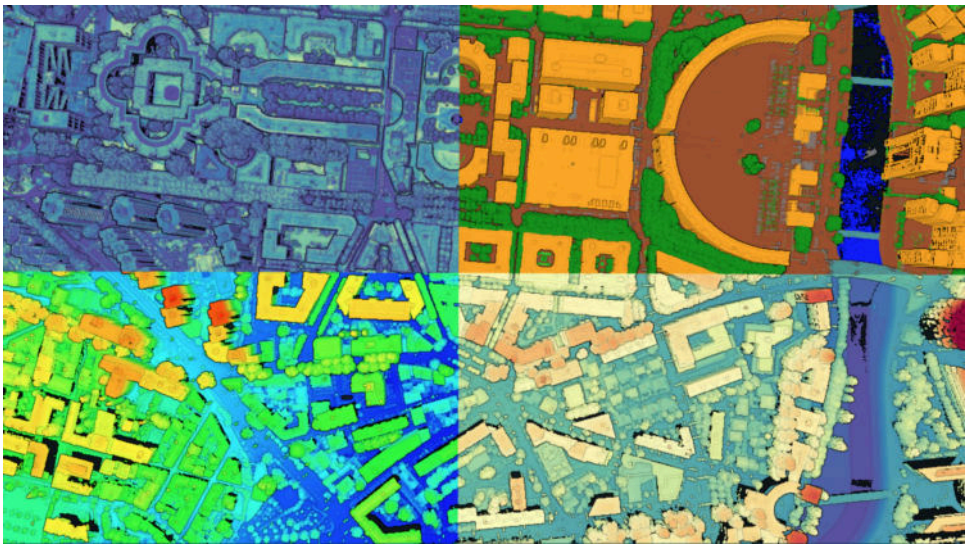

4 LiDAR HD point cloud tiles over Montpellier, France (LiDAR HD)

A Complete Guide to Potree's Interface Functionalities.

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In this third article, we'll explore Potree's functionalities, a WebGL-based Open Source viewer tailored for large point clouds (It's thanks to Markus Schütz that it exists). Potree stands out for its high display speed, making it an excellent choice for handling substantial point cloud datasets. Our focus will be on the diverse navigation and display options Potree offers.

Please note that the installation and use of the Potree converter were covered in our previous article (1, 2). To ensure good performance, it's vital to use a WebGL-supported browser like Chrome, Firefox, Safari, or Edge. Additionally, Potree's compatibility extends to tablets and mobile devices, providing flexibility in accessing your data.

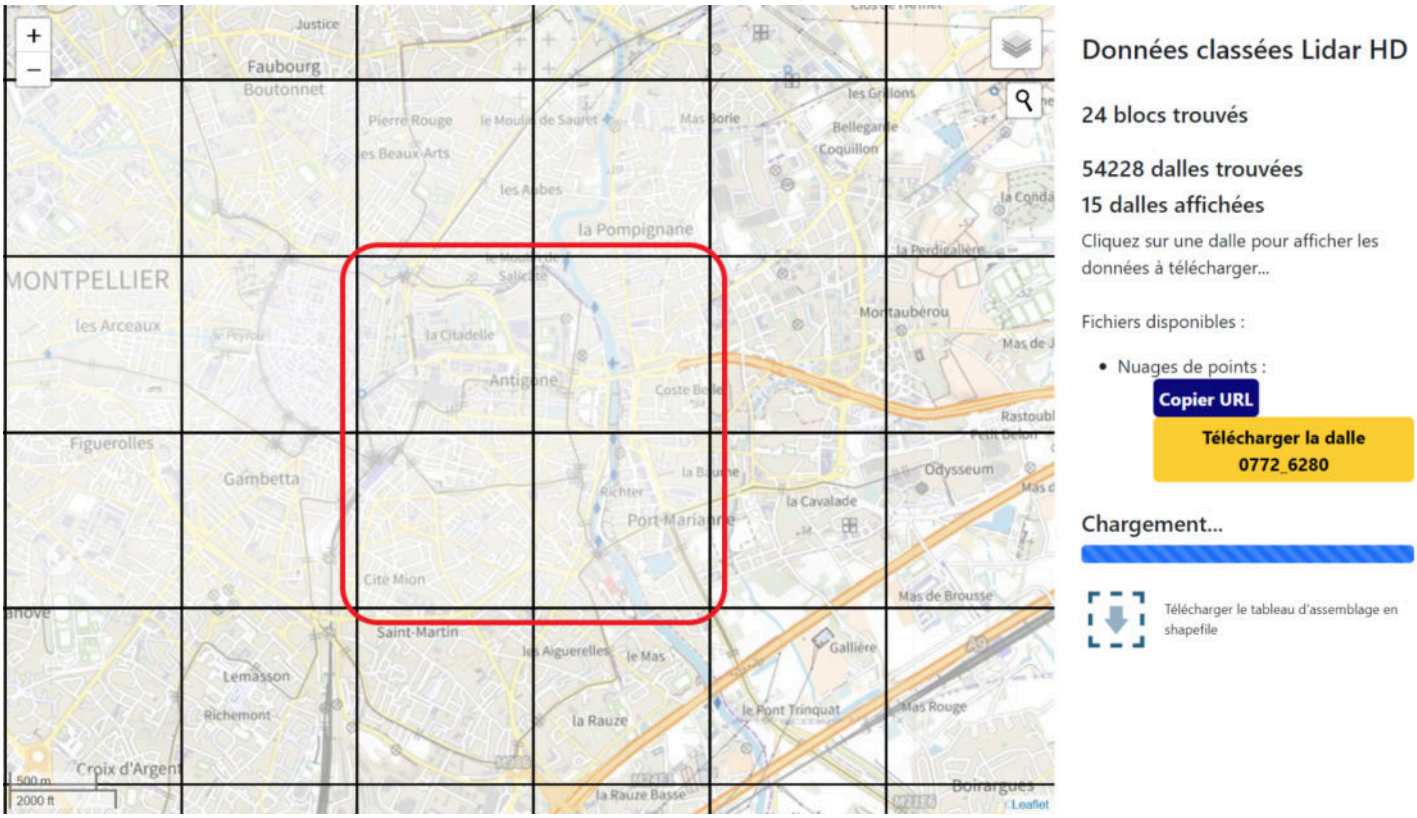
If you encounter any issues, feel free to try another browser or explore the Potree Desktop version, which I found to deliver satisfactory results in my experience.

Introduction

If you don't already have a point cloud and wish to obtain one, I recommend utilizing Geotiles for data from the Netherlands, LiDAR HD for data from France or the 3DE program for data from the USA. These sources offer valuable point cloud data that you can use for your projects. However, if you already have your own data, that's even better as it allows you to work with familiar datasets tailored to your needs. You can also manipulate some Potree examples just in your browser (Entwine & Potree).

Entwine & Potree
potree.entwine.io

For this demo, I downloaded 4 tiles of LiDAR HD over Montpellier, in France, then imported them into Potree Desktop.

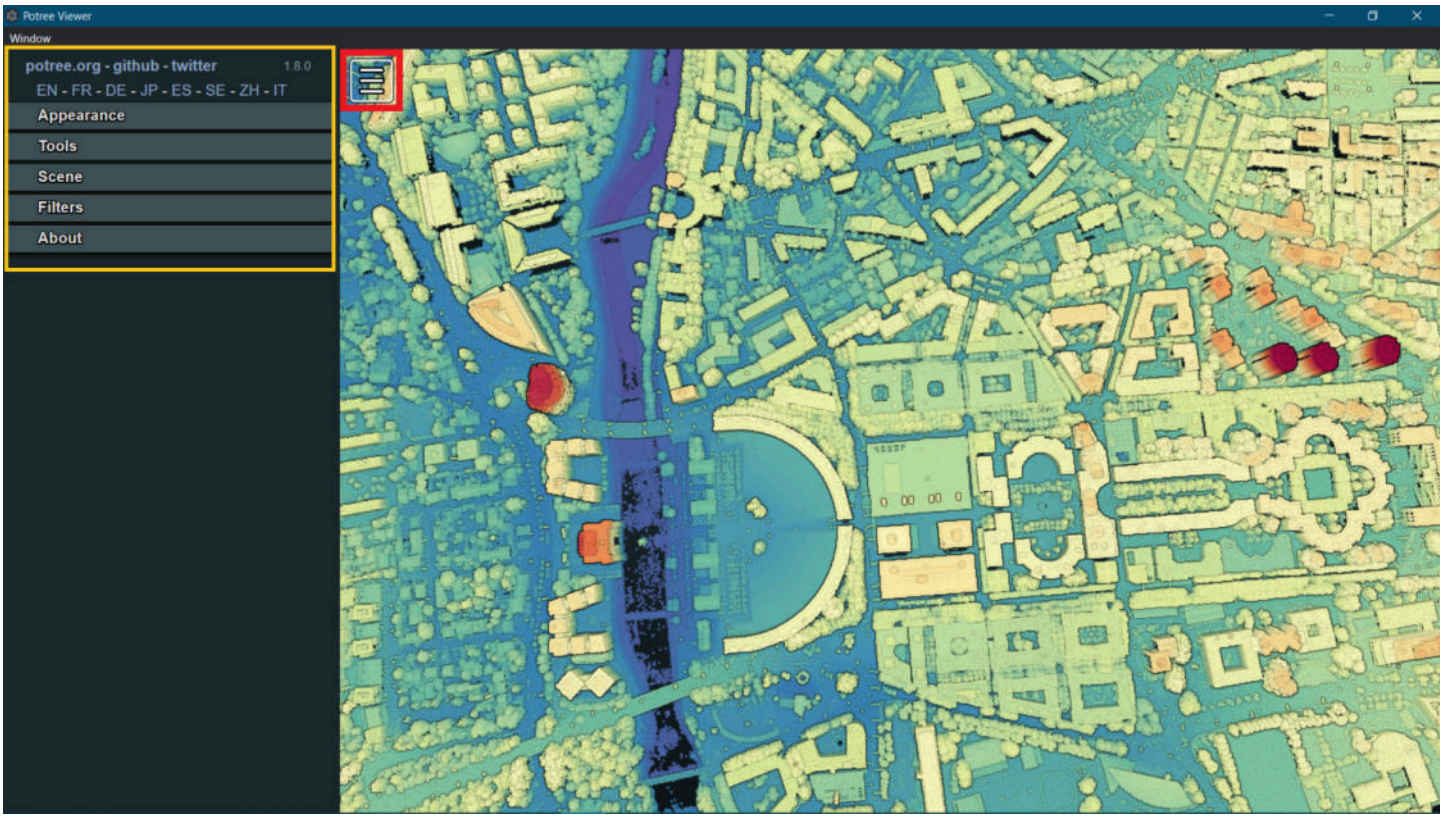


4 tiles of LiDAR HD over Montpellier city, France @LiDAR HD

Upon accessing the Potree interface, you'll notice the default settings that were specified during the generation of the Potree files. These files consist of data files, HTML, and scripts, which are interpreted by the web server or your web browser. To access the Potree tools, simply click on the button typically located at the top left of the screen, opening up the menu with various options to explore and analyze your point cloud data.

Potree's sections (Appearance, Tools, Scene, Filters) offer the ability to:

- Define the visual aspect of the point clouds.
- Optimize display performances (Standard, High quality).
- Choose navigation modes to explore the data.
- Perform measurements (distances, profiles, slices, etc.).
- Create animations.



Menu of Potree with different sections

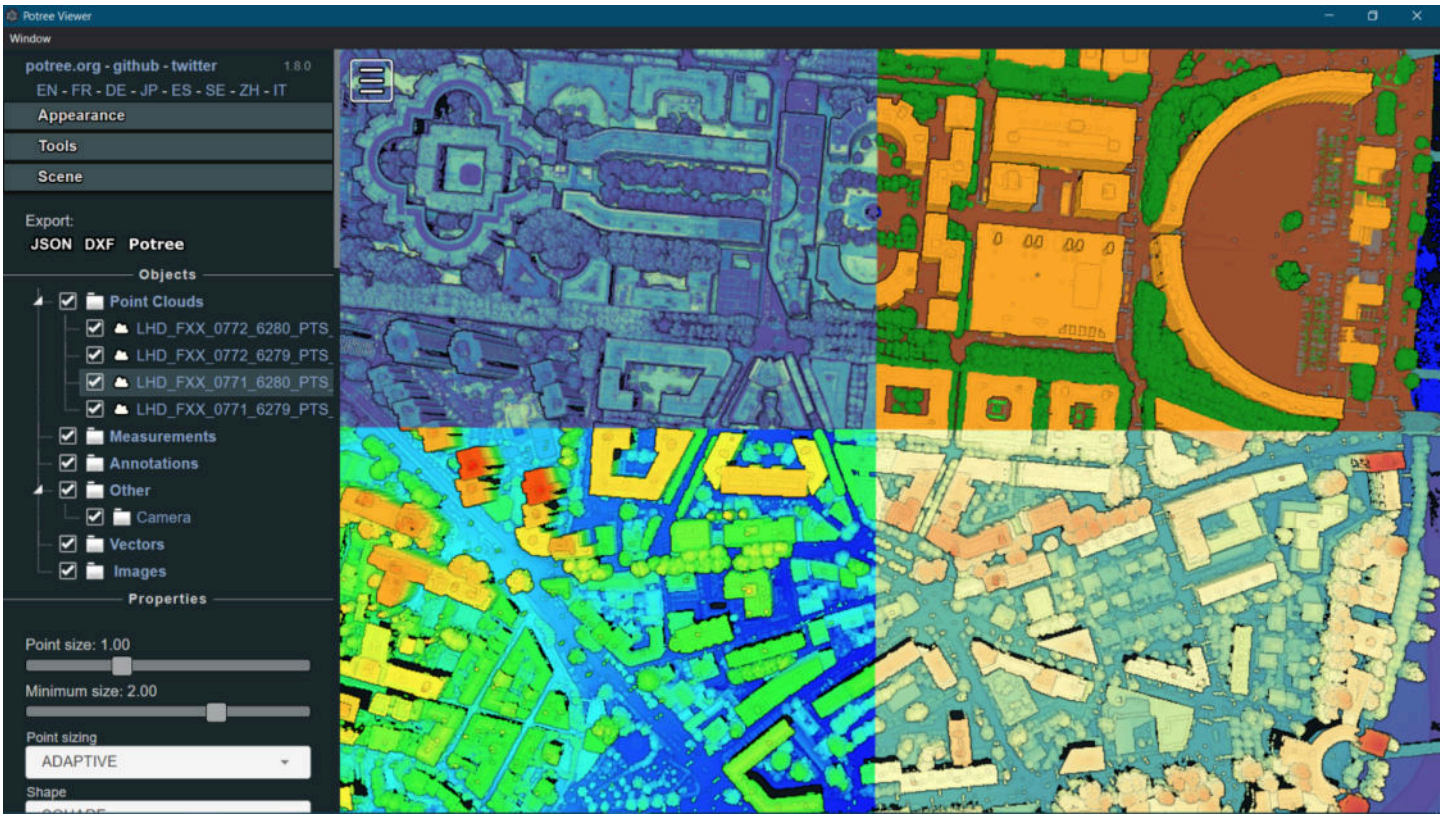
> **Before going into detail about each window in the Potree menu, it's important to know that each item in this window is fully customizable.**

The top line of the Potree menu provides quick access to essential links, including the Potree website, the GitHub repository, and the release number (currently 1.8.0). Additionally, it offers language options to switch between EN-FR-DE-JP-ES-SE-ZH-IT.

Clicking on a section expands its content, allowing you to access the desired functionalities. The "Appearance" and "Scene" sections control the visual aspects of the point clouds. While properties in the "Appearance" section apply globally, the "Scene" properties are specific to each scene (point cloud) individually.

Within the "Scene" section, users can toggle on/off individual point cloud scenes, enabling seamless navigation and analysis of specific datasets.

In the following example, we have multiple point clouds loaded simultaneously, but, allow us to color each cloud separately.

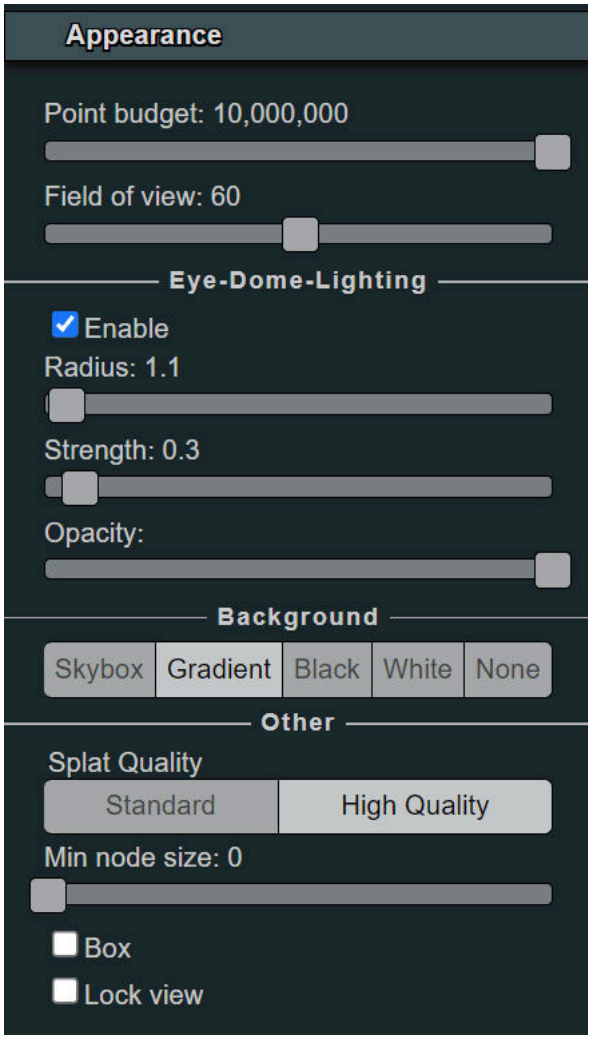


4 separated point clouds rendered with different styles (Intensity, classification, and elevation)

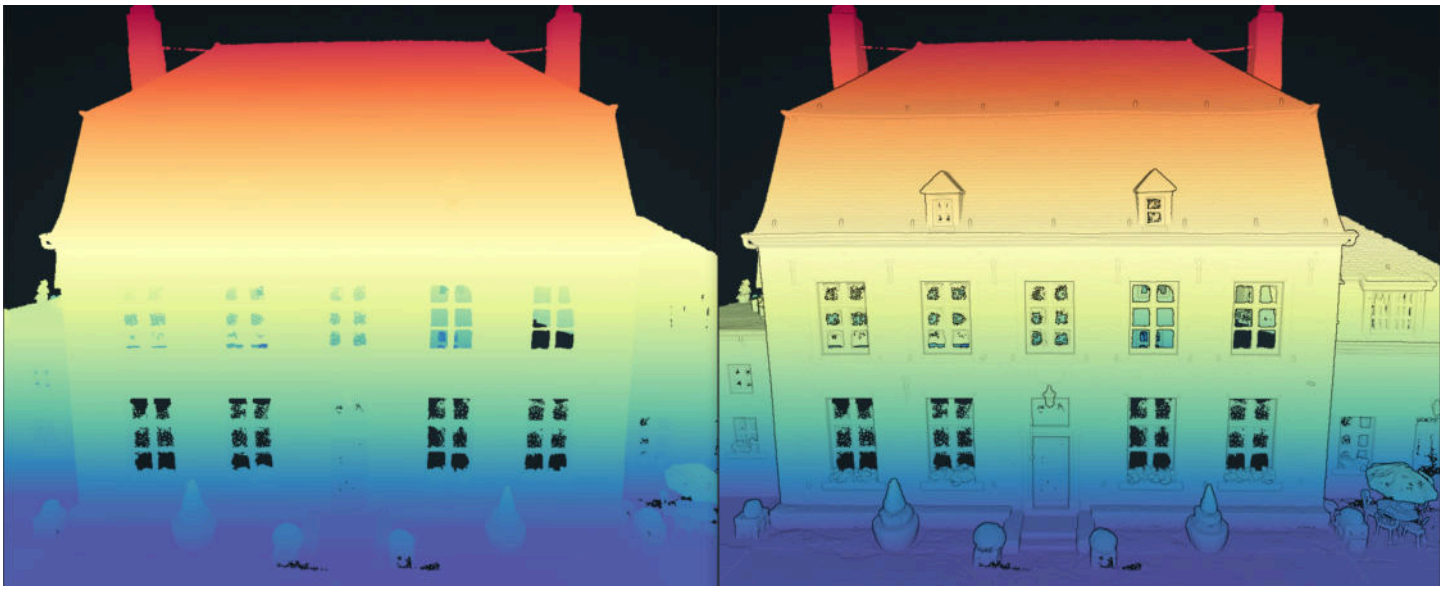
Section 1: Appearance

In the "Appearance" section of the Potree viewer, you gain the ability to personalize the visual representation of the point cloud (all). This section encompasses a range of options. It includes options to adjust:

- ***Point Budget***: This parameter allows users to set the number of points considered for display, influencing the point density on the screen. While it's not the sole factor affecting point density, adjusting the point budget helps optimize the level of detail for efficient visualization. The maximum is set to 10 Million, but it can be adjusted in the code.
- ***Field of view***: It determines the extent of the scene visible from the viewer's perspective. The optimal FoV is set to 60.
- ***Eye Dome Lighting***: By enabling Eye Dome Lighting, you benefit from an enhanced shading calculation method that sharpens edges, improving the perception of depth. You can manage the darkening effect caused by eye dome lighting by adjusting the trade between the Radius and Strength. This tool is very useful when dealing with uncolored point clouds, as shown in the next example.

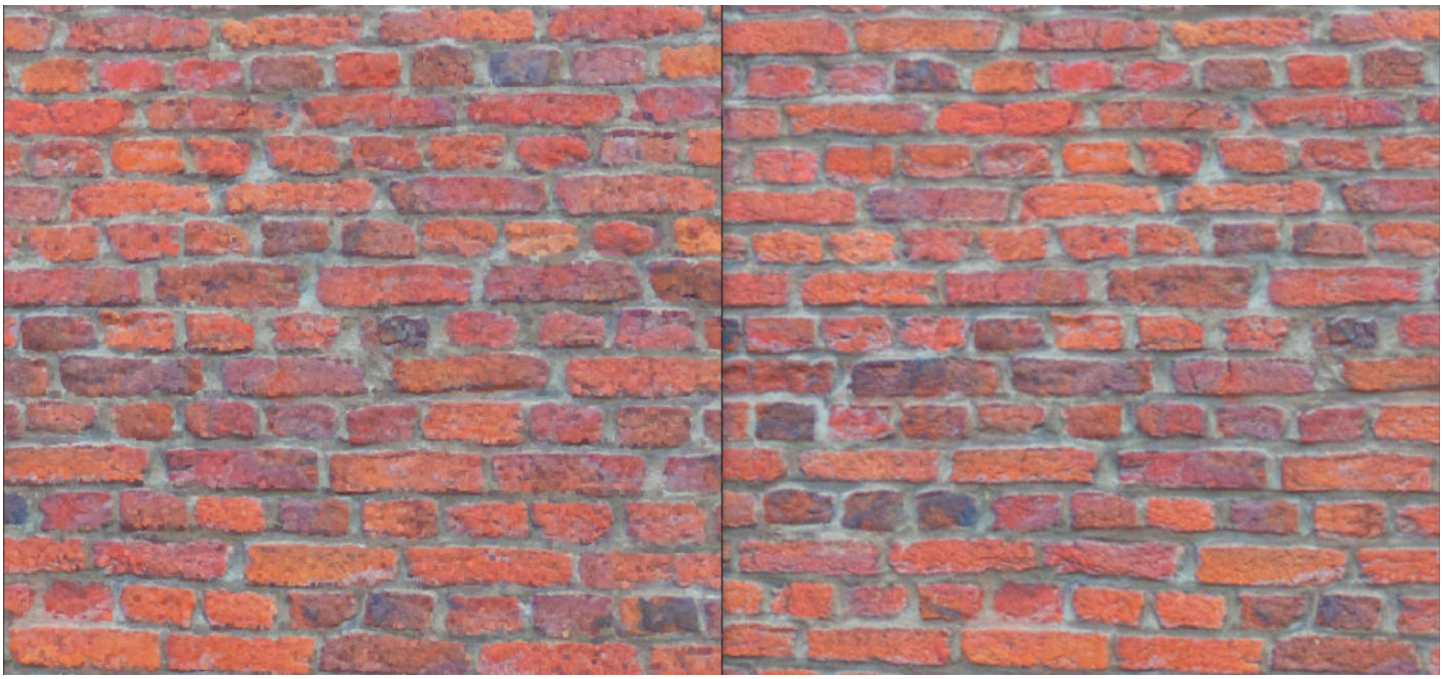


Appearance section @Potree



Same point cloud without EDL (left) and with it (right), Radius and Strenght parameters impact the degree of edge shadowing @ULB

- ***Background***: set the background style (Skybox, Gradient, Black, White, or none). You can even personalize the background with a personal image.
- ***Splat quality***: set point aspect between standard and high quality. As the name suggests, the high-quality option is visually more realistic.



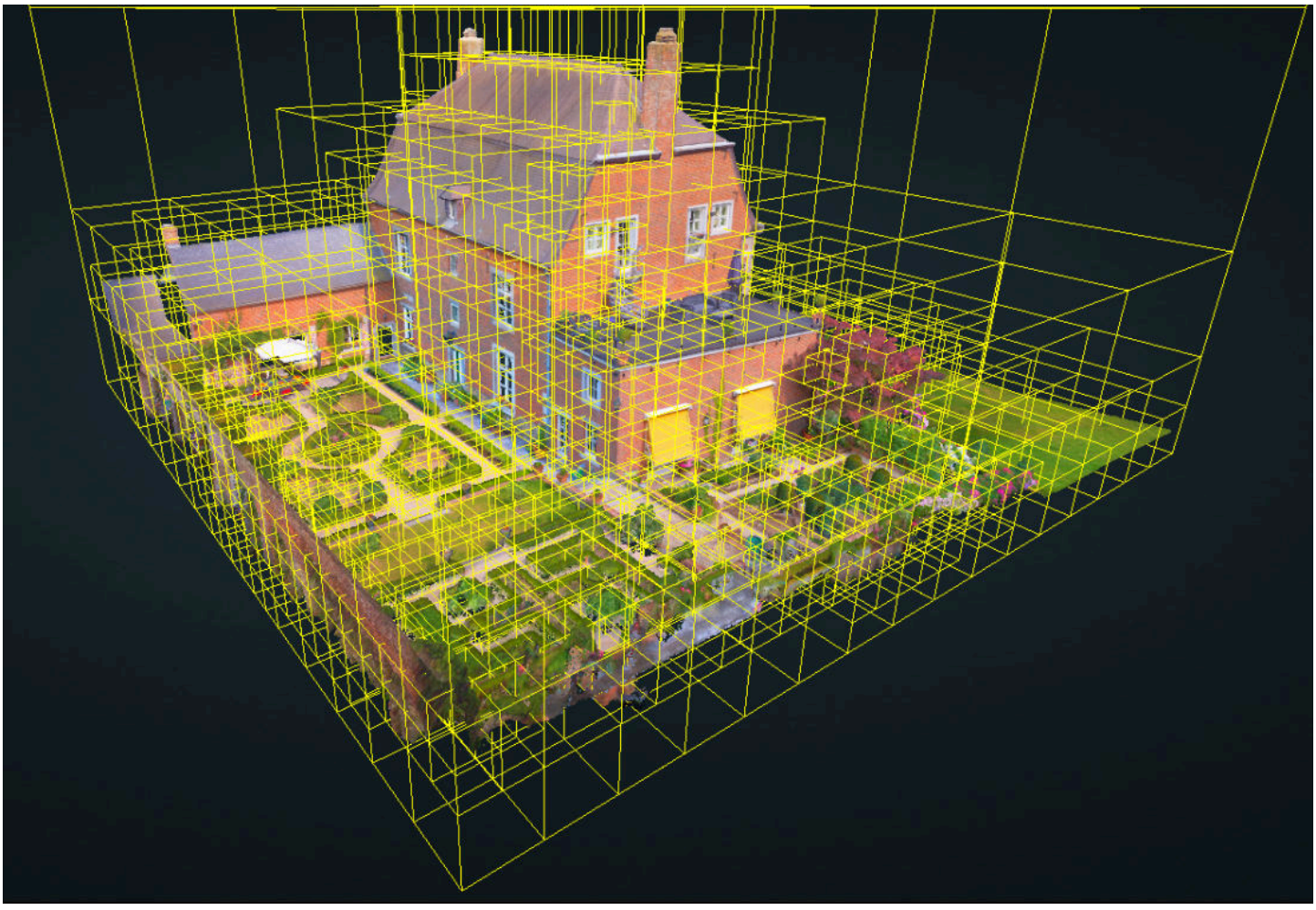
Point cloud with Standard Quality (left) and High Quality (right)

Minimum node size: This setting defines the size of the Octree nodes. Potree utilizes an innovative point-storing technique based on an octree data structure. This structure subdivides the space into cubes of varying sizes, each with a specific level of detail. As you navigate through the point cloud, Potree dynamically loads and displays cubes based on the camera and target positions, optimizing performance even for vast point clouds (you've probably already noticed). By adjusting this parameter you can control the size of these cubes and the level of detail displayed. *Smaller node sizes offer higher detail*, providing a more intricate view of your data. On the other hand, if you encounter performance issues, increasing the "Min Node Size" value can enhance rendering speed by displaying fewer cubes, especially for dense point clouds. But, be careful to not be confused it with the "Point Budget" even if it influences the number of points also.

Minimum Node Size = 1000 (lower detail = big nodes)

Minimum Node Size = 20 (higher detail == small nodes)

- ***Box***: when checked, it displays the cube structure of the octree. This feature visually illustrates how the point cloud is organized into hierarchical cubes of varying sizes. By enabling the "Box" display, you gain insights into the octree's division and hierarchy, enhancing their understanding of the data organization.

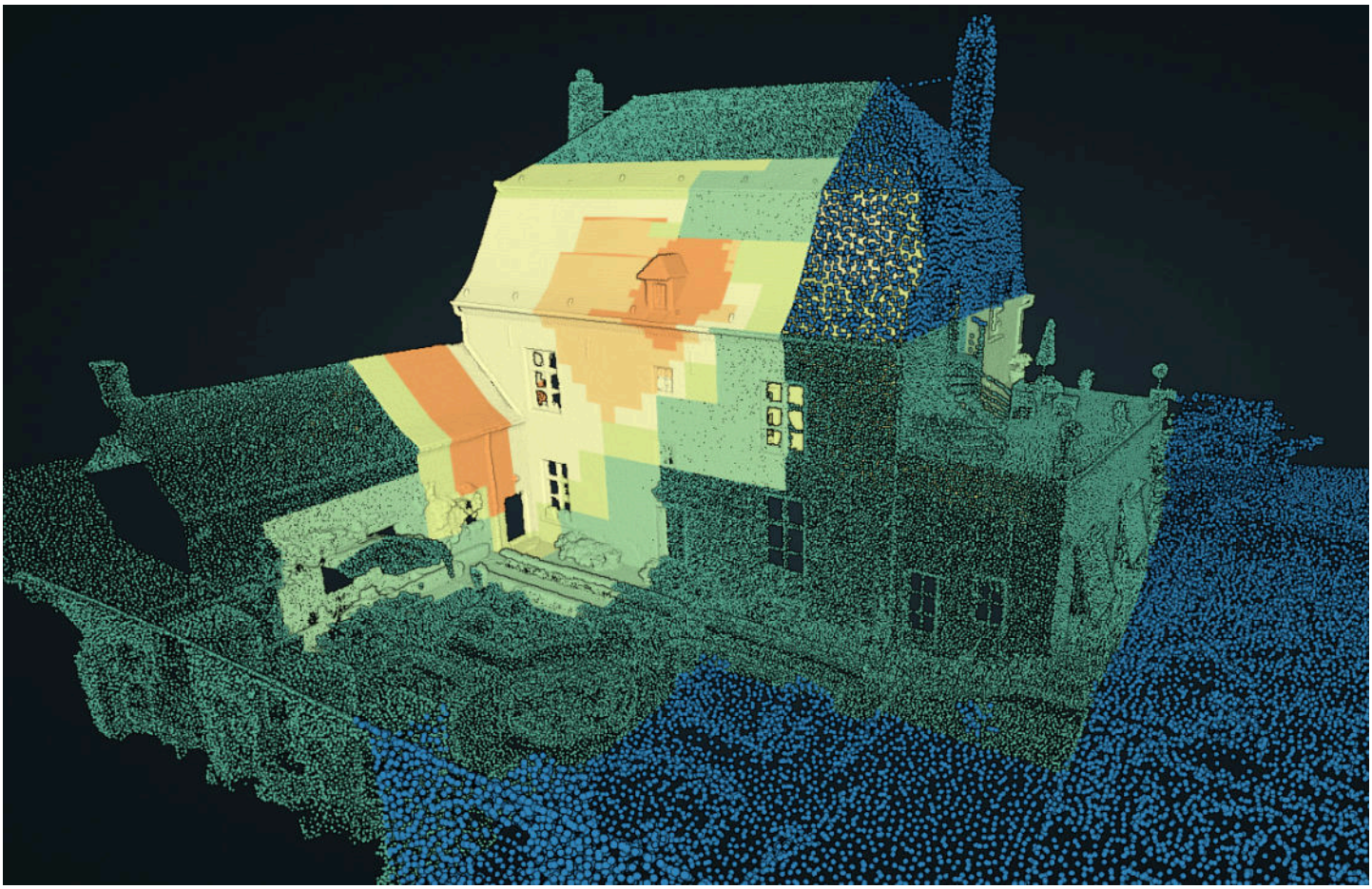


Cube structure of the octree @Potree

- ***Lock***: froze the node size view. When the "Lock" option is enabled, the node size remains constant regardless of zooming or navigation. This functionality ensures that the point cloud's level of detail remains consistent throughout the exploration, providing a stable and controlled visualization experience.

User field of view

In this example, I've zoomed in on this window, then checked the lock, and I've also displayed the point cloud in the level of detail so you can see how potree works. The user's field of view is well displayed (at a high level of detail), but the rest, which is not visible to the camera, is at a low level of detail.



What do the rendered point clouds look like

Section 2: Tools

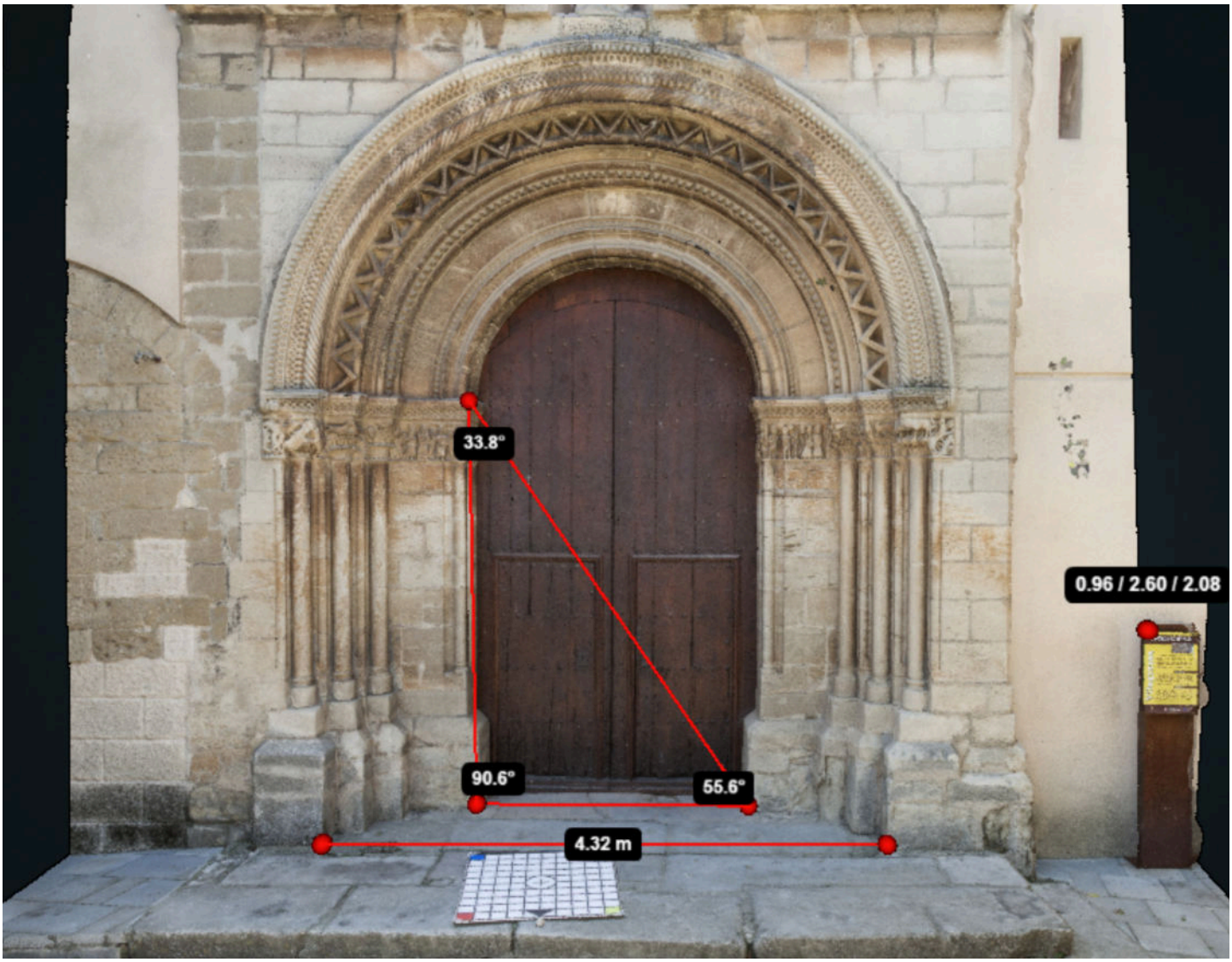
Under the "Tools" section, Potree offers a diverse set of functionalities to support data exploration and analysis. The "**Measurement**" section provides essential tools for accurately measuring distances, angles, areas, and volumes directly within the point cloud. Additionally,
The *Profile* tool allows for the extraction and visualization of elevation profiles, aiding in the comprehensive understanding of terrain and structures within the data.

In the "**Clipping**" section, you can employ the clipping tool to cut through the point cloud, effectively isolating and focusing on specific regions of interest. This capability enhances the examination of detailed sections within the point cloud, improving data interpretation and exploration efficiency.

The "**Navigation**" section offers a selection of navigation modes and view toggles (left, right, front, back, top, bottom), so, you can effortlessly navigate and inspect the data from multiple perspectives. Additionally, this section allows you to switch between perspective and orthographic camera projections.

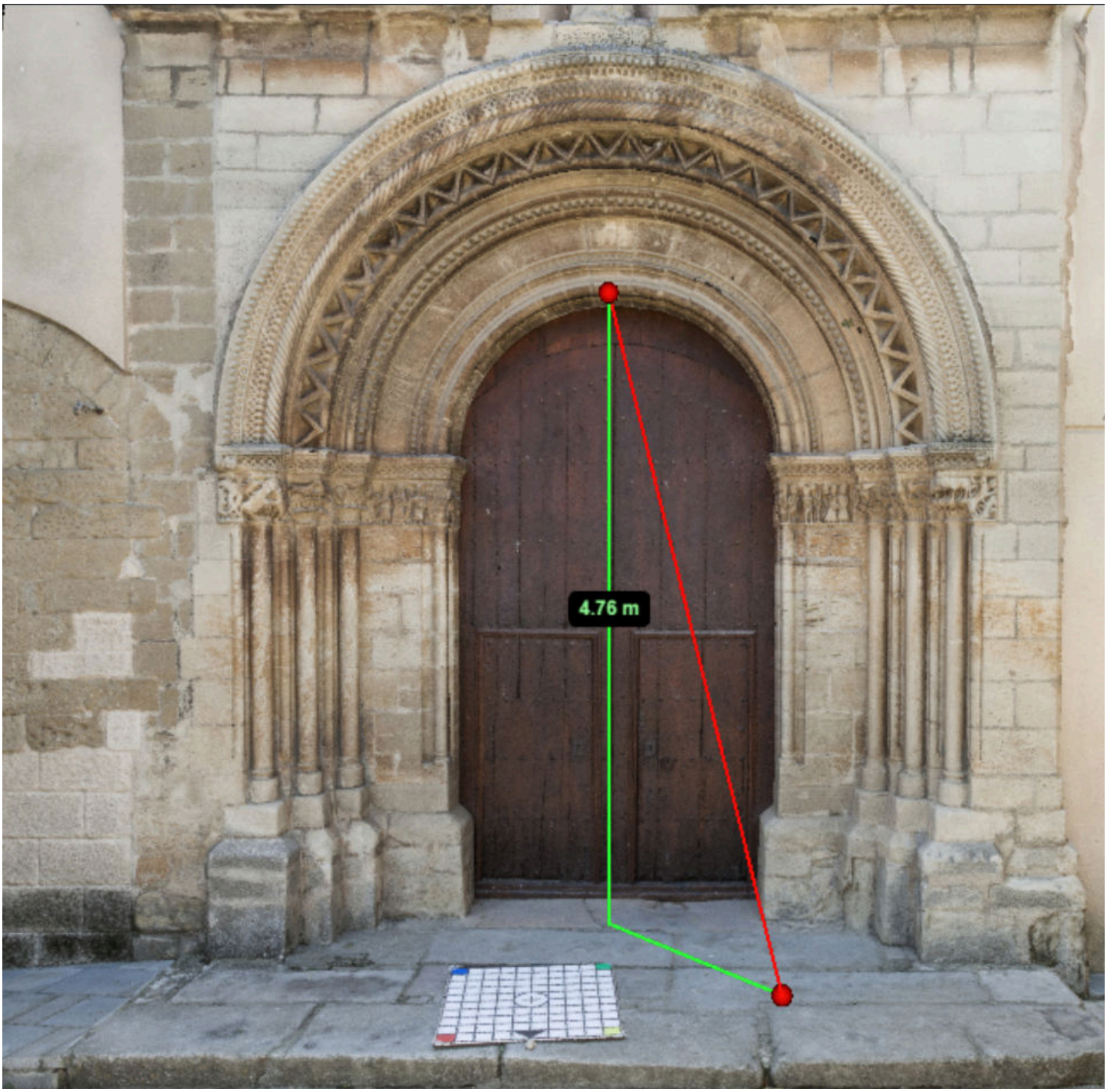
In the following illustrations, we've used a point cloud that we downloaded in LAS format from Sketchfab (**here**). You can also use the version provided by OpenHeritage3D in the viewer potree (**here**).

Tools section @Potree



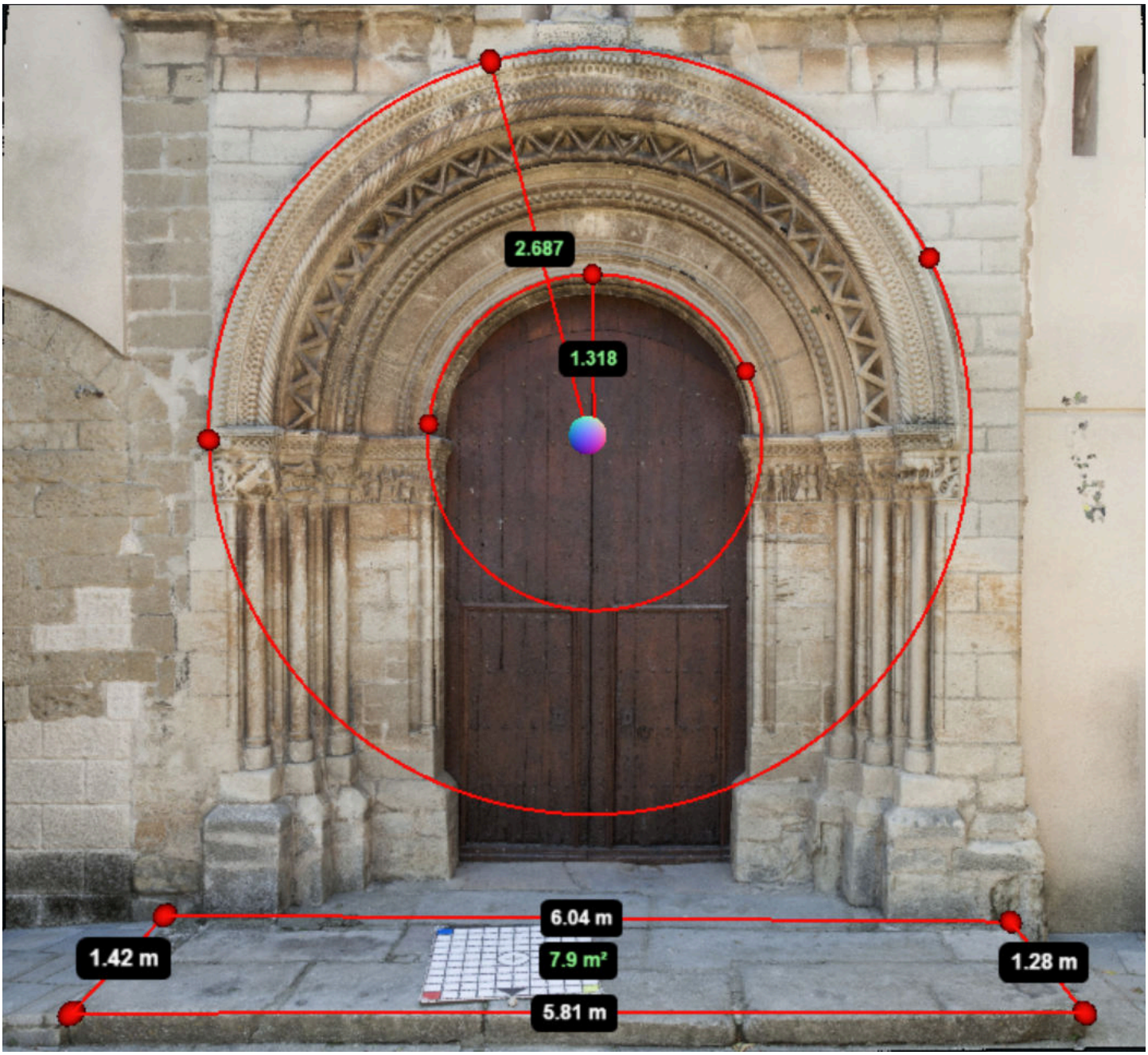
Point, Distance, and Angle measurements (Courtesy of OpenHeritage3D)

- Measure heights



Vertical Height measurement (Courtesy of OpenHeritage3D)

- Area and circles measurements



Area and Circles measurements (Courtesy of OpenHeritage3D)

- Volume measurement

Volume measurement (Courtesy of OpenHeritage3D)

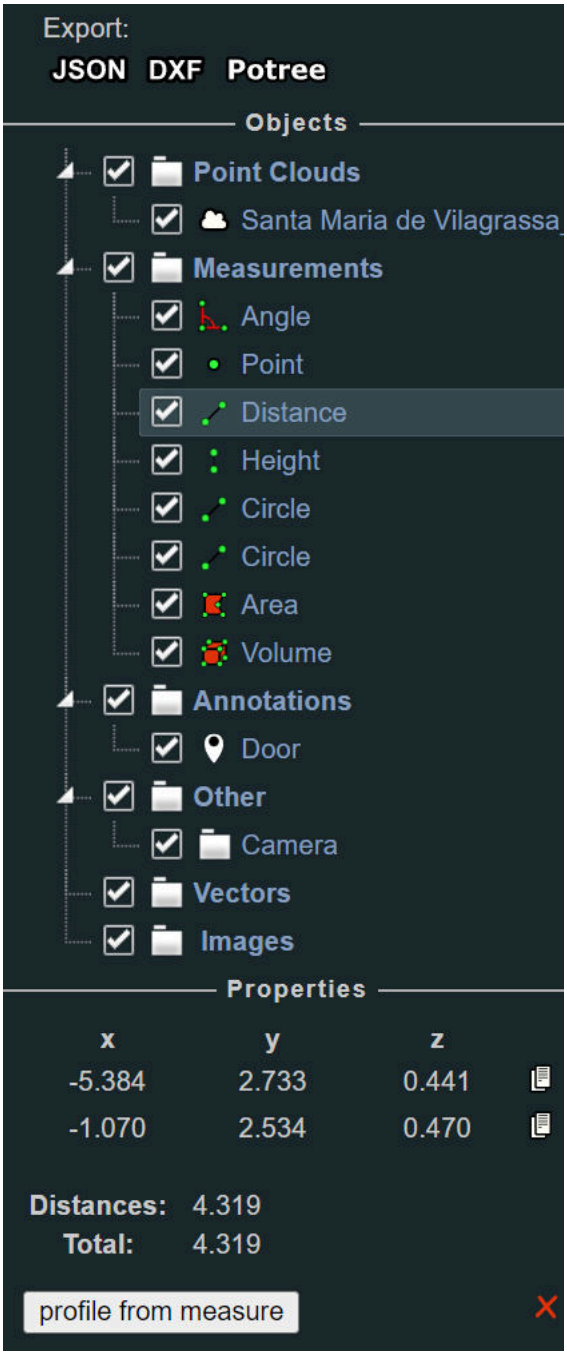
- Add annotation

Annotation (Courtesy of OpenHeritage3D)

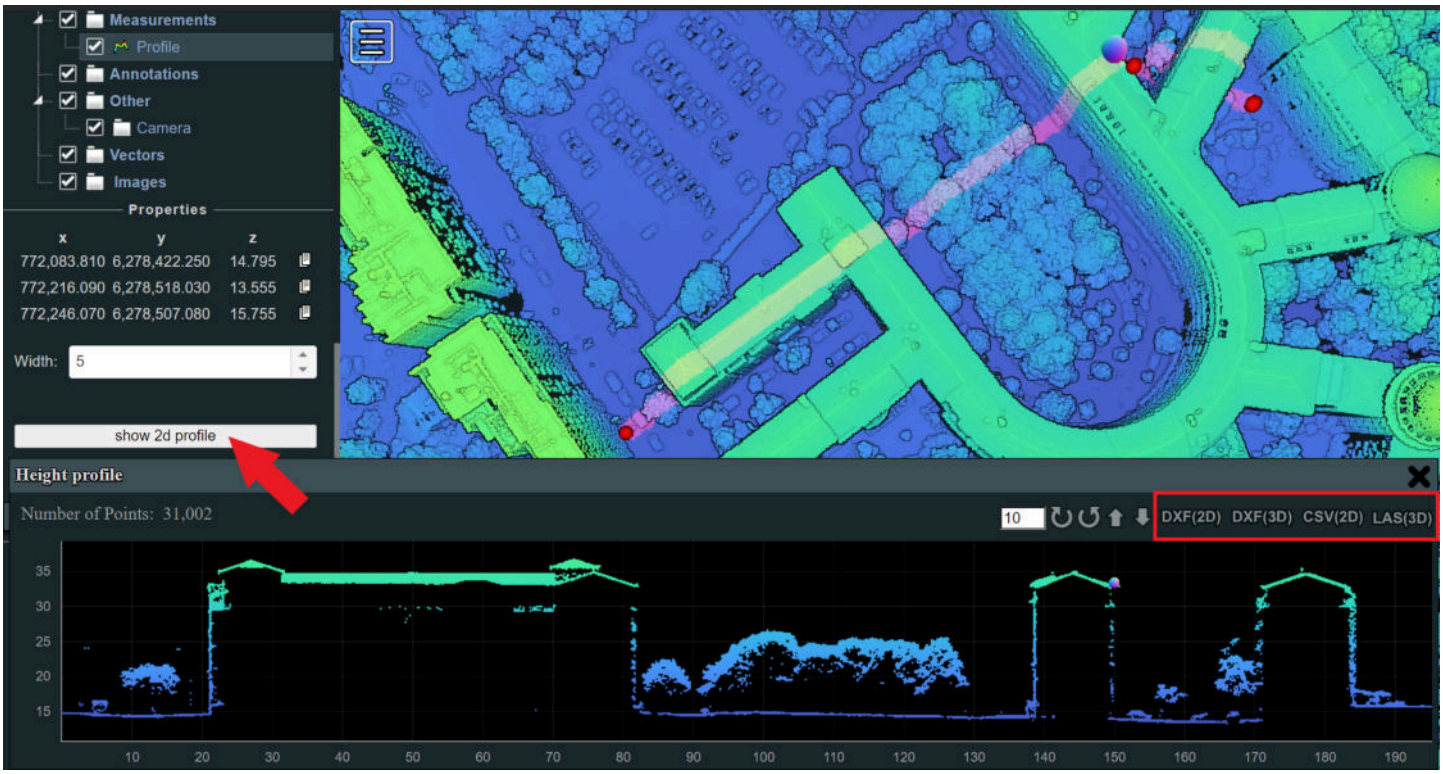
Once measurements are taken, they can be found in the "Scene >> Measurements" section of Potree. From there, you have the flexibility to manage the measurements as needed. You can delete specific measurements using the red X icon located at the bottom or export them globally in JSON, DXF, or Potree formats.

In the next illustration, the "Profile" tool proves highly convenient, offering not only instant elevation profile visualization but also the option to export the points as a CSV (2D) or DXF (2D) file, or a point cloud in DXF or LAS format. This facilitates seamless data exchange with CAD/BIM software, enhancing interoperability across different platforms.

Notice, that you can also specify the width considered for capturing points within the profile, allowing for focused and precise analysis. The display of previously taken measurements can be easily enabled or disabled for a clutter-free visualization (just uncheck the boxes).

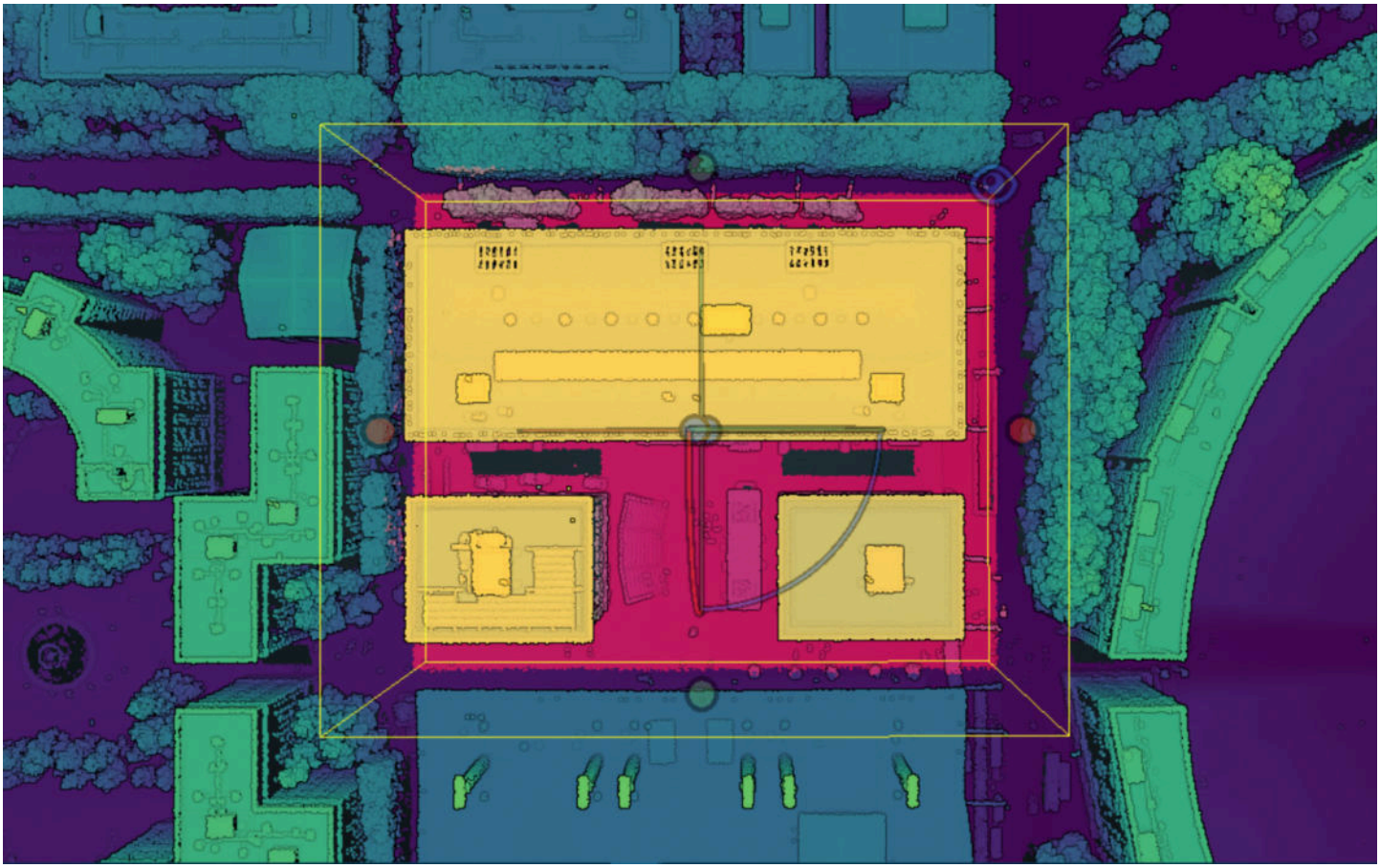


Measurements objects @Potree



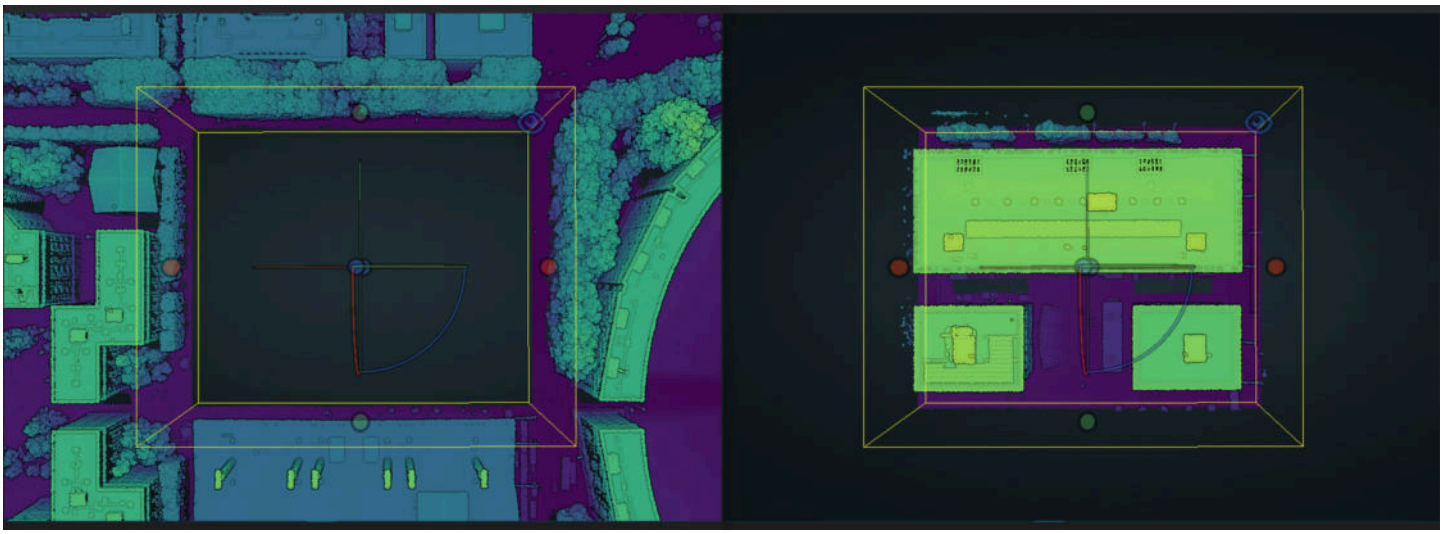
Profile extraction (point cloud of LiDAR HD, Montpellier, France)

2. Clipping: Allows you to precisely control what parts of the point clouds are displayed, or just highlighted as in the example below.



Inside cude highlighting of a point cloud (LiDAR HD, Montpellier, France)

Clipping in Potree allows users to focus on specific regions of interest within the point cloud data. By defining a clip volume, you can focus on specific regions of interest, either by displaying points within the volume (clipping inside) or excluding points outside of it (clipping outside).



Clipping results, outside (left) and inside (right), (point cloud of LiDAR HD, Montpellier, France)

3. Navigation: Potree offers various navigation modes to provide you with flexible and intuitive control over the 3D point cloud visualization.

1. Earth control: Hover over the point clouds and left-click to move, or right-click to rotate the model. A colored circle appears at the initial click point, representing the center of rotation. Zooming is achieved using the mouse wheel.
2. Fly control: Left-click to steer the flight direction and use keyboard arrow keys to move forward or backward. Right-click combined with movement enables the panning of the view. The mouse wheel, in this mode, is utilized to accelerate or decelerate the movement.
3. Helicopter control: Relatively similar to Fly control.
4. Orbit: Left click, 3D rotation around the current center (possibility to adjust the center with a double-click on one of the points of the point cloud, click right = Pan
5. Full extents: Zoom extends to the point cloud limits; 6. Cube: display the view cube; 7. Compass: for orientation; 8. Create a camera animation.

11. Orthographic projection is generally useful when measuring the model. Perspective mode (10) is used to visualize and present point clouds and meshes.

12. Speed: you can speed up/ slow down as required.

Section 3: Scene

The Scene section contains different objects.

Point Clouds: A scene can be composed of one or multiple point clouds.

Annotations: Annotation management is made here.

Other: Here you will find the camera and target positions.

Vectors: This feature allows the inclusion and management of vector data within the scene.

Images: You can incorporate images (oriented and georeferenced or not) into the scene.

If there are multiple objects within a category, a triangle indicator appears, allowing you to expand and scroll through the list easily. When you select an object, its properties become visible, providing specific details unique to each object type.

Point Clouds:

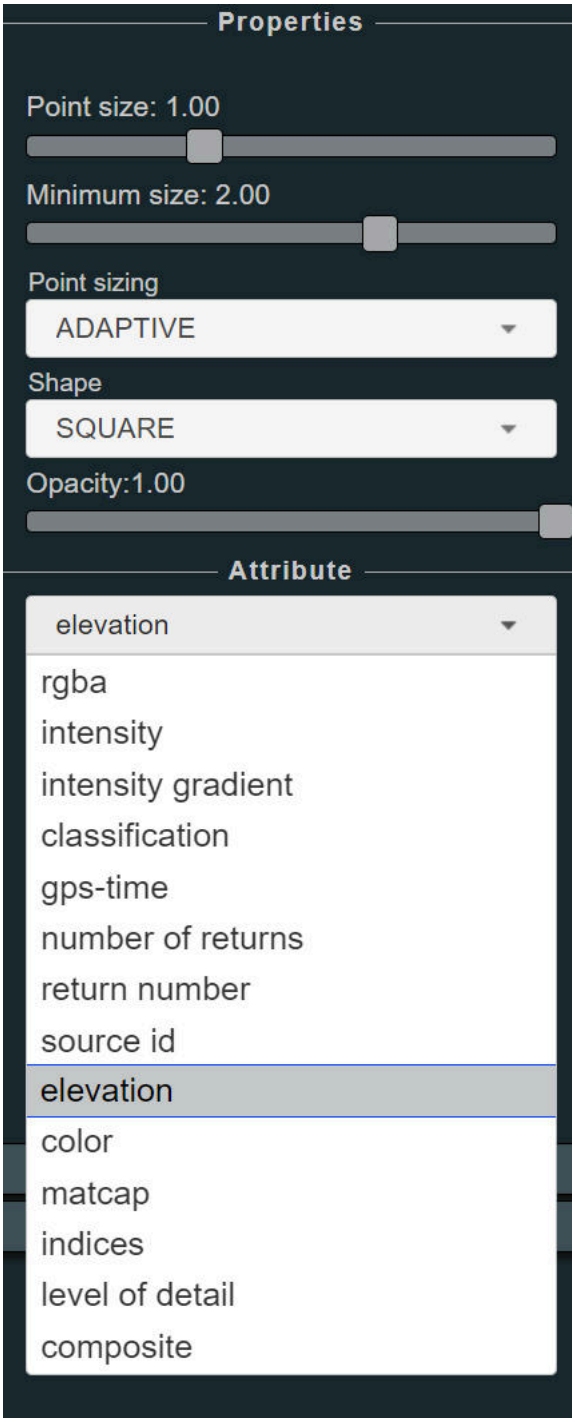
In Potree, point cloud properties play a crucial role in defining their visual aspect. You have control over several display settings, including point size, point sizing options (Fixed, Attenuated, or Adaptive), shape (Square, Circle, Paraboloid), and opacity. These settings allow for fine-tuning the appearance of the point cloud to suit specific visualization needs.

The subsection « Attribute » for point clouds lets you choose a colorization style:

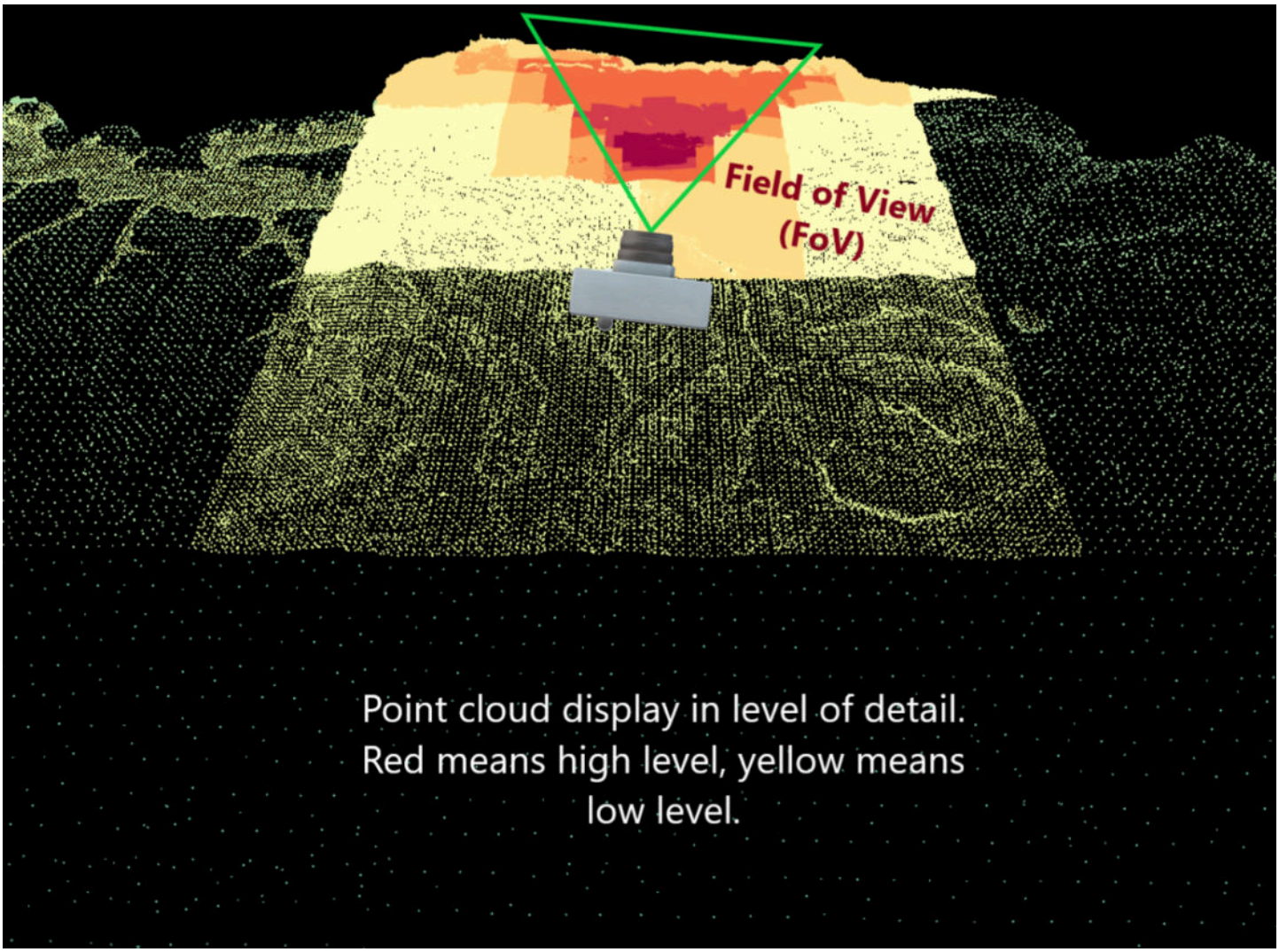
- RGB: True colors, if you point clouds are colored.
- RGB & Elevation: Blend between RGB and color ramp by elevation.
- Color: One color only RGB (e.g. red, yellow, white...)
- Elevation: Color ramp by elevation. You have different ramps styles to use.
- Intensity: Color ramp by intensity (grayscale), available only in LiDAR point clouds, no photogrammetry.

- Intensity Gradient: Intensity color ramp
- Classification: If a point cloud is classified.
- Return number: number of signal returns (usually only LIDAR data)
- Level of details: level of details
- Composite: You can blend all of the above.
- GPS time, indices... etc.

This latest version of Potree supports all the attributes that are stored in the LAS file according to ASPRS specifications. It even allows you to add additional attributes if your point cloud contains them. We give an example if your point cloud contains a tree identifier, then you'll have the trees displayed with different colors. Other attributes, such as level of detail, don't come at the time of conversion but are calculated on the fly according to the camera's field of view.



Properties of a point cloud



Point cloud rendered in Level of Detail with Lock to see the outside part of the FoV.

As you may have noticed, we only manipulate point clouds. However, other types of data such as oriented images, vector data, and meshes can be added to your Potree viewer. As this requires customization of the viewer, these data must be added to the HTML page. This is what we'll be looking at in the next few articles.

Section 4 & 5: Filters & About

The "Filters" section allows users to apply attribute filters to the point cloud data, such as classification, GPS time, return number, and more. This feature enables selective display and focused analysis of specific attributes.

In the "About" section, you'll find essential information about the Potree viewer, including version details and developer information sponsors of the project. Our heartfelt thanks go to them for their efforts in making this wonderful tool possible.

Conclusion

In this third article, we explored Potree's functionalities for large point clouds, offering high display speed and seamless performance. We focused on navigation, display options, and essential tools like measurements, profiles, annotation, and clipping. In the next article, we'll delve into customizing the Potree viewer to incorporate other data types. Stay tuned for more insights!

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