

User Manual

3GSM

3GSM GmbH
Plüddemangasse 77
A-8010 Graz, Austria
Tel. +43-316-464744
office@3gsm.at
www.3gsm.at



BMX TiePointReferencer



**User Manual
for Version 4.11**

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1 Introduction

UAV imagery may not give adequate information of the properties of the quarry face; e.g. geological assessment of the quarry face is required. Terrestrial imagery taken by freehand photography may contribute to overcome this problem (see *BlastMetriX* user manual). The *BMX TiePointReferencer* is used to align a 3D model generated from images taken by terrestrial imagery with a 3D model generated from images taken by aerial imagery or vice versa. The *BMX TiePointReferencer* saves the position of the aligned 3D model. The models are finally merged to one 3D model in the *BMX BlastSiteGenerator3D*.

This user manual addresses all topics related to the *BMX TiePointReferencer* i.e. installation, user interfaces, features and operations. Let us know if we can support you, and give us your valuable feedback. Only this way it remains possible to keep the system both, flexible enough for broad usage and sufficiently specific for your applications.

We wish you success with the *BMX TiePointReferencer*.

The Team of 3GSM

Graz, October 2024

2 General

The *BMX TiePointReferencer* is part of the *BlastMetriX* package and is not available as a stand-alone program. The installation takes place during the installation of *BlastMetriX* and is described in the corresponding user manuals.

Note:

SMX software components are used under this name in *ShapeMetriX* and *BlastMetriX*, i.e. there are no dedicated *BMX* versions for e.g. *SMX MultiPhoto*.

3 Prerequisites

For a proper alignment of the 3D models, a setup with following markers is required:

- *Left Delimiter*
- *Right Delimiter*
- *Left Floor Level Marker*
- *Right Floor Level Marker*

The markers have to be positioned at exactly the same locations in both setups, i.e. aerial and terrestrial, before imaging. For further details, refer to the user manuals *BlastMetriX – Field Procedure*, *BMX BlastSiteGenerator* and *BMX BlastSiteGenerator3D*.

The *BMX TiePointReferencer* requires following operations:

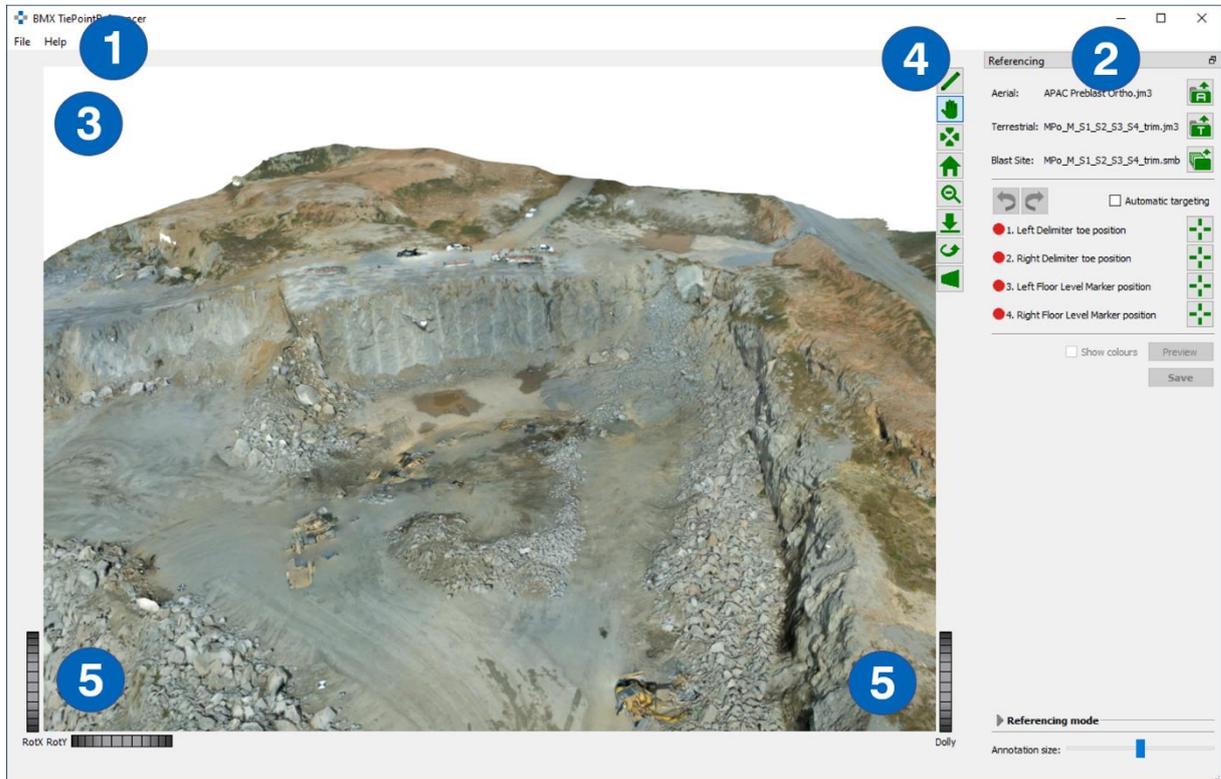
- Generation and referencing of the aerial 3D model – “.jm3” file generated by the *SMX MultiPhoto*
- Generation of the terrestrial 3D model - “.jm3” file generated by the *SMX ReconstructionAssistant* or *SMX ModelMerger*
- Generation of the *Blast Site* (marker geometry) corresponding to the terrestrial 3D model – “.smb” file generated by the *BMX BlastSiteGenerator*
- Targeting of the markers (*Delimiter* and *Floor Level Markers*) on the aerial 3D model in the *BMX TiePointReferencer*

Note:

The *BMX TiePointReferencer* supports 3D model alignment in local co-ordinate systems as well as in geo-referenced systems.

4 User Interface

The user interfaces of the *BMX TiePointReferencer* (Figure 1) comprises the menu bar, the navigation, the toolbar, the 3D viewer, and the thumb wheels.



- 1 Menu bar
- 2 Toolbar
- 3 3D viewer
- 4 Navigation bar
- 5 Thumb wheels

Figure 1: User interface of the *BMX TiePointReferencer*

5 Features

This section describes the available functions of the *BMX TiePointReferencer*

5.1 Context menu of the 3D viewer

The context menu of the 3D viewer allows the change in the display of the 3D model. A click on the right mouse button in the viewer opens a pop up window and several options can be chosen:

<i>Draw as is</i>	The 3D topography is completely overlaid by the digital photograph (3D model)
<i>Wireframe</i>	A Triangulated red coloured point cloud is forming the topography
<i>Wireframe overlay</i>	The 3D model and a red coloured overlay of the wireframe is forming the topography
<i>Points</i>	The point cloud of the scene according to the topography is shown
<i>All Points</i>	All available points of the 3D model according to the photograph are shown
<i>Fullscreen</i>	Switches between the fullscreen display and the windowed display
<i>Show Texture</i>	Displays the 3D model with texture in the viewer

5.2 Menu bar

File Help

The menu bar comprises two main menus. The menu commands are accessible using the mouse cursor. The following paragraphs describe the structure and commands of the two main menus (*File* and *Help*).

Menu File

Exit Closes the program

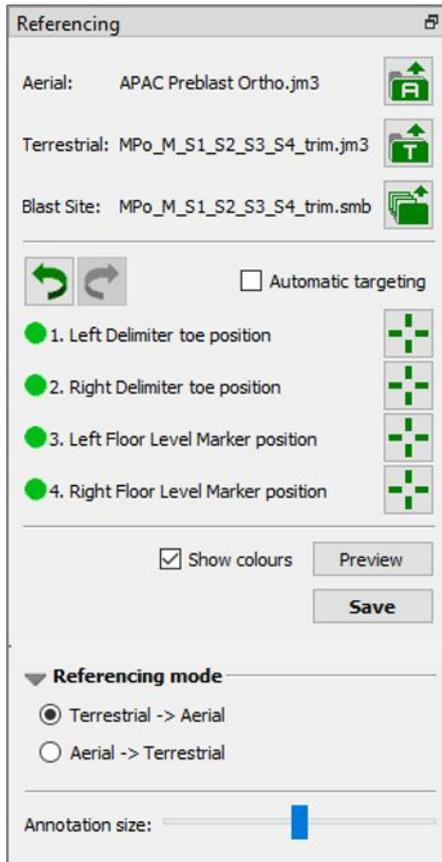
Menu Help

User Manual Opens the manual of the software component

Units Displays the units used by the software

About TiePointReferencer Displays version and release information of the software component

5.3 Toolbar



Load Aerial 3D Model



Opens an 3D model generated from aerial imagery, i.e. *Aerial 3D Model* (".jm3" file)

Load Terrestrial 3D model



Loads a (corresponding) 3D model generated form terrestrial imagery, i.e. *Terrestrial 3D Model* (".jm3" file)

Load Blast Site



Loads the geometry of the *Blast Site* of the *Terrestrial 3D Model* (".smb" file)

Undo



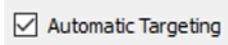
Revokes the previously executed commands step by step

Redo



Redoes commands revoked by the “Undo” function step by step

Automatic Targeting



Enables or disables automatic targeting

Automatic Targeting



Automatic targeting is activated

Manuel Targeting



Manual targeting is activated

Left Delimiter Toe Position



Activates the positioning of toe point of the *Left Delimiter*

Right Delimiter Toe Position



Activates the positioning of toe point of the *Right Delimiter*

Left Floor-Level Marker Position



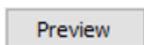
Activates the positioning of the *Left Floor Level Marker*

Right Floor-Level Marker Position



Activates the positioning of the *Right Floor Level Marker*

Preview



Shows a preview of the aligned (*Aerial* and *Terrestrial*) 3D Models

Save



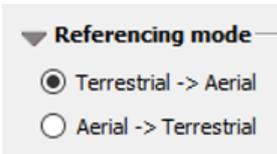
Saves the alignment (i.e. terrestrial to aerial or aerial to terrestrial) to the 3D model (“.jm3” file)

Show Colours



Displays the *Aerial 3D Model* green and the *Terrestrial 3D Model* violet in the viewer

Referencing Mode



Aligns the *Terrestrial 3D Model* (“*.jm3*” file”) to the *Aerial 3D Model* or vice versa

Annotation Size



Changes the size of the markers in the viewer

5.4 Navigation bar

Hint:

The *BMX TiePointReferencer* toggles between the *Edit* and *Navigate* mode by pressing the “*Esc*” key.

Edit



Performs actions within the 3D model such as marking annotations, etc. (active = blue)

Navigate



Controls the motion and inspection of a 3D model (active = blue)

Seek to a Selected Point



Zooms towards the selected location on the 3D model

Move to Home Position



Sets the viewer to its initial position

Zoom out / Zoom in



Zooms out from the current view. Zooms to the previous view again.

Top Down View



Orientates the 3D model from the camera view (top down).

Auto Rotate (fixed or view)



Rotates the 3D model from a fixed point (top down) or from the current point of view

Toggle Perspective/Parallel Projection



Toggles between perspective and parallel projection

Thumb wheels

The thumb wheels are used for rotation and zooming

5.5 Navigation mode

The devices used in the *Navigate* mode are the mouse and/or the keyboard.

Mouse navigation

It is preferred to have a mouse with 3 buttons, or a wheel mouse. Usually the wheel acts as the third mouse button.

- Rotation: The left mouse button rotates the 3D model. Just keep the left button pressed and move the mouse around to see the 3D model rotating.
- Context menu: The right mouse button opens a context menu where the representation of the 3D model can be influenced.
- Panning: The middle mouse button is used to pan the 3D model. The same can be done by pressing “Ctrl” or “Shift” and using the left mouse button.
- Zooming: Pressing the left and middle mouse button at the same time is used to zoom. The same can be done by pressing “Ctrl” and “Shift” and using the left mouse button. When turning the wheel of a wheel mouse the 3D model is also zoomed.

Keyboard navigation

The arrow keys can be used to quickly and easily navigate to a desired view. Straight motion is performed with the left and right arrow key, whereas the up and down keys are used for zooming. Rotation of the 3D model in a desired direction is performed by pressing “*Ctrl*” simultaneously with the corresponding arrow key.

6 Operation

6.1 Standard operation procedure

1. Load the *Aerial 3D Model* (".jm3" file) by clicking the "Load Aerial 3D Model"  icon in the toolbar.
2. Load the *Terrestrial 3D Model* (".jm3" file) by clicking the "Load Terrestrial 3D Model"  icon in the toolbar.
3. Load the geometry of the *Blast Site* (".smb" file) of the *Terrestrial 3D Model* by clicking the "Load Blast Site"  icon in the toolbar.
4. Activate "Automatic Targeting" Automatic Targeting (the targeting icon changes automatically to "Automatic Targeting" ) or keep the pre-set parameter "Manual Targeting" . Description of proper targeting is found in Chapter 6.2.

Note:

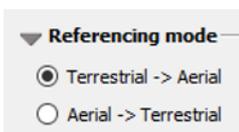
Switching between the "Automatic Targeting"  and "Manual Targeting"  is not possible.

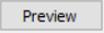
5. Click on the "Edit Left Delimiter Position"  or  icon next to 1. *Left Delimiter Toe Position* to activate the positioning. The red spot in front will turn into yellow.
6. Define toe point of the *Left Delimiter* by clicking the position in the 3D viewer. Set the position with a click on the left mouse button in the 3D model. For an accurate position zoom into the 3D model until the position can be proper determined.
7. Confirm the position with the middle mouse button or return button on the keyboard. The spot will turn into green and the position is set.
8. Repeat step 5 to step 7 to set the toe position of the *Right Delimiter*, the *Left Floor Level Marker* and the *Right Floor Level Marker* (e.g. see Figure 2) .

Hint:

Adjust the size of the markers with the slider "Annotation Size"  in the toolbar.

9. Choose between the referencing (alignment) modes "Terrestrial into Aerial" or "Aerial into Terrestrial"; *i.e.* the *Terrestrial 3D Model* will be aligned to the *Aerial 3D Model* or vice versa.



10. Click on "Preview"  button and the 3D models (terrestrial and aerial) appear superimposed in the 3D viewer (Figure 3).
11. Check if the toe positions of the *Delimiters* and *Floor Level Markers* in the *Aerial* and the *Terrestrial 3D Model* coincide (Figure 4).

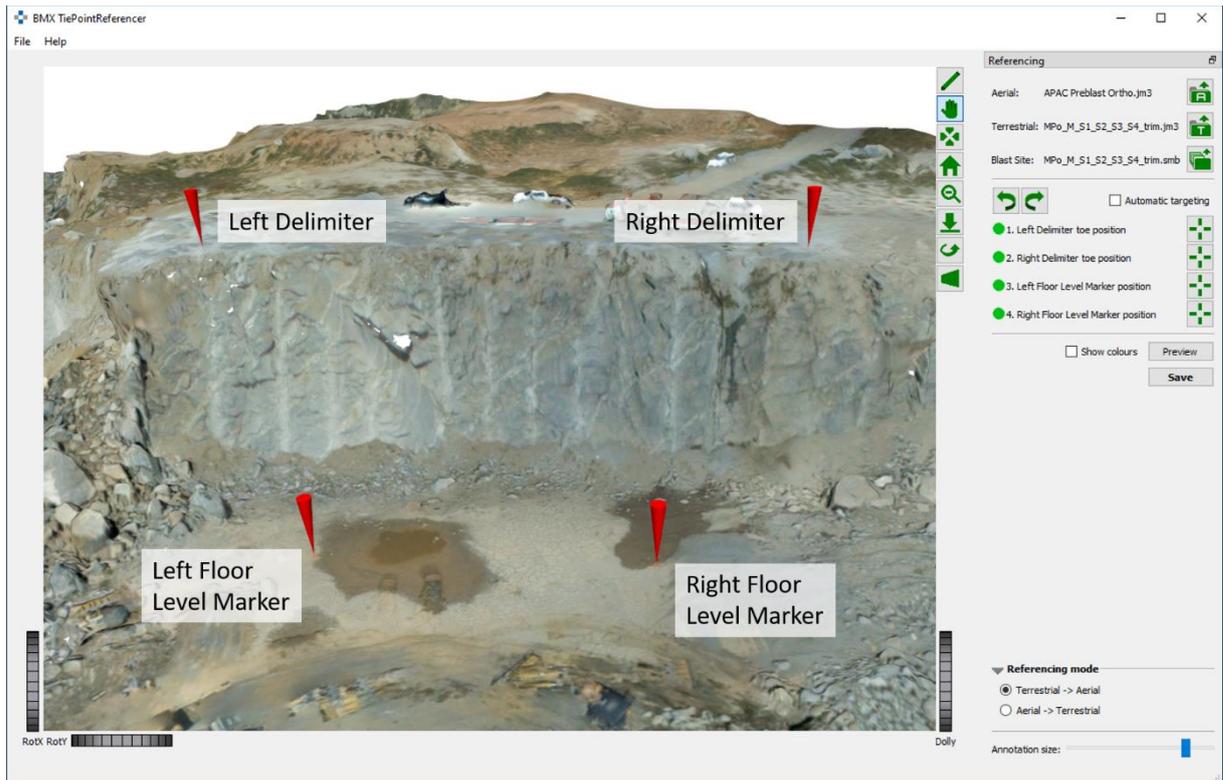


Figure 2: Positioning of Delimiters and Floor Level Markers

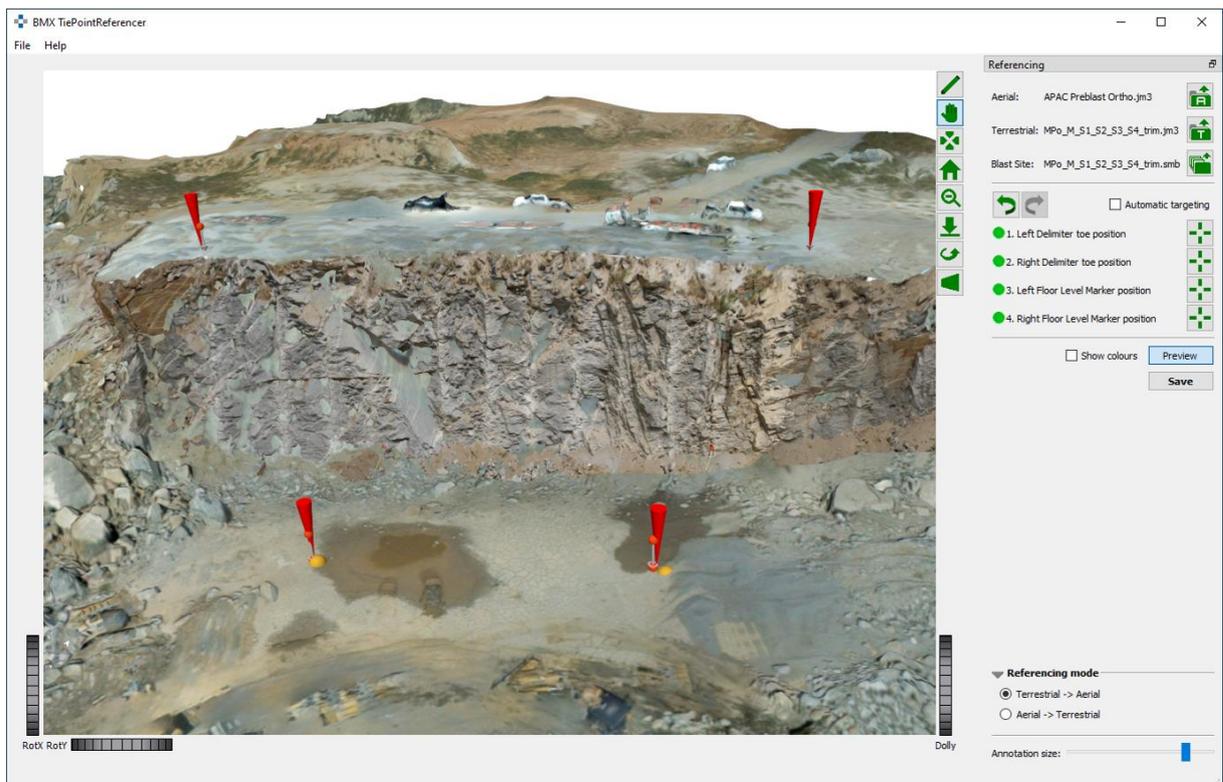


Figure 3: Terrestrial and Aerial 3D Model superimposed in the viewer

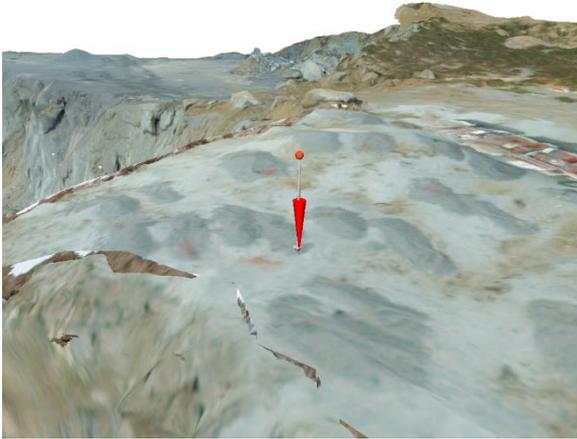


Figure 4: Left Delimiter of the Aerial and the Terrestrial 3D Model

12. Check the alignment of the 3D models for plausibility with a mouse click on “Show Colours” Show colours . The 3D models are recoloured in the 3D viewer, i.e. the *Aerial 3D Model* appears green and the *Terrestrial 3D Model* appears violet. A proper alignment is reached if the two models cut through each other (see Figure 5).

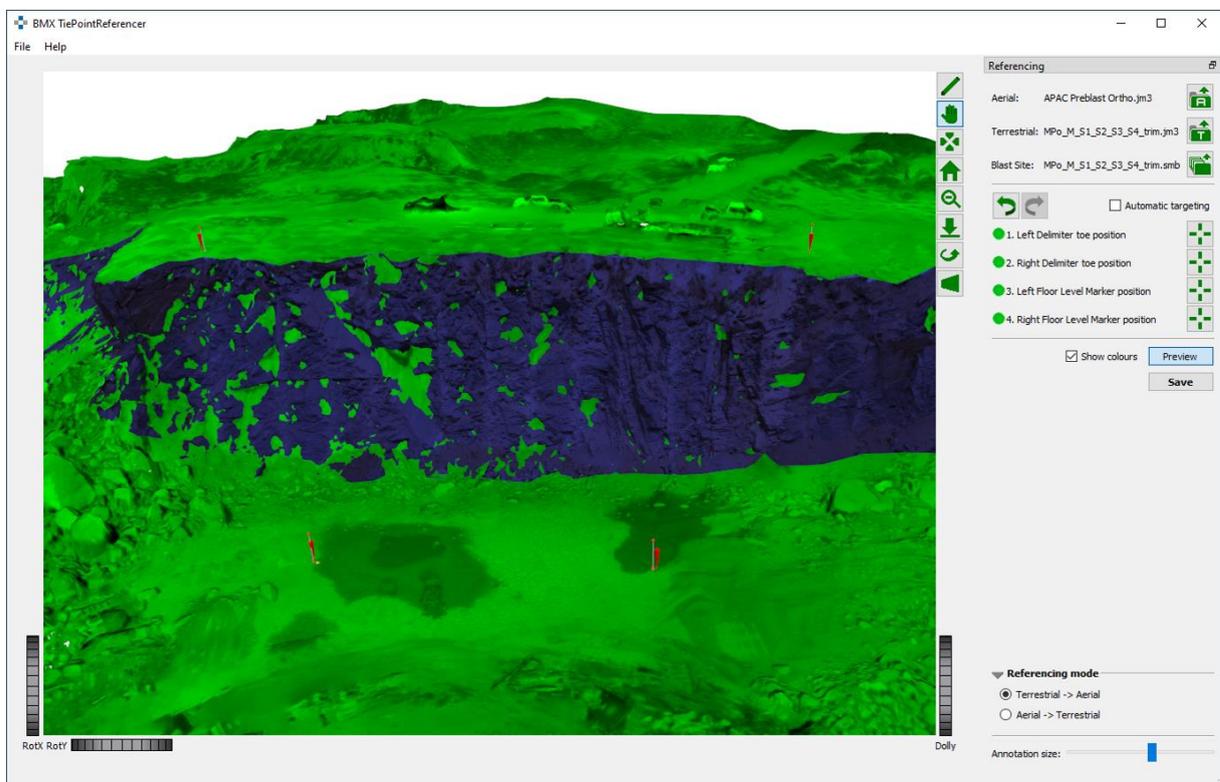


Figure 5: Recoloured models: Aerial 3D Model in green and Terrestrial 3D Model in violet

13. Click on the “Save” button and the alignment of the 3D model is saved in the corresponding “.jm3” file (i.e. *Aerial* or *Terrestrial 3D Model*).
14. Close the program using “File | Exit”.

Note:

The *Aerial* and the *Terrestrial 3 Model* are finally merged to one 3D model in the *BMX BlastSiteGenerator 3D* (see corresponding user manual).

6.2 Targeting

Automatic targeting

- Activate the “Automatic Targeting” Automatic Targeting (the icon changes automatically to .
- Click with the left mouse button somewhere within the *Control Point*. If the automatic centering was successful, a reticule appears indicating the center of the target. If the reference target is too small or automatic centering failed, a warning or error message appears, respectively.
- Check the identified center for plausibility. For assistance, the identified target boundary is displayed as a dashed line (Figure 6).



Figure 6: Automatic targeting places the reticule in the center of the ellipse represented by the dashed green line. This ellipse is the boundary of the target disc. Its shape must be checked for plausibility.

Hint:

The automatic targeting works reliably only if the entire disc is visible and the image of the disc is sufficiently large (diameter about 8 pixels) and contrasting from the surrounding. If for any reason the identified center is not reasonable or the automatic targeting fails, the manual targeting mode () can be activated anytime.

Manual targeting

- Keep the pre-set parameter “Manual Targeting” .
- Click into the center of the *Control Point*. A reticule appears indicating the manually defined center of the *Control Point*.
- Adapt the size of the reticule according to the current zoom level which supports to identify the center correctly.

- d. Check the accuracy of the centering in two directions by changing the size of the reticule (Figure 7). This is especially important if the circular targets appear as ellipses.

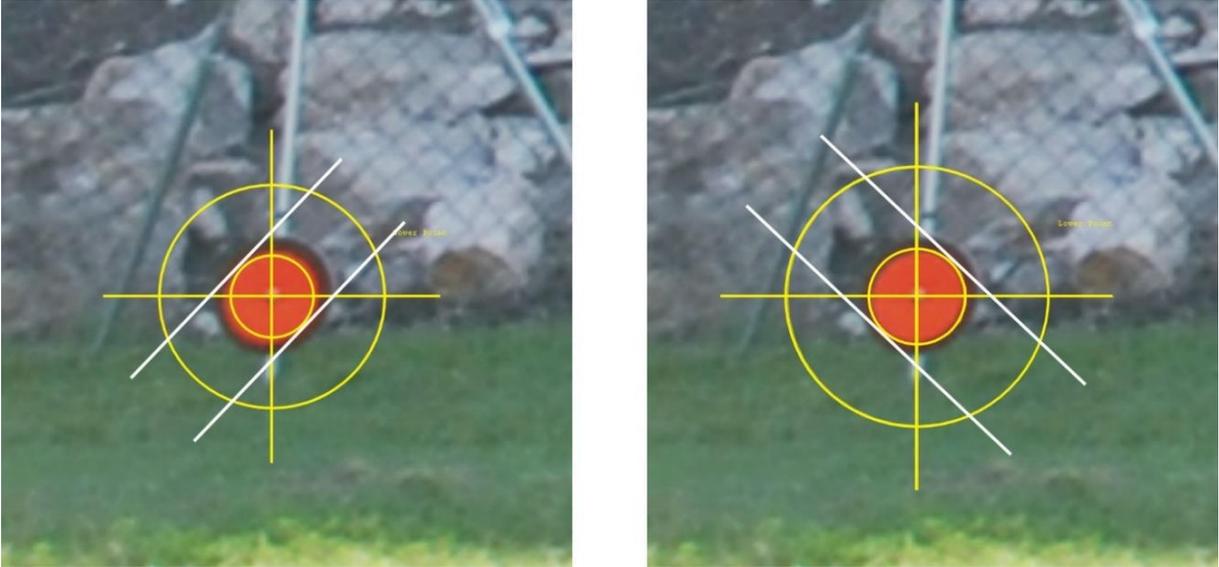


Figure 7: For locating the target discs the image should be zoomed as much as reasonable for visual interpretation. Check the position of the center by changing the size of the reticule. The reticule is well-centered if the circles touch the target's boundary simultaneously at two opposing points and in two perpendicular directions.

Examples of targeting



Figure 8: Definition of a Control Point. Automatic targeting is possible but delivers an insecure result as target is too small. Manual targeting is recommended.



Figure 9: Definition of a Control Point. Automatic targeting is not possible. Reference target has not a shape adequate for automatic targeting. Manual targeting is required.



Figure 10: Definition of a Control Point. Automatic targeting is recommended. Reference target has an adequate size and shape for automatic targeting. Note that the images are shown smoothed.