data will not be displayed.
- In the latter case, you should fix the location of the original data, or warrant permissions to create the pyramid cache folder in the original location. If this is not possible, then delete the point cloud object from the project and add the data again.

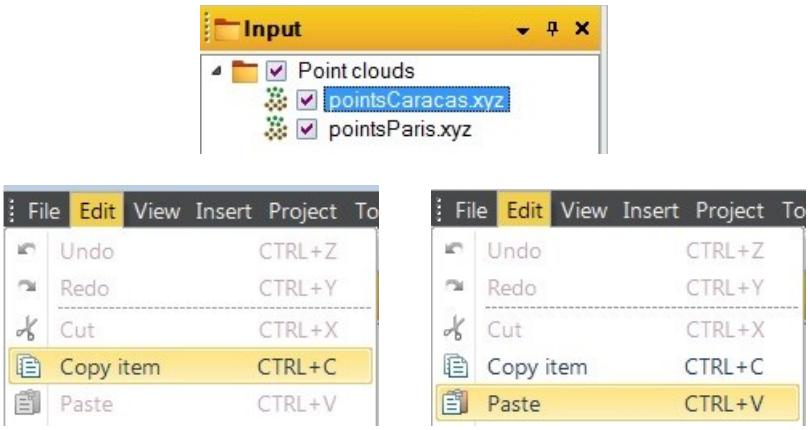
Copying PointCloudViz custom objects

The custom PointCloudViz objects added to the **Point clouds** folder in the **Inputs** tab of the Petrel Explorer can be copied to the same project or between projects.

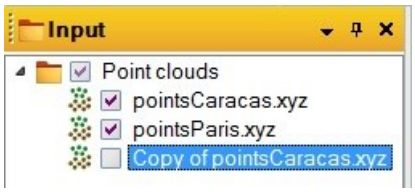
However, you must note that coping the object does not make a copy or the original and processed point cloud data, which is external to the Petrel project. If you need to move the point cloud data or access them from a different location, see the previous "Moving point data" section.

Copying objects in the same project

To copy a point cloud object in the same project, select the source point cloud in the Petrel Explorer, then use the **Copy item** command in the Edit menu, and then the **Paste** command.



The new point cloud object will share the same original and processed data, but you will be able to change independently its display properties (including Z offset and scale).

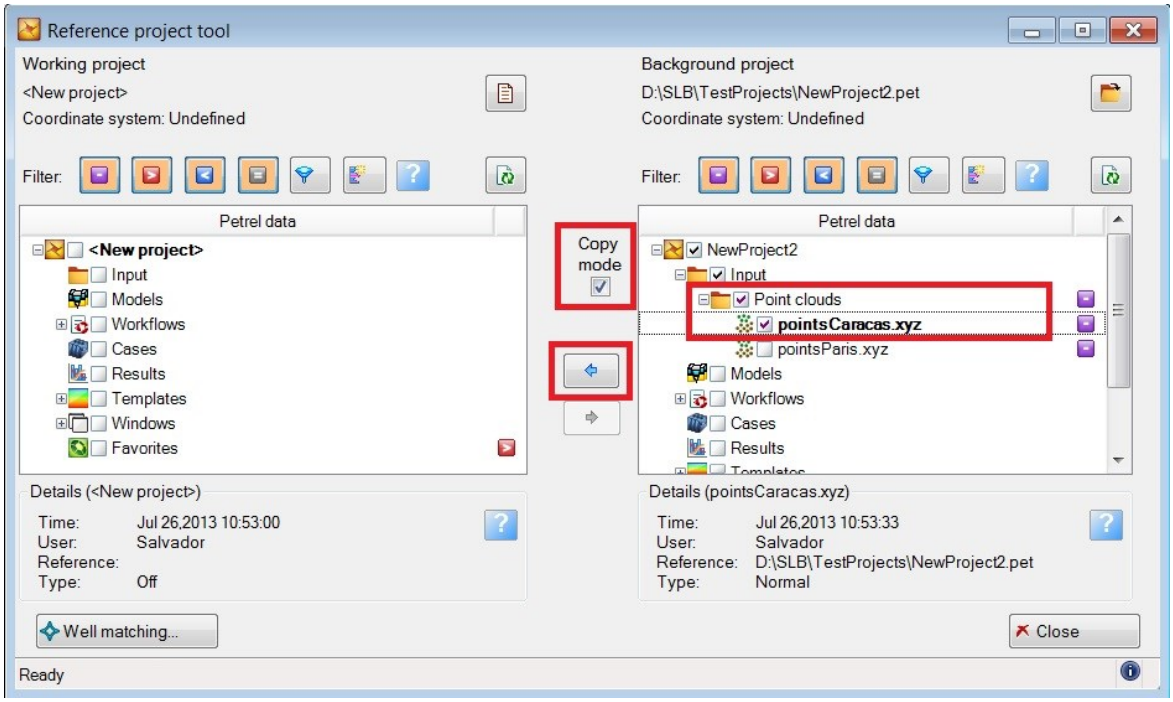


Copying objects between projects

In order to copy point cloud objects between projects, preserving their references to the original and processed data, as well as their display settings, you can use Petrel's **Reference Project Tool** (**RPT**) from the **File** menu.

Once you open the RPT with a reference project including point cloud objects, you can select them and use the left/right arrows to copy them to the other project.

It is strongly recommend that you check the Copy mode option to copy point cloud objects in RPT.



Standard LiDAR point classification

This is the standard specification for the classification values stored in the LAS/LAZ formats, according to the *American Society for Photogrammetry and Remote Sensing* (ASPRS).

The first table shows the meaning of different bits in the classification value.

Bits	Field Name	Description
0-4	Material classification	The ASPRS standard classification shown below
5	Synthetic	A point that was created by other process than lidar collection, such as digitized from a photogrammetric stereo model
6	Key point	A point considered to be a model key-point and should not be withheld in any thinning algorithm
7	Withheld	The point should not be included in processing

This second first table shows the meaning of the values stored in the first 4 bits (32 possible values), corresponding to the *material* classification.

Classification	Meaning
0	Never classified
1	Unassigned
2	Ground
3	Low Vegetation
4	Medium Vegetation
5	High Vegetation
6	Building
7	Noise
8	Model Key
9	Water
10 - 11	Reserved for ASPRS Definition
12	Overlap
13 - 31	Reserved for ASPRS Definition

Known issues/problems

This is a list of known limitations or problems you may face when using PointCloudViz.

Issue	Solution or workaround
Memory increases a lot when I add a point cloud dataset, and then as I move around. Memory consumption multiplies as I add more datasets.	PointCloudViz uses a memory cache to page in and out point cloud data. To reduce memory usage of a dataset, reduce the number of points per tile when the pyramid cache is generated. If you plan to display multiple point clouds that are located in the same or contiguous areas, add them as a single object by using multiple input sources in the Insert point cloud wizard.
The original coordinate reference system of the point cloud input data is not displayed in the object settings dialog.	This is an Ocean limitation. The issue has been marked for a future fix by the SLB Ocean team.
History for the point cloud object is not visible.	History data has not been implemented yet for point clouds, since no changes can be performed on these objects as of version 1.0. It may be implemented in the future.
Point cloud does not display after moving the pyramid cache data or the Petrel project to a different location.	This happens because the original point cloud data is not accessible from the new location, and/or the pyramid cache can't be read nor recreated in its original location. Remove the point cloud in the project and add it again. See the *Moving the point cloud data* topic in this Guide.

Getting technical support

Review the *Known Issues* section before contacting technical support.

- For installation and license issues, contact the Ocean Store support.
- For software run-time issues (errors, performance problems) or if interested in collaboration or further development regarding LiDAR and point cloud visualization, contact Mirage Technologies by email at mirage@mirage-tech.com.