User Manual

3GSM

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BlastMetriX

BMX BlastSiteGenerator
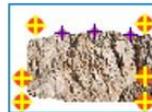
**User Manual
for Version 4.11**

October 2024

Subject to change without notice

CONTENTS

1   Introduction

This software component *BMX BlastSiteGenerator* is part of the *BlastMetriX* software package. It is required to:

- establish metrics and a vertical reference for the 3D model

- define the geometric borders of the *Blast Site*

- define the *Top Level Surface* of the *Blast Site*

- define borehole collars (*Collar Markers*)

- enable volume calculations in the *BMX BlastPlanner*

- enables geo-referencing by the use of surveyed *Control (Reference) Points*

It is tightly bound to the *SMX ReconstructionAssistant, SMX ModelMerger* and *BMX BlastPlanner.*

The user manual addresses all topics related to the *BMX BlastSiteGenerator*. The covered topics include installation, user interface, features, and operation of the *BMX BlastSiteGenerator*. Let us know if we can support you, and give us your valuable feedback. Only this way it remains possible to keep the systems both, flexible enough for broad usage and sufficiently specific for your applications.

We wish you success with your *BMX BlastSiteGenerator*.

The Team of 3GSM

Graz, October 2024

2 General

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

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 ReconstructionAssistant*.

3 User interface

The user interface (Figure 1) of the *BMX BlastSiteGenerator* comprises the menu bar, the toolbar and the stereo viewers displaying the two photos of a *Stereoscopic Image Pair.*
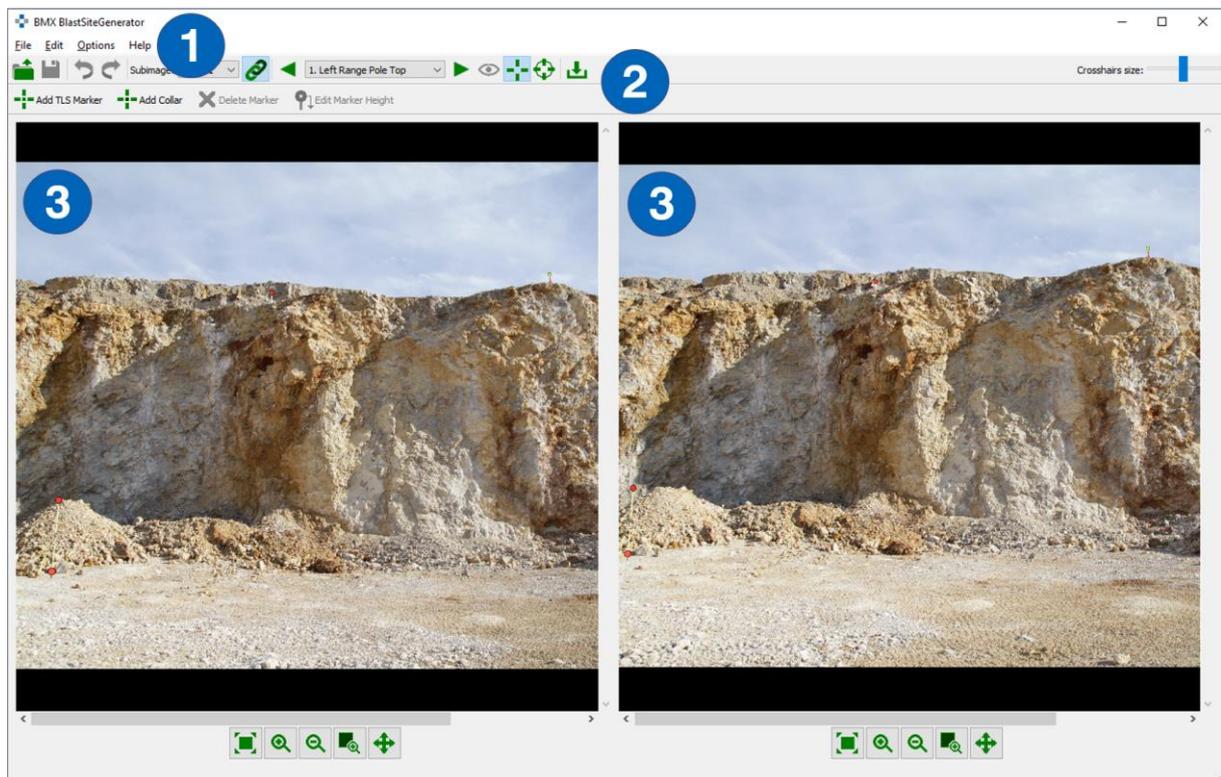
1   Menu bar
2   Toolbar
3   Stereo viewer
Figure 1: User interface of BMX BlastSiteGenerator

4   Features

This section describes the available functions of the *BMX BlastSiteGenerator*.

4.1   Stereo viewer

The stereo viewers display the two photos of a *Stereoscopic Image Pair* (Figure 2). Each viewer comprises two scroll bars and a toolbar supporting the image display with following features:

Window fit

Fits the size of the image to the size of the viewer

Zoom in

Zooms into the photo

Zoom out

Zooms out of the photo

Zoom to region

Enables to zoom in and out by using the computer mouse

Move

Enables mouse navigation

Hint:

Zooming can also be done using the mouse wheel. Click on middle mouse button zooms in and centres the photograph to the clicked point. In general clicking with the left mouse button performs an action, for instance definition of points.

Hint:

Panning is performed with the horizontal and vertical scroll bars at the bottom and the right hand side of the viewer window.

1   Viewer window
2   Scroll bar
3   Toolbar
Figure 2: Stereo viewer

4.2   Menu bar

File   Edit   Options   Help

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

Menu File

Open 3D Model	Opens the *Stereoscopic Image Pair* of a 3D model
Generate and Save	Scales the 3D model, generates the geometry of the *Blast Site*, enables volume calculation, and saves the *Blast Site* file (".smb" file)
Load Existing Blast Site	Loads the settings and markers of an existing *Blast Site*
Exit	Closes *BMX BlastSiteGenerator*

Menu Edit

Undo	Revokes the previously executed commands step by step
Redo	Redoes the commands revoked by the *Undo* function step by step

Next Point	Switches to the next point in the *Point List*
Previous Point	Switches to the previous point in the *Point List*
Automatic Targeting	Uses automatic targeting of circular targets when clicking a point in the image pairs
Manual Targeting	Allows manually clicking a point in the image pairs
Add TLS-Marker	Adds a new *Top Level Surface Marker* entry to the *Point List*
Add Collar	Adds a new *Collar Marker* entry to the *Point List*
Delete Marker	Removes the currently selected *Top Level Surface Marker* or *Collar Marker* from the *Point List*
Edit Marker Height	Allows changing the height of the currently selected *Top Level Surface Marker* or *Collar Marker*
Show Selected	Switches the display to the *Stereoscopic Image Pair* that contains the selected point in the *Point List*
Import Control Points	Imports co-ordinates from a file (".prt", ".txt", ".dat", or ".csv")
Remove Control Points	Removes the *Control Points*
Show Control Points	Shows the *Control Points*
Entitle Blast Site	Allows defining and editing names for the *Blast Site*
Set North Direction	Allows defining an externally measured azimuth for the *Reference Line*

Menu Options

Link Views	Links the motion of the left and the right image of a *Stereoscopic Image Pair* when navigating (zooming and panning)
Show Image Smoothed	Activates pixel interpolation when displaying the images; interpolates the pixel grid
Set Marker Geometry	Allows setting the used marker configuration and marker dimensions (*Range Poles*, *Delimiters*, *Top Level Surface Markers*)

Menu Help

User Manual	Opens the manual of the software component
Units	Displays the units used by the software
About BlastSiteGenerator	Displays version and release information of the software component

4.3 Toolbar 1

Toolbar 1 contains all tools for managing a complete *Blast Site*.

Open 3D Model

Opens the *Stereoscopic Image Pair* of a 3D model ("".jm3"" file)

Generate and Save

Scales the 3D model, generates the geometry of the *Blast Site*, enables volume calculation, and saves the *Blast Site* file ("".smb"" file).
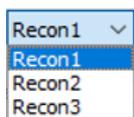
Undo

Revokes the previously executed commands step by step

Redo

Redoes the commands revoked by the *Undo* function step by step

Switch Subimages

Pull-down menu for switching between subimages of a merged 3D model
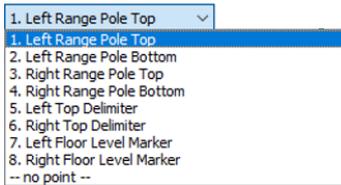
Link Views

Links the motion of the left and the right image of a *Stereoscopic Image Pair* when navigating (zooming and panning)

Previous Point

Switches to the previous point in the *Point List*

Select Point

1. Left Range Pole Top	⌄
1. Left Range Pole Top	
2. Left Range Pole Bottom	
3. Right Range Pole Top	
4. Right Range Pole Bottom	
5. Left Top Delimiter	
6. Right Top Delimiter	
7. Left Floor Level Marker	
8. Right Floor Level Marker	
-- no point --	

Selects and activates a point to mark from the *Point List*

Next Point

▶

Switches to the next point in the *Point List*

Show Selected

👁

Switches the display to the *Stereoscopic Image Pair* that contains the selected point in the *Point List*

Manual Targeting

✛

Allows manually clicking a point in the image pairs

Automatic Targeting

✛

Uses automatic targeting of circular targets when clicking a point in the image pairs

Import Control Points

⬇

Imports co-ordinates from a file (".prt", ".txt", ".dat", or ".csv")

Crosshairs Size

Adjusts the size of the crosshairs markers in the pictures

4.4   Toolbar 2

Toolbar 2 contains all tools for generating an uneven *Top Level Surface*.

Add TLS-Marker

Adds a new *Top Level Surface Marker* entry to the *Point List*

Add Collar

Adds a new *Collar Marker* entry to the *Point List*

Delete Marker

Removes the currently selected *Top Level Surface Marker* or *Collar Marker* from the *Point List*

Edit Marker Height

Allows changing the height of the currently selected *Top Level Surface Marker* or *Collar Marker*

5   Marker Geometry

Number, configuration and location of marking elements have changed during ongoing development of the system. Thus the correct geometry has to be selected. The setting interface is activated by clicking *"Options | Set Marker Geometry"* (Figure 3).
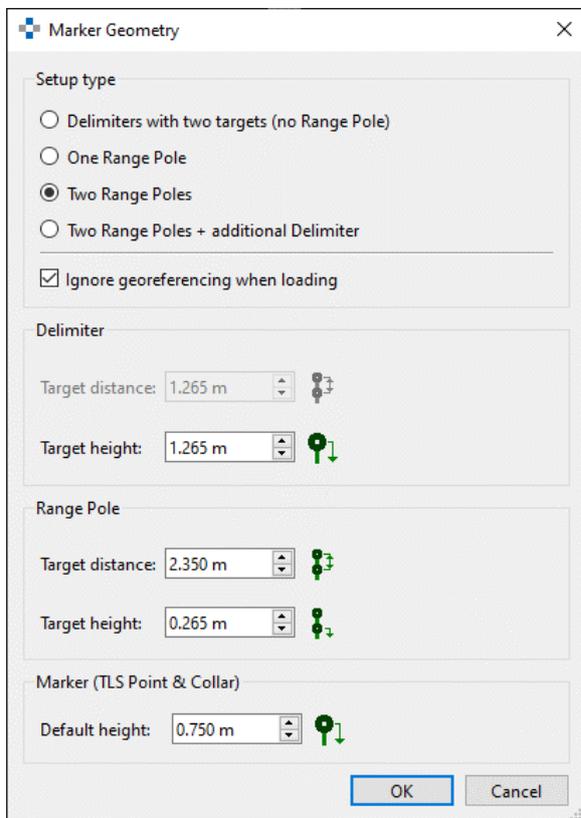

Figure 3: Dialog window for selecting and configuring the marking elements. Sizes are provided in the user manual BlastMetriX - Field Procedure.

Ignore geo-referencing

3D models generated by the *SMX MultiPhoto* software are generally geo-referenced by GPS datasets (see corresponding user manual), which may insufficient for absolute metric accuracy of the 3D model. Therefore, pre-existing geo-referencing of a loaded 3D model can be reset by enabling the feature "*Ignore geo-referencing when loading*" ☑ Ignore georeferencing when loading .

Attention:

If a geo-referenced 3D model is loaded, the *Point List* in toolbar 1 (4.3) is adapted. The input of *Delimiters*, *Floor Level Markers* and if used, *Top Level Surface (TLS) Markers* (Chapter 5.5) and *Collar Markers is* possible. The definition of *Range Pole* parameters is inactive.

Note:

After enabling the "*Ignore geo-referencing when loading*" feature, the 3D model has to be loaded again to activate all markers in the *Point List*.

> **Note:**
>
> The target distance of the *Delimiter* is deactivated in the dialog window "*Marker Geometry*", as the usage of *Delimiters* with two targets is no longer recommended.

5.1   Option 1: Delimiters with two targets (no Range Pole)

This option is no longer supported and it is no longer recommended for usage. Kept for downwards compatibility reasons.

5.2   Option 2: One Range Pole

This option is no longer supported and it is no longer recommended for usage. Kept for downwards compatibility reasons.

5.3   Option 3: Two Range Poles

This is the standard configuration for blasts with one main face. It is recommended to use this configuration (Figure 4). The configuration can be applied regardless of using single or merged 3D models. With a single 3D model, the limits of stated in the user manual *BlastMetriX – Field Procedure* apply. The width of a blast can be increased with merged 3D models (see user manual *SMX ModelMerger*). The limits apply for each of the single 3D subimages. For defining markers in a merged 3D model switching between 3D subimages may be required (see below).

The configurations comprises the following mandatory markers (Figure 4):

- 2 *Range Poles* at the floor level

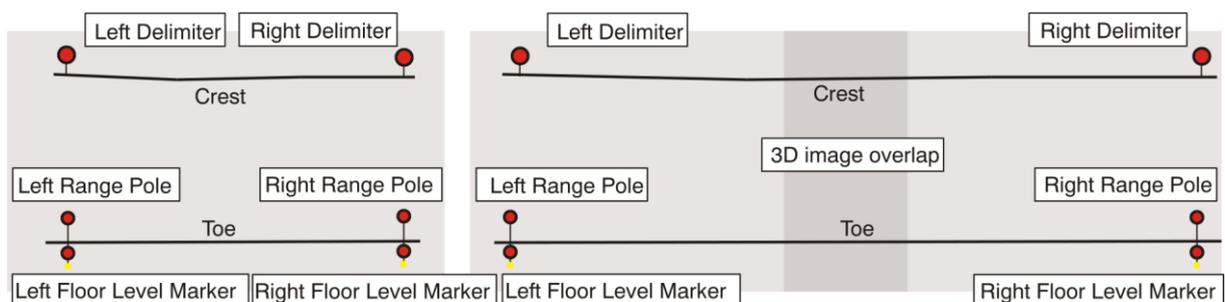- 2 *Delimiters* at the top level

- 2 *Floor Level Markers*

Figure 4: Configuration of Option 3 with single and merged 3D models: 2 Range Poles at the toe, 2 Delimiters at the crest, and two Floor Level Markers at the toe.

The *Left* and *Right Delimiter* define the *Reference Line*. The *Range Poles* are used to scale and orientate the 3D model. The *Floor Level Markers* define the *Floor Level Plane*. The *Top Level Plane* is defined by the toe points of the *Delimiters*. Additional *TLS Markers* can be used optionally at an arbitrary number. As the height of the *TLS Markers* typically differs from the *Delimiters* it is definable separately through *"Options | Set Marker Geometry"* (see Figure 3).

5.4   Option 4: Two Range Poles & additional Delimiter

This configuration is used only if the blast has a free end (open corner). The configuration comprises the following mandatory markers (Figure 5):

- 2 *Range Poles* at the floor level

- 3 *Delimiters* at the top level

- 3 *Floor Level Markers*

Similar to to Option 3 the *Left* and Right *Delimiter* along the main face plane define the *Reference Line*. The *Range Poles* are used to scale and orientate the 3D model. The *Floor Level Markers* define the *Floor Level Plane*. The additional *Floor Level Marker* allows for inclined *Floor Level Planes* at open corners. The *Top Level Plane* is defined by the toe points of the three *Delimiters*. This allows for inclined *Top Level Plane* at open corners. Additional *TLS Markers* can be used optionally at an arbitrary number. As the height of the *TLS Markers* typically differs from the *Delimiters* it is definable separately through *"Options | Set Marker Geometry"* (Figure 3).

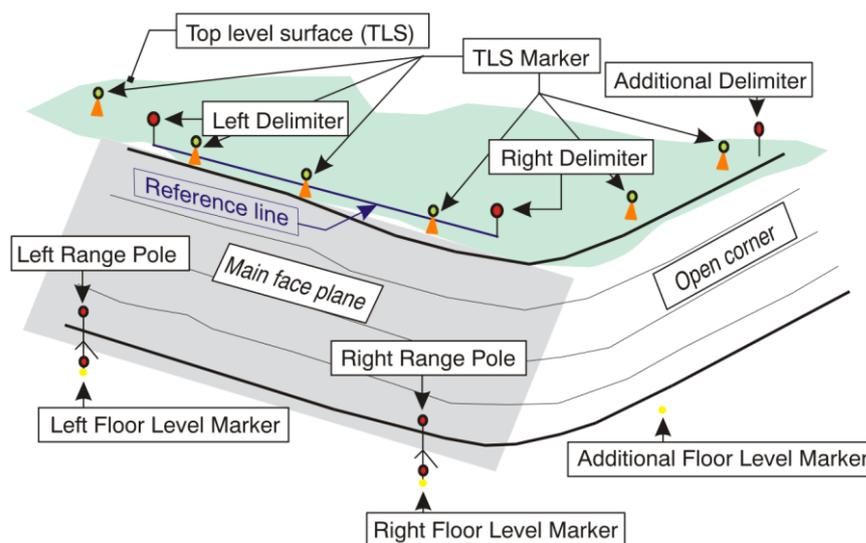*Figure 5: Configuration of option 4 at an open corner. 2 Range Poles at the toe, three Delimiters at the crest, and three Floor Level Markers at the toe. Additional TLS Markers can be applied along the crest at an arbitrary number.*

5.5   Top level surface (TLS)

The *Top Level Surface* is part of the *Blast Site* borders and used to model an uneven crest. The *TLS* contains the toe points of the *Delimiter*, the points of the *TLS* and borehole collars (*Collar Markers*).

TLS Markers and *Collar Markers* are defined in the *BMX BlastSiteGenerator* along the bench face's crest. They are defined either directly at the surface (natural point) by manual placement or using targets with a known height offset by automatic placement (Figure 6). The standard height for *TLS Markers* and *Collar Markers* can be specified in *"Options | Set Marker Geometry"*. *Top Level Surface* finally contains the toe points of the markers. *TLS Markers* shall be established along the crest and describe the shape of the crest properly (Figure 7). For instance, they shall be placed at edges rather than at planar areas.

Upon saving the blast a summary table about the defined *TLS Markers* and *Collar Markers* appears. It is possible to modify the height offset by a click into the list (Figure 8).

Note:
In order to distinguish *TLS Markers* and *Collar Markers* their crosshairs appear green and blue, respectively. The points are highlighted in the same colour in the *BMX BlastPlanner.*
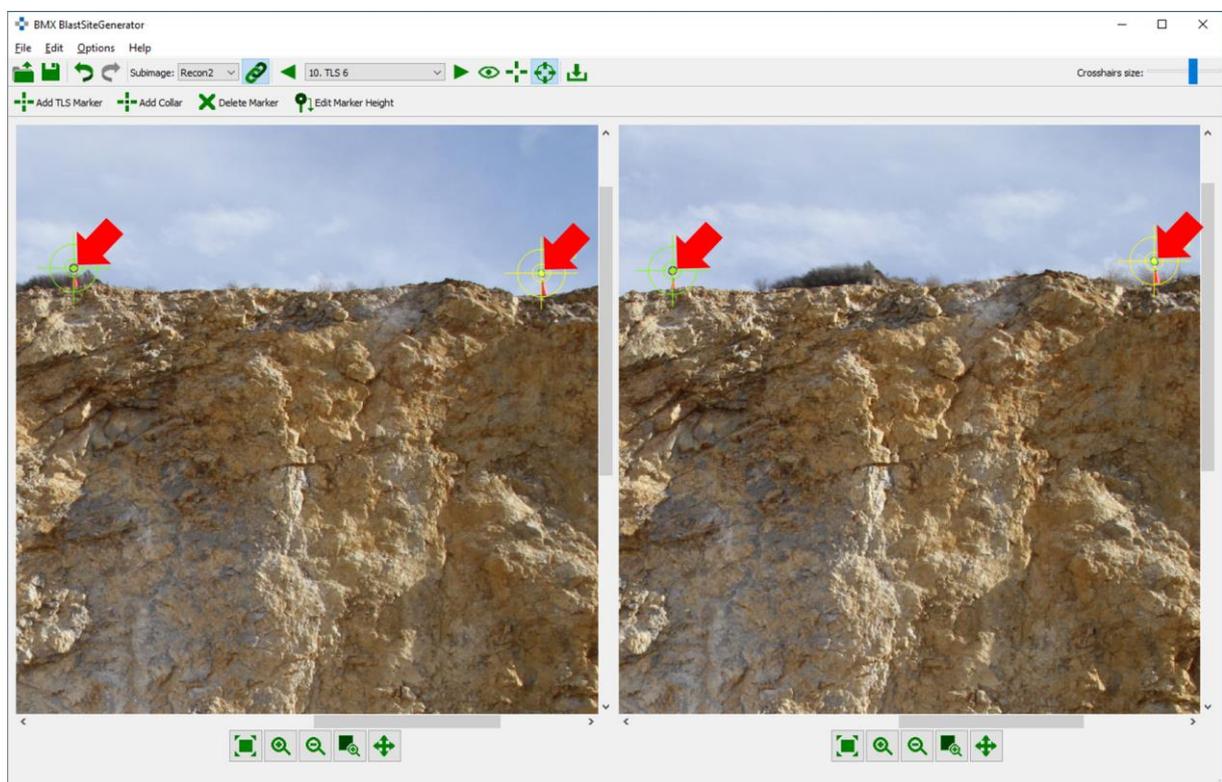

Figure 6: Top Level Surface Markers at the crest

Top Level Surface Marker

— Real irregular top level surface

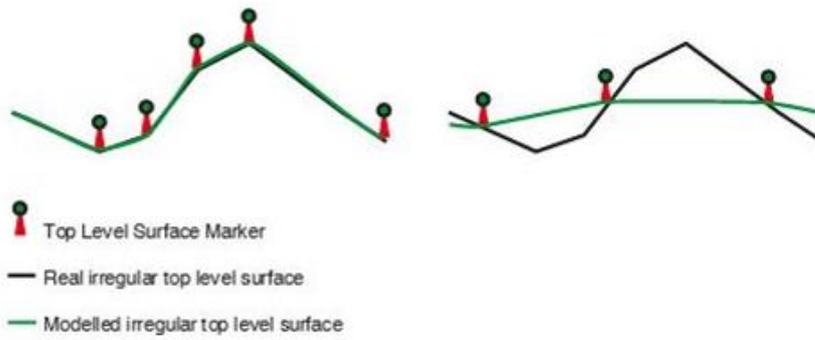— Modelled irregular top level surface

Figure 7: Established TLS Markers. Left: TLS Markers describe the crest properly. Right: TLS Markers do not lead to a proper representations of the Top Level Surface.
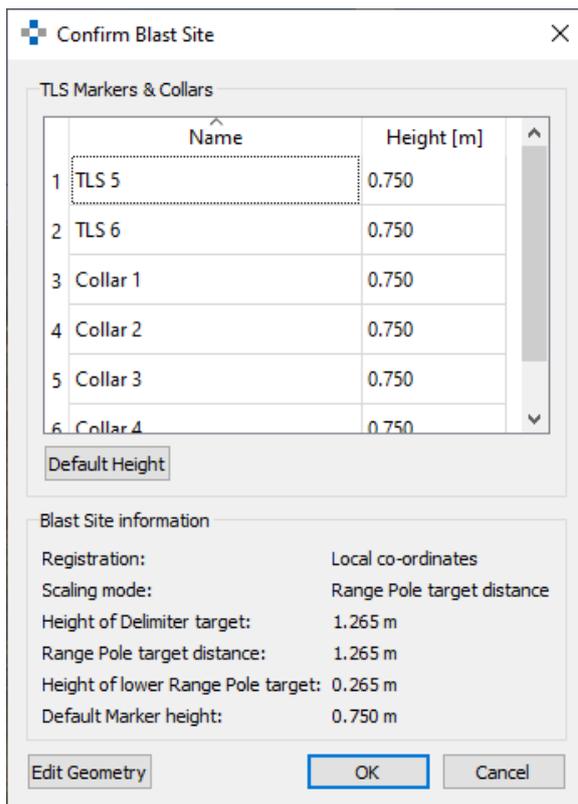

Figure 8: Editable summary for TLS and Collar Markers

6 Switching between 3D subimages

Merged 3D model (*SMX ModelMerger*) may show the markers (*Range Poles*, *Delimiters,* etc.) in different 3D subimages. In this case it is necessary to switch between 3D subimages in order to access and define the markers in the photos. Use the pull down menu in toolbar 1 (see Chapter 4.3 and Figure 9) for switching between image pairs. The pull down menu shows all 3D subimages (corresponding to image pairs) contained in the merged 3D model.
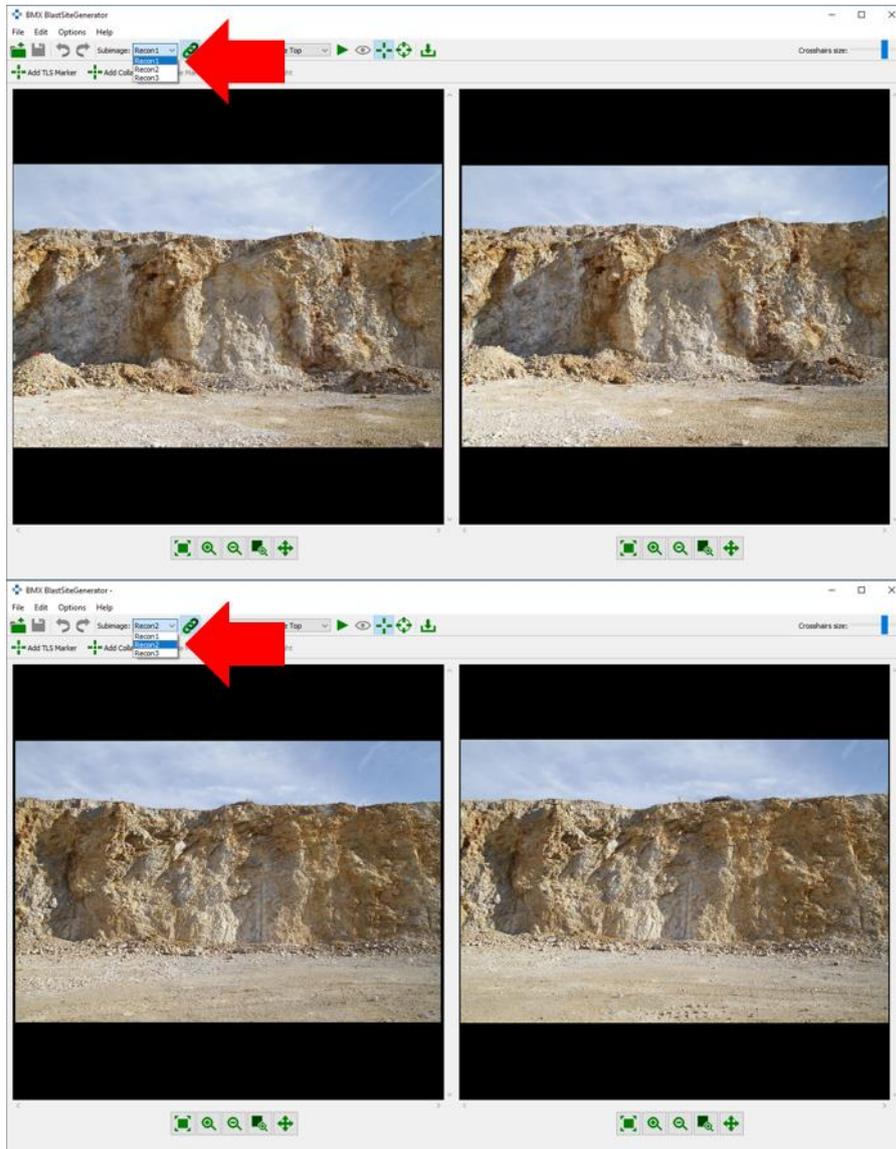

Figure 9: Switching between 3D subimages using the pull down menu

7   Operation

7.1   Standard operation procedure

Hint:
If *BMX BlastSiteGenerator* is launched the first time, the *Marker Geometry* has to be confirmed or set. The dialog appears automatically.

1. Load a 3D model by clicking *"File | Open 3D Model"* or use the according icon ![icon] in toolbar 1 and choose the intended file with extension ".jm3".

2. Check if the selected configuration of the marking elements coincides with the used configuration in your photos (*"Options | Set Marker Geometry"*).

3. Check if the two image views are clamped to each other (*"Link Views"* ![icon] in toolbar 1). If yes, zooming and panning is performed on both images simultaneously.

Hint:
Clicking the middle mouse button at the current position of the mouse cursor zooms in. Zooming can also be done using the mouse wheel.

4. Choose automatic or manual targeting by choosing either *"Edit | Automatic Targeting"* or *"Edit | Manual Targeting"* from the menu bar or use the corresponding icons ![icon] or ![icon] In toolbar 1.

Hint:
Automatic targeting is recommended if standardized reference target at a sufficiently large size are used. In other cases manual targeting should be used (small reference targets or natural reference points). Detailed description of targeting is found in Chapter 7.2.

5. Bring the target disc corresponding to the currently displayed point in the *Point List* into the viewing field of the left and right image view.

6. Center the target with the left mouse button in both pictures (Figure 10 and Chapter 7.2).

Attention:
Marking of the *Range Poles* and *Delimiters* in the images is a crucial step for the absolute metric accuracy of the 3D model and thus should be performed carefully.
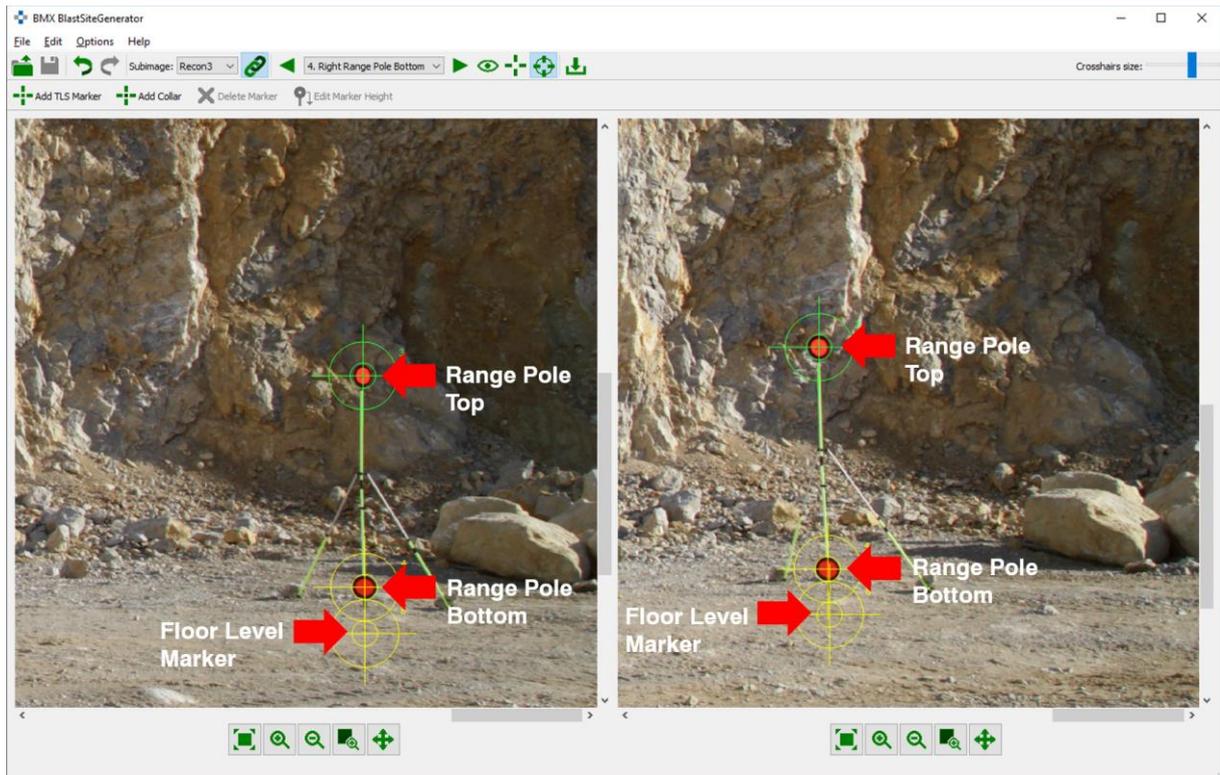
Figure 10: Corresponding points marked in the left and the right image

7. Switch to the next point to mark by clicking the "*Next Point*" ▶ icon in toolbar 1.

8. Repeat steps 5 – 7 for all mandatory points to mark.

9. If necessary, add *TLS Markers* or *Collar Markers* to the *Point List* by clicking *"Edit | Add TLS Marker"* or *"Edit | Add Collar",* respectively, or use the corresponding buttons from toolbar 2 (✛ or ✛, respectively).

10. Bring the target discs or location corresponding to the currently displayed point in the *Point List* into the viewing field of the left and right image view.

11. Center the target with the left mouse button in both pictures (see Chapter 7.2)

12. Edit the height of the marker by clicking the "*Edit Marker Height*" 🔑↓ icon in toolbar 2 and enter the default height in the corresponding dialog window (Figure 11).
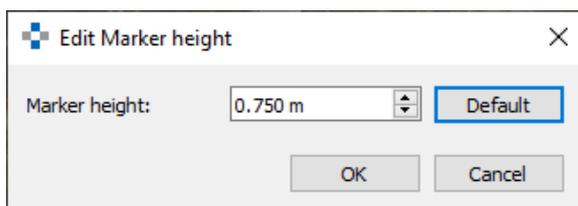

Figure 11: Edit marker height

13. Repeat steps 9 – 11 for all necessary *TLS Markers* and *Collar Markers*.

14. If necessary, *TLS Markers* and *Collar Markers* are deleted by clicking the "*Delete Marker*" ✖ button in toolbar 2.

15. If the orientation of the *Reference Line* (connection between the *Delimiters*) is known, the value can be inserted in the dialog window that opens when clicking *"Edit | Set North Direction".*

16. Save the *Blast Site* by clicking *"File | Generate and Save"* in the menu bar clicking the corresponding icon 💾 in toolbar 1. *BMX BlastSiteGenerator* asks for confirmation of the marker sizes, the scaling mode and, if available, the heights of the *TLS* and *Collar Markers* (Figure 8).

17. Check the correct scaling mode, heights and distances. If the parameters are incorrect, click on the Edit Geometry button and the change the values in the *Marker Geometry* dialog (Figure 12).
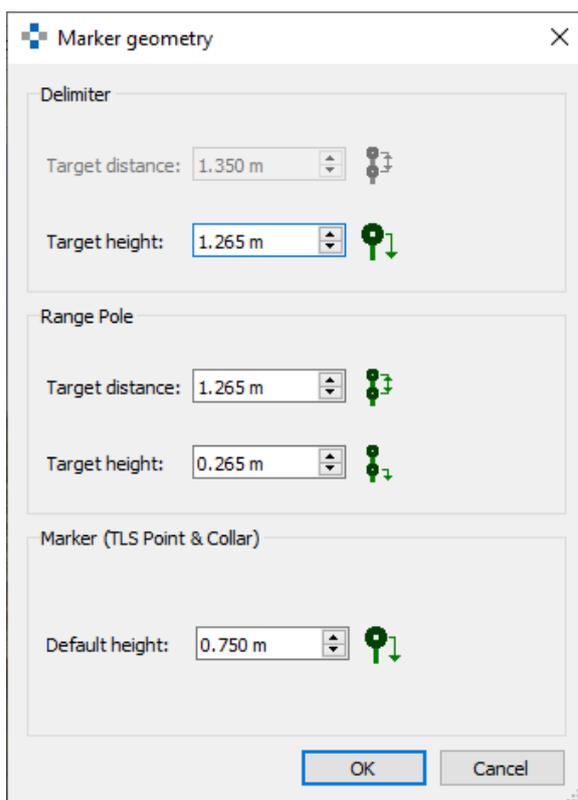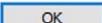

Figure 12: Marker Geometry

18. Confirm the marker sizes by clicking the "*OK*" OK button. A progress window appear (Figure 13). The 3D model is scaled according to the scaling mode, the geometry of the *Blast Site* generated and volume calculations enabled at the same time.
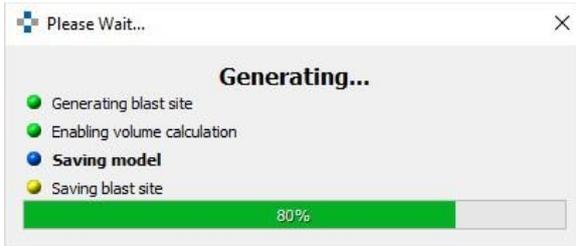
Figure 13: Progress window, which appears during the generation of the Blast Site

Hint:

As long as not all required points are marked in both pictures, the Blast Site cannot be saved (button is inactive) and the 3D model will not be scaled.

Hint:

The plane markers (*Left Floor Level Markers* and *Right Floor Level Markers*) are automatically determined based on the measured targets of the *Range Poles*. In case the locations are not on the desired bottom level they can be set manually to another location. Zero level (z = 0) is automatically assigned to the lower plane marker.

7.2 Targeting

Hint:

Menu "*Option | Show Image Smoothed*": If this function is turned on, colour interpolation between pixel transitions is applied. If it is turned off, the pure pixels are displayed. Switching between these two modes may sometimes ease the manual targeting.

Hint:

The size of the crosshairs can be influenced by the slider in toolbar 1.

Colour codes:

 yellow: crosshairs active

 green/blue: marker set

 red: marker potentially wrong

Automatic targeting

a. Activate the *"Automatic Targeting"* ⊕ button or select *"Edit | Automatic targeting"* from the main menu.

b. 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.

c. Check the identified center for plausibility. For assistance, the identified target boundary is displayed as a dashed line (Figure 14).

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, "*Manual Targeting*" can be activated anytime.

Figure 14: 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.

Manual targeting

a. Activate the *"Manual Targeting"* button or select *"Edit | Manual targeting"* from the main menu.

b. Click into the center of the *Control Point*. A reticule appears indicating the manually defined center of the *Control Point*.

c. Check the accuracy of the centering in two directions by changing the size of the reticule (Figure 17). This is especially important if the circular targets appear as ellipses.
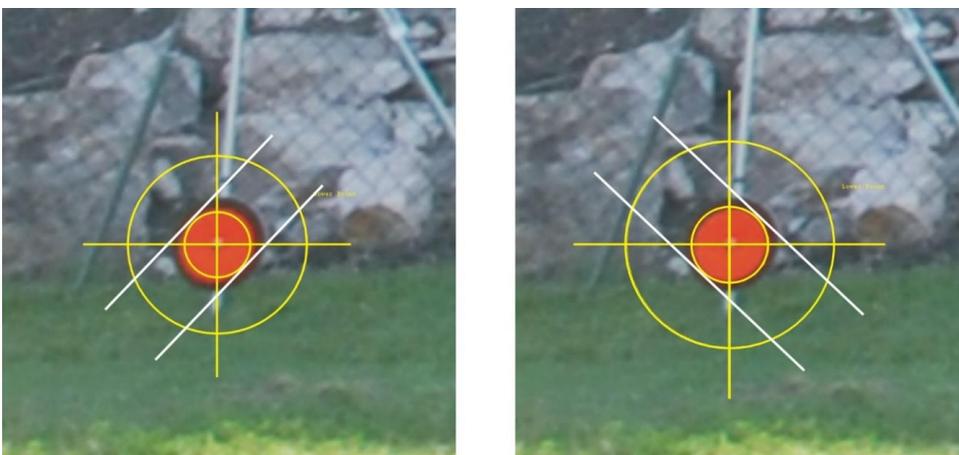

Figure 15: For locating the target discs the image should be zoomed as much as reasonable for visual interpretation. Check the position of the center by changing the size of the reticule. The reticule is well-centered if the circles touch the target's boundary simultaneously at two opposing points and in two perpendicular directions.

Examples of targeting

Figure 16: Definition of a Control Point. Automatic targeting is possible but delivers an insecure result as target is too small. Manual targeting is recommended.

Figure 17: Definition of a Control Point. Automatic targeting is not possible. Reference target has not a shape adequate for automatic targeting. Manual targeting is required.
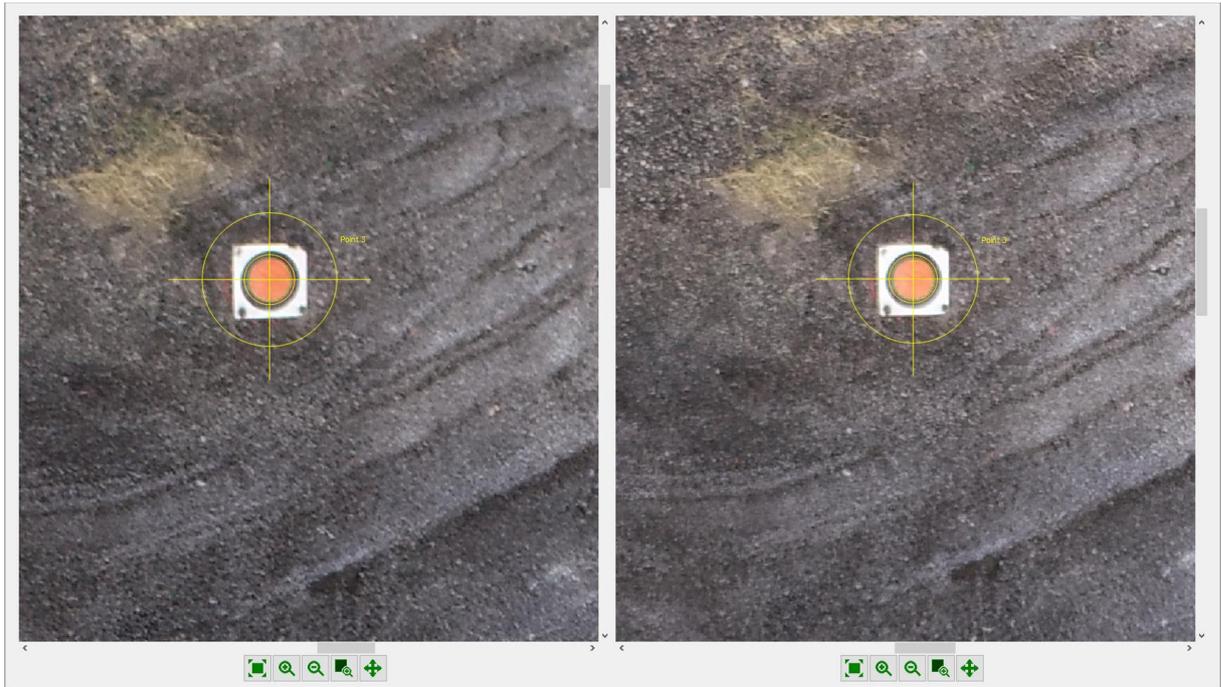
Figure 18: Definition of a Control Point. Automatic targeting is recommended. Reference target has an adequate size and shape for automatic targeting.

7.3   Naming the Blast Site

The name of the bench face and the blast site can be inserted using the following dialog window that opens when clicking *"Edit | Entitle Blast Site"* in the menu bar. These names can also be edited within the *BMX BlastPlanner* software.
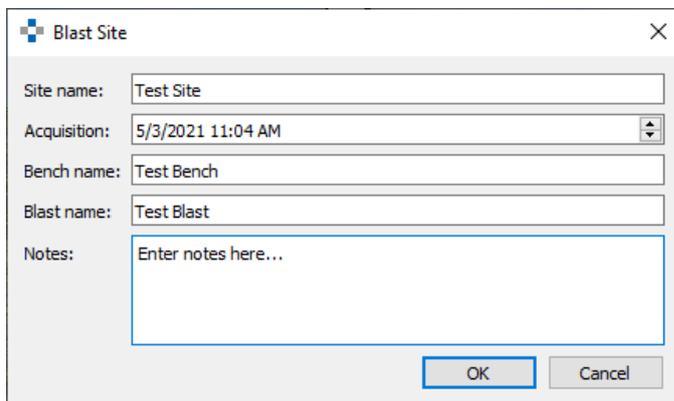

Figure 19: Dialog window for providing a denomination of the Blast Site

7.4 North correction of the Blast Site

The 3D model and the *Blast Site* can be oriented to North if the azimuth of the *Reference Line* is known. The dialog for defining the azimuth opens after clicking *"Edit | Set North Direction"* (Figure 20). The azimuth has to be measured from the *Left* to the *Right Delimiter*. A typical means of determining the azimuth is a compass measurement (Figure 21).

The current (uncorrected) value is shown in the first line in the field *"Current azimuth of Reference Line"*. The measured value is inserted in the second line in the field *"Target azimuth of Reference Line"*. After clicking the *"OK"* OK button the 3D model is transformed accordingly.

Attention:
Compass measurements correct to the geomagnetic co-ordinate system.

Hint:
North-correction is not possible if the loaded 3D model is geo-referenced.
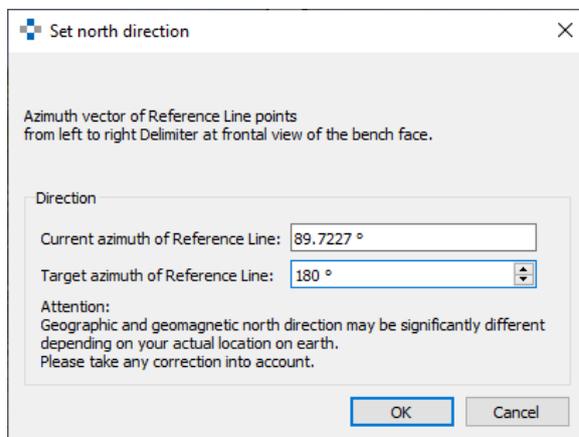
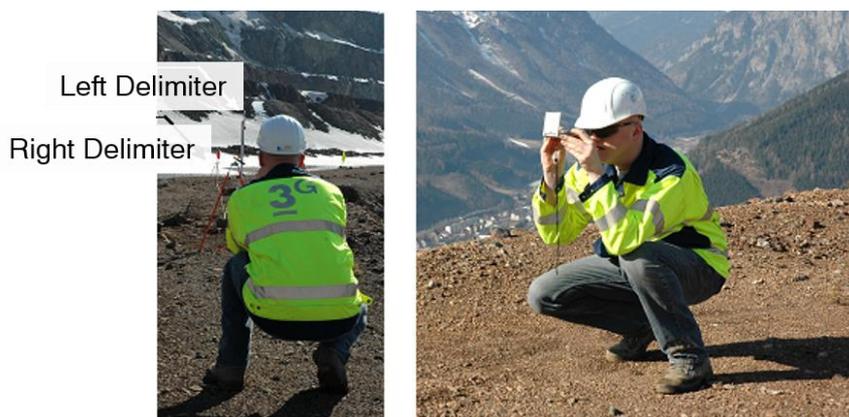*Figure 20: Dialog for specifying the azimuth of the Reference Line*

Figure 21: Determining the azimuth of the Reference Line from the Left to the Right Delimiter using a compass measurement

7.5   Geo-referencing of the 3D model

The 3D model is transformed into a global co-ordinate system by using the known co-ordinates of externally surveyed *Control (Reference) Points*. The *BlastSiteGenerator* requires following points:

- toe position of the *Left Range Pole*

- toe position of the *Right Range Pole*

- toe positon of the *Left Delimiter*

- toe position of the *Right Delimiter*

The *Control Points* have to be surveyed accurately either by total station measurement or by accurate GPS. Accuracy of the final results is directly related to the accuracy of the *Control Points*. The accuracy of the co-ordinates of the *Control Points* should be in the one centimetre range or better.

The co-ordinates of the *Control Points* have to be loaded from a ".csv" file or other text based files (e.g. ".txt", ".prt", ".dat"). The format has to be defined correctly during the import process (see Figure 22).

Examples for ".csv" files
Point – Comma
```
XX.XXX,YY.YYY,ZZ.ZZZ
```

Comma – Semicolon
```
XX,XXX;YY,YYY;ZZ,ZZZ
```

Point – Space
```
XX.XXX YY.YYY ZZ.ZZZ
```

Co-ordinates:
Easting / Northing / Elevation
```
9453674.75   456235.21    248.45
9452978.18   456576.89    223.15
9458763.65   456832.76    287.83
```

*Co-ordinates and point name:*
Easting / Northing / Elevation / Point_Name
```
9453674.75   456235.21    248.45       Point2
9452978.18   456576.89    223.15       Point3
9458763.65   456832.76    287.83       Point4
```

Procedure:

1.   Perform step 1 to 8 of the standard operation procedure described in Chapter 7.1.

2.   Import the co-ordinates of the *Control Points* by clicking *"Edit | Import Control Points"* or use the according icon ⬇ in the toolbar.

3. A dialog window (Figure 22) appears requiring following inputs:

    a. character encoding

    b. used separator

    c. data classification (E/N/H and name)

    d. units (millimeter [mm], meter [m], inch [in], international foot [ft], US survey foot [ft])

4. Click the *"OK"* button to import the co-ordinates.
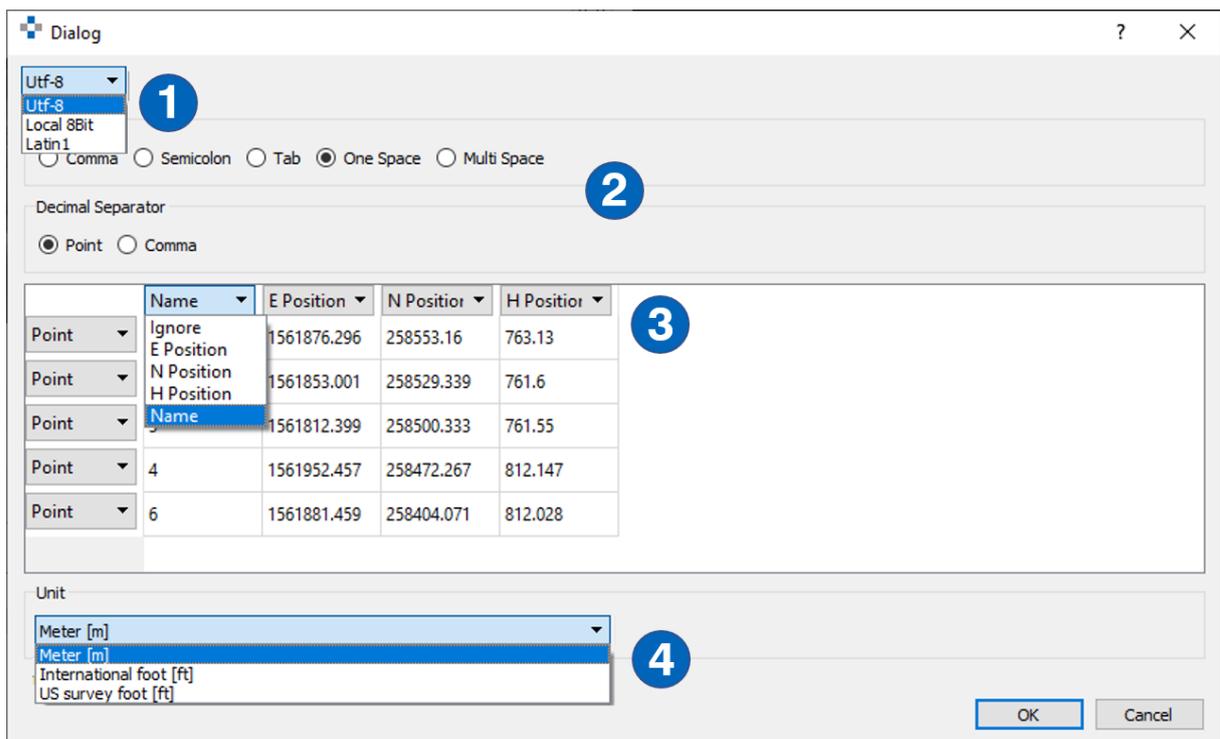
1 Character encoding
2 Separators
3 Data
4 Unit
Figure 22: Import of co-ordinates

5. The information insert *"Model will be referenced"* in the menu bar indicates referencing of the model (Figure 23).
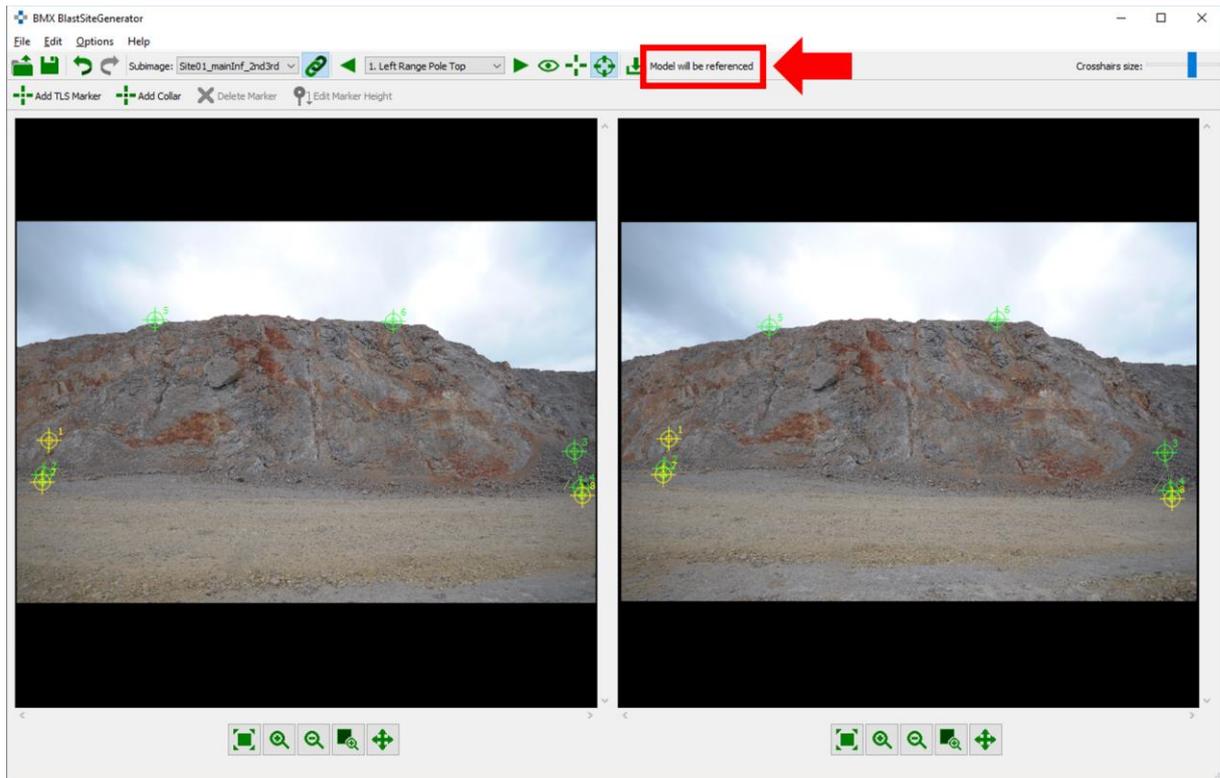
Figure 23: Information insert "Model will be referenced"

6. Save the *Blast Site* and perform referencing of the 3D model by clicking *"File | Generate and Save"* in the menu bar clicking the corresponding icon in toolbar 1.

7. Check the correct scaling mode, heights and distances in the *Confirm Blast Site* dialog (see Figure 24). If the parameters are incorrect, click on the Edit Geometry button and the change the values in the *Marker Geometry* dialog.

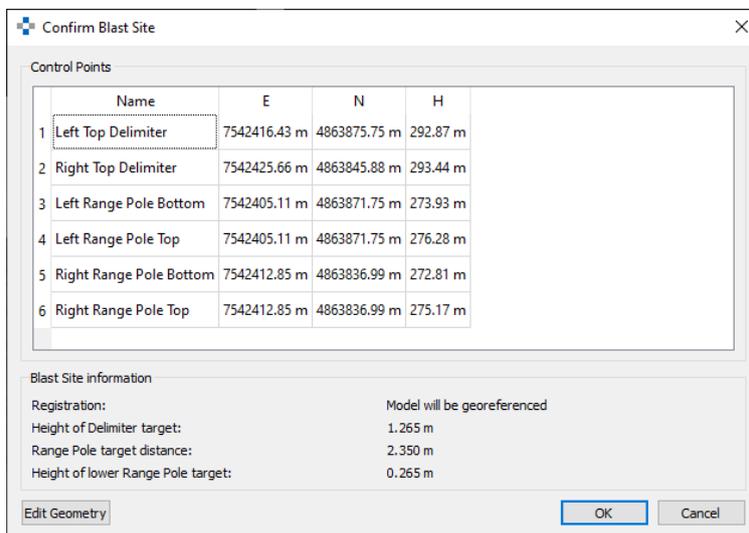8. Rename the ".jm3" file and the ".smb" file and click in the "*Save*" button

Figure 24: Confirm Blast Site dialog

8 Warnings

Inconsistent Range Poles

As plausibility check the respective verticality of the two *Range Poles is* compared. If a significant deviation is detected a warning is provided (see Figure 25). In this case re-check the positions of the marked points.
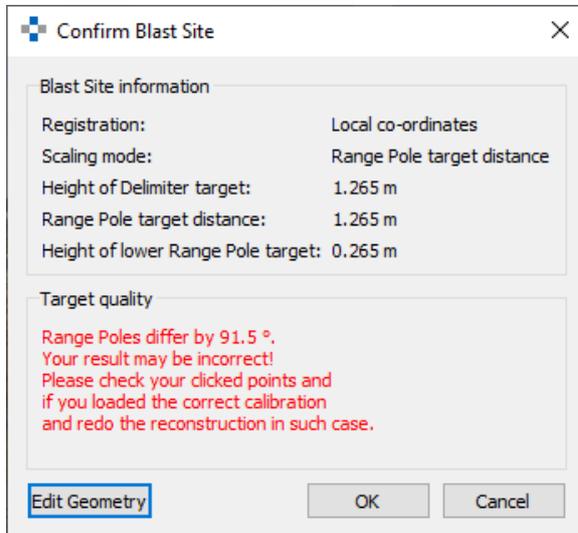

Figure 25: Warning on inconsistent Range Poles

Small target discs

During the automatic targeting of the software determines the size of the target discs within the photos. When going below a threshold for the diameter of the coloured area (approx. 8 pixels) the automatic centering might become unreliable. Therefore the system warns (Figure 26) and the centres should be checked and corrected by manual targeting if necessary. In general the photos should be taken in a way that the recommended limits for the 3D model generation are not exceeded which ensures sufficient size of the target discs.
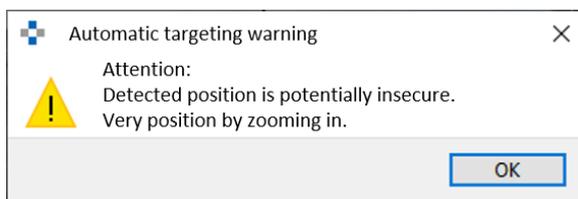

Figure 26: Warning on small target discs. Detected position is potentially insecure.

Enabling volume calculation failed

Enabling the volume calculation in *BMX BlastPlanner* requires a consistent 3D model. If the 3D model and its meta-data are not consistent, the volume calculation cannot be enabled. In this case *BMX BlastSiteGenerator* gives a warning (Figure 27).

Volume calculation cannot be enabled if the following issues take place:

1. Model merging has been performed without trimming the 3D models with the trim polygon (see user manual for *SMX ModelMerger)*

2. 3D models have been generated or modified by the user with software components which do not support volume calculation (previous versions).
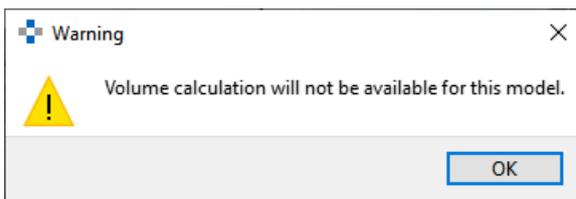

Figure 27: Warning, if volume calculations could not be enabled