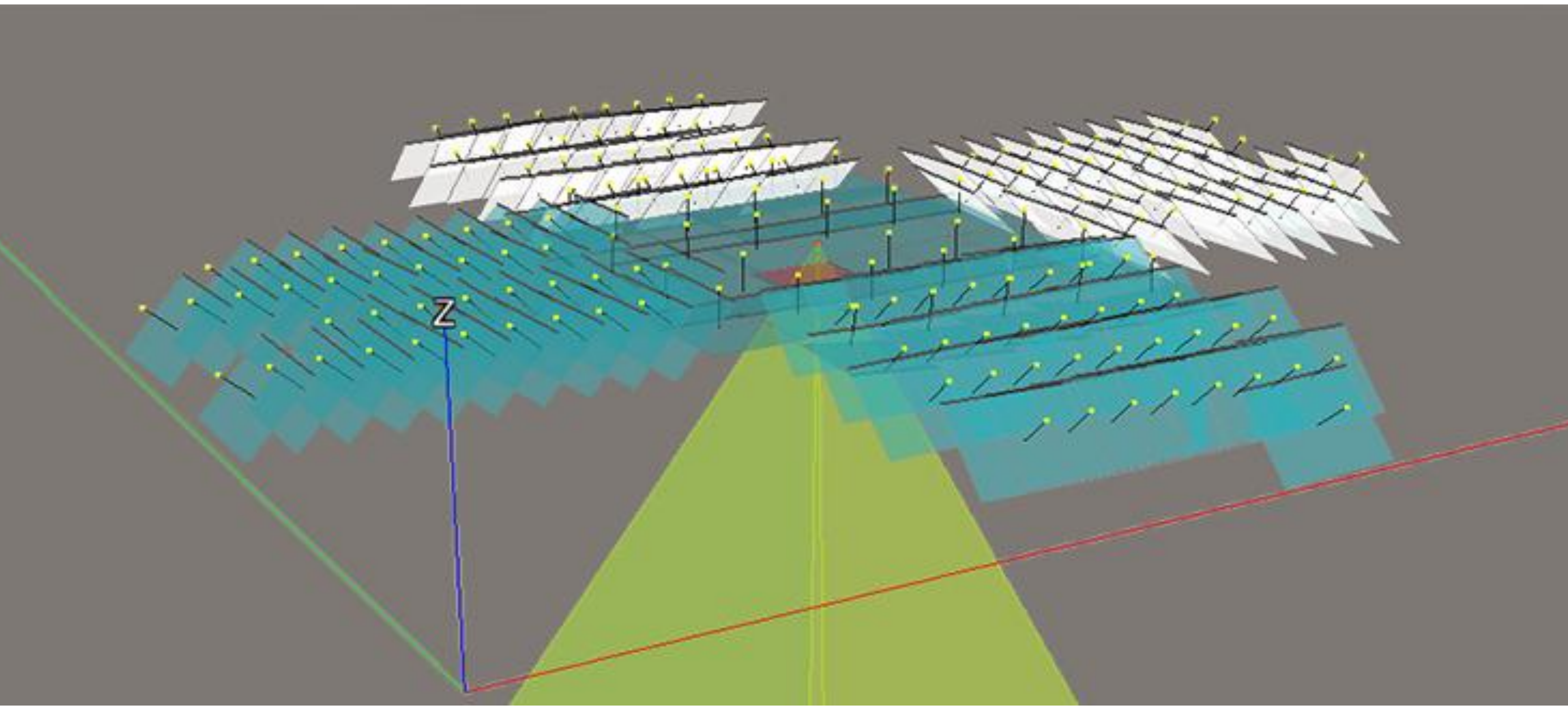
smart3Dcapture® | Tutorial | Importing orientation metadata



About this tutorial

Smart3DCapture allows you to import all needed information to create a block from an XML or an Excel file (.xls). This is useful in many situations, including the case of aerial projects containing a large amount of photos, when orientation and positioning values are known a priori, either coarse values or accurate values estimated by third party software.

While the concepts are generally known, it appears that many of them are ambiguous and depend on conventions. This tutorial will guide you in this convention jungle. It will teach you how to **import data from Excel and XML files,** how to **check the consistency and the accuracy of the imported data** and **how to correct** them if necessary.

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Introduction

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While the concepts are generally known, it appears that many of them are ambiguous and depend on conventions. This tutorial will guide you in this convention jungle. It will teach you how to **import data from Excel and XML files,** how to **check the consistency and the accuracy of the imported data** and **how to correct** them if necessary.

Section 1 and 2 define the format of the import files. Section 3 gives the recommended procedure to check conventions. Finally, section 4 proposes a run with a real sample, downloadable with this tutorial.

⚠ ***The impatient reader may proceed directly to section 4, collecting complementary information from previous sections if necessary.***

Note that, while importing an XML file is preferred in a production scenario, importing an Excel one is easier for quick evaluations.

acute3D capturing reality

Importing an XML file

Importing an XML file is thoroughly described in our User Manual. Please refer to the following files in Smart3DCapture doc folder: *Smart3DCaptureUserManual.pdf*, *BlocksExchangeFormat.xml* and *Smart3DCaptureCameraModel.pdf*.

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Importing an Excel file

⚠ *Since the concepts used to import XML and Excel files are similar, please read the documents mentioned in the previous section before proceeding.*

A sample Excel import document is available in the *doc* folder: *BlockImportSample.xls*. It is composed of several sheets:

Figure 1: Excel sheets

Each sheet contains several columns that are either mandatory or optional. Columns and sheets that are unfilled can be deleted.

⚠ *The case of the words defining the different sheets and fields is important.*

The Photogroups sheet

This sheet is used to define the different "photogroups" that will be used in the block. There should be one line per photogroup. Several mandatory fields are required to define a photogroup and some are optional.

Mandatory Fields

Name	Width	Height	Focal Length	SensorSize	PixelSize
unique	In pixels	In pixels	In mm	In mm	In mm
				Either one	or the other

- The **name** of each Photogroup should be unique.
- Photo dimensions **width** and **height** are given in pixels.
- The **focal length** is given in millimeters.
- You can choose to fill either the **sensor size** (mm) or the **pixel size** (mm).

Optional Fields

PrincipalPointX	PrincipalPointY	PrincipalPointXmm	PrincipalPointYmm	CameraOrientation
In pixels	In pixels	In mm	In mm	String
Either in pixels		or in mm		

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- The **principal point** can either be given in pixels (column, line) or in millimeters (along the X and Y axis defined by the camera orientation).
- The **camera orientation** defines the XY-axis of the camera sensor for pose rotation and any position eventually given in millimeters (principal point, measurements, etc.).

  The possible values are: XRightYDown (default), XRightYUp, XLeftYDown, XLeftYUp, XDownYRight, XDownYLeft, XUpYRight, XUpYLeft (see documentation, in particular *Smart3DCaptureCameraModel.pdf*).

K1	K2	K3	P1	P2
Real	Real	Real	Real	Real

- **K1, K2, K3, P1** and **P2** are the distortion coefficients (see documentation, in particular *Smart3DCaptureCameraModel.pdf*).

The Photos sheet

This sheet is used to list all the photos of the block. There can be only one line per photograph. This sheet gives the location of the photos on your disk (mandatory) and also pose and orientation data (optional).

Mandatory Fields

FileName	PhotogroupName
String	String

- The **file name** can be given either with or without the file extension.
- The **photogroup name** should match one of the photogroups defined in the previous sheet.

Optional Fields

Directory	Extension
String	String

- A **directory** containing the photos can be given here. Note that, in the *Options* sheet, a base path can also be given (see below). Filling directory here is useful when photos are split into several sub-folders.

- If not already given through the **file name**, a file **extension** can be added here.

Longitude	Latitude	Height	Easting	Northing	Height
Real	Real	Real	Real	Real	Real
Either LLH			or ENH		

- If known, the position can be defined either in **latitude**, **longitude** and **height** or in **easting**, **northing** and **height,** according to the SRS given in the *Options* sheet (see below).

Omega	Phi	Kappa	Heading	Pitch	Roll	Rot00	...	Rot22
Real	Real	Real	Real	Real	Real	Real	...	Real
			Either OPK	HPR	or Rotation			

- If known, the angular orientation can either be informed by **omega**, **phi** and **kappa** angles, by **heading**, **pitch** and **roll** angles, or by the coefficients of the **rotation** matrix (see documentation, in particular *Smart3DCaptureCameraModel.pdf*)

The ControlPoints sheet

This optional sheet is used to define control points.

Optional Fields

Name	Longitude	Latitude	Height	Easting	Northing	Height
String	Real	Real	Real	Real	Real	Real
	Either LLH			or ENH		

Coordinates are given the same way than positions.

The Options sheet

The options sheet allows you to choose the SRS, angle units (degree or radian), a base photo path and a block type.

OptionName	Value
SRS	Default=WGS84
InRadians	Default=false
BasePhotoPath	Default=none
BlockType	Default=Aerial

- **SRS**: the default SRS is WGS84. To choose an SRS, you have to inform the EPSG code as following: "EPSG:XXXX"

⚠ Boolean values should be given in the language of your Excel software (English: true/false, French: vrai/faux, German: wahr/falsch, etc.).

- **InRadians**: by default, angles are given in degrees. If *true*, angles will be considered in radian.
- **BasePhotoPath**: add a base photo directory before photo paths.

⚠ Finally, photos locations are obtained by concatenating the following fields: *BasePhotoPath+Directory+FileName+Extension*

- **BlockType**: allows you to choose the type of block you are importing. So far, possible options are "Aerial" and "None" (see documentation)

Dealing with orientations

Importing navigation data requires several verifications. Due to the large choice of conventions, it is highly recommended to check the consistency of the imported data on a small sample before performing aero-triangulation.

Here are the recommended steps to control and correct your import if necessary. In the following, we assume that both angles and position are known for each photo.

Step 1: Checking the SRS

After importing, check the consistency of the positions by exporting the block in a KML file. Open the KML file in your favorite GIS software (e.g., Google Earth) and check if the photos are correctly located on the globe. If not, the SRS definition is probably wrong (either wrong choice of SRS or wrong definition in the import file).

Step 2: Checking viewing directions and photo orientations

After importing your block, open the *3D view* tab. When selecting a photo, a cone shows its viewing direction and a gray line its top row.

⚠ You can set the size of cameras using Camera size

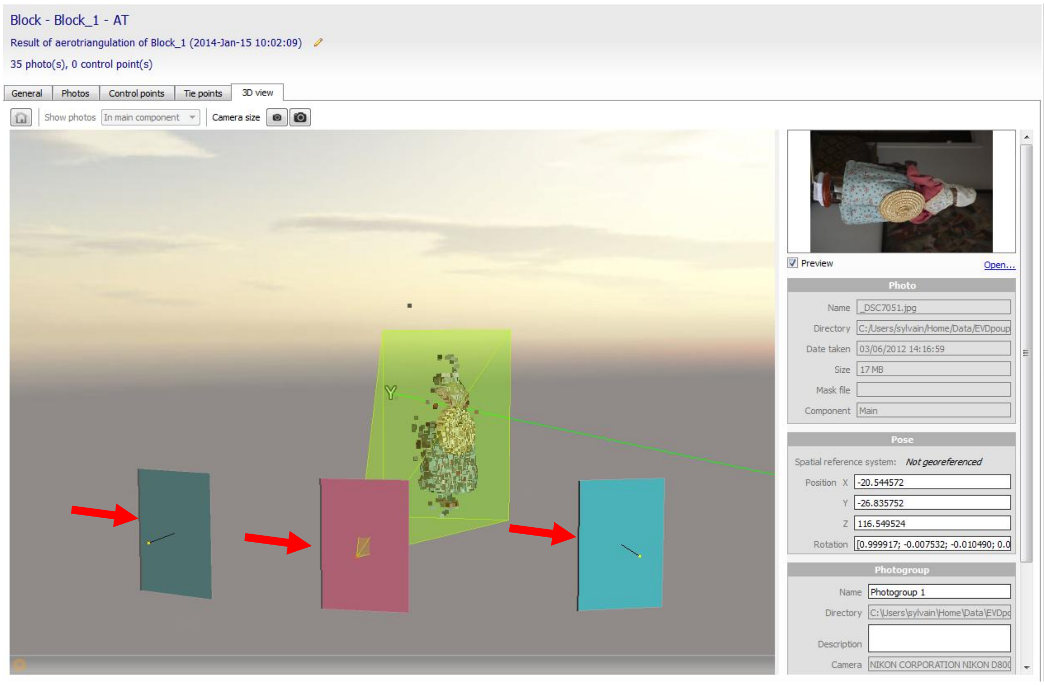


Figure 2: a gray line shows the top of the photo (see thumbnail)

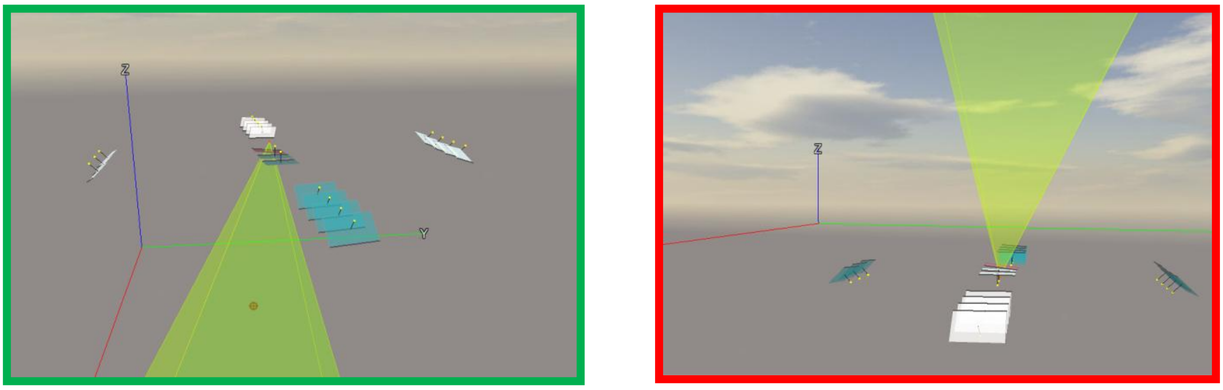
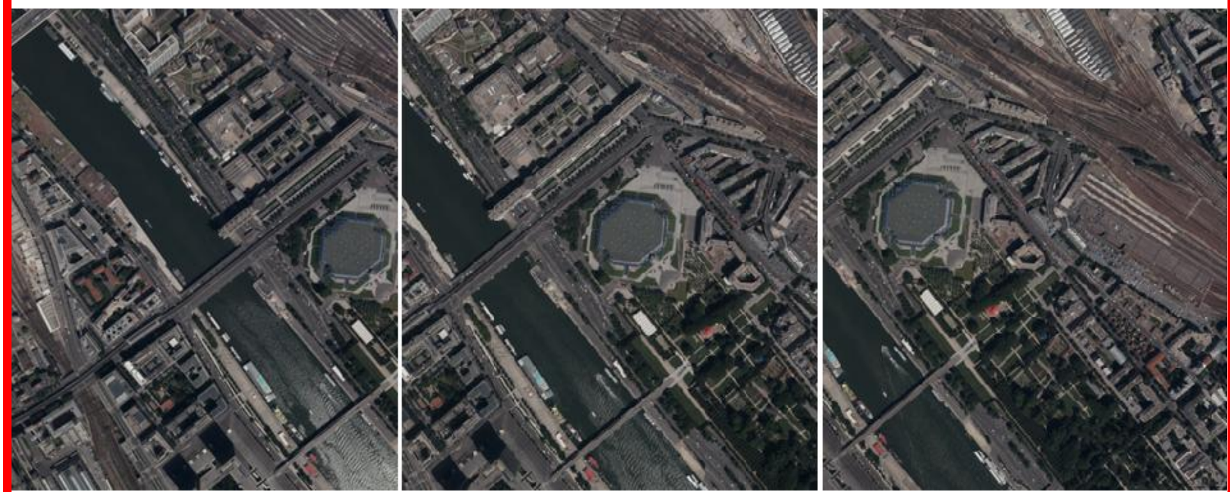


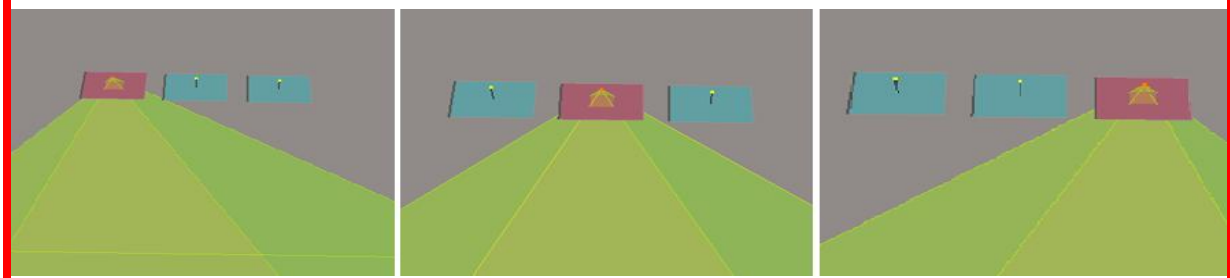
Figure 3: a cone shows the viewing direction

First, check that the projection cone seems consistent. If it is upside down or not looking at the scene, try changing the camera orientation value (XRightYDown, XRightYUp, XLeftYDown, XLeftYUp, XDownYRight, XDownYLeft, XUpYRight, XUpYLeft). This should eliminate 4 values among 8. If none of those choices seems good, the definition of the angles might be incorrect: proceed to step 4 and come back.

Among the 4 left choices, use several photos and the grey line hint to the find the correct one.

XUpYRight

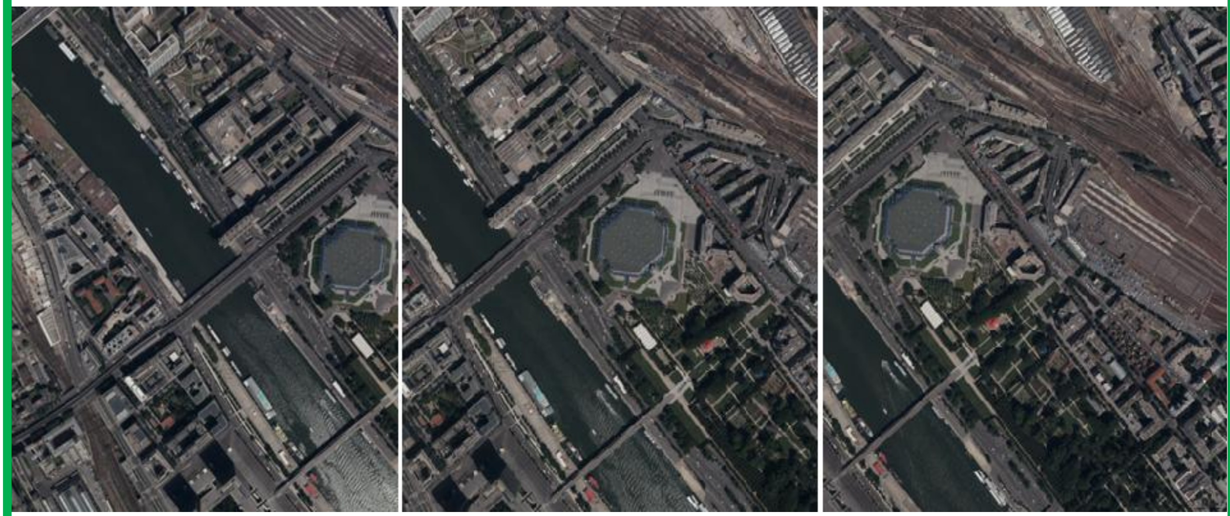


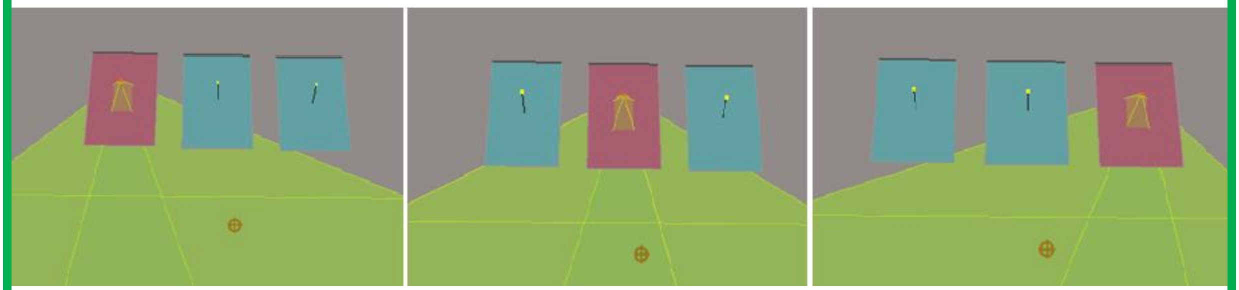


Incorrect choice: the hexagonal building is moving from the right to the left of the photos,

but should be moving from the top to the bottom according to the camera orientation.

XRightYDown





Correct choice: the hexagonal building is moving from the right to the left of the photos. This is consistent with camera orientation on the 3D view.

Again, if no choice seems good, the definition of the angles might be incorrect: proceed to step 4 and come back.

Step 3: Using a ground control point

Even a coarse control point obtained from a third-party map provider (e.g., Google Earth) is useful to check orientations. In Smart3DCapture Master, open the control points tab and add a new control point in the control point editor (Figure 4). Note that Google Earth gives MSL Height so that the following SRS should be used: WGS84 + vertical datum EGM96. See Smart3DCapture user manual to learn how to change the vertical coordinate system.

Open the photo measurements' window by clicking on the "add measurements" plus sign.

Click on the thumbnails on the left and check if the control point is inside the green circle for each photo selected (Figure 5).

Depending on the precision of the orientation, coarse or refined, the control point will be projected more or less precisely in the photo.

If the control point is not projected at the right place in the photo, the orientation is wrong or not accurate enough. Proceed to next step.

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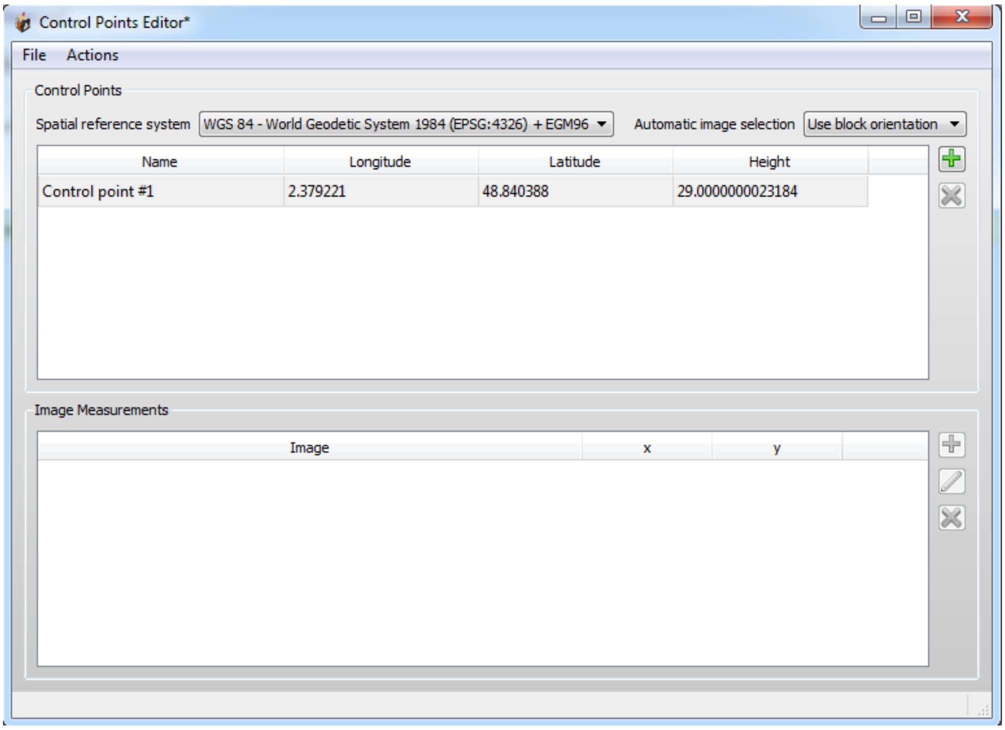

Figure 4 : control point editor

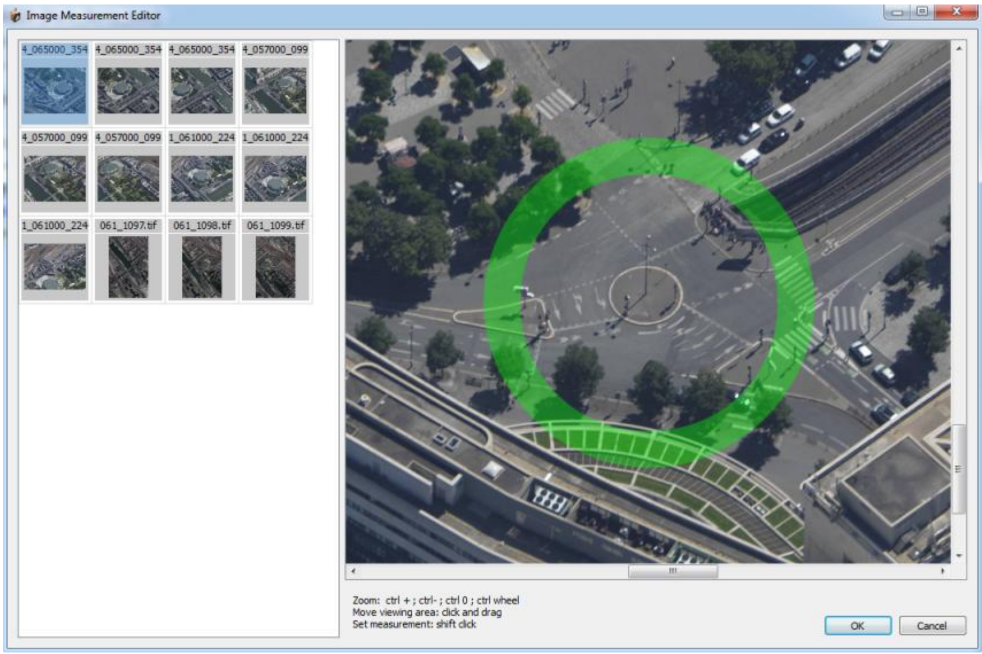

Figure 5: estimated projection of the control point into photos

Step 4: Correcting the orientations

If the orientations seem incorrect, they might not be accurate enough. However, it is more likely that the definitions and conventions used in your metadata are not consistent with the one you used in your import file. Please, check the rotation or angle definitions in *Smart3DCaptureCameraModel.pdf*. Frequent problems are:

- A sign problem: use the right one.
- Mismatching degree and radian: use the right option.
- The elementary rotations are not composed in the right order when using Heading/Roll/Pitch (HPR) or Omega/Phi/Kappa (OPK): since HPR and OPK have opposite orders, using one instead of the other and changing some signs should solve the problem.
- The rotation is not going from world to camera but the other way: change signs, composition order, or transpose the matrix when given by its coefficients.

After correcting the orientation, you should probably check everything again from step 2.

Use case: Paris sample

Please download the appropriate files on our website: Importing_orientation_metadata_exercise.zip. Through this small extract of Paris, we will see the different issues one can be faced to when importing a block.

⚠ **Before trying to import the XLS file, change the base photo path in the *Options* sheet of the XLS document according to the location of the photos on your computer.**

Step 1: importing the file

In Smart3DCapture Master, create a project, then click on Import Block and select the file *Paris_block_import_with_errors.xls*.

Step 2: first check

To get a first feedback, click on the *3D view* tab.

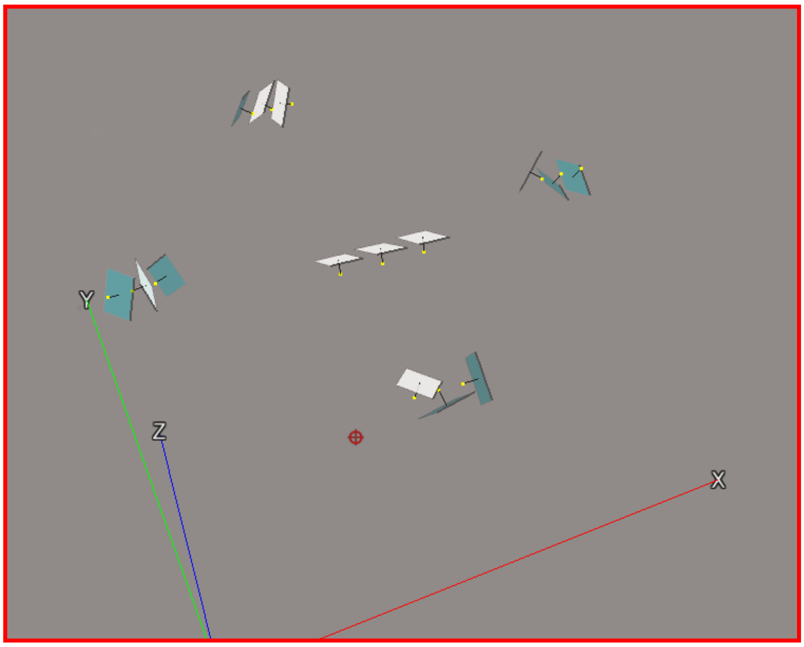

Figure 6: random photo orientation

Figure 6 shows that there is no consistency between photos of a same flight line. This is typical of an error in angle units. In our use case, the angles are given in degrees. The value of *InRadians* should then be *false*. Check the Excel file and correct the option. Note again that Excel might expect a Boolean value to be entered in your own language.

OptionName	Value
SRS	EPSG:2154
InRadians	**TRUE**
BasePhotoPath	C:\#########\#########\Paris_sample_tuto

OptionName	Value
SRS	EPSG:2154
InRadians	**FALSE**
BasePhotoPath	C:\#########\#########\Paris_sample_tuto

Import the file again. Now, the orientation seems regular (Figure 7)

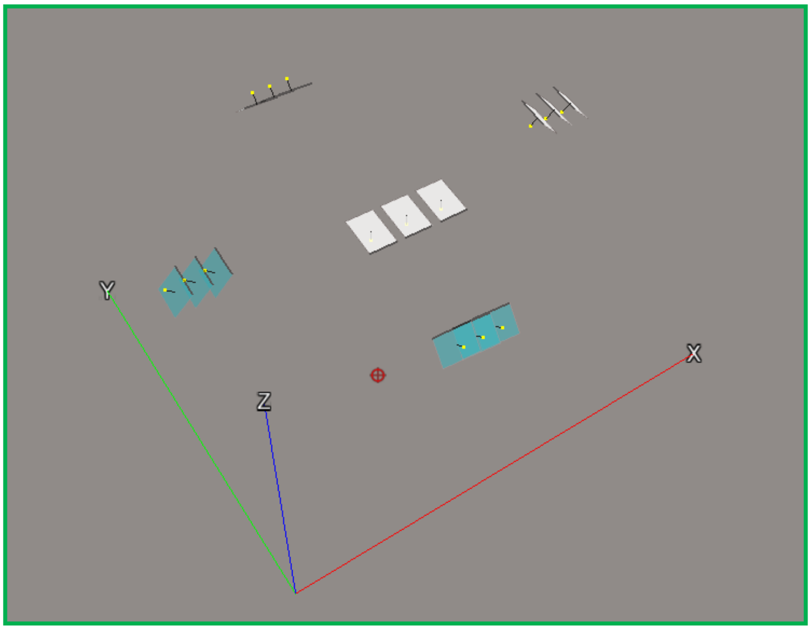

Figure 7: better orientation

Step 3: checking the SRS

Export your block in KML format (*Block → Export → Export to KML*) and open the generated file in Google Earth.

Figure 8: incorrect geo-referencing on Earth

The photos are georeferenced over the Arctic Ocean (Figure 8) instead of being projected over Paris. The right SRS for this block is EPSG:2154 (RGF93/Lambert93). Correct it.

OptionName	Value
SRS	**EPSG:2192**
InRadians	FALSE
BasePhotoPath	C:\#########\#########\Paris_sample_tuto

→

OptionName	Value
SRS	**EPSG:2154**
InRadians	FALSE
BasePhotoPath	C:\#########\#########\Paris_sample_tuto

Import the block again and check the projection in Google Earth.

Figure 9: correct geo-referencing

The photos are now correctly geo-referenced over Paris (Figure 9).

Step 4: checking viewing directions and camera orientations

Using the 3D view, it appears that photos from the photogroups "UCX" and "120724_Bleue_0001" are not looking at the correct direction (Figure 10).

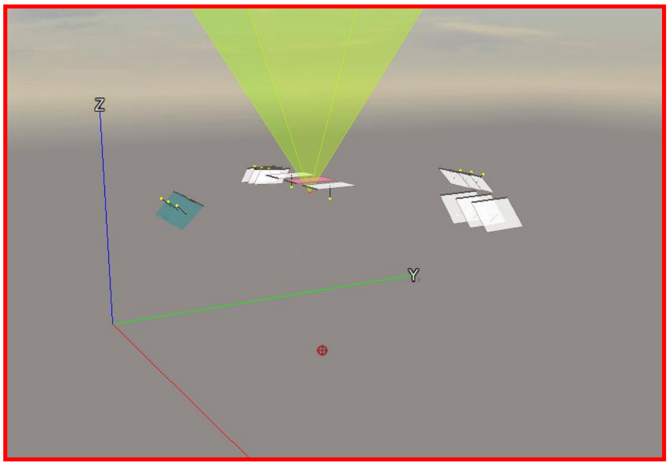

Figure 10: incorrect viewing directions

In the Excel file, change camera orientations until you find a good one. Remember that the 8 possible options are *XRightYDown* (default), *XRightYUp, XLeftYDown, XLeftYUp, XDownYRight, XDownYLeft, XUpYRight,* and*XUpYLeft.* Four of these options will result in the projection cone looking at the right direction. Find the good one using successive photos and the grey line indicating their top row (see section 3.b for details). Here is the correct choice and the resulting 3D view (Figure 11).

Name	Width	Height	FocalLength	SensorSize	CameraOrientation
120724_Bleue_0001	8176	6132	150.0576234	49.056	XLeftYDown
120724_jaune_0002	8176	6132	149.716018	49.056	XRightYDown
120724_Verte_0003	8176	6132	150.0851242	49.056	XRightYDown
UCX	9420	14430	100.4146502	103.896	XRightYUp

→

Name	Width	Height	FocalLength	SensorSize	CameraOrientation
120724_Bleue_0001	8176	6132	150.0576234	49.056	XRightYDown
120724_jaune_0002	8176	6132	149.716018	49.056	XRightYDown
120724_Verte_0003	8176	6132	150.0851242	49.056	XRightYDown
UCX	9420	14430	100.4146502	103.896	XRightYDown

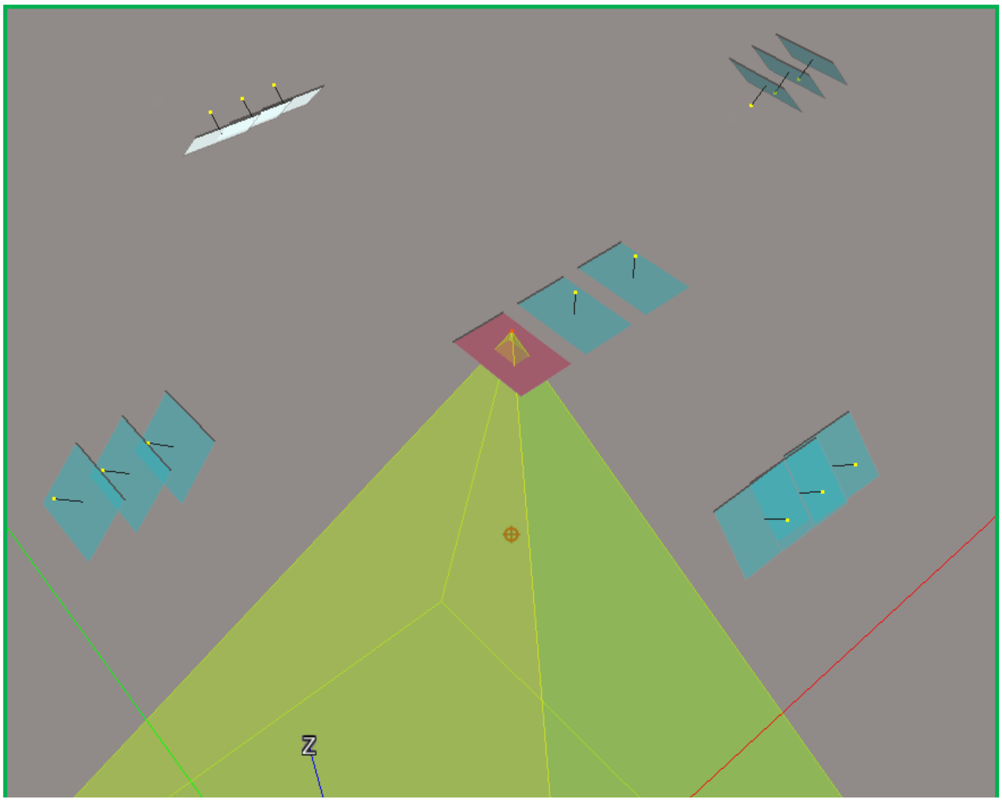

Figure 11: corrected camera orientations

Step 5: using a control point

Any coarse control point is useful to check orientations (see section 3.c.). Here, the Excel file already contains a control point set on the top of a building easily to find on the photos (Figure 12).

Figure 12: a ground control point

Open the control points tab and click on *Edit control points* (Figure 13).

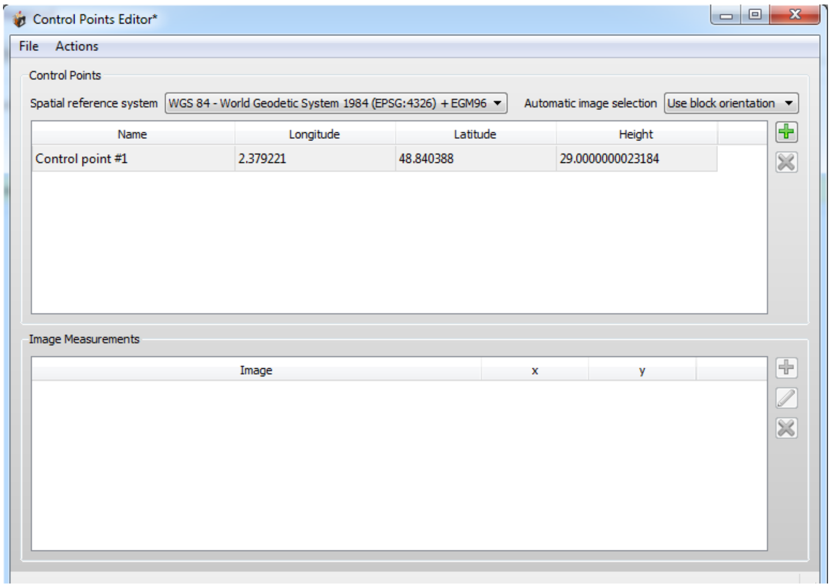

Figure 13: control points editor

Note that *Use block orientation* is selected, so that only the photos viewing the control point will be accessible when adding 2D measurements. Select the existing control point and click on *Add measurements*.

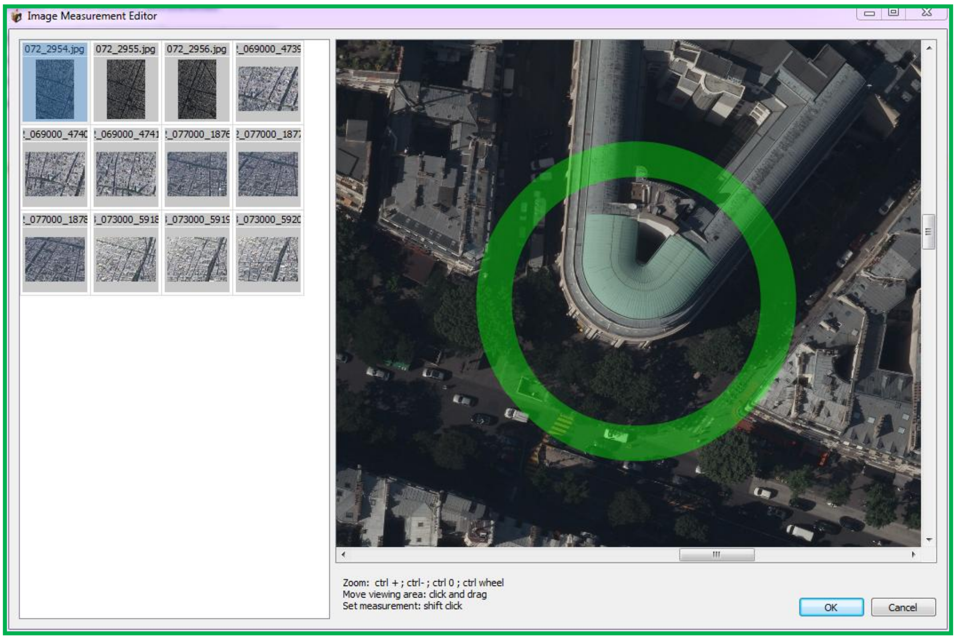

Figure 14: the predicted position of the control point

Click on the different thumbnails to see the predicted position of the control point in all selectable photos (Figure 14).The control point seems correctly positioned in all photos except for the ones from photogroup*120724_jaune_0002* (Figure 15 and 16).The orientations seemed correct in the 3D view so this might be a slight problem in the angles. After several tries, it appears that Phi angle is of the wrong sign for this photogroup.

Name	Extension	Directory	PhotogroupName	Easting	Northing	Height	Omega	Phi	Kappa
0002_069000_4739	jpg	120724_jaune_0002	120724_jaune_0002	652569.658	6862442.639	1313.6163	-135.34488	1.5776786	2.37382449
0002_069000_4740	jpg	120724_jaune_0002	120724_jaune_0002	652434.242	6862440.744	1317.3595	-136.03553	0.1595121	2.871351
0002_069000_4741	jpg	120724_jaune_0002	120724_jaune_0002	652298.259	6862438.929	1321.1916	-132.29513	0.4386679	0.96742971
0002_077000_1876	jpg	120724_jaune_0002	120724_jaune_0002	652217.811	6864953.63	1314.9964	134.064158	-2.26670986	179.950124
0002_077000_1877	jpg	120724_jaune_0002	120724_jaune_0002	652349.822	6864954.74	1315.8827	134.673592	-2.32098416	179.721256
0002_077000_1878	jpg	120724_jaune_0002	120724_jaune_0002	652483.354	6864955.99	1315.8852	135.149468	-1.93018145	179.439557

→ change the sign of Phi angle for the photos belonging to photogroup "120724_jaune_0002" only.

Name	Extension	Directory	PhotogroupName	Easting	Northing	Height	Omega	Phi	Kappa
0002_069000_4739	jpg	120724_jaune_0002	120724_jaune_0002	652569.658	6862442.639	1313.6163	-135.34488	-1.5776786	2.37382449
0002_069000_4740	jpg	120724_jaune_0002	120724_jaune_0002	652434.242	6862440.744	1317.3595	-136.03553	-0.1595121	2.871351
0002_069000_4741	jpg	120724_jaune_0002	120724_jaune_0002	652298.259	6862438.929	1321.1916	-132.29513	-0.4386679	0.96742971
0002_077000_1876	jpg	120724_jaune_0002	120724_jaune_0002	652217.811	6864953.63	1314.9964	134.064158	2.26670986	179.950124
0002_077000_1877	jpg	120724_jaune_0002	120724_jaune_0002	652349.822	6864954.74	1315.8827	134.673592	2.32098416	179.721256
0002_077000_1878	jpg	120724_jaune_0002	120724_jaune_0002	652483.354	6864955.99	1315.8852	135.149468	1.93018145	179.439557

Figure 15: incorrect GCP_1 projection

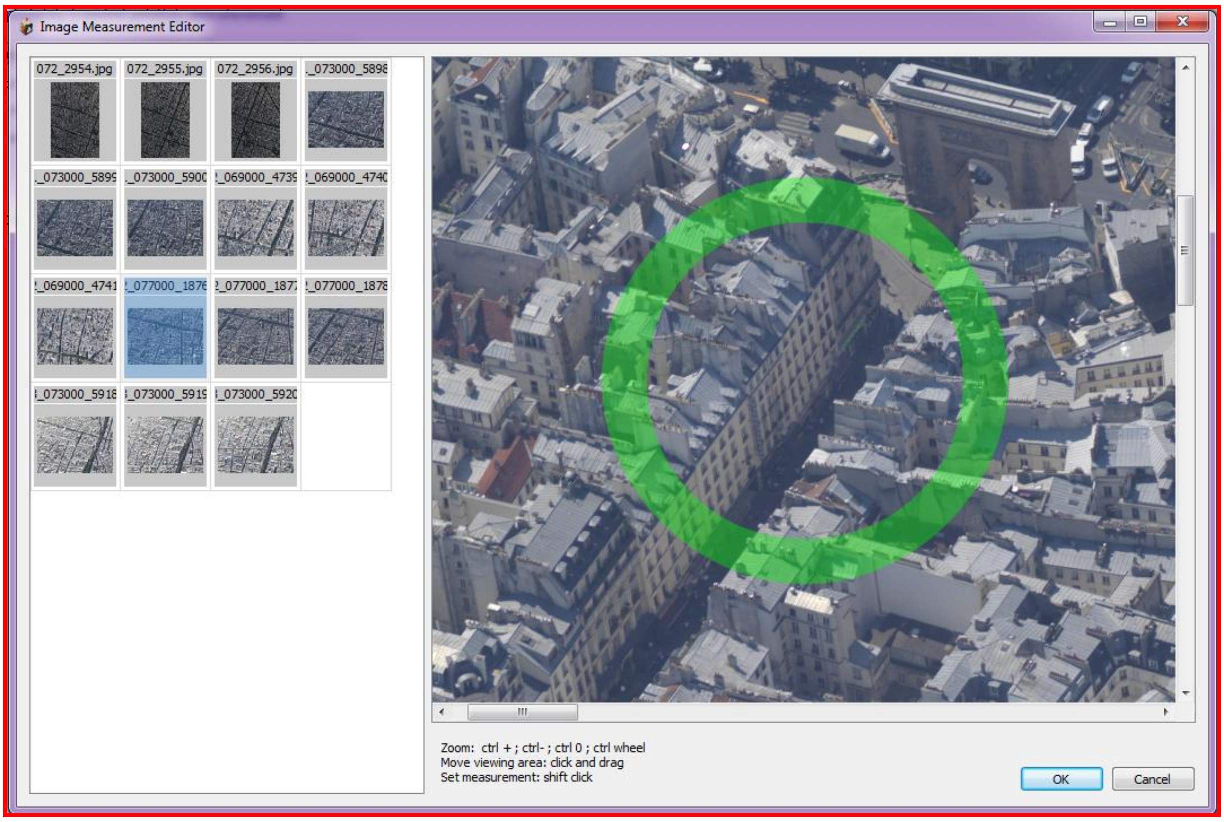

Figure 16: incorrect GCP_1 projection

Import the block again. The control point is now correctly positioned in every photo.

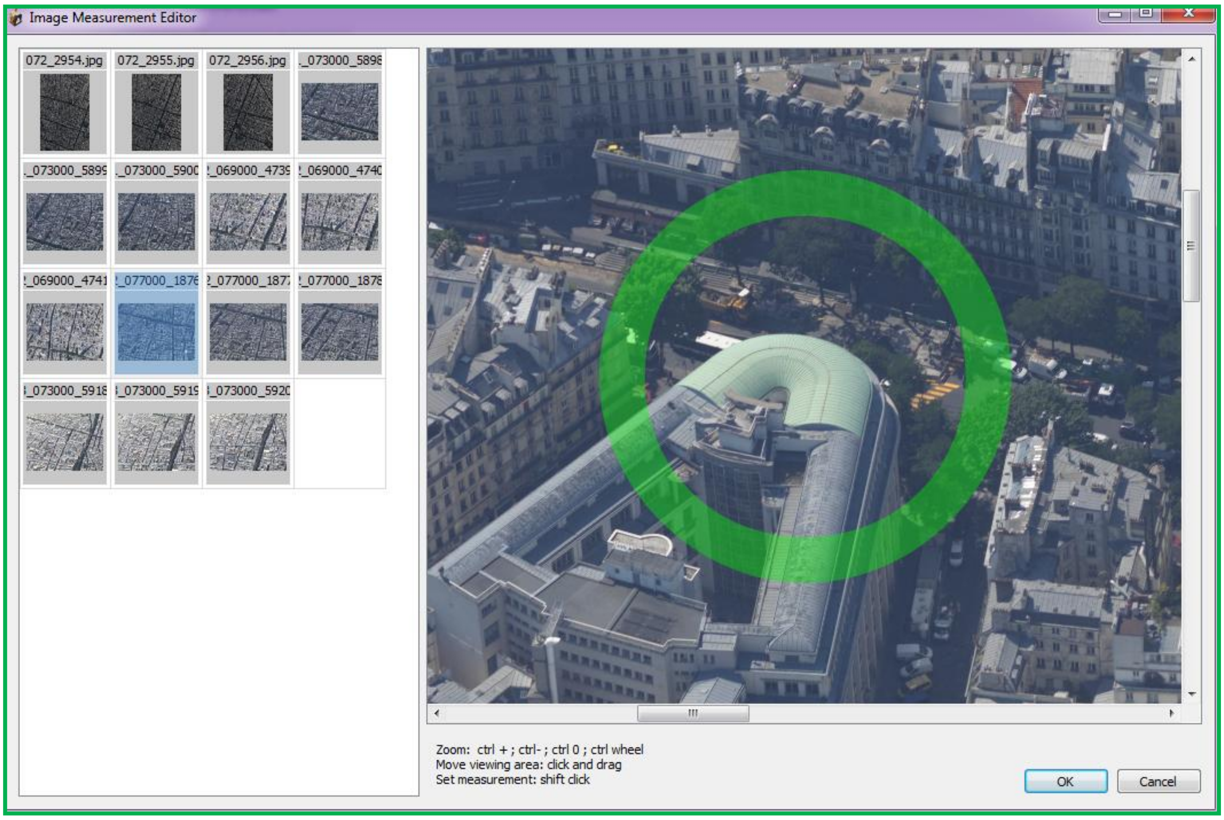

Figure 17: Correct GCP_1 projection

Your data is now correctly imported and ready for aero-triangulation. Please note that this toy sample dataset has too few images to be correctly adjusted by automatic tie point detection. Anyway, we hope that it will help you importing your own dataset correctly and proceed to aero-triangulation and reconstruction with Smart3DCapture. We recommend performing a similar check on a small part of your dataset and then apply the spotted modifications to your complete dataset.

Our Support Team is at your disposal should you have any question or request.

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