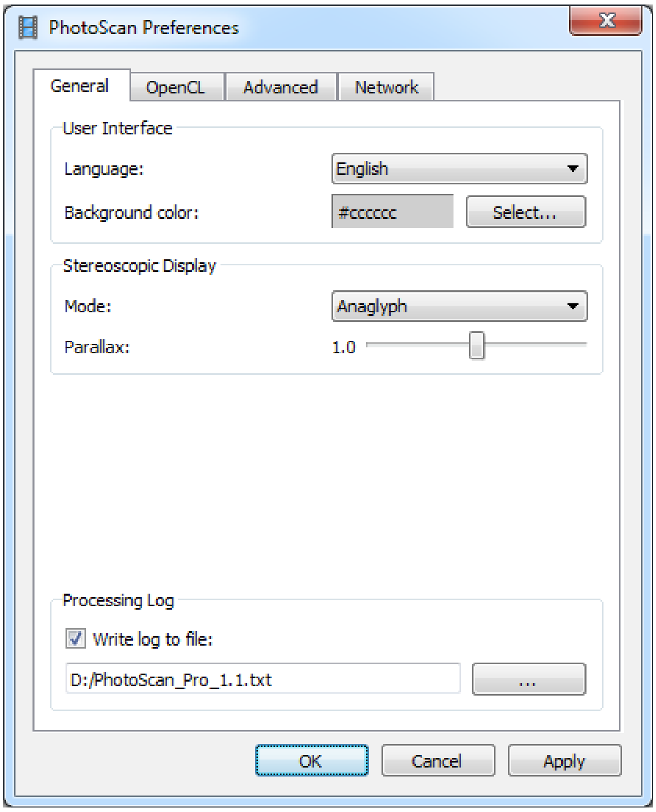
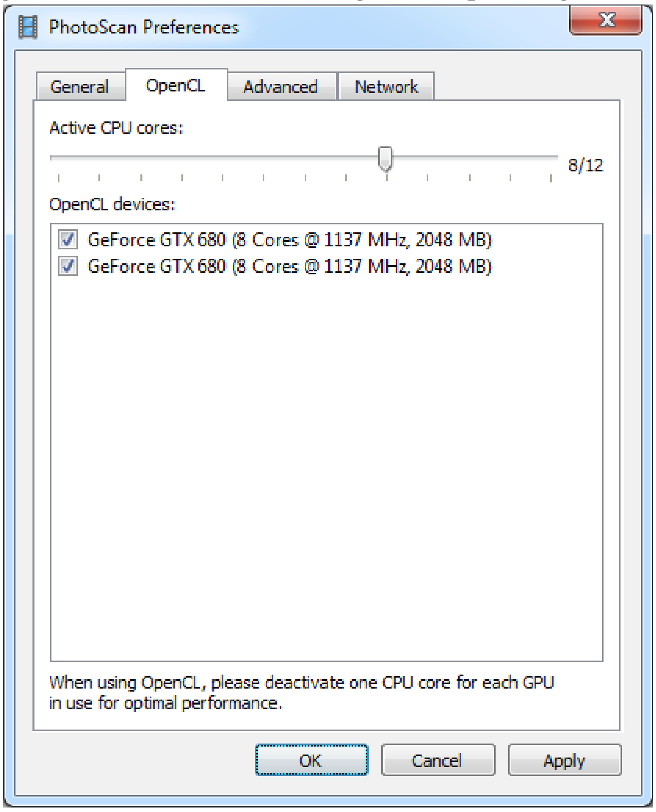
Tutorial (Beginner level):
Orthophoto and DEM Generation with Agisoft PhotoScan Pro 1.1
(with Ground Control Points)

PhotoScan Preferences

Open *PhotoScan Preferences* dialog from *Tools* menu using corresponding command.





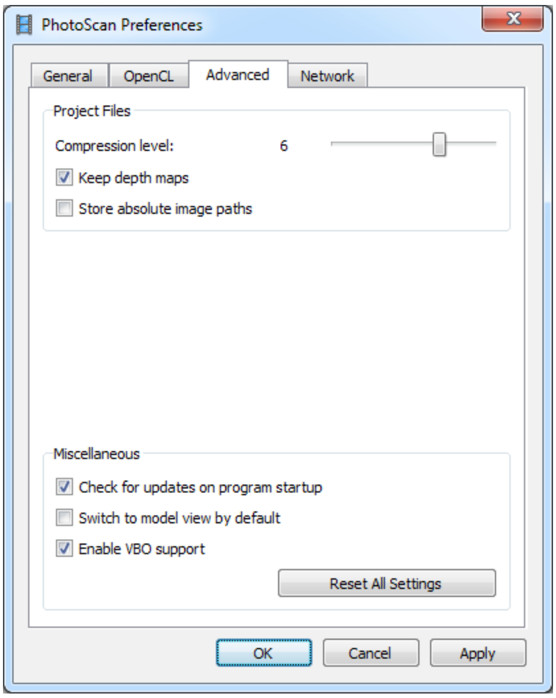
Set the following values for the parameters in the *General* tab:

Stereo Mode: *Anaglyph* (use *Hardware* if your graphic card support Quad Buffered Stereo)

Stereo Parallax: *1.0*

Write log to file: *specify directory where Agisoft PhotoScan log would be stored*
(in case of contacting the software support team it could be required)

Set the parameters in the *OpenCL* tab as following: *Check on any OpenCL devices detected by PhotoScan in the dialog and reduce the number of active CPU cores by one for each OpenCL device enabled.*



Set the following values for the parameters in the *Advanced* tab:

Project compression level: *6*

Keep depth maps: *enabled*

Store absolute image paths: *disabled*

Check for updates on program startup: *enabled*

Enable VBO support: *enabled*

Add Photos

To add photos select *Add Photos...* command from the *Workflow* menu or click *Add Photos* button located on *Workspace* toolbar.

In the *Add Photos* dialog browse the source folder and select files to be processed. Click *Open* button.

Load Camera Positions

At this step coordinate system for the future model is set using camera positions.

<u>**Note:** If camera positions are unknown this step could be skipped. The align photos procedure, however, would take more time in this case.</u>

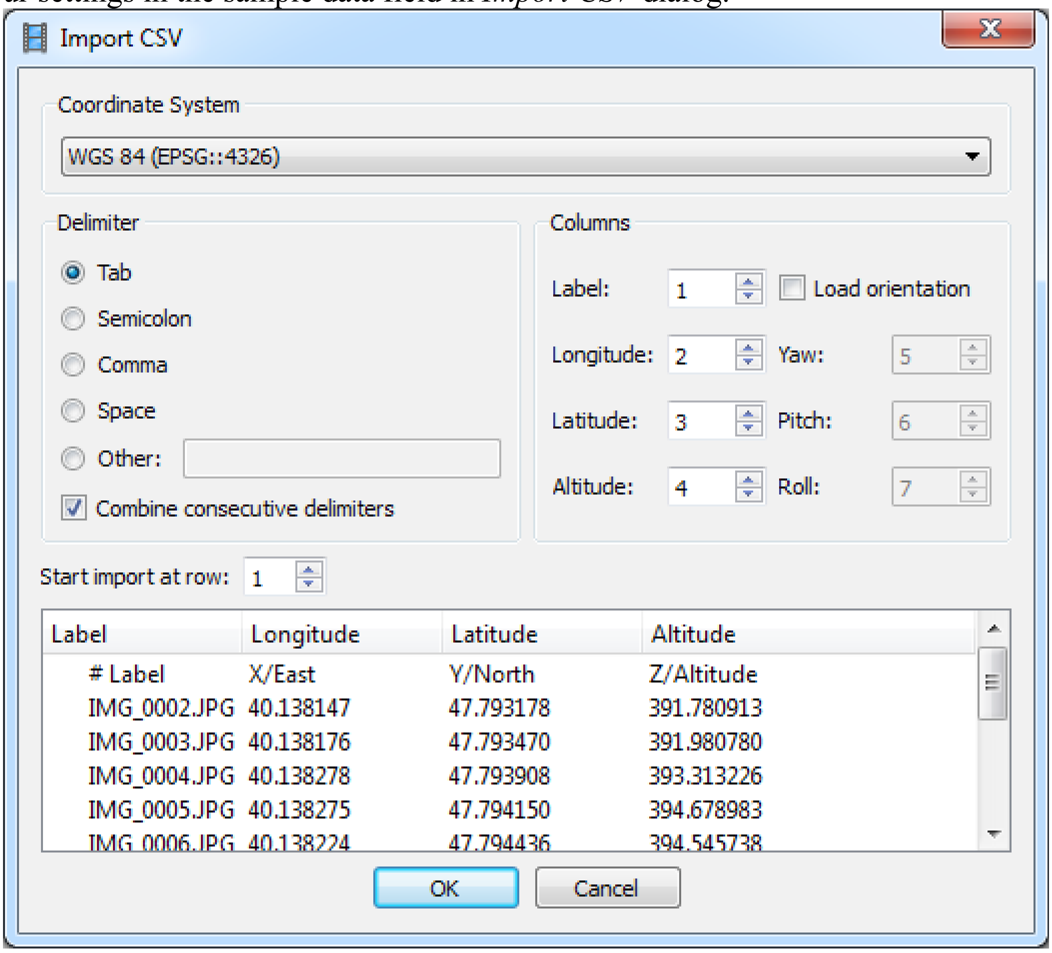
Open *Reference* pane using the corresponding command from the *View* menu.

Click *Import* button on the *Reference* pane toolbar and select file containing camera positions information in the *Open* dialog.

The easiest way is to load simple character-separated file (*.txt) that contains x- and y- coordinates and height for each camera position (camera orientation data, i.e. pitch, roll and yaw values, could also be imported, but the data is not obligatory).

In the *Import CSV* dialog indicate the delimiter according to the structure of the loading file and select the row to start loading from. Note that # character indicates a commented line that is not counted while numbering the rows. Indicate for the program what parameter is specified in each column through setting correct column numbers in the *Columns* section of the dialog. Also it is recommended to specify valid coordinate system in the corresponding field for the values used for camera center data.

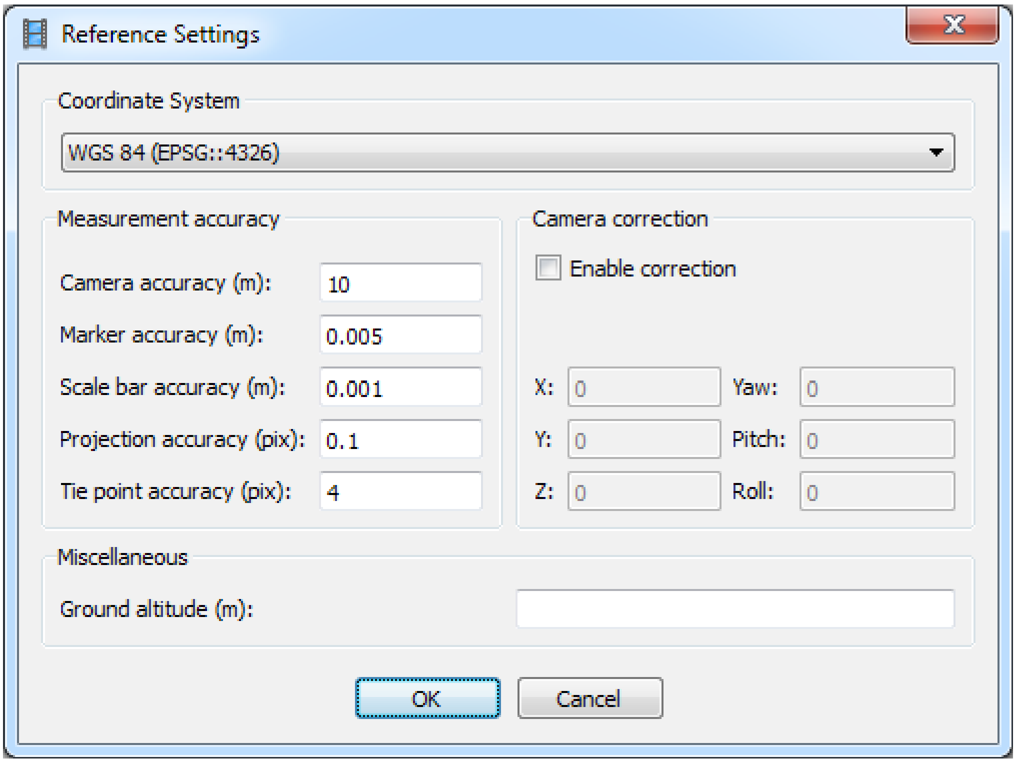
Check your settings in the sample data field in *Import CSV* dialog.



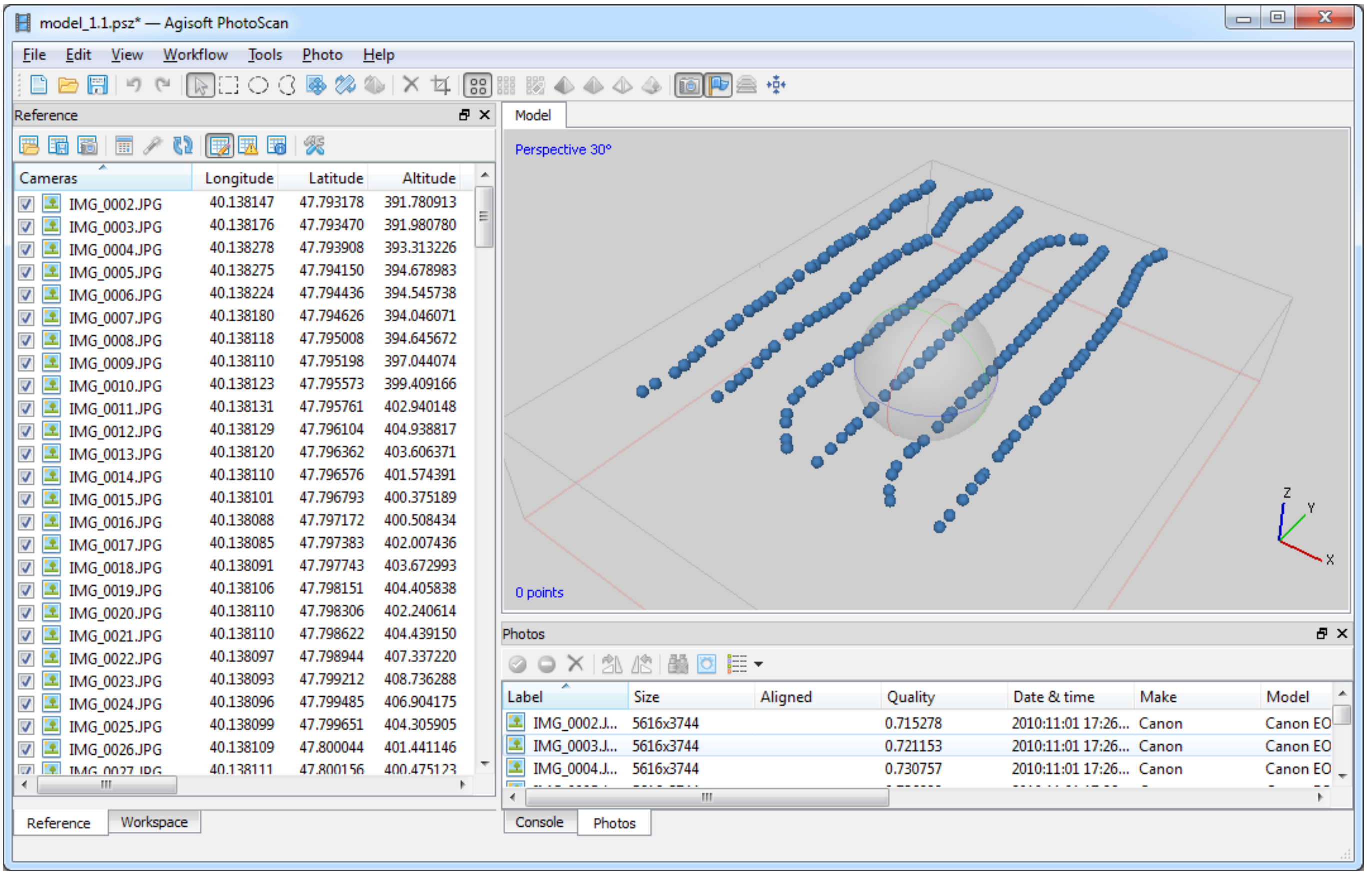
Click *OK* button. The data will be loaded into the *Reference* pane.

Import EXIF button located on the *Reference* pane can also be used to load camera positions information if EXIF meta-data is available.

Then click on the *Settings* button in the *Reference* pane and in the *Reference Settings* dialog select corresponding coordinate system from the list.



Click OK and camera positions will be marked in *Model View* using their geographic coordinates:

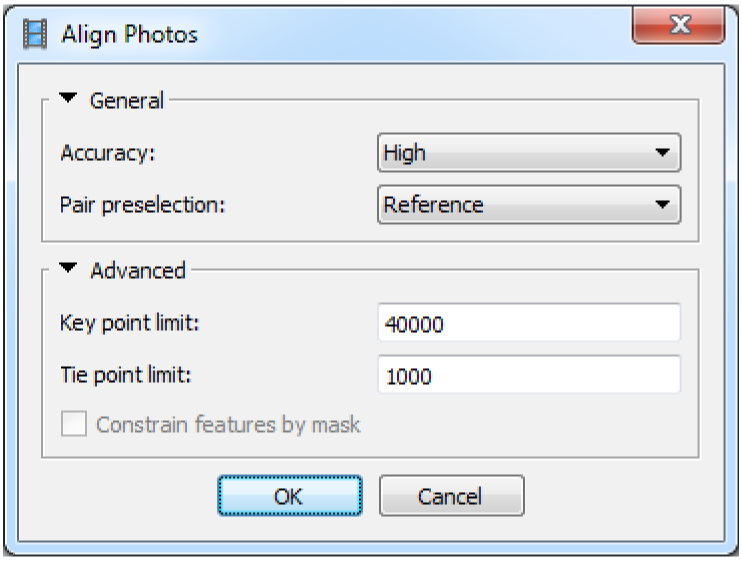


If you do not see anything in the Model view, even valid camera coordinates have been imported, please check that Show Cameras button is pressed on the Toolbar. Then click Reset View button also located on the Toolbar.

Align Photos

At this stage PhotoScan finds matching points between overlapping images, estimates the camera position for each photo and builds the sparse point cloud model.

Select *Align Photos* command from the *Workflow* menu.



Set the following recommended values for the parameters in the *Align Photos* dialog:

Accuracy: *High* (lower accuracy setting can be used to get the rough camera positions in the shorter time)

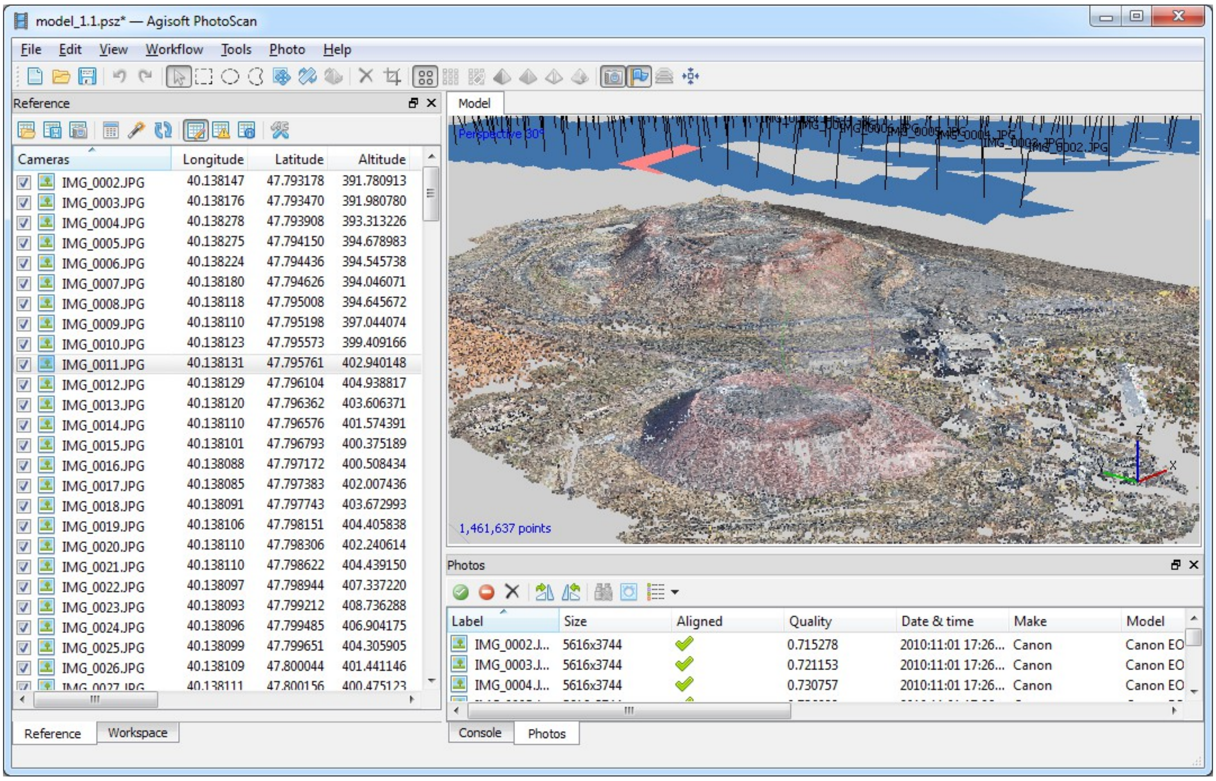
Pair preselection: *Reference* (in case camera positions are unknown *Generic* preselection mode can be used)

Constrain features by mask: *Disabled* (*Enabled* in case any areas has been masked prior to processing)

Key point limit: *40000*

Tie point limit: *1000*

Click *OK* button to start photo alignment. After some time you'll get sparse point cloud model shown in the Model view. Camera positions and orientations are indicated by blue rectangles in the view window:



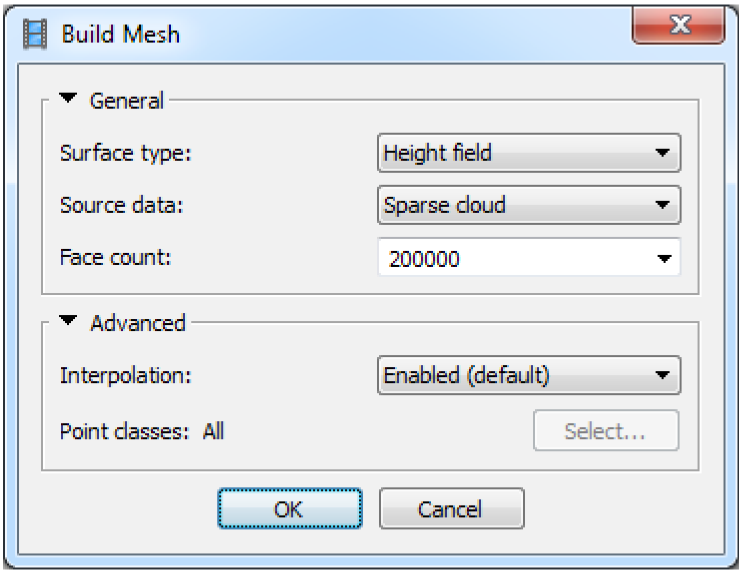
Place Markers

Markers are used to optimize camera positions and orientation data, which allows for better model reconstruction results.

To generate accurately georeferenced orthophoto at least 10 – 15 ground control points (GCPs) should be distributed evenly within the area of interest.

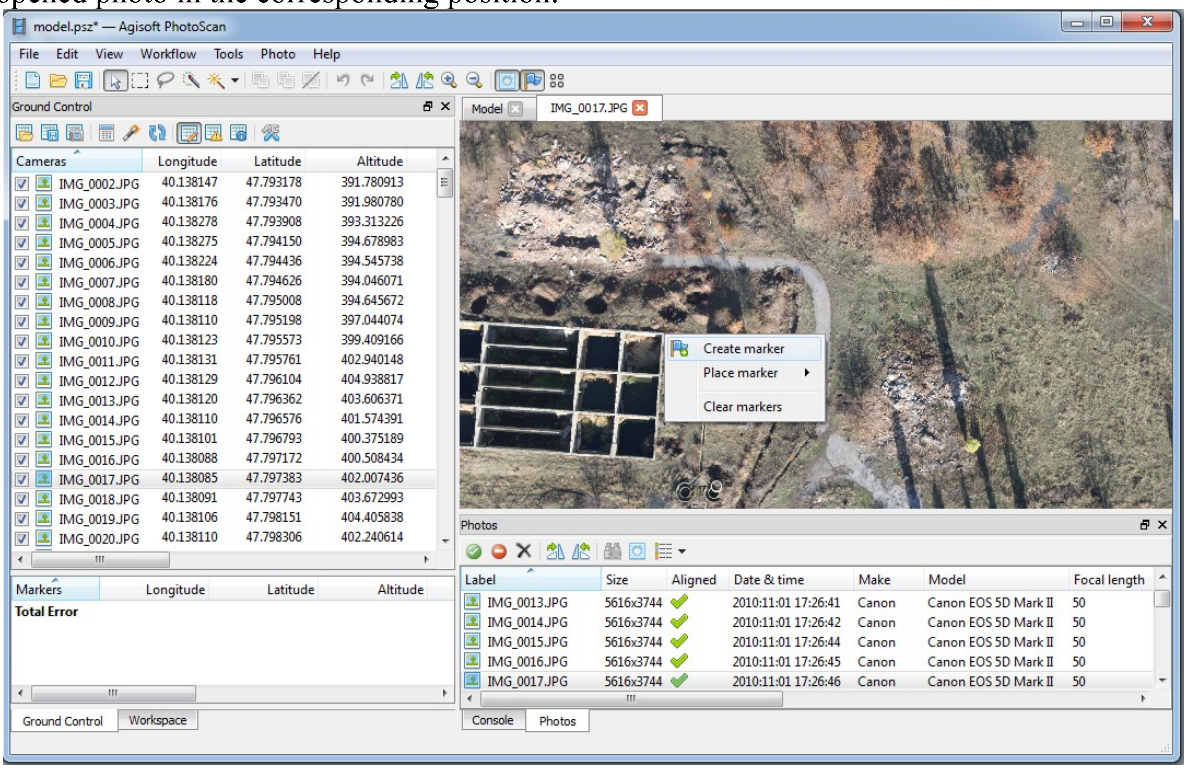
To be able to follow guided marker placement approach (that would be faster and easier) you need to reconstruct geometry first.

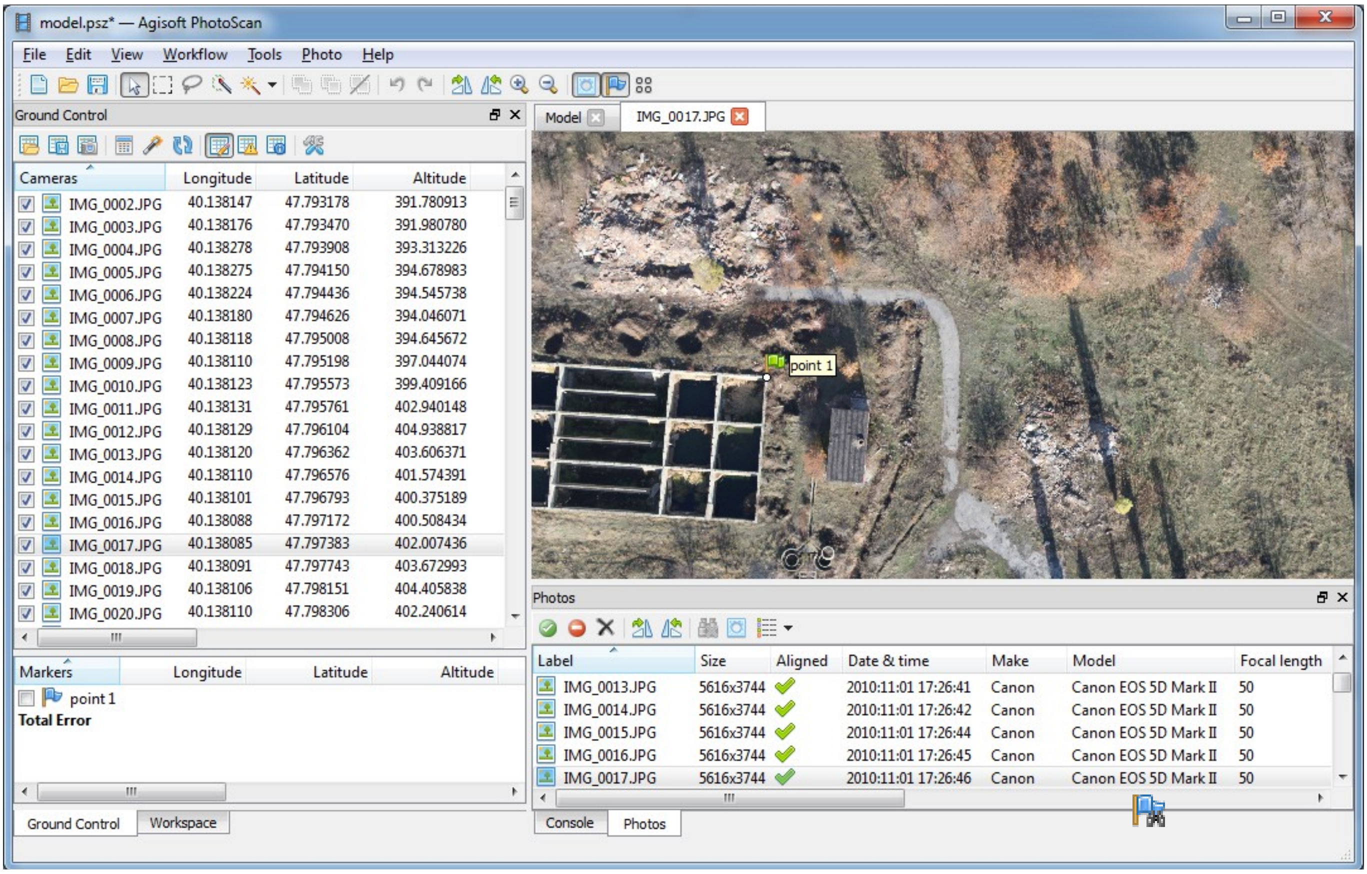
Select *Build Mesh* command from the *Workflow* menu and specify following parameters in the *Build Mesh* dialog:



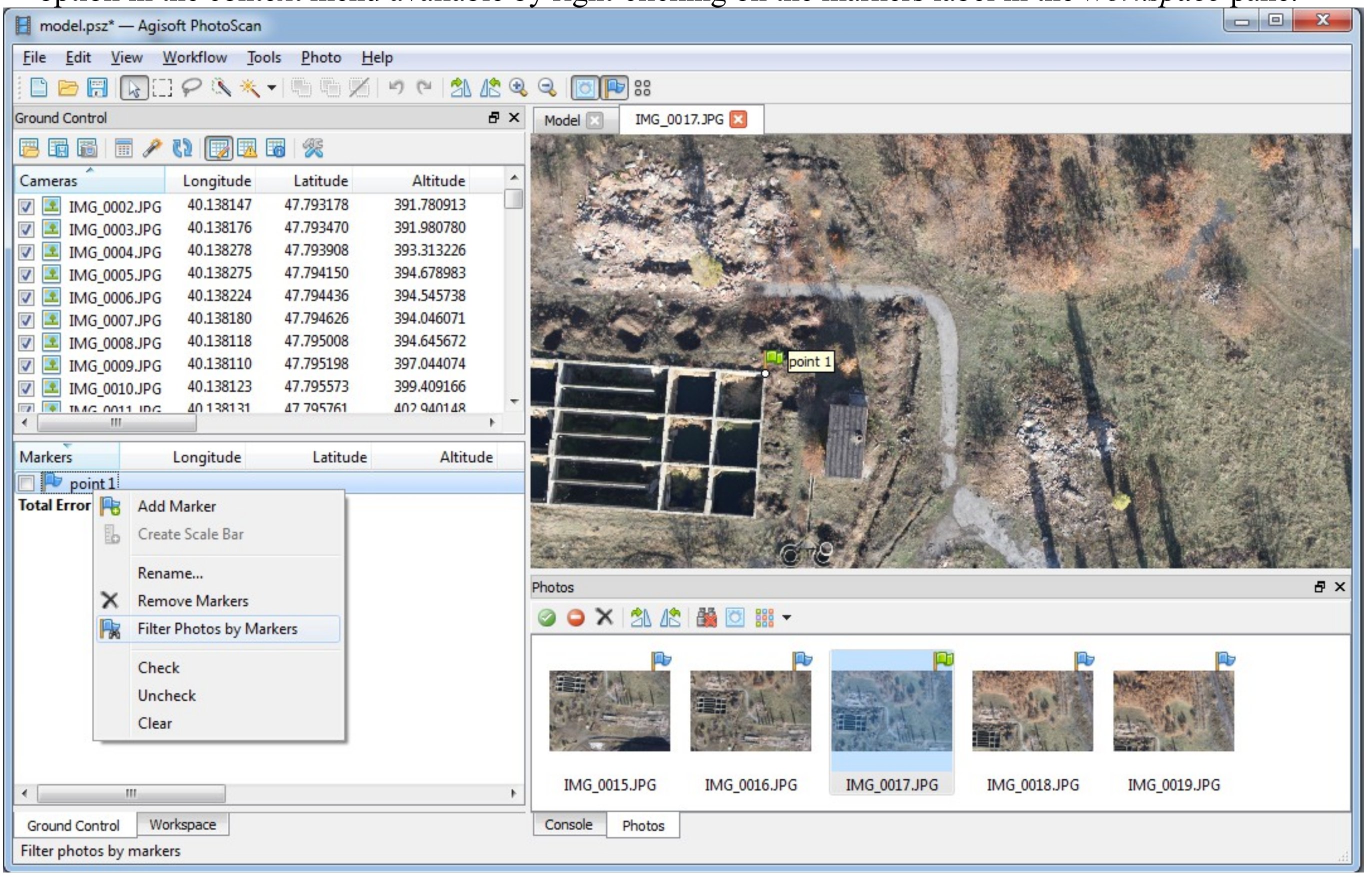
Click OK button.

Then, when the geometry is built (it usually takes a few seconds to reconstruct mesh based on the sparse point cloud), open a photo where a GCP is visible in Photo View by double-clicking on its icon in the *Photos* pane. Zoom in to locate the GCP on the photo and place a marker in the corresponding point of the image using *Create Marker* command from the photo context menu available on right-click on the opened photo in the corresponding position:





Select the marker on the *Reference* pane. Then filter images in *Photos* pane using *Filter by Markers* option in the context menu available by right-clicking on the markers label in the *Workspace* pane.



Now you need to check the marker location on every related photo and refine its position if necessary to provide maximum accuracy. Open each photo where the created marker is visible. Zoom in and drag the marker to the correct location while holding left mouse button. Repeat the described step for every GCP.

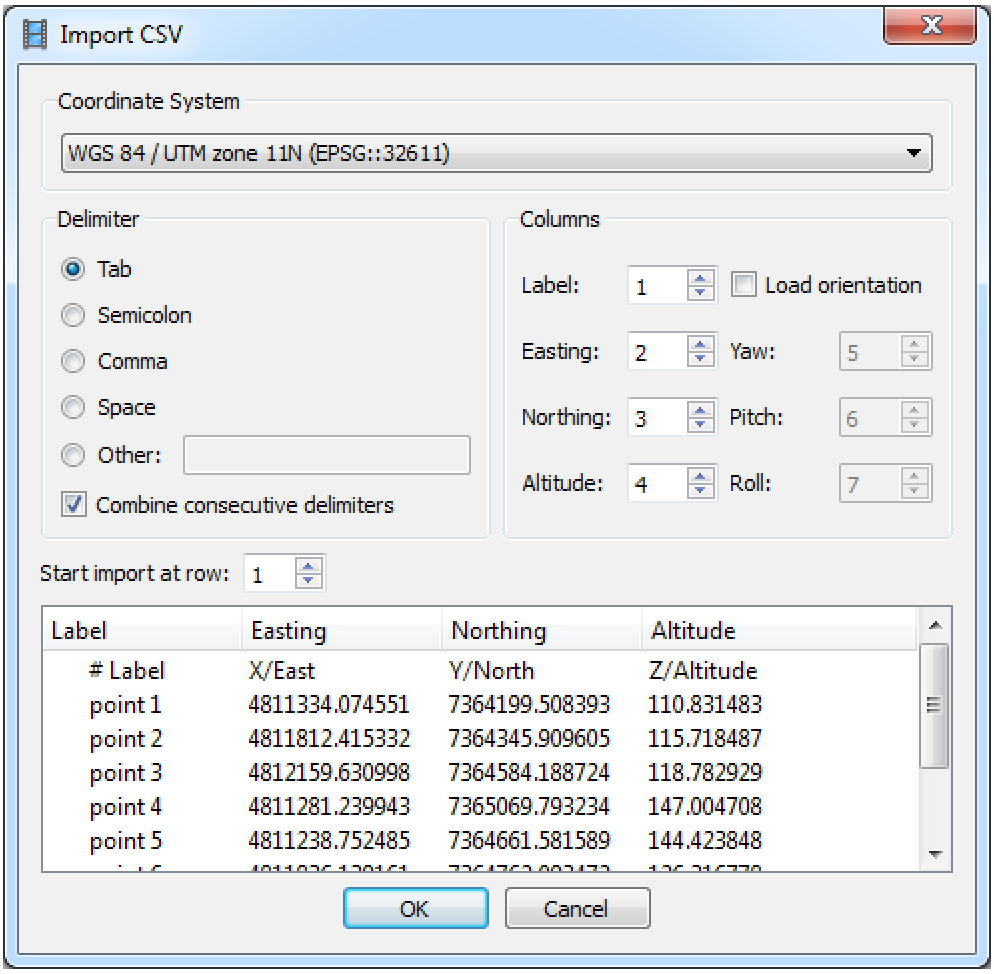
Input Marker Coordinates

Finally, import marker coordinates from a file. Click *Import* button on the *Reference* pane toolbar and select file containing GCP coordinates data in the *Open* dialog. The easiest way is to load simple character-separated file (*.txt) that contain markers name, x-, y- coordinates and height.

In *Import CSV* dialog indicate the delimiter according to the structure of the file and select the row to start loading from. Note that # character indicates a commented line that is not counted while numbering the rows. Indicate for the program what parameter is specified in each column through setting correct column numbers in the *Columns* section of the dialog.

Also it is recommended to specify valid coordinate system in the corresponding field for the values used for camera center data.

Check your settings in the sample data field in *Import CSV* dialog:



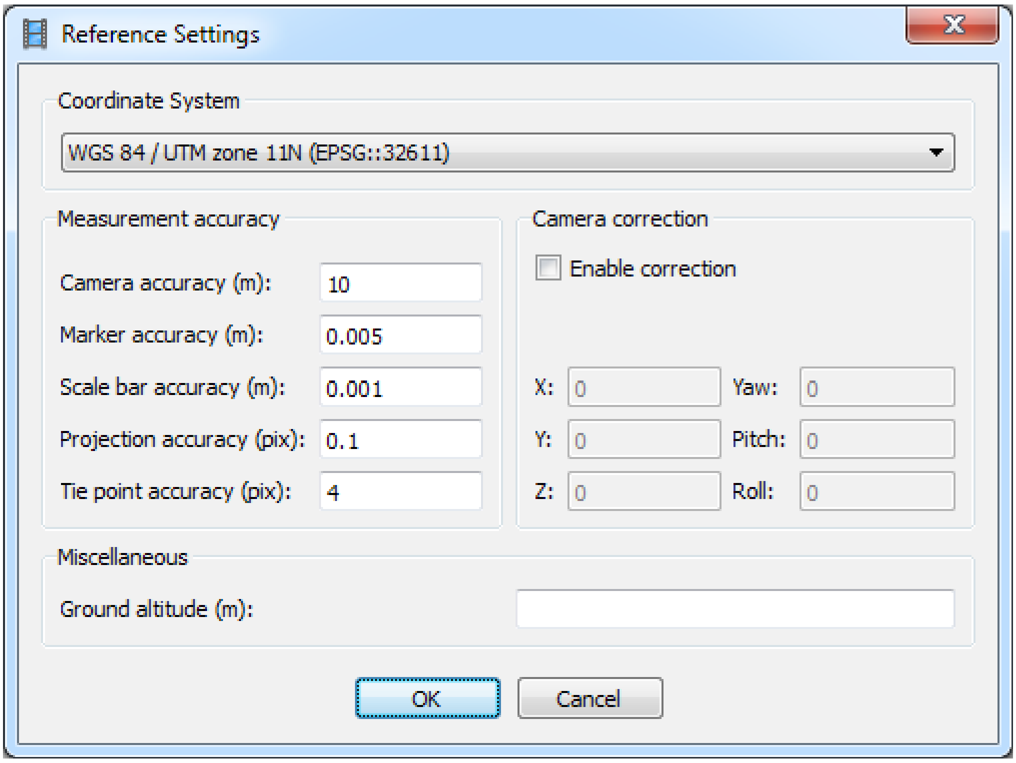
Click *OK* button. The data will be loaded into the *Reference* pane.

Optimize Camera Alignment

To achieve higher accuracy in calculating camera external and internal parameters and to correct possible distortion (e.g. “bowl effect” and etc.) optimization procedure should be run. This step is especially recommended if the ground control point coordinates are known almost precisely – within several centimeters accuracy (marker based optimization procedure).

Click the *Settings* button in the *Reference* pane and in the *Reference Settings* dialog select corresponding coordinate system from the list according to the GCP coordinates data.

Set the following values for the parameters in *Measurement accuracy* section:

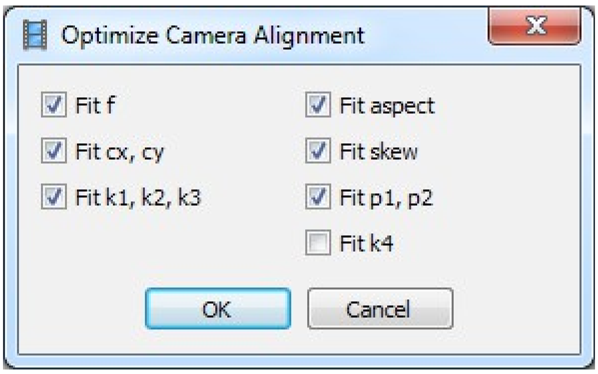


Camera accuracy: *10*
Marker accuracy: *0.005* (The marker accuracy is recommended to be set at 0.005 value if the real marker accuracy is within 0.02 m).
Scale bar accuracy: *0.001*
Projection accuracy: *0.1*
Tie point accuracy: *4*

Click OK button.

On the *Reference* pane **uncheck all photos** and check on the markers to be used in optimization procedure. The rest of the markers that are not taken into account can serve as control points to evaluate the optimization results. It is recommended since camera coordinates are usually measured with considerably lower accuracy than GCPs, also it allows to exclude any possible outliers for camera positions caused by the onboard GPS device failures.

Click *Optimize* button on the *Reference* pane toolbar.

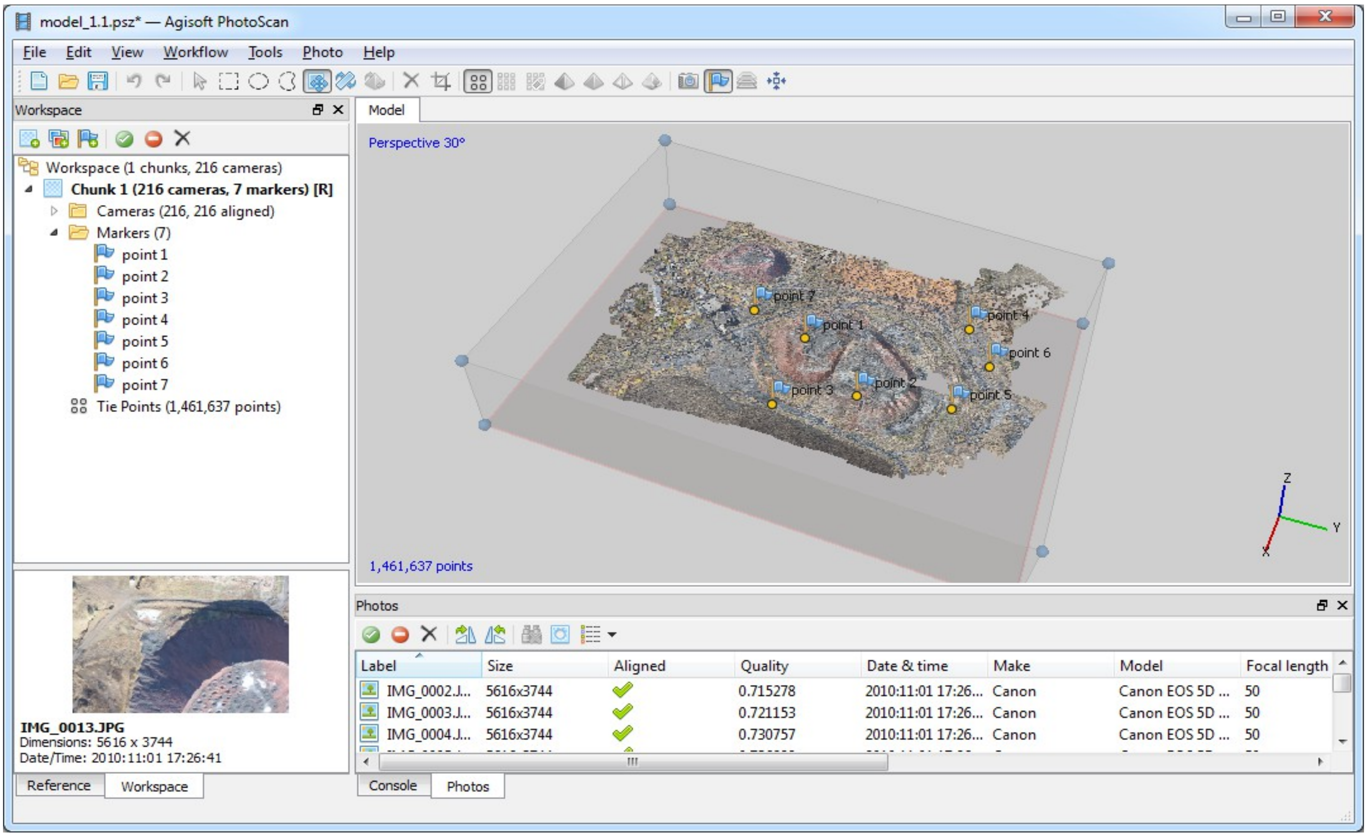


Select camera parameters you would like to optimize. Click *OK* button to start optimization process.

Set Bounding Box

Bounding Box is used to define the reconstruction area.

Bounding box is resizable and rotatable with the help of Resize Region and Rotate Region tools from the Toolbar.

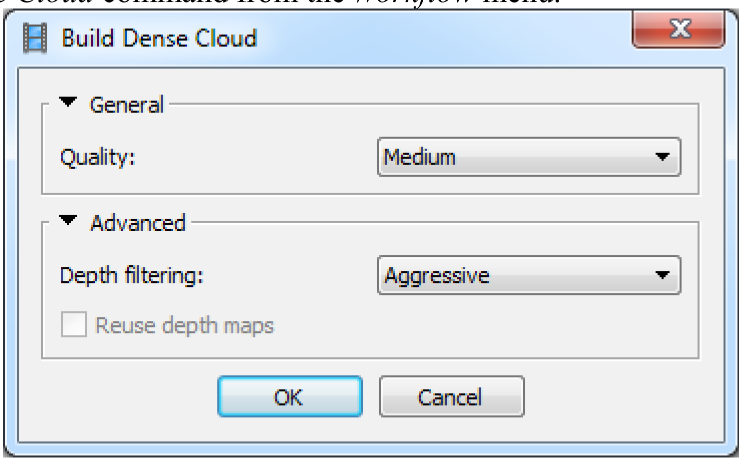


<u>**Important:** The red-colored side of the bounding box indicates the plane that would be treated as ground plane and has to be set **under** the model and **parallel** to the XY plane.</u>

Build Dense Point Cloud

Based on the estimated camera positions the program calculates depth information for each camera to be combined into a single dense point cloud.

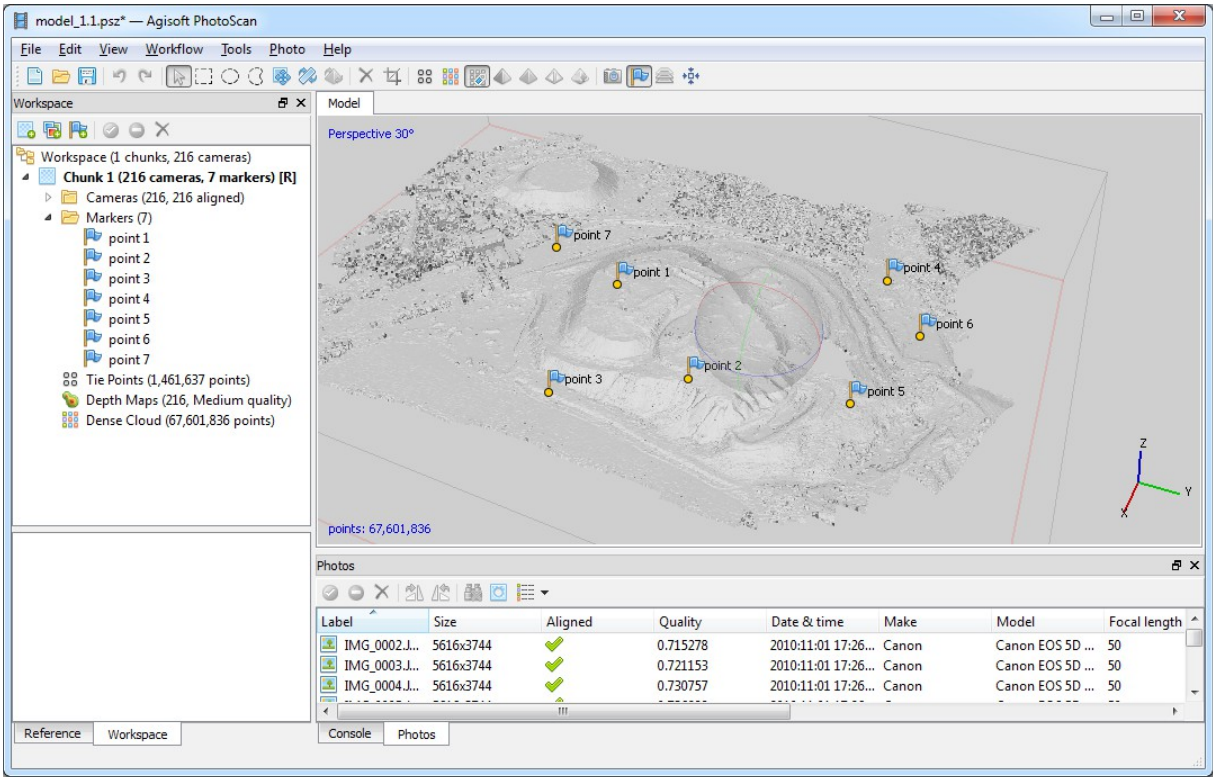
Select *Build Dense Cloud* command from the *Workflow* menu.



Set the following recommended values for the parameters in the *Build Dense Cloud* dialog:

<u>Quality</u>: *Medium* (higher quality takes quite a long time and demands more computational resources, lower quality can be used for fast processing)

<u>Depth filtering</u>: *Aggressive* (if the geometry of the scene to be reconstructed is complex with numerous small details or untextured surfaces, like roofs, it is recommended to set *Mild* depth filtering mode, for important features not to be sorted out)

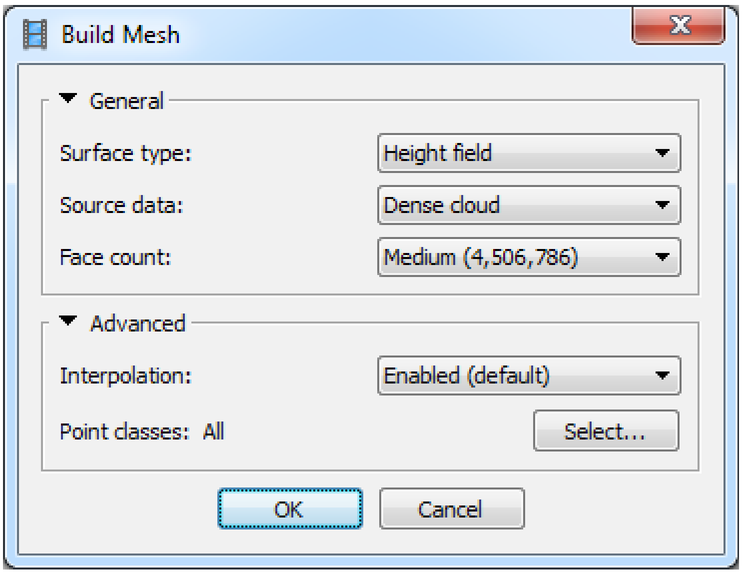


Points from the dense cloud can be removed with the help of selection tools and *Delete/Crop* instruments located on the Toolbar.

Build Mesh

After dense point cloud has been reconstructed it is possible to generate polygonal mesh model based on the dense cloud data.

Select *Build Mesh* command from the *Workflow* menu.



Set the following recommended values for the parameters in the *Build Mesh* dialog:

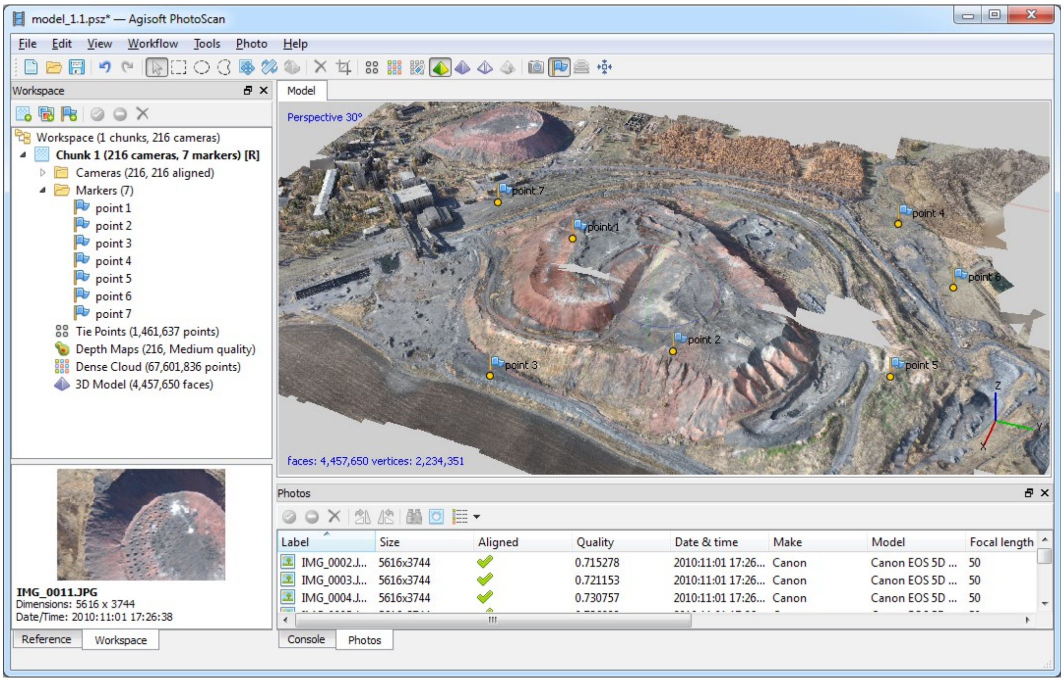
Surface type: *Height Field*

Source data: *Dense cloud*

Polygon count: *Medium* (maximum number of faces in the resulting model. The values indicated next to *High/Medium/Low* preset labels are based on the number of points in the dense cloud. Custom values could be used for more detailed surface reconstruction).)

Interpolation: *Enabled*

Click *OK* button to start mesh reconstruction.

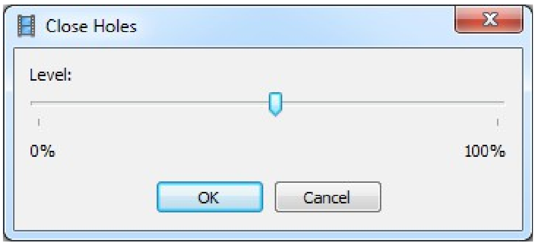


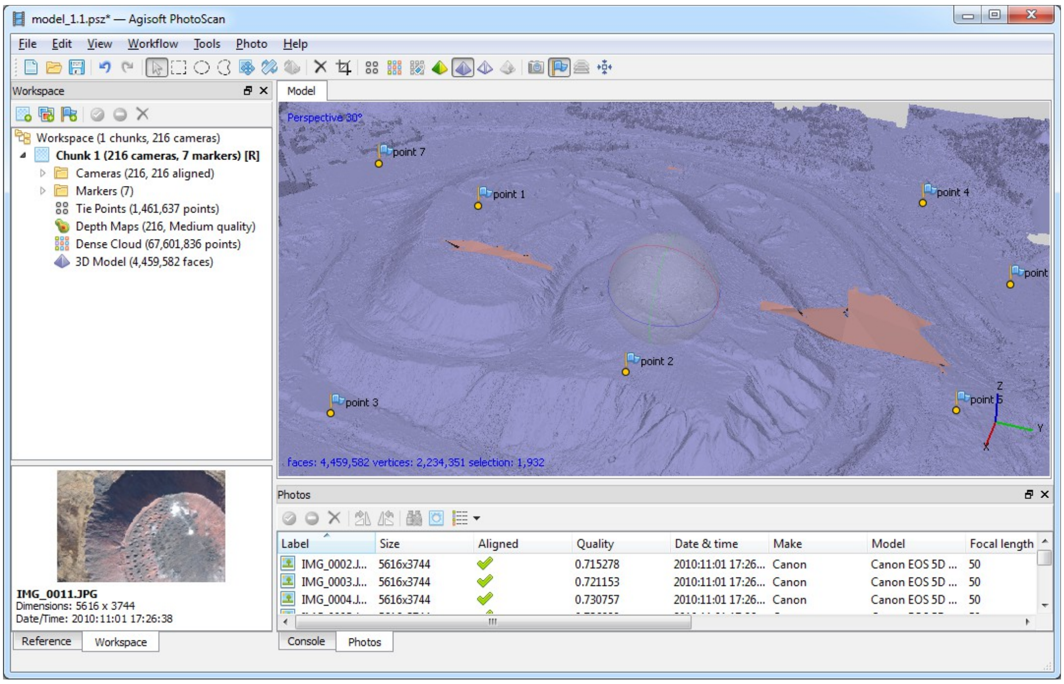
Edit Geometry

Sometimes it is necessary to edit geometry before building texture atlas and exporting the model.

Unwanted faces could be removed from the model. Firstly, you need to indicate the faces to be deleted using selection tools from the toolbar. Selected areas are highlighted with red color in the Model View. Then, to remove the selection use Delete Selection button on the Toolbar (or Del key) or use Crop Selection button on the Toolbar to remove all but selected faces.

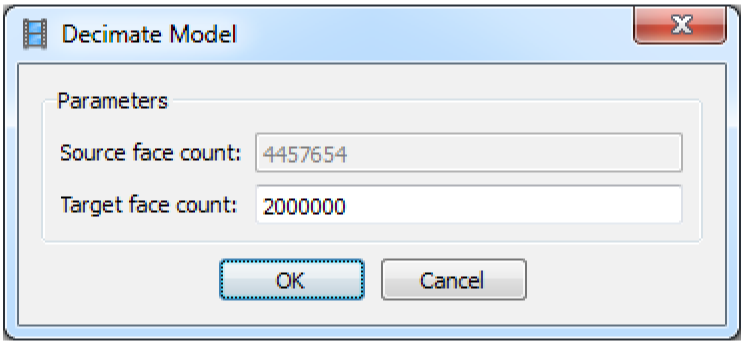
If the overlap of the original images was not sufficient, it may be required to use *Close Holes* command from the *Tools* menu at geometry editing stage to produced holeless model. In *Close Holes* dialog select the size of the largest hole to be closed (in percentage of the total model size).





PhotoScan tends to produce 3D models with excessive geometry resolution. That's why it is recommended to decimate mesh before exporting it to a different editing tool to avoid performance decrease of the external program.

To decimate 3D model select *Decimate Mesh...* command from the Tools menu. In the *Decimate Mesh* dialog specify the target number of faces that should remain in the final model. For PDF export task or web-viewer upload it is recommended to downsize the number of faces to 100,000-200,000.

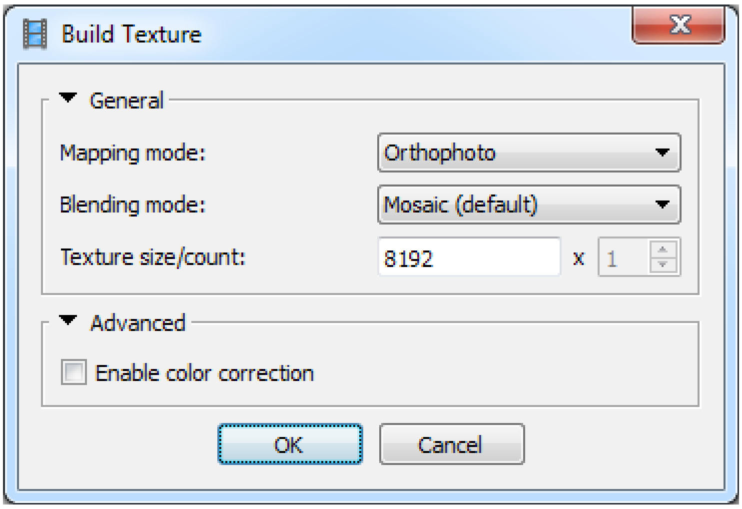


Click *OK* button to start mesh decimation procedure.

Build Texture

This step is not really needed in the orthophoto export workflow, but it might be necessary to inspect a textured model before exporting it or it might be useful for precise marker placement.

Select *Build Texture* command from the *Workflow* menu.



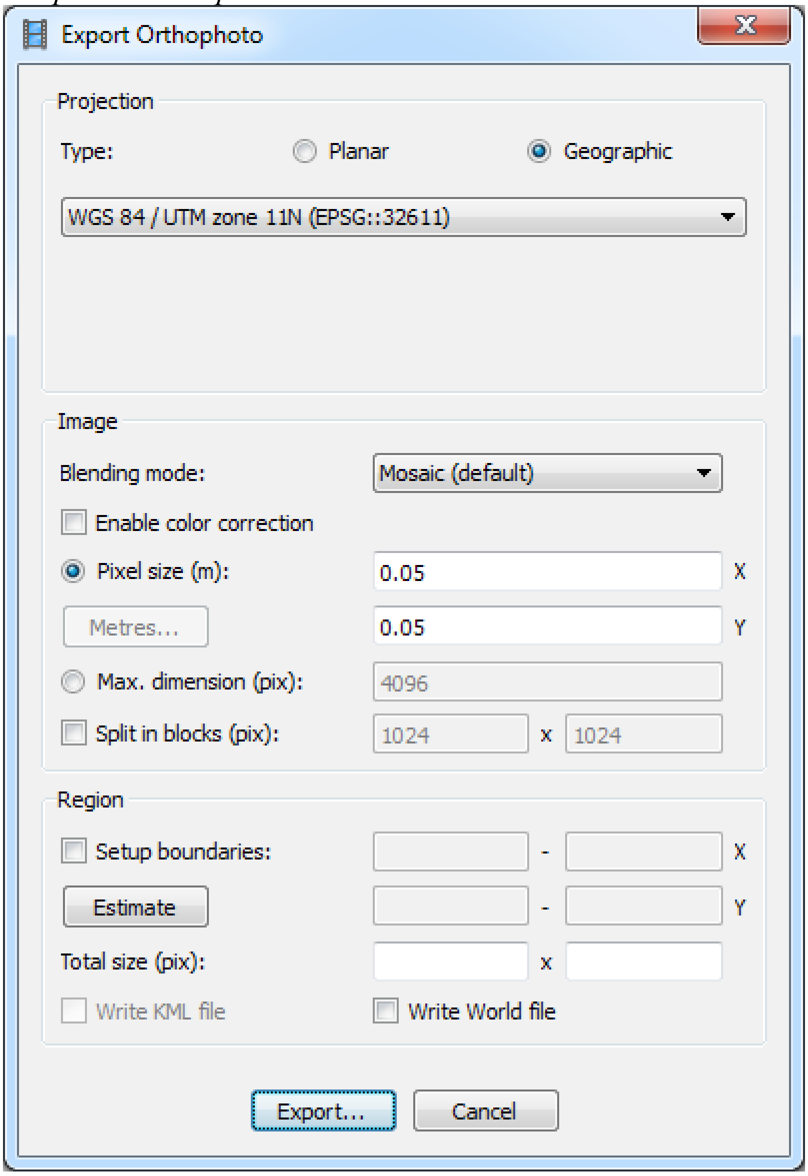
Set the following recommended values for the parameters in the *Build Texture* dialog:

Mapping mode: Orthophoto
Blending mode: *Mosaic*
Texture size/count: 8192 (width & height of the texture atlas in pixels)
Enable color correction: *disabled* (the feature is useful for processing of data sets with extreme brightness variation, but for general case it could be left unchecked to save the processing time)

Click *OK* button to start texture generation.

Generate Orthophoto

Select *Export Orthophoto* → *Export JPEG/TIFF/PNG* command from *File* menu.



Set the following recommended values for the parameters in the *Export Orthophoto* dialog:

Projection type: *Geographic*

Projection: by default the projection set in the *Reference Settings* is used

Blending mode: *Mosaic*

Enable color correction: *disabled* (the feature is useful for processing of data sets with extreme brightness variation, but for general case it could be left unchecked to save the processing time)

Pixel size: maximum effective resolution is shown by default (please note that for WGS84 coordinate system units should be specified in degrees. Use *Metres* button to specify the resolution in metres).

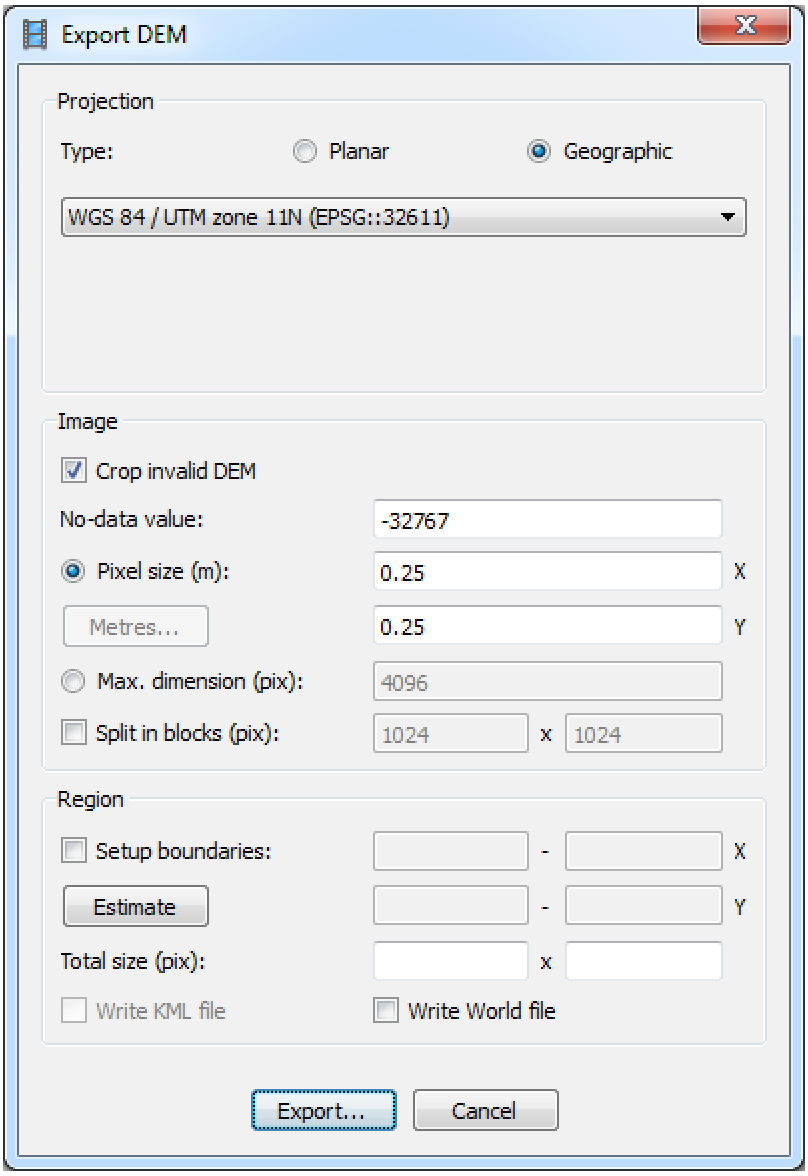
Split in blocks: *10000* x *10000* (if the exported area is large it is recommended to enable *Split in Blocks* feature, since the memory consumption is rather high at exporting stage)

Region: set the boundaries of the model's part that should be projected and presented as orthophoto.

Click *Export...* button and then specify target file name and select type of the exported file (e.g. GeoTIFF). Click *Save* button to start orthophoto generation.

Generate DEM

Select *Export DEM* → Export GeoTIFF/BIL/XYZ command from *File* menu.



Set the following recommended values for the parameters in the *Export DEM* dialog:

Projection type: *Geographic*

Projection: by default the projection set in the *Reference Settings* is used

Crop invalid DEM: check this option to crop the regions with unreliable elevation data, since they are visible on less than two source photos

Pixel size: you can increase the effective resolution compared to the default value

Split in blocks: *10000* x *10000* (if the exported area is large it is recommended to enable *Split in blocks* feature, since the memory consumption is rather high at exporting stage)

Region: set the boundaries of the model's part that should be presented as DEM.

Click *Export...* button and then specify target file name and select type of the exported file (e.g. GeoTIFF). Click *Save* button to start DEM generation.