# Unmanned Aircraft Systems Data Post-Processing

## Section 2 – MicaSense 5-band MultiSpectral Imagery

**Synopsis**
In this introductory training class, we will explore how to handle image data captured from an unmanned aerial vehicle equipped with an on-board camera or sensor. Utilizing Computer Vision – Structure-from-Motion techniques that estimates three-dimensional information from two-dimensional images. Using real world data captured from a UAS, we will illustrate how it is possible to generate georeferenced point clouds, elevation models and mosaiced image bases for mapping and geographic information system data layer creation.

**Requirements**
- A registered version of Agisoft PhotoScan Version 1.2.3
- Access the data files noted below
- No previous experience with PhotoScan is necessary

**Workflow**
The following step-by-step instructions are intended to familiarize participants with the relevant components of PhotoScan. A short description is given, followed by a specific "cookbook" of instructions for how to process a dataset from beginning to end.

**Data**
Two separate real world datasets are provided for Exercises to see how actual collected data is processed into workable GIS data layers.

**Class Outline**
- Import images collected from a UAS
- Align the images and remove or adjust errors to create a sparse point cloud
- Create a dense point cloud
- Create a mesh or digital surface model
- Create image texture
- Output the products for use in GIS

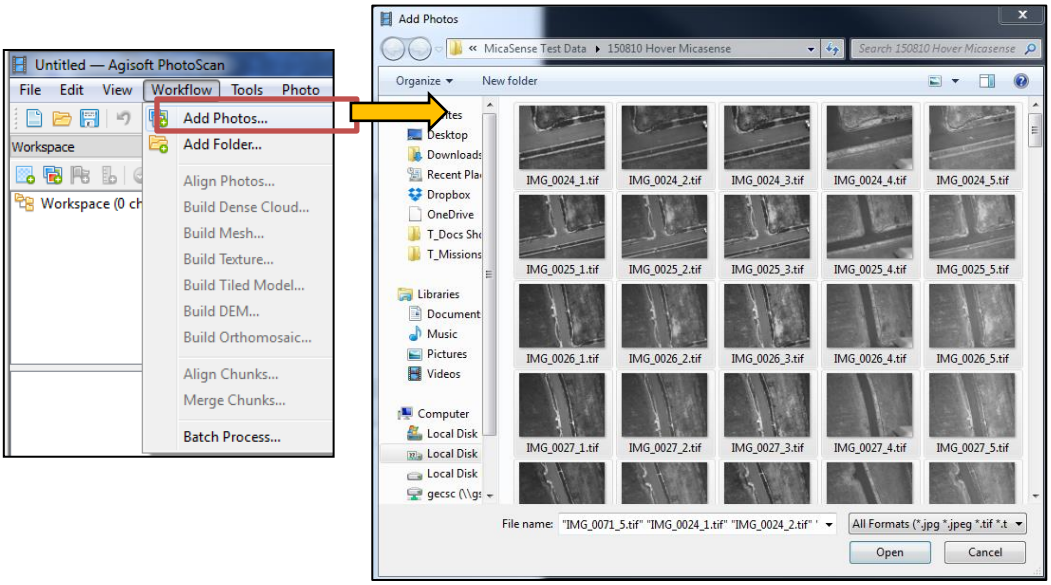
# MicaSense RedEdge 5-band image captures to mosaic and rectify using Agisoft PhotoScan

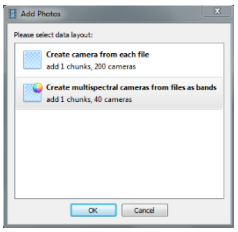
*Agisoft PhotoScan Version 1.2.3 (Build 2331 – 64bit)*

## 1.) Adding Photos

Procedure Description: Images are loaded to begin the mosaic and rectification process. Images that contain GPS embedded coordinate data available directly from the camera or captured from the UAS, allows for initial referencing of the images to the ground. Images can be from different flights, altitudes and folders with standard image formats supported such as .jpg, .png, .tif, etc.

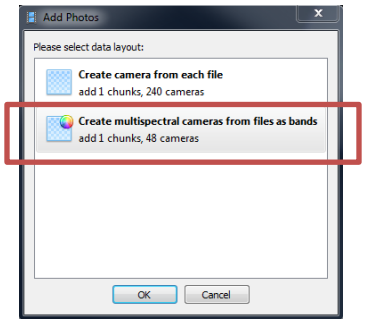
- Workflow… Add Photos … Select all the photos (each image capture should have 5 separate files (.tif format)…Open.
- Select 'Create multispectral cameras from files as bands'… OK

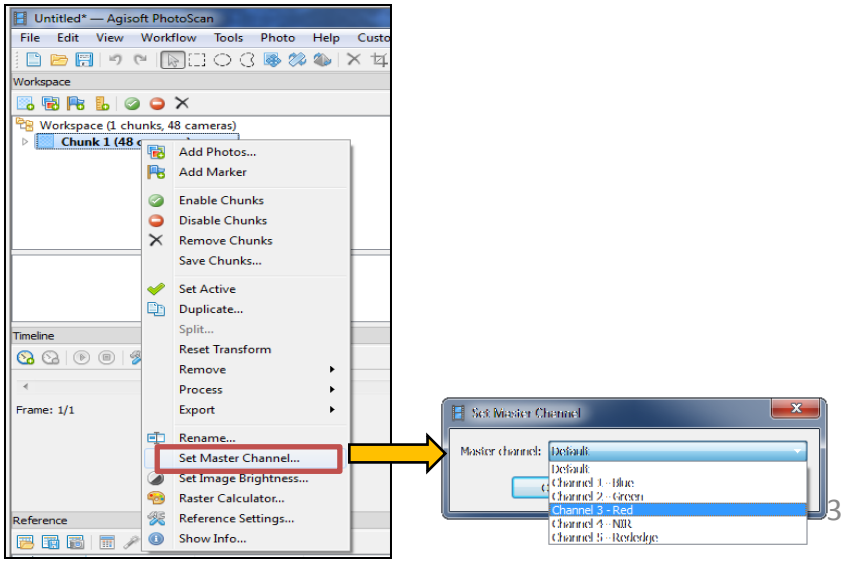



- Once photos are added, they will appear as a 'Chunk' in the Workspace panel with the number of photos that were added. Thumbnails of the photos will appear in the Photos panel.

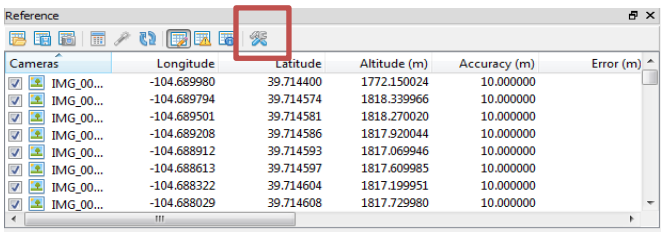
- [Optional] - In the 'Workspace' panel, right click on the 'Chunk'… Set Master Channel…select the master channel (or band) you prefer to use for the PhotoScan image correlation process, or use the default.

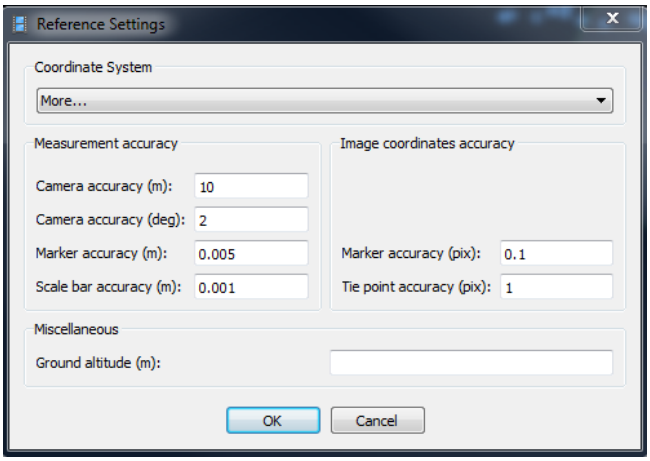


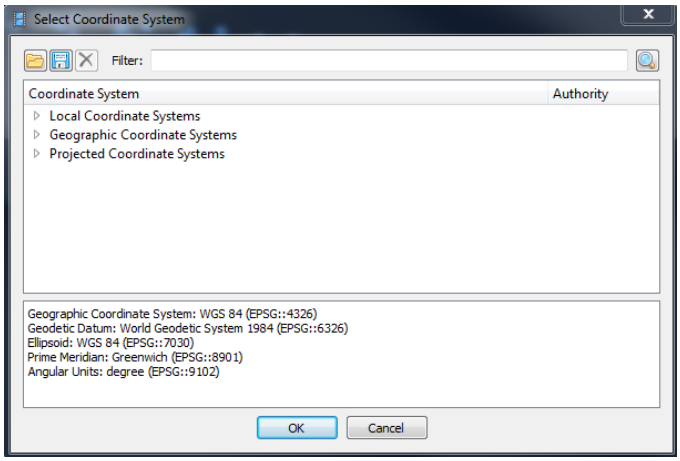



## Setting the Coordinate System for Image Referencing

- On the 'Reference' panel … Select the 'Settings' icon … check to make sure the coordinate system is set to what the camera or UAS GPS was using while collecting the photos (i.e.. Geographic Coordinate System, WGS84). <u>Note</u>: Keep the accuracy settings to the default values.

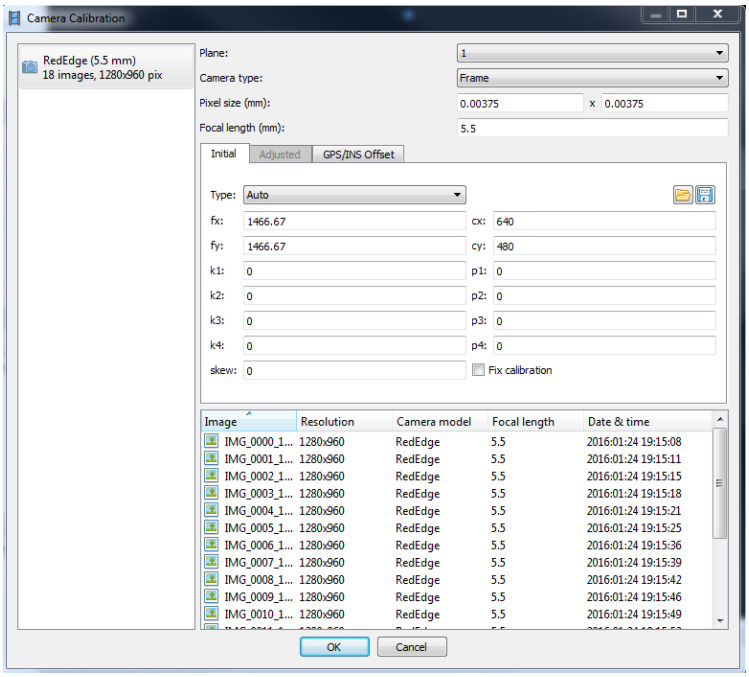



## Checking the Camera Calibration

- Select Tools from the main menu…Camera Calibration
- Basic information is extracted from the EXIF (image header info) such as pixel size, focal length and resolution

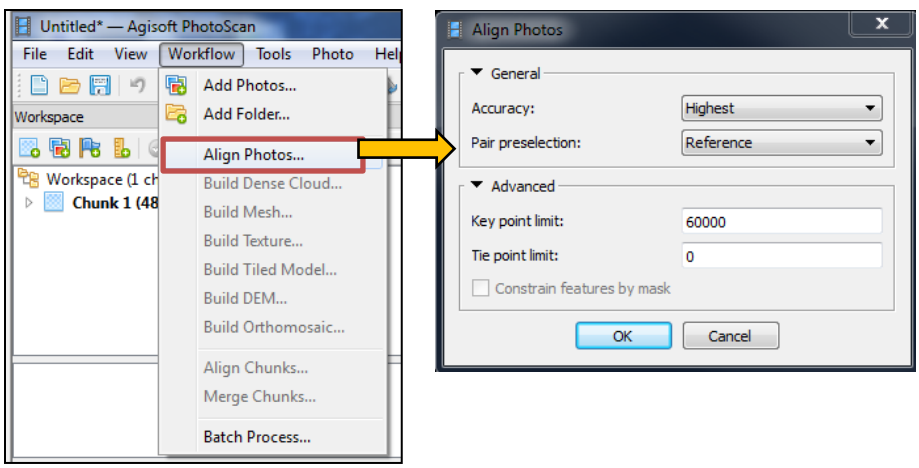


## 2.) Aligning Photos

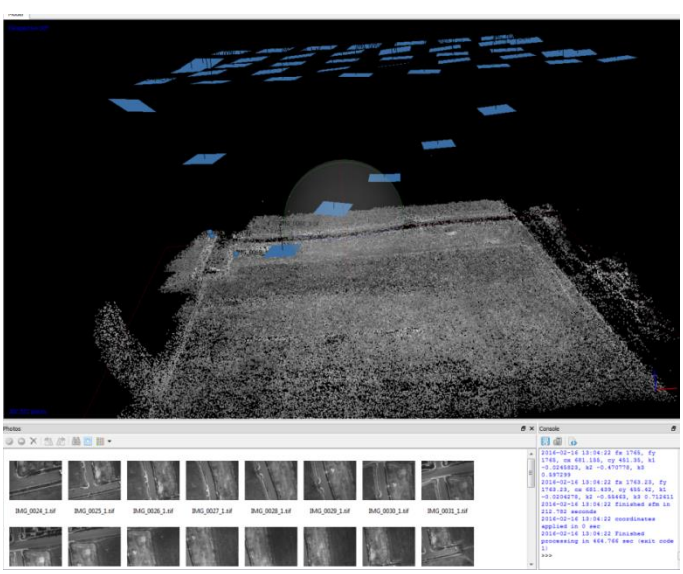
Procedure Description: To begin the photo alignment process, three steps are performed to tie the images together in an automated image correlation process in order to create a sparse point cloud. This initial phase is also used to select the best images to use for the model.

Note: Bad images can initially be removed before running the align photo process by selecting them, right clicking and removing the cameras. This can save considerable time in the alignment process.

- Workflow… Align Photos…
- Settings:
  - Accuracy : highest = full image resolution lowest = down sampled resolution
  - Pair preselection : use generic or disabled if image locations are not known
    use reference if images have known reference info in EXIF or log file
  - Advanced:
    Key point limit (point of interest) = 60000
    Tie point limit (pts matched on 2 or more photos) = 0

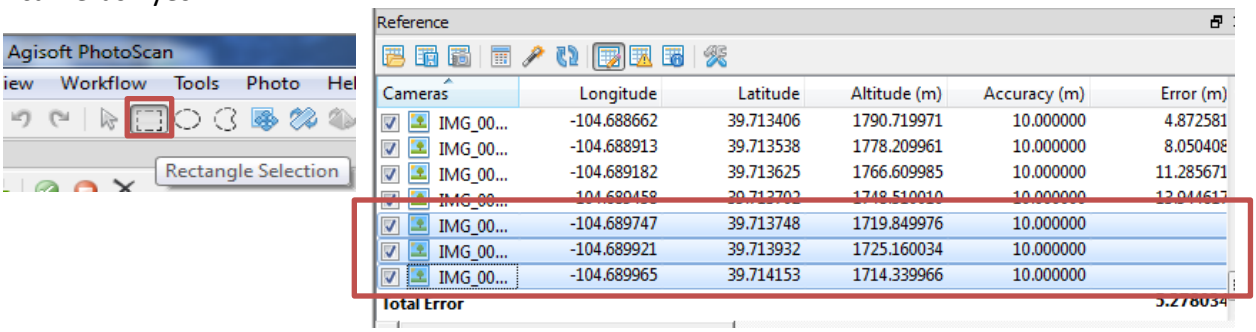


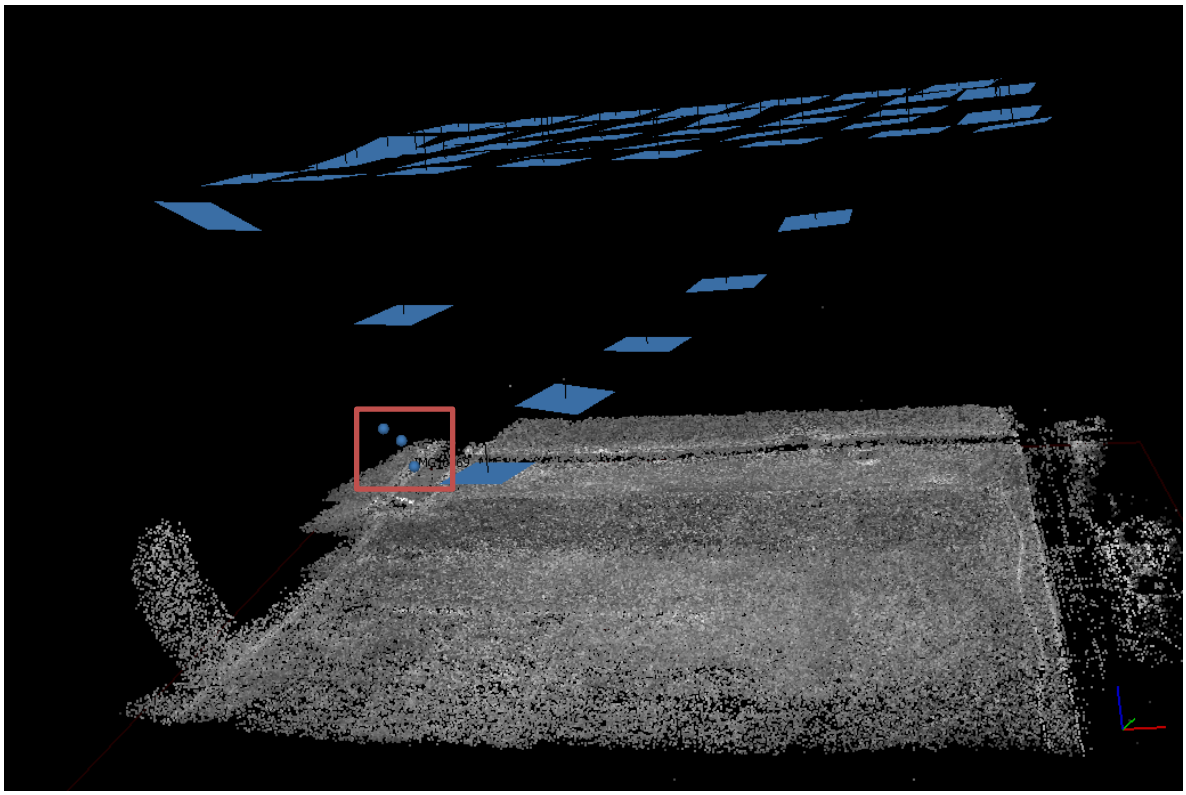

- PhotoScan processes three steps in order to create a sparse point cloud; detecting points, selecting pairs of images, and matching points.



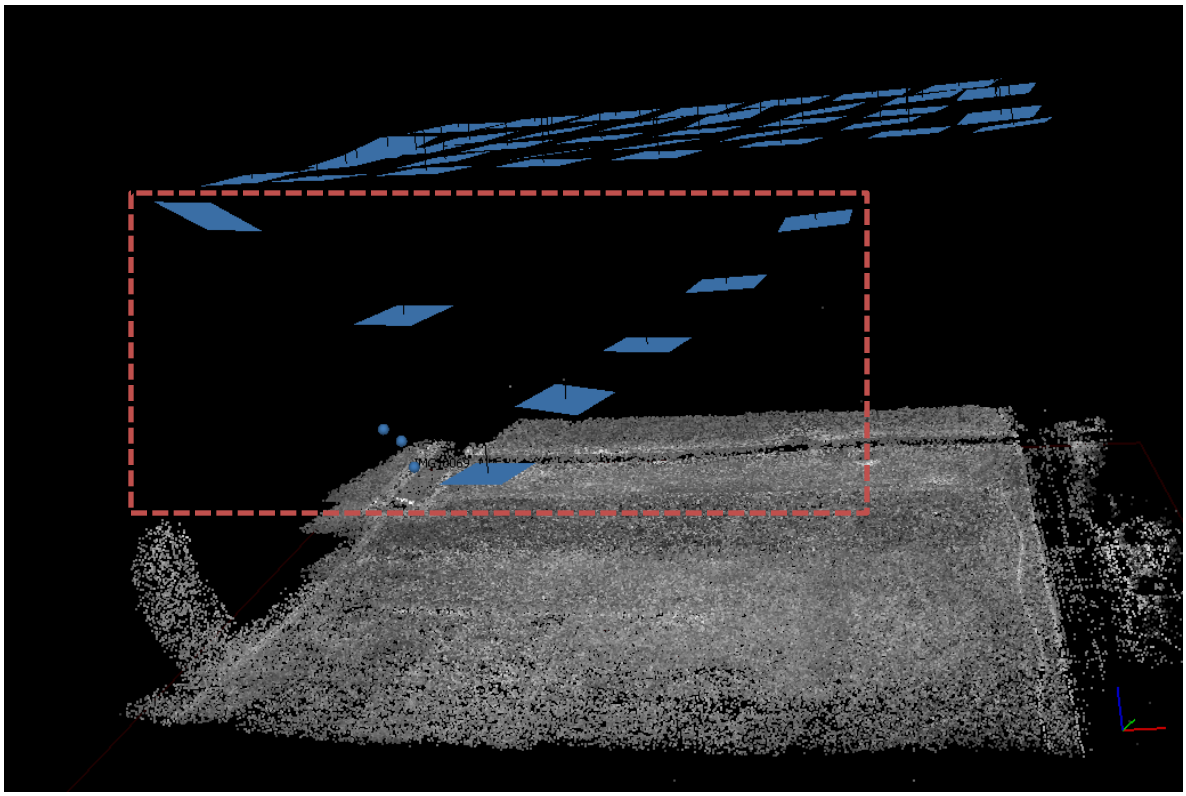
**Eliminating bad photos**

- Photos that did not align are shown graphically by the 'dots' and also in the Reference Panel with no error measurements calculated. These photos can be removed by selecting with the Rectangle Selection tool, or by highlighting in the Reference Panel…right click…remove cameras…yes.

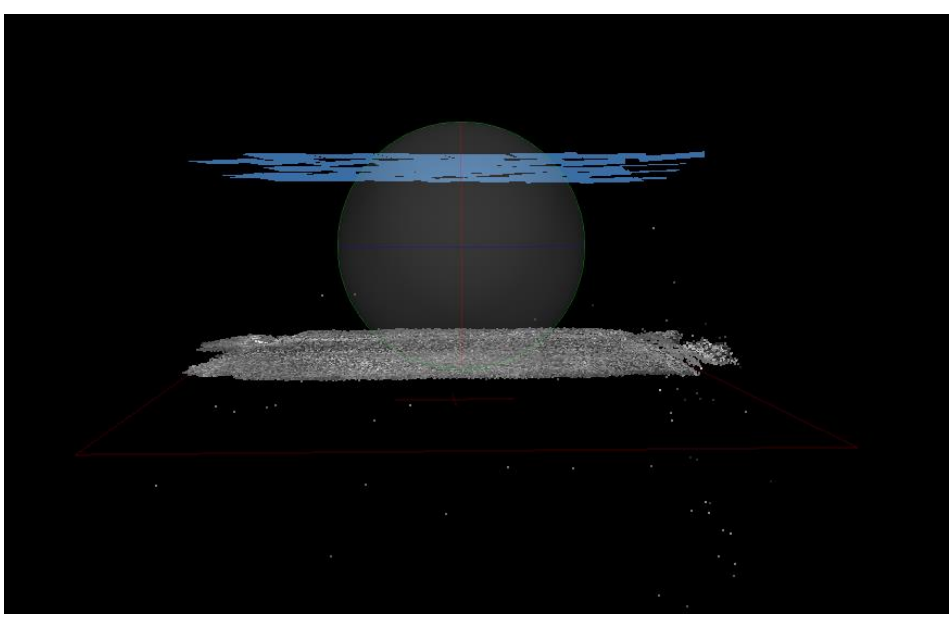


- Photos that don't add value to the model – such as take off and landing times from the UAS - can also be removed. The Rectangle Selection tool can be used to select…right click in the Reference panel on the highlighted image…remove camera…yes.



- A realignment of the photos is necessary when images are removed. Workflow…Align Photos…(use the same settings as before or increase accuracy to a higher level)…OK



### 3.) Place Markers (Adding Ground Control)

Procedure Description: Markers, or ground control points can be added to better improve the model and georeferencing accuracy of the final data outputs.

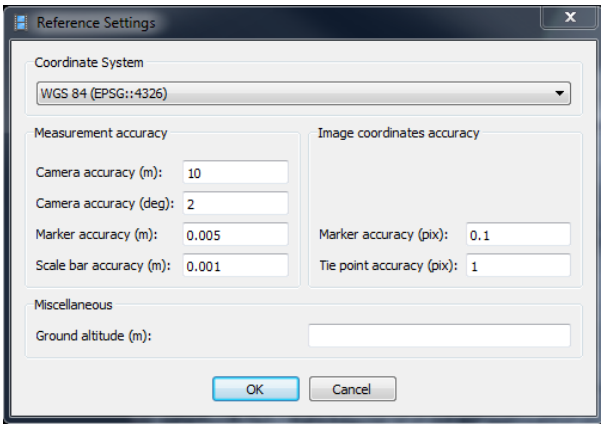
- Will not be covered due to time constraint

## Optimizing the Photo Alignment

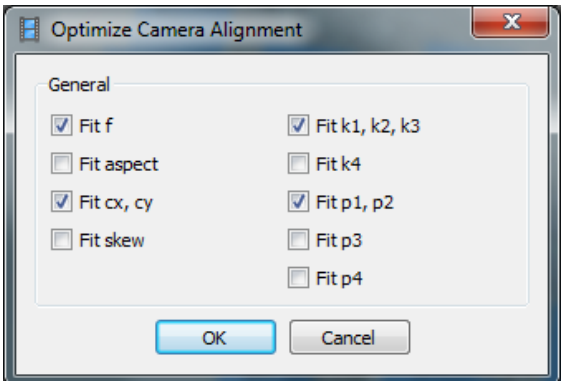
Procedure Description: Optimizing allows for a higher accuracy in the camera parameters and corrects distortions caused by the camera lens – often seen in a bowl shaped point cloud. This function is performing a photogrammetric bundle adjustment.

## Optimizing the Photo Alignment

On the 'Reference' panel … Select the 'Settings' icon … (use settings below if it does not default to these values).

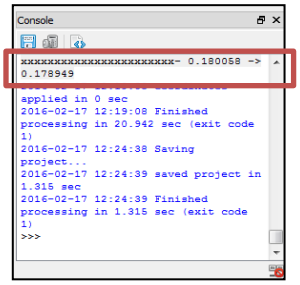


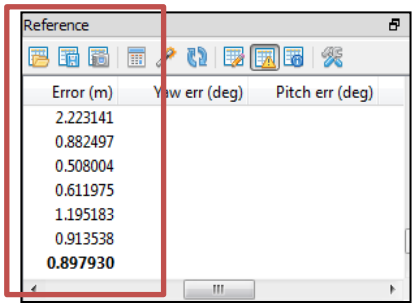

- Select the Optimize Cameras either from the 'Tools' tab on the 'Main Menu' or from the icon on the 'Reference' panel Use the default values or check parameters as shown below…OK

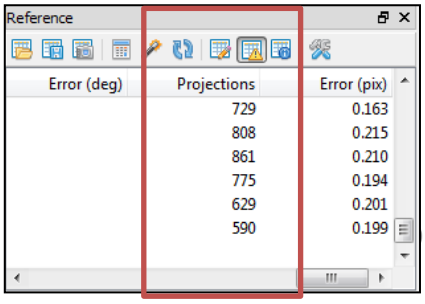



| | |
|---|---|
| f | – camera focal length (x,y) |
| cx, cy | – center of lens or principal point |
| Other values | – radial distortion coefficients |

- After Optimizing, check the 'Console' window and look for the RMSE. Ideally it should be between .13 --> .17. It is also good to watch the Projection and Error columns in the Reference Panel. The limit is to not go less than 200 on Projections and less than 1 meter on the overall error.



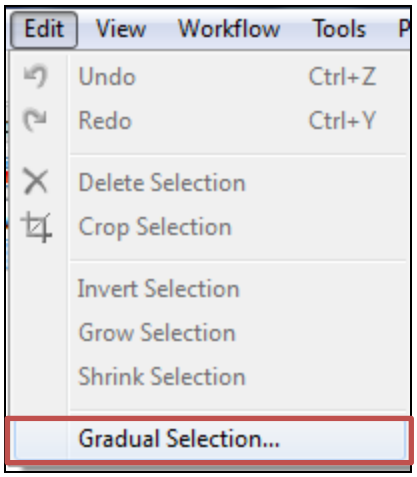



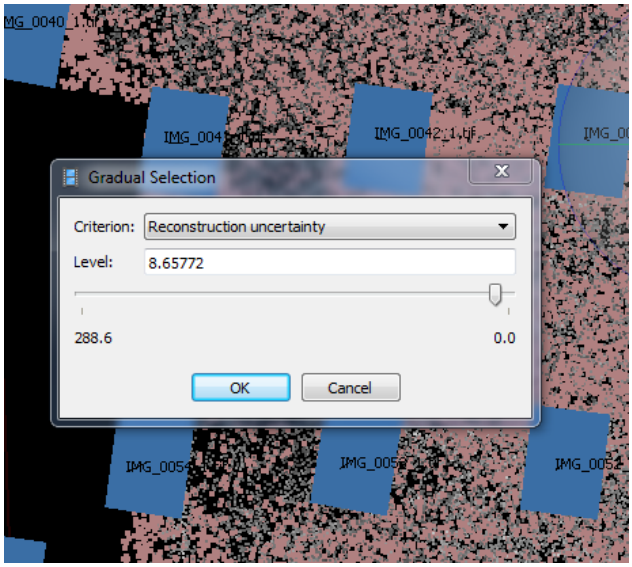
## 4.) Gradual Selection

Procedure Description: The Gradual Selection procedure will be used several times in order to improve the geometry of the overall model.

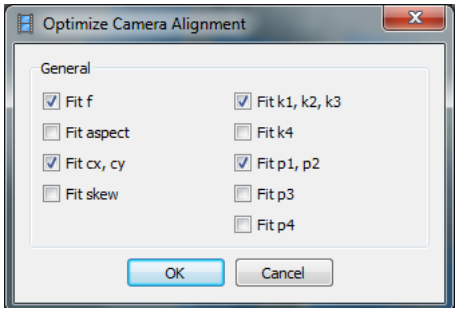
**Reconstruction Uncertainty**

- Select 'Edit' from the main menu…Gradual Selection…Reconstruction uncertainty (from the pulldown menu)… the goal is to reach a Level = 10 although if too many points are selected this may not be possible (below 50 is highly recommended)…OK.



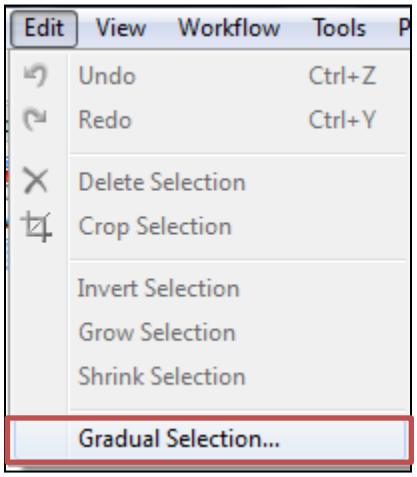

- Selected points will show up as pink. To delete those points, select the ✕ from the main menu. After deleting points, another optimization is needed . Select the optimize icon from the Reference panel Use the same setting as before.

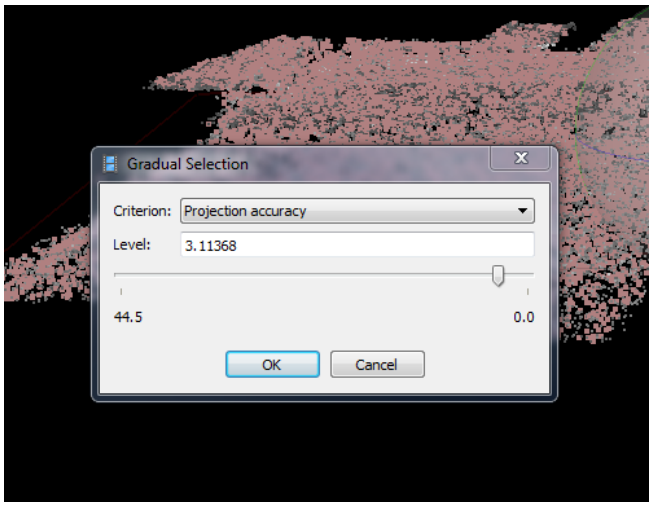



- The Reconstruction uncertainty procedure should be run 2 times.

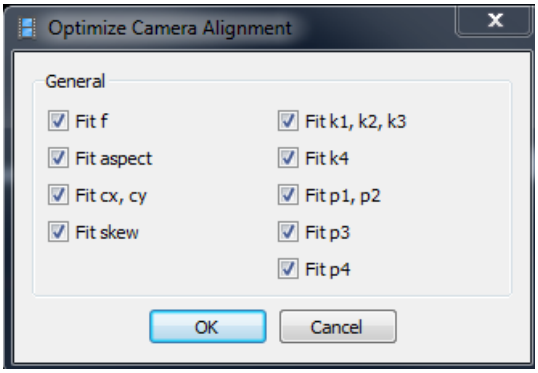
**Projection Accuracy**

- Select 'Edit' from the main menu…Gradual Selection…Projection accuracy (from the pulldown menu)… goal is to reach a Level = 2-3… OK.



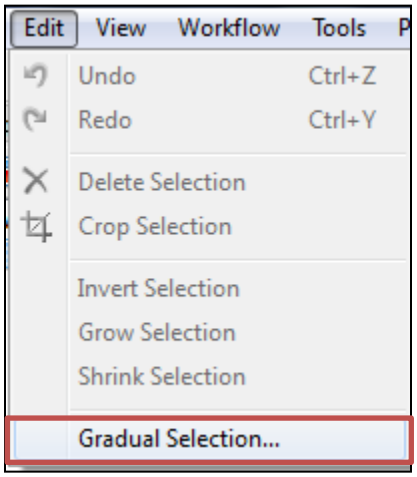

- Selected points will show up as pink. To delete those points, select the ✕ from the main menu. After deleting points, another optimization is needed . Select the optimize icon from the Reference panel

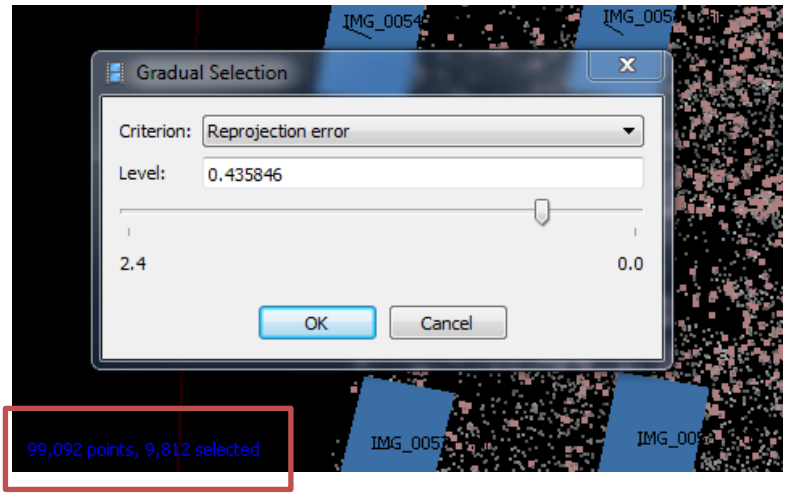



- The Project Accuracy procedure should be run 2 times.

**Reprojection Error**

- Select 'Edit' from the main menu…Gradual Selection…Reprojection Error (from the pulldown menu)… goal is to reach a Level = 10% of the points. Note: in the lower left-hand corner, try to get close to 10% of the point selected (i.e.. 9,812 out of 99,092 selected to be deleted)…OK.

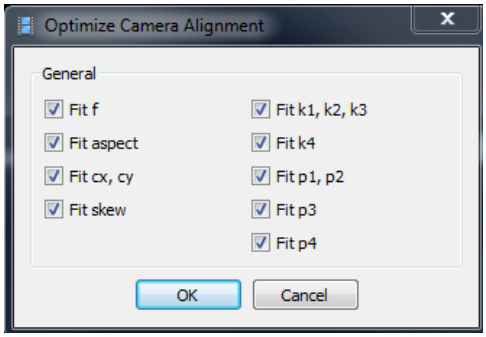


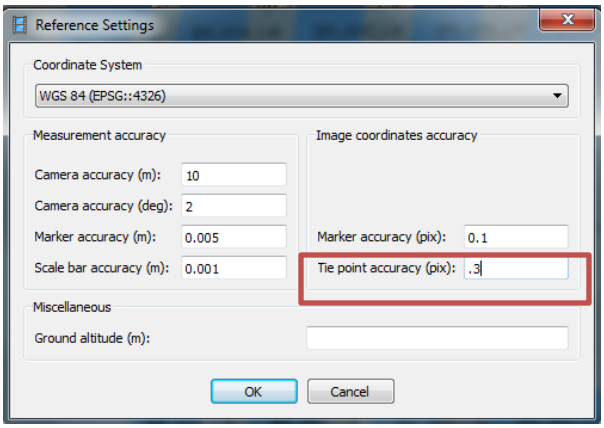




- Selected points will show up as pink. To delete those points, select the from the main menu. After deleting points, another optimization is needed but, before doing so, the tie point accuracy can now also be tightened.

- Select the icon from the Reference Panel, and enter the desired tie point accuracy value. Use .1 if the images are very clear, .3 – 1.0 if they are not as crisp.

- Select the optimize icon from the Reference panel and check all the remaining distortion parameters…OK.



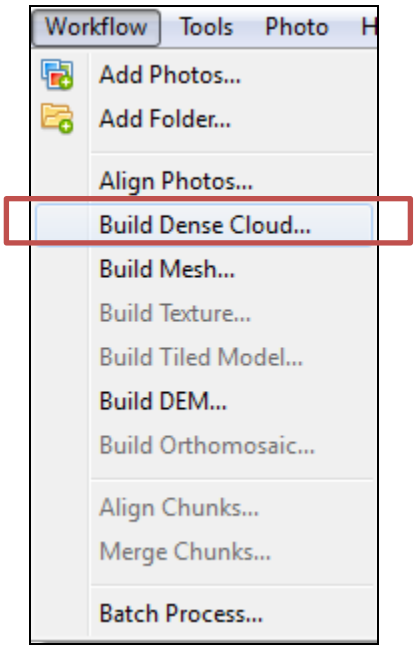



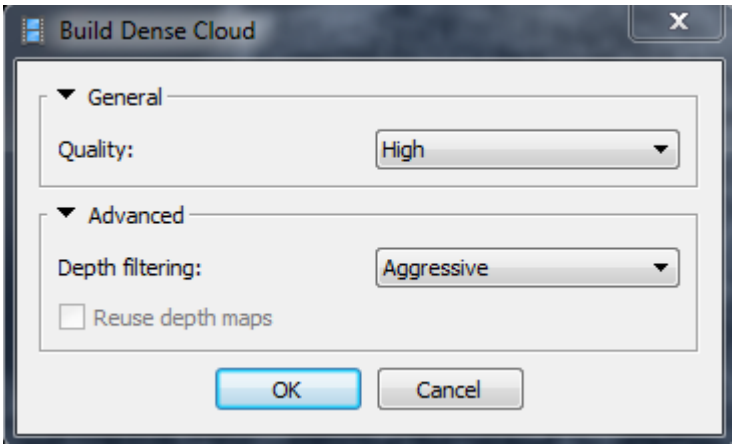

- The Reprojection Error procedure only needs to be run 1 time.

## 5.) Build the Dense Point Cloud

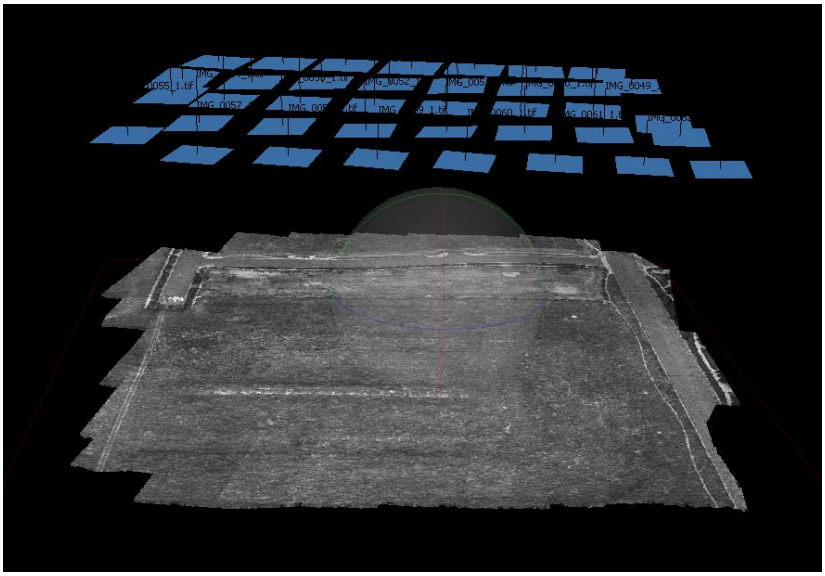
Procedure Description: A dense point cloud can be now be derived from the better estimated camera positions calculating several x,y,z points as well as assigning color values to accurately create the model.

- Workflow…Build Dense Cloud…(Note: Higher the quality the more intensive processing and time needed to derive. Depth filtering set to Aggressive is used for the most complex detail.)…OK



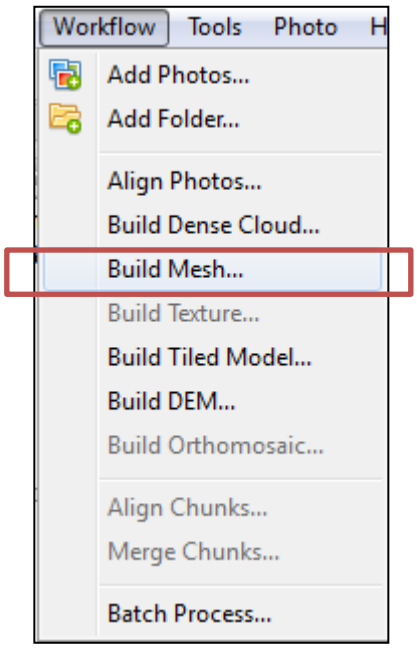

- Select the icon on the main menu if the dense point cloud does not display (usually defaults to a sparse point cloud display.

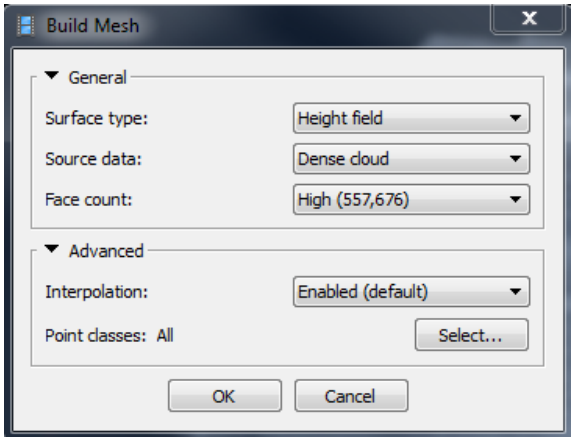


## 6.) Build Mesh

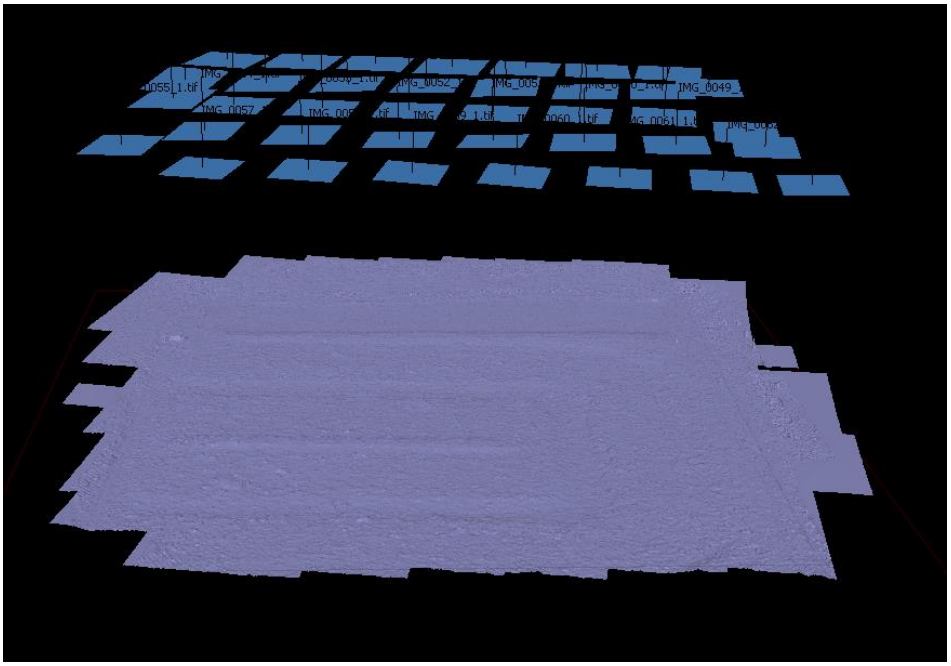
Procedure Description: From the dense point cloud, a polygon mesh model can be generated.

- Workflow…Build Mesh…OK
  (Note: Surface type = Height Field for vertical photography, Arbitrary is used for oblique models)



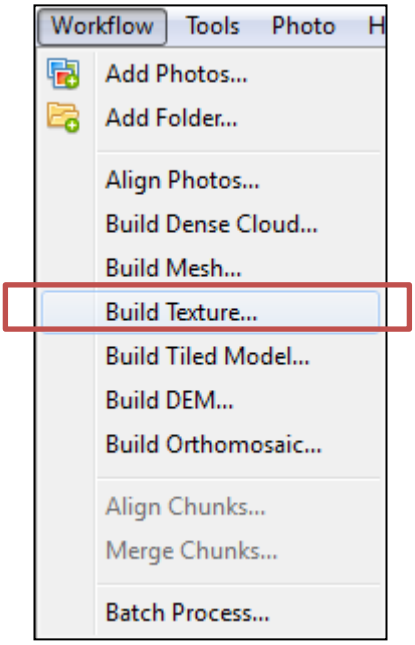

- Select the icon on the main menu to display the mesh (shaded, solid or wireframe).

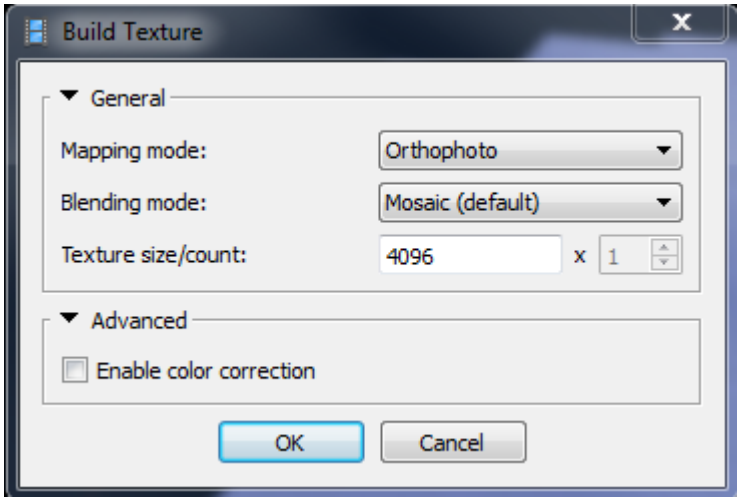


## 7.) Build Texture

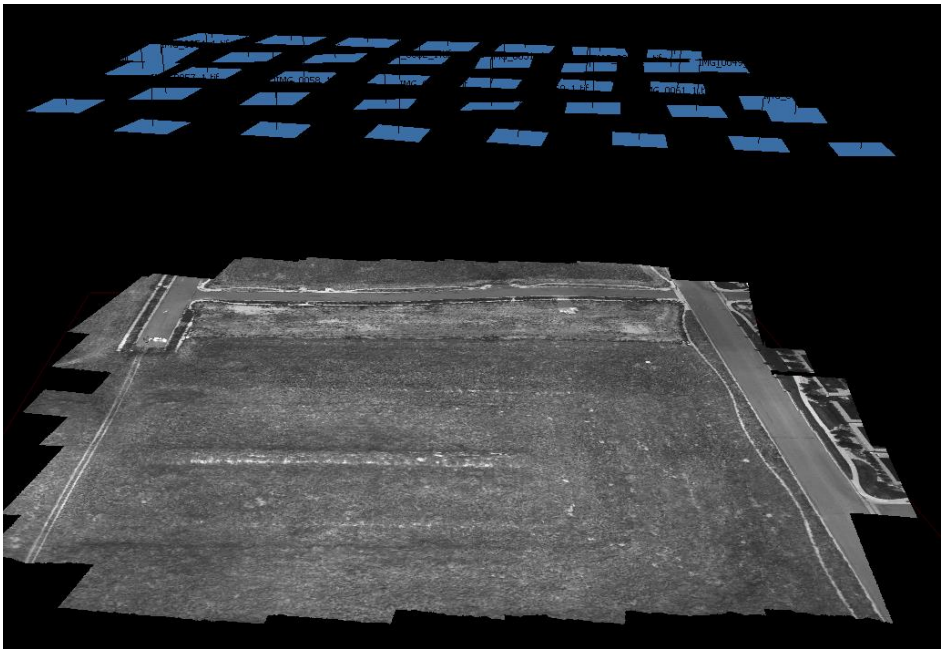
Procedure Description: Texture in the form of image overlay can be generated to be able to inspect the model before exporting the orthophoto mosaic.

- Workflow…Build Texture…OK
  (Note: If 'Enable color correction' is used, the time to generate the texture may be increased)



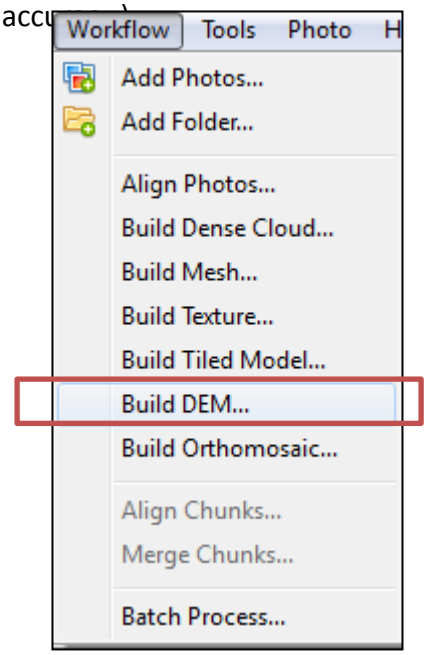

- Select the icon on the main menu to display the orthophoto (texture).

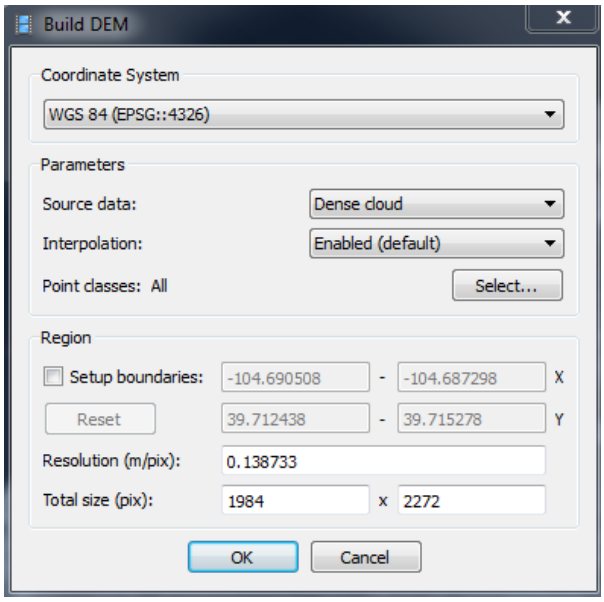


## 8.) Build DEM

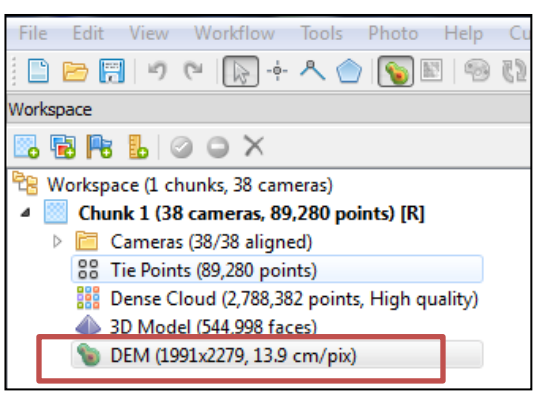
Procedure Description: A digital elevation model can be generated from the model into a desired coordinate system and projection.

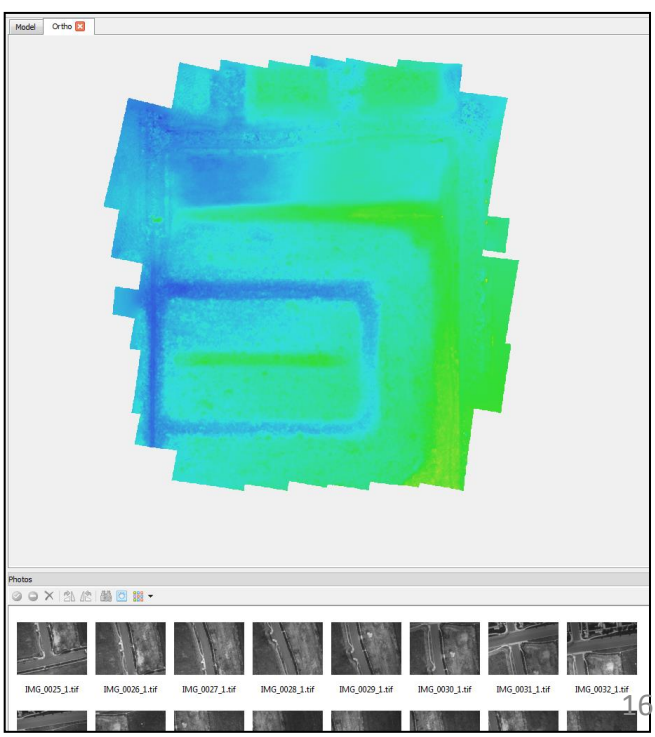
- PhotoScan will want you to save the project at this point. File…Save as…Filename.psx. Workflow…Build DEM…select the coordinate system of the output (defaults to the model setup)…OK. (Note: Source data can be either Dense Cloud or Mesh. Dense cloud is used for better accu




- After the DEM is generated it can be displayed in the Ortho Display by double clicking the layer in the Workspace Panel under the 'Chunk'.

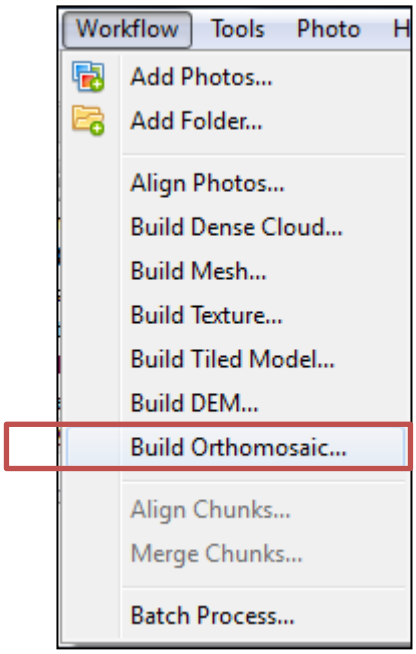


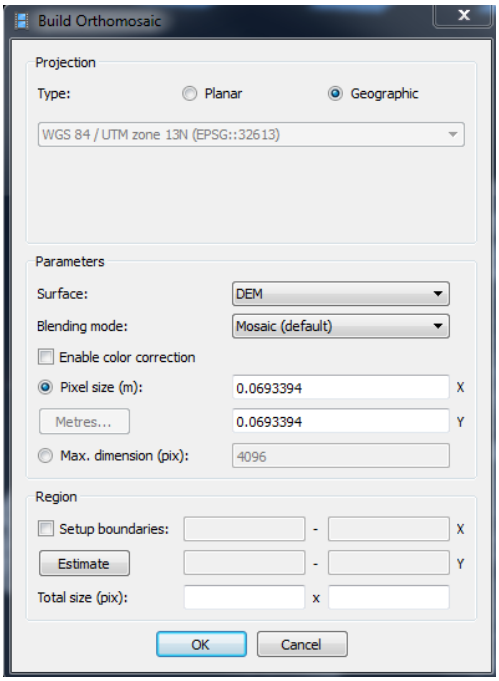



## 9.) Build Orthomosaic

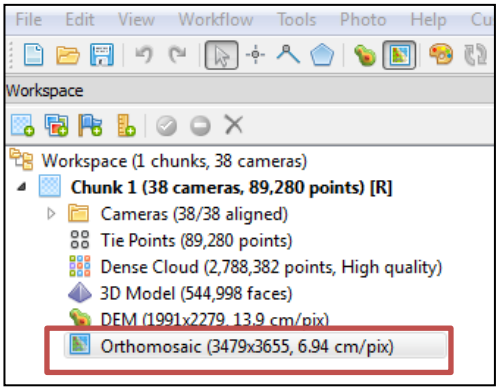
Procedure Description: A digital orthomosaic can be generated from the model into a desired coordinate system and projection.

- Workflow…Build Orthomosaic…OK
  (Note: Reprojection of the image can be done at this point or during the export of the orhtoimage.)



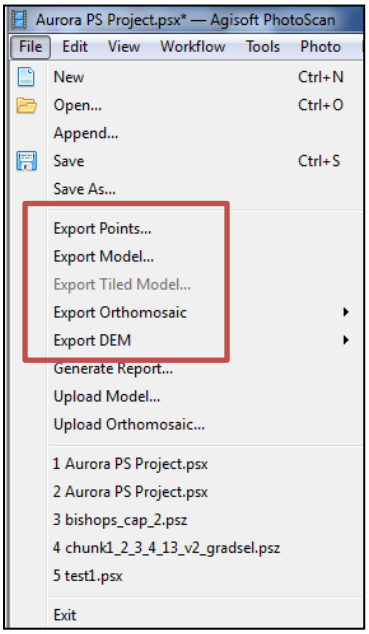

- After the Orthomosaic is generated it can be displayed in the Ortho Display by double clicking the layer in the Workspace Panel under the 'Chunk'.

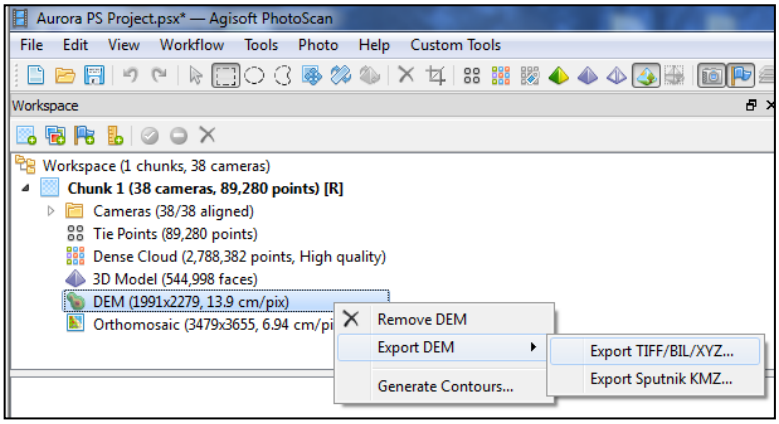


## 10.) Exporting Products

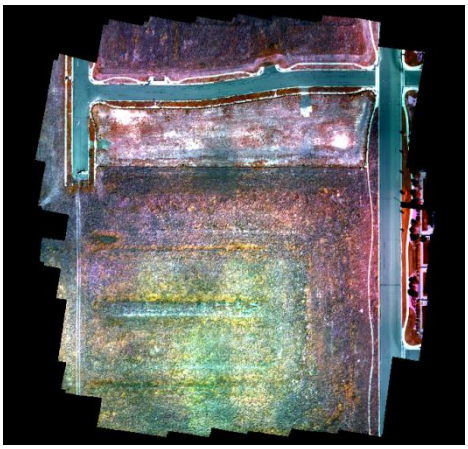
Procedure Description: The various products generated through the modeling process can all be exported into standard formats for use in display or GIS data layers.

- From the Main Menu Select File…Export (Points, Model, Orthomosaic or DEM). Another option is to export by right clicking on the layer under the 'Chunk' in the Workspace Panel.

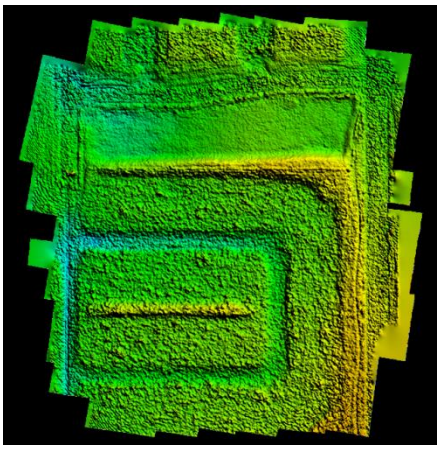


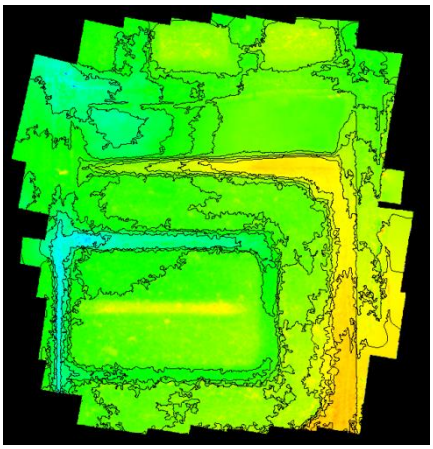

- Exported layers can then be used in standard GIS software (i.e.. Global Mapper below)



Orthophot mosaic (5-band)



Digital Elevation Model



DEM with Contours