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MicroStone: Exploring the capabilities of the Artec Micro in scanning stone tools

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3D Lithics



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We use this protocol and it's working

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Disclaimer

The stone tool used to run this example is not an archaeological item but a bladelet resulted from an experimental knapping activity conducted at the Department of Early Prehistory and Quaternary Ecology at the University of Tübingen.

Abstract

In this protocol, I describe how to scan small-sized lithics with the high-precision desktop 3D scanner **Artec Micro**. This scanner is particularly efficient when it comes to scan small objects with a 3D resolution of up to 0.029 mm and a 3D accuracy of 0.01 mm. However, a few slight modifications to the common workflow are needed to obtain accurate 3D meshes of small stone tools such as bladelets, microblades, microflakes. Overall, this scanner represents an efficient and reliable alternative to scan artifacts that cannot be successfully captured by other laser or structured light scanners, such as the **Artec Space Spider**. If several hundreds of artifacts need to be scanned, a less time-consuming alternative is represented by Micro-CT scanners, using a protocol specifically adapted to this task (i.e., the **StyroStone Protocol**).

Guidelines

I divided the protocol into four main parts . Photos and screenshots of all scanning phases will enable the reader to efficiently follow all steps required to obtain accurate 3D scans of stone tools as well as other small-sized archaeological artifacts (e.g., bone tools, ornaments, etc.).



Materials

In order to run this protocol efficiently you will need the following materials:

- An **Artec Micro** scanner with the associated jigs and mount objects;
- The associated scanning software **Artec Studio 16 Professional**;
- A workstation with enough processing power;
-
- A reusable adhesive tack (e.g., Blu Tack®);
- A volatile matting agent for optical 3D laser scanning, such as the **REFLECON®TARNISH 11 3D SCANNINGSPRAY**;
- ..and of course the lithics you intend to scan!

Safety warnings

- ! When the scanner is not in function, cover it with the blanket provided by Artec to protect all scanning components.

Before start

This protocol is optimized to scan small-sized lithics. Therefore, all steps indicated throughout the protocol are related to this particular class of artifacts. The procedure used to scan other artifacts classes might differ slightly. Please, refer to the **Artec Micro User Manual** for additional information. I recommend watching **this** video, released by Artec 3D, to have additional tips on the scanning process.

Part 1 - Object positioning

- 1 Use the *Vise Jig* provided by Artec to securely hold the artifact between its jaws (Fig. 1). The *Vise Jig* can be safely mounted thanks to the magnetic plate (i.e., the *Gum Jig*) on the *Screw Jig*. The object should be stable enough to avoid movements during the scanning process. I recommend placing the object according to its longitudinal axis.



Fig. 1. The *Vise Jig* provided by Artec. Notice the soft plastic placed between the jaws, which will prevent the artifact from being damaged.

- 2 Place additional tracking features on the magnetic plate using an adhesive putty such as the Blu Tack (Fig. 2). This procedure is extremely important when scanning small-sized objects.



Fig. 2. The lithic artifact placed between the jaws of the *Vise Jig* and the adhesive putty attached to the *Gum Jig* used to create additional tracking features. In this case, the artifact is oriented according to the longitudinal axis with the proximal part at the bottom.

- 3 You might need to use a dust anti-glare spray if you are scanning a dark and/or translucent artifact. For instance, the **REFLECON®TARNISH 11** is a volatile matting agent for optical 3D laser scanning (Fig. 3). Please, notice that Artec recommends to use an air brush to avoid the formation of unwanted features on the object's surface.



Fig. 3. The Reflecon Tarnish 11 spray.

- 4 Use the magnetic locks of the *Screw Jig* to attach the object to the spacers (Fig. 4).

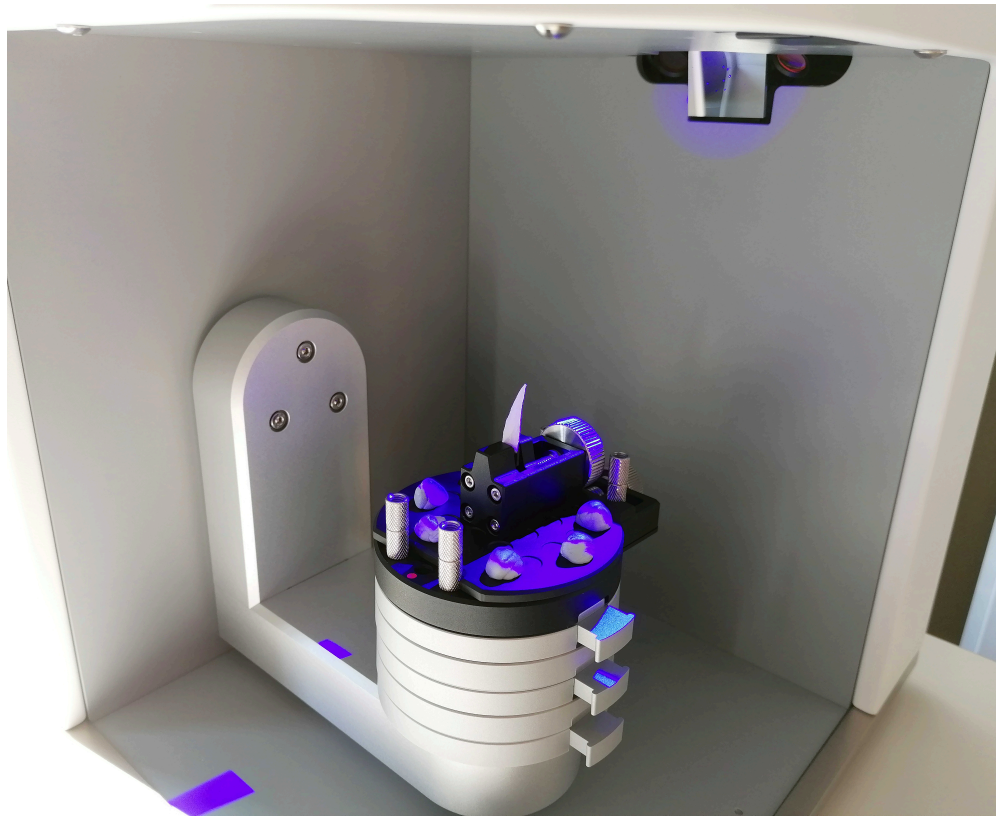


Fig. 4. The scanning setup used in this example.

Part 2 - Scan in Artec Studio 16

- 5 Boot the computer and the scanner.
- 6 Open Artec Studio 16 Software.
- 7 Select *Scan* and then *Scan with Artec Micro* (Fig. 5).



Fig. 5. Artec Studio Scan panel overview.

- 8 The camera view on the top left side (Fig. 6) will show the artifact mounted on the *Vise Jig*. If needed, slide it to roughly center the object to the field of view using the red cross as reference. If the object is not entirely visible, remove one or more spacers until it is completely visible.

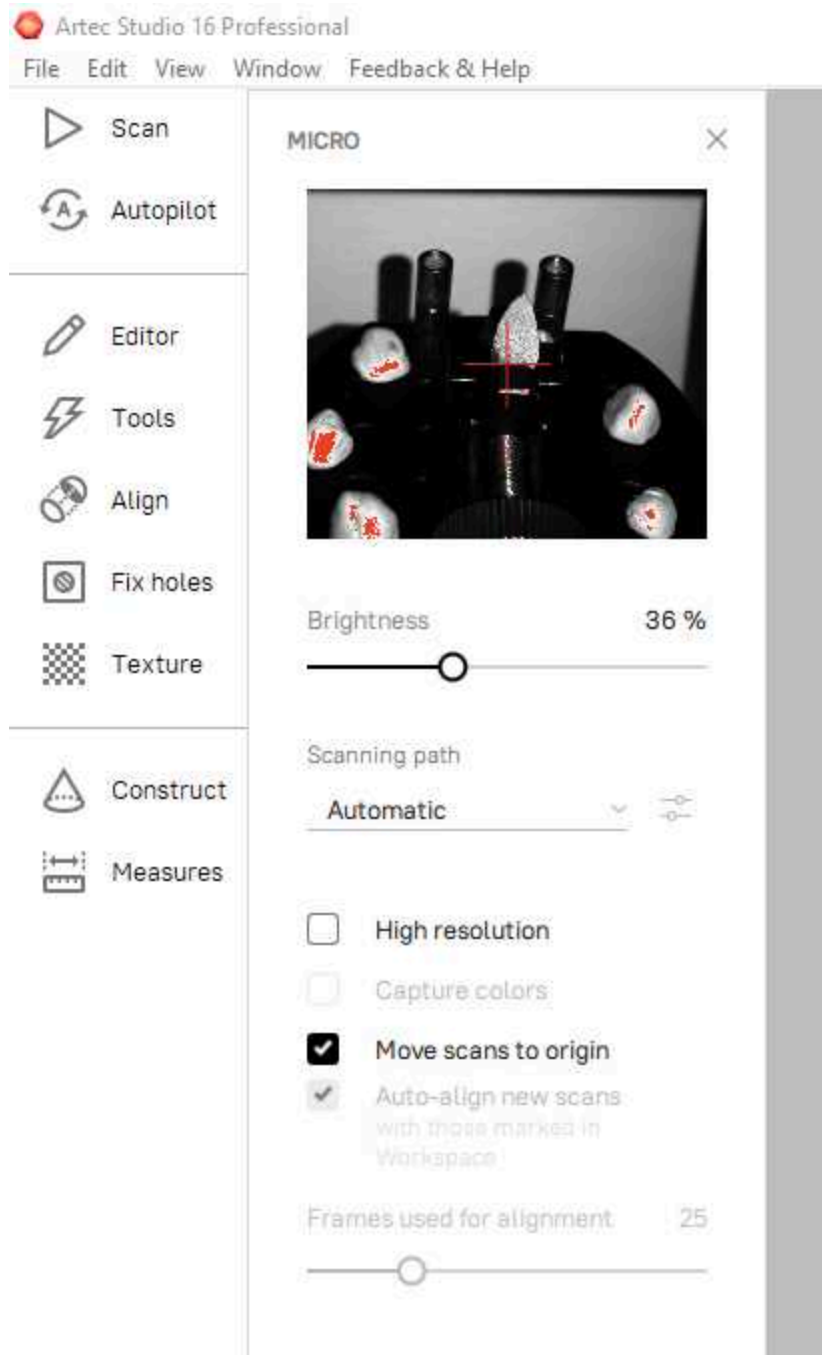


Fig. 6. The camera preview that pops up after clicking *Scan with Artec Micro*.

- 9 Adjust the brightness to make the object more visible in the preview while avoiding overexposure of the artifact. Overexposed areas are highlighted in red (Fig. 6). The value should be thus adjusted to minimize the red dots on the artifact.
- 10 Select the *Scanning path* (Fig. 6) according to the complexity of the artifact. I recommend using the *Automatic* path, as this setting will automatically calculate the number of frames needed to capture the complexity of the artifact.



Safety note: If the artifact cannot be safely secured on the *Vise Jig*, select the path *Rotation only*. In this case, the turntable movement is limited to a fixed number of horizontal rotations.

- 11 Select *Move scans to origin* (Fig. 6).

Extra: If you want to capture the object's texture, select also *High Resolution* and then *Capture colors*.

- 12 Finally press *Scan*.

- 13 Once the first scan is complete, rotate the artifact, securing it again on the *Vise Jig*, and start a new scan using the same parameters listed above. Unclick the option *Auto-align new scans* before pressing *Scan* (Fig. 7).

Two scans should be enough to capture small objects. If needed, though, run a third and/or fourth scan changing views (e.g., orientating the object according to its transversal axis). This might be needed when artifacts have marked plunging distal terminations.

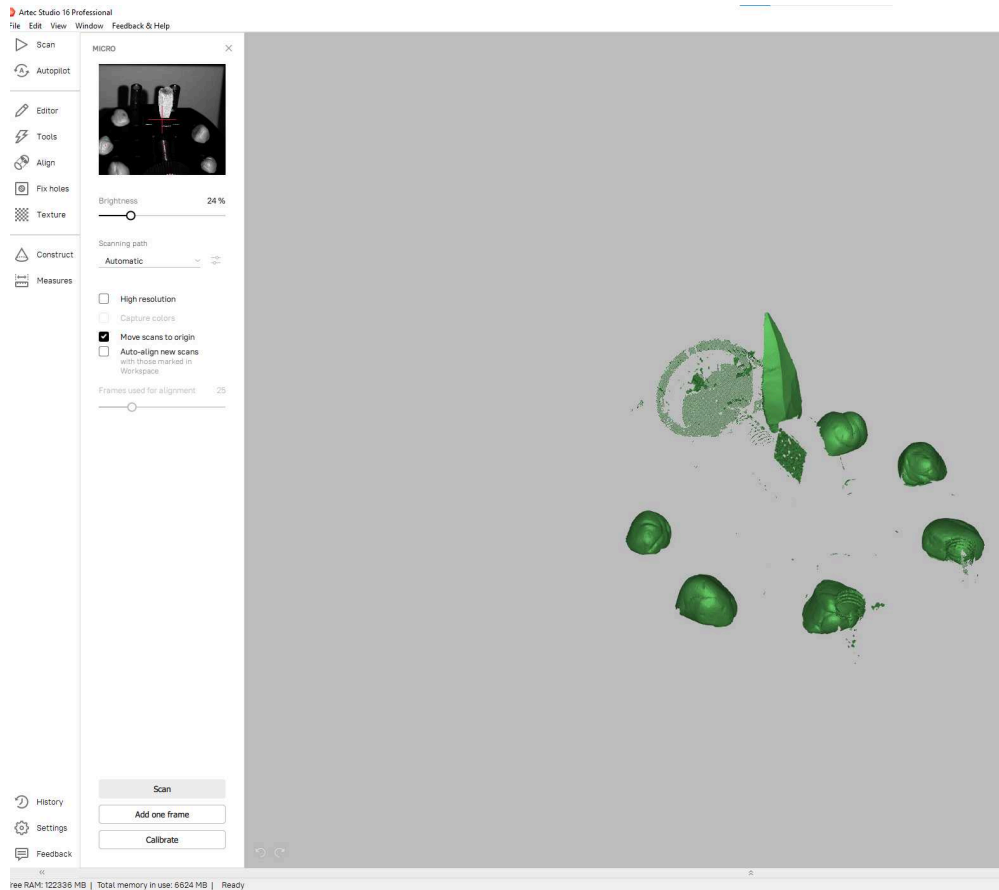


Fig. 7. Visualization of the first scan (object in green) and rotation of the artifact (see the preview window on the top left side) prior to starting a second scan.

Part 3 - Processing the scans

- 14 After completing the second scan, go to *Tools* and run a *Global registration* **for each scan separately**, by selecting one scan at a time. *Key frame ratio* should be set to 1 and *Search features within, mm* to 0.1 (Fig. 8).



Note: This step is highly recommended when scanning small-sized objects, while you may not need to run a global registration for each scan separately when bigger artifacts are scanned. In this case you can simply skip steps 14 and 18.

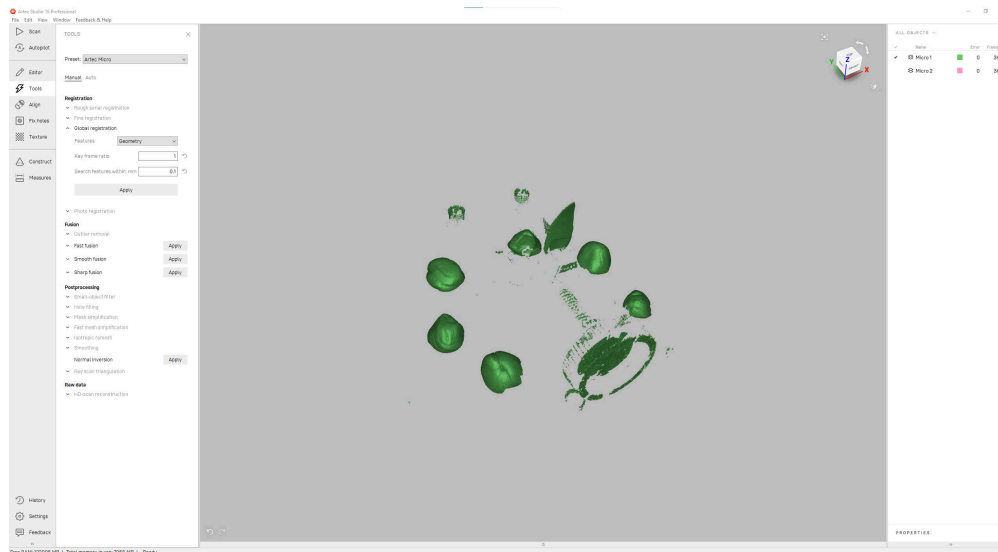


Fig. 8. The *Tool* panel in Artec Studio 16 Professional. In this case, the *Global registration* was done for each scan separately.

- 15 Go to the *Editor* panel and select *Eraser*. Select one scan at a time and erase all scanner's jigs and adhesive putty, leaving only the artifact. The best way to do so is to use the *Lasso* function (Ctrl + left-click) to first select the whole artifact. Then, select *Inverse* and *Erase* (Fig. 9).



Fig. 9. Selection of the artifact with the *Lasso* function used to erase all unwanted parts of the scan after pressing *Inverse* and *Erase*.

- 16 Select both scans and go to the *Align* panel. The left panel will list all scans selected (in this case two). The blue and green dots indicate with scan is movable (i.e., green dot) and which is instead fixed (i.e., blue dot). Rotate the green scan to match the orientation of the other (Fig. 10). To make rotations more effective, double-click on the green object. In this way, the pivot point (displayed as a pink dot) is set on the movable object.

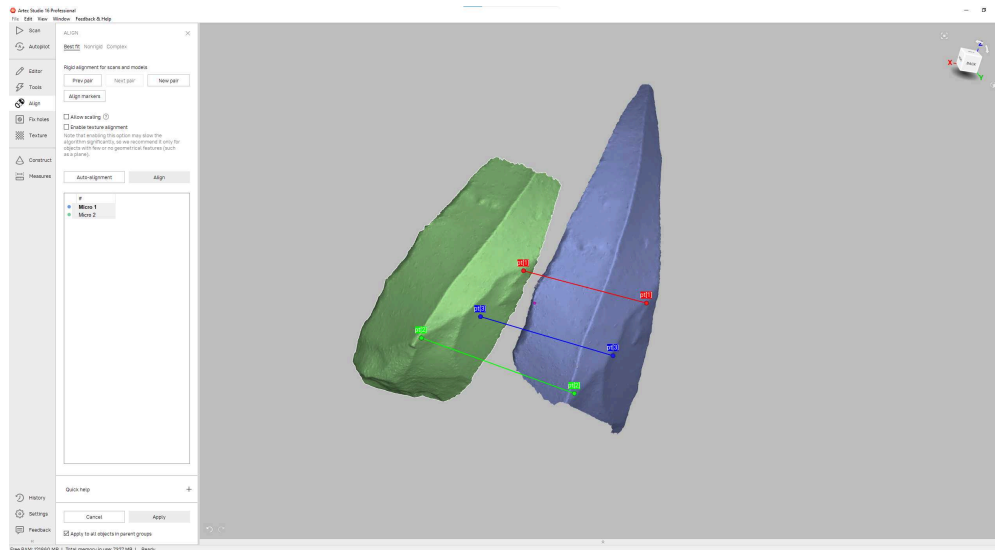


Fig. 10. Alignment process in Artec Studio 16 Professional. The two scans have been orientated according to the technological axis and with the dorsal side facing the viewer. Three roughly correspondent points are then selected to facilitate the alignment algorithm.

16.1 Useful commands during the alignment process:

- Ctrl + left-click of the mouse: Rotate and move the object along its axis;
- Ctrl + click on scroll: Move the object along the x and y axes;
- Ctrl + scroll up and down: Move the object along the z axis.

- 17 Select three to four roughly correspondent points on both scans (Fig. 10) and press *Align*. If the alignment was successful, press *Apply* to save and exit the alignment process.
- 18 Go to *Tools* again and lock the registrations of each scan before moving to the next steps. This can be done either by clicking on the lock symbol on the right panel or right-clicking on each scan and selecting *Lock registration* (Fig. 11).



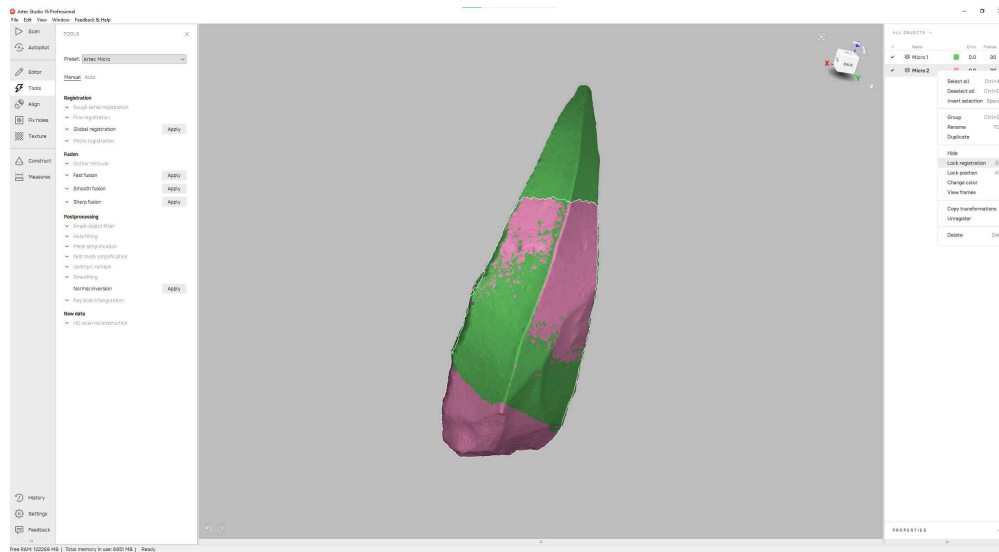


Fig. 11. The aligned bladelet and the *Lock registration* step to do before running a new *Global registration* and the *Fast fusion*.

- 19 Run a new *Global registration* using the same parameters listed in Step 14. Note that being the scans locked, this process will result only in a *Fine registration* process. Nevertheless, this step is recommended to increase the accuracy of the alignment.
- 20 Run then the *Sharp fusion* (Fig. 12) with the following parameters:
 1. *3D resolution, mm* set between 0.03 and 0.06;
 2. *Fill holes*: All (watertight);
 3. *Glare-noise reduction*.



Fig. 12. The parameters set to run the *Sharp fusion*.

- 21 Once you click on *Apply*, a warning message will appear. Select *Run Fusion* to proceed (Fig. 13). The software will then create a 3D mesh of the aligned scans.

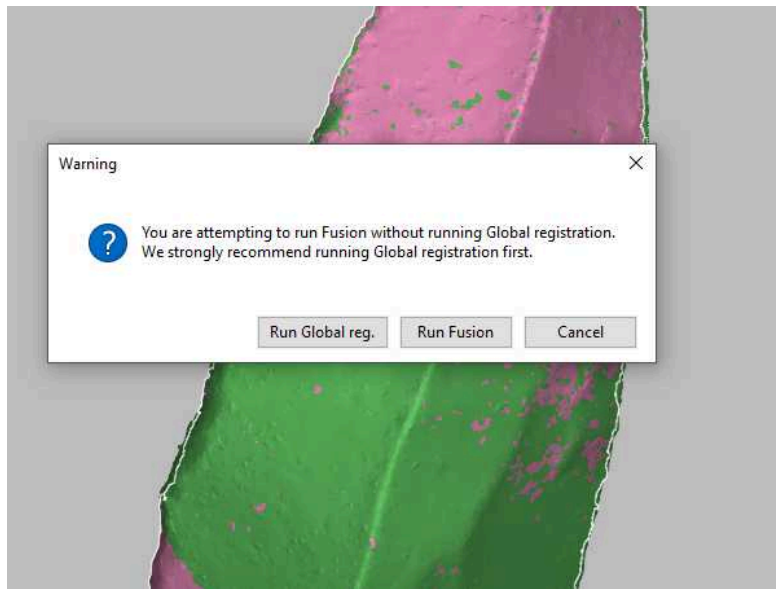


Fig. 13. The warning message that will appear when trying to run a *Sharp fusion* while having the scans locked. Simply press on *Run Fusion* to continue.

Part 4 - Postprocessing phase

- 22 I recommend running a few postprocessing algorithms to increase the quality of the mesh (Fig. 14).

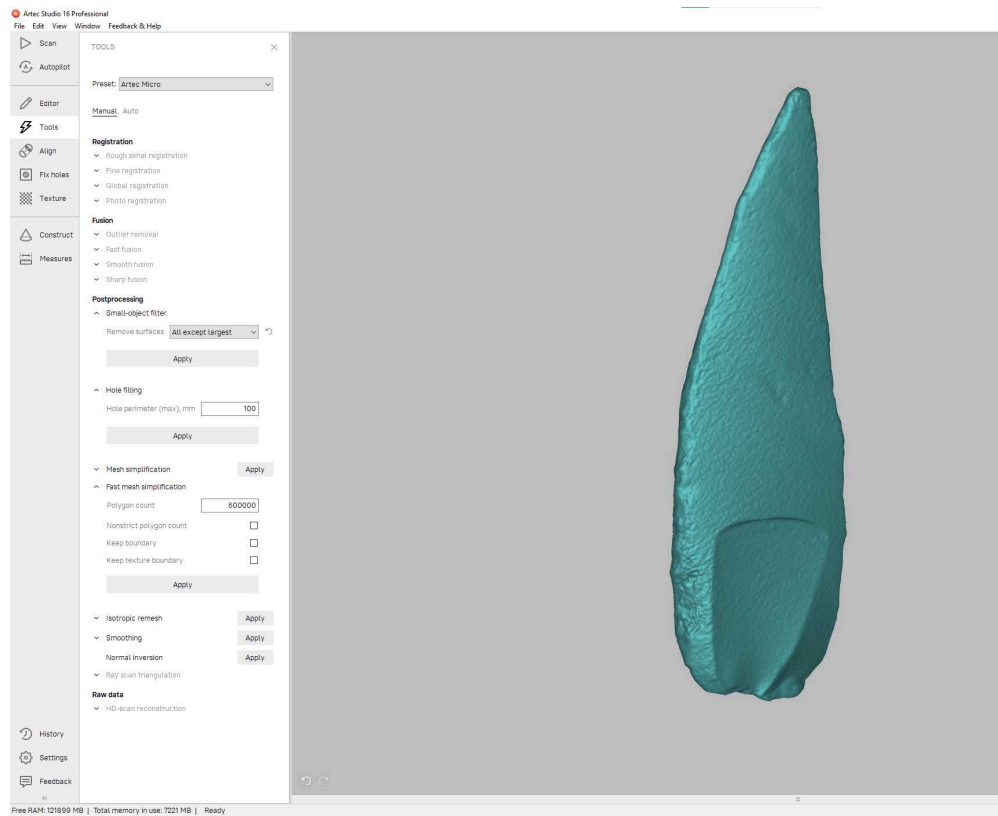


Fig. 14. Postprocessing steps suggested to increase the accuracy of the mesh.

- 22.1 Run the *Small-object filter* with the option *All except largest*.
- 22.2 Run *Hole filling* selecting the *Hole perimeter (max), mm* at e.g. 100.
- 22.3 Finally, run the *Fast mesh simplification*. In this example, I used 600,000 polygons (Fig. 14). There is not an ideal number of polygons to be used. Experiment with different values and visually assess how the quality of the mesh is affected, trying to keep all important features unaltered.
- 23 If the color function was enabled (see Step 11), move to the *Texture* panel and select the scans from which you want to get the texture information. Select the resolution preferred and press *Apply*. Once the texture is applied, the software allows to modify several visual parameters such as saturation, brightness, and hue.

- 24 Save the Artec project going to *File* and selecting *Save project as*.
- 25 Finally, export the 3D model in the preferred format (e.g., .ply, .stl, .obj, .wrl) going to *File*, *Export*, and *Meshes* (Fig. 15). In alternative, just press Ctrl+Shift+E.

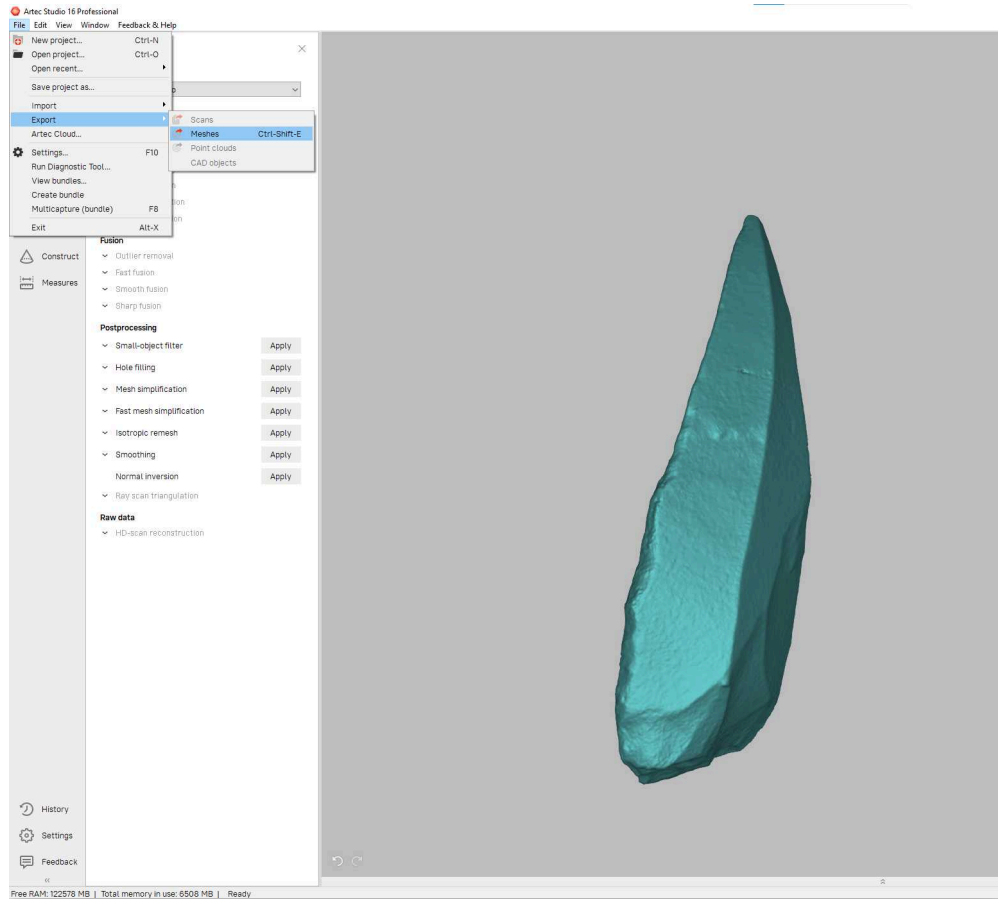


Fig. 15. The final step of the scanning process consists in exporting the mesh in the preferred 3D format.

Final result

- 26 Here you can download the 3D model of the bladelet used in this example. Notice how the retouch, bulbar scar, and the internal fracture on the distal portion of the artifact were successfully captured.

