

# Grain Elevator 2023 — Optimized Digital Twin

High mesh and four-page 8K photoreal texture from 432 aligned RTK images. See the adjacent coverage assessment for explicit limitations.

13 July 2026



# Survey Data

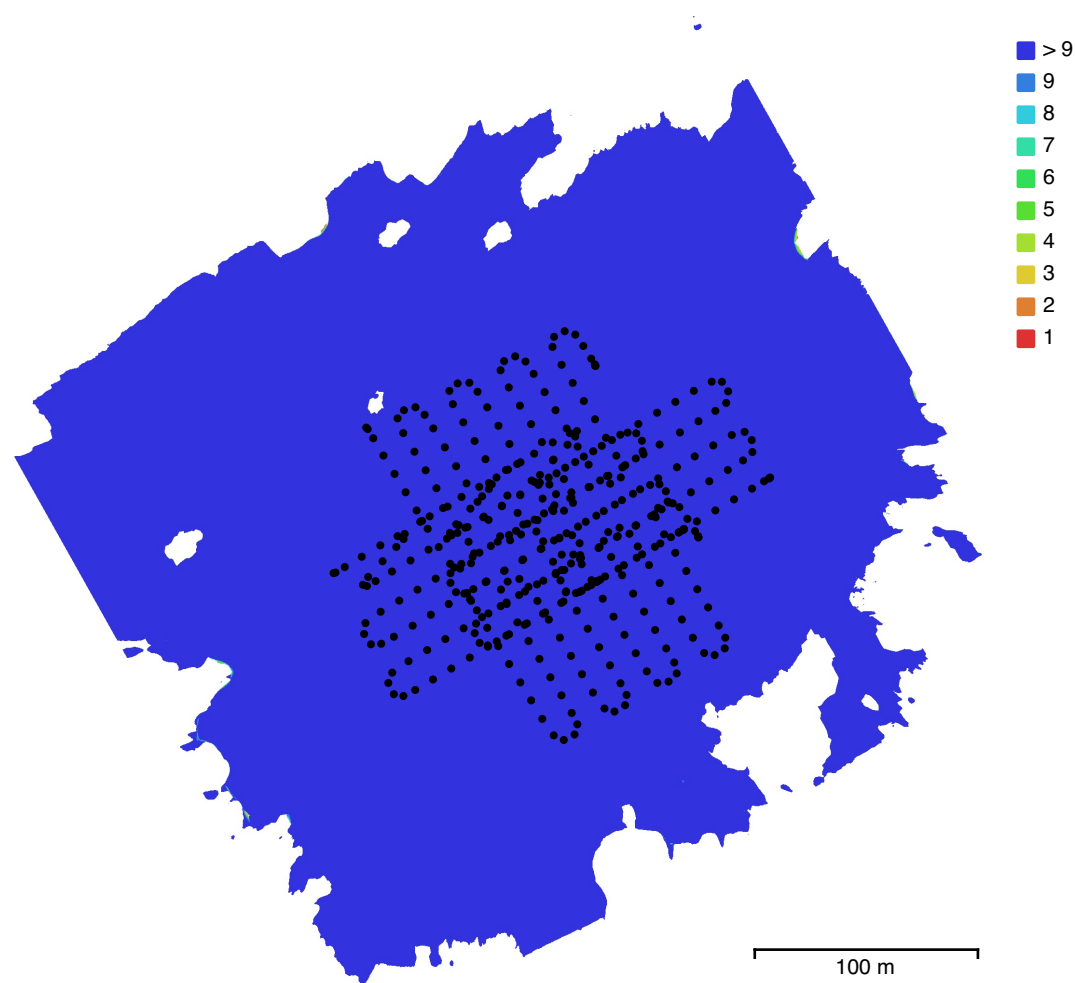


Fig. 1. Camera locations and image overlap.

|                    |                       |                     |           |
|--------------------|-----------------------|---------------------|-----------|
| Number of images:  | 432                   | Camera stations:    | 432       |
| Flying altitude:   | 60.5 m                | Tie points:         | 868,768   |
| Ground resolution: | 1.61 cm/pix           | Projections:        | 2,937,896 |
| Coverage area:     | 0.102 km <sup>2</sup> | Reprojection error: | 0.476 pix |

| Camera Model  | Resolution  | Focal Length | Pixel Size     | Precalibrated |
|---------------|-------------|--------------|----------------|---------------|
| M3E (12.29mm) | 5280 x 3956 | 12.29 mm     | 3.36 x 3.36 μm | Yes           |

Table 1. Cameras.

# Camera Calibration

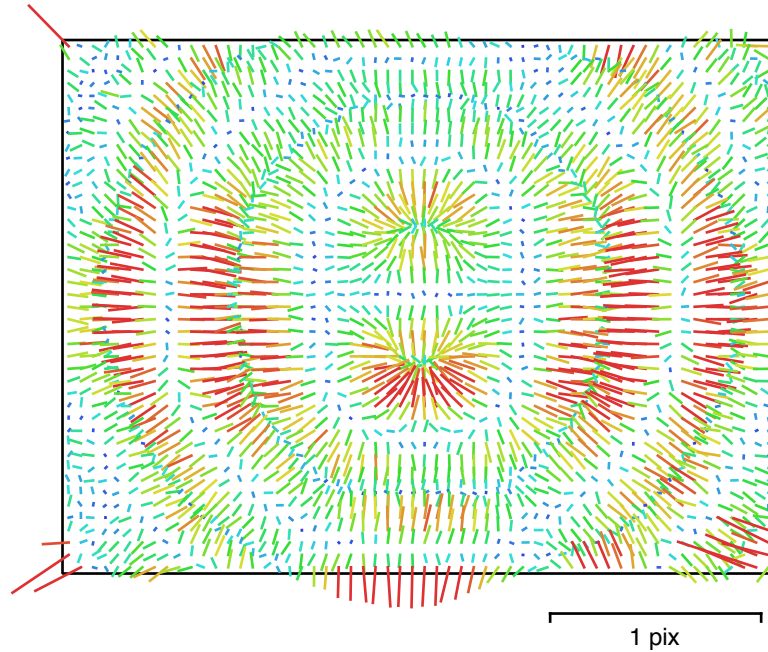


Fig. 2. Image residuals for M3E (12.29mm).

## M3E (12.29mm)

432 images, precalibrated, additional corrections

| Type  | Resolution  | Focal Length | Pixel Size                |
|-------|-------------|--------------|---------------------------|
| Frame | 5280 x 3956 | 12.29 mm     | 3.36 x 3.36 $\mu\text{m}$ |

|    | Value        | Error   | F    | Cx    | Cy    | B1    | B2    | K1    | K2    | K3    | K4    | P1    | P2    |
|----|--------------|---------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| F  | 3768.31      | 0.17    | 1.00 | -0.01 | -0.03 | -0.14 | 0.00  | -0.99 | 0.98  | -0.96 | 0.94  | -0.02 | -0.05 |
| Cx | 9.03715      | 0.027   |      | 1.00  | -0.02 | -0.01 | -0.11 | 0.01  | -0.01 | 0.01  | -0.01 | 0.79  | -0.03 |
| Cy | -62.6698     | 0.033   |      |       | 1.00  | 0.16  | 0.01  | 0.03  | -0.04 | 0.05  | -0.05 | -0.03 | 0.85  |
| B1 | -0.644688    | 0.0077  |      |       |       | 1.00  | 0.01  | 0.16  | -0.19 | 0.20  | -0.21 | 0.00  | 0.18  |
| B2 | 0.112824     | 0.0051  |      |       |       |       | 1.00  | -0.00 | -0.00 | 0.00  | -0.00 | -0.15 | 0.02  |
| K1 | -0.226148    | 0.00031 |      |       |       |       |       | 1.00  | -1.00 | 0.98  | -0.97 | 0.02  | 0.05  |
| K2 | 0.314239     | 0.00079 |      |       |       |       |       |       | 1.00  | -1.00 | 0.98  | -0.02 | -0.06 |
| K3 | -0.352044    | 0.00088 |      |       |       |       |       |       |       | 1.00  | -1.00 | 0.02  | 0.06  |
| K4 | 0.125984     | 0.00036 |      |       |       |       |       |       |       |       | 1.00  | -0.02 | -0.07 |
| P1 | -0.000181029 | 1.6e-06 |      |       |       |       |       |       |       |       |       | 1.00  | -0.03 |
| P2 | -4.77561e-05 | 2.2e-06 |      |       |       |       |       |       |       |       |       |       | 1.00  |

Table 2. Calibration coefficients and correlation matrix.



# Camera Locations



Fig. 3. Camera locations and error estimates.  
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.  
Estimated camera locations are marked with a black dot.

| X error (cm) | Y error (cm) | Z error (cm) | XY error (cm) | Total error (cm) |
|--------------|--------------|--------------|---------------|------------------|
| 1.91505      | 1.77714      | 4.75738      | 2.61259       | 5.42755          |

Table 3. Average camera location error.  
X - Longitude, Y - Latitude, Z - Altitude.

# Digital Elevation Model

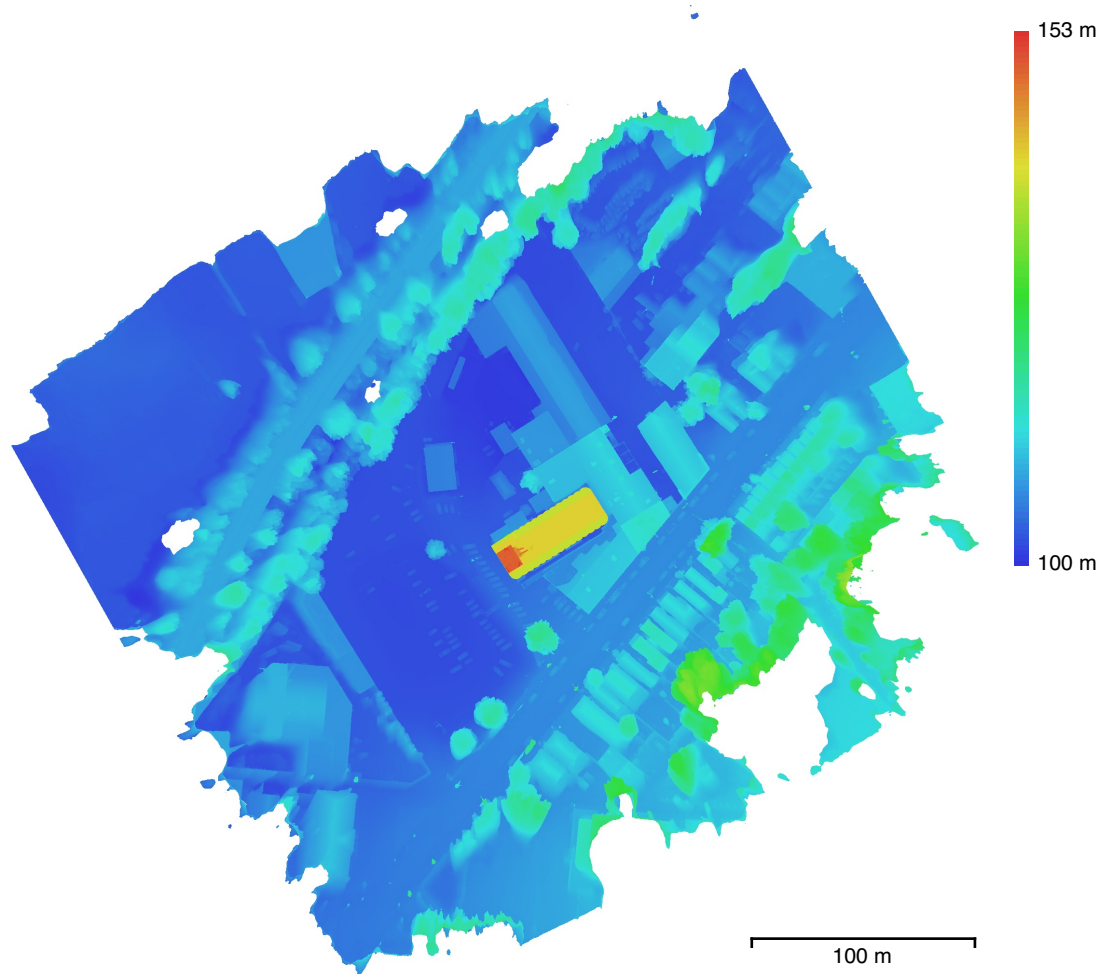


Fig. 4. Reconstructed digital elevation model.

Resolution: 6.39 cm/pix  
Point density: 245 points/m<sup>2</sup>

# Processing Parameters

## General

|                   |                     |
|-------------------|---------------------|
| Images            | 432                 |
| Aligned images    | 432                 |
| Coordinate system | WGS 84 (EPSG::4326) |
| Rotation angles   | Yaw, Pitch, Roll    |

## Tie Points

|                                |                        |
|--------------------------------|------------------------|
| Points                         | 868,768 of 1,456,248   |
| RMS reprojection error         | 0.15518 (0.475993 pix) |
| Max reprojection error         | 0.912682 (8.11982 pix) |
| Mean key point size            | 2.93657 pix            |
| Point colors                   | 3 bands, uint8         |
| Key points                     | No                     |
| Average tie point multiplicity | 4.74946                |

## Alignment parameters

|                               |                      |
|-------------------------------|----------------------|
| Accuracy                      | High                 |
| Generic preselection          | Yes                  |
| Reference preselection        | No                   |
| Key point limit               | 40,000               |
| Key point limit per Mpx       | 1,000                |
| Tie point limit               | 0                    |
| Exclude stationary tie points | Yes                  |
| Guided image matching         | No                   |
| Adaptive camera model fitting | No                   |
| Matching time                 | 3 minutes 10 seconds |
| Matching memory usage         | 2.07 GB              |
| Alignment time                | 3 minutes 28 seconds |
| Alignment memory usage        | 102.84 MB            |

## Optimization parameters

|                               |                                  |
|-------------------------------|----------------------------------|
| Parameters                    | f, b1, b2, cx, cy, k1-k4, p1, p2 |
| Fit additional corrections    | Yes                              |
| Adaptive camera model fitting | No                               |
| Exclude corners               | No                               |
| Optimization time             | 30 seconds                       |
| Date created                  | 2026:07:13 17:54:17              |
| Software version              | 2.1.3.18670                      |
| File size                     | 129.64 MB                        |

## Depth Maps

|       |     |
|-------|-----|
| Count | 432 |
|-------|-----|

## Depth maps generation parameters

|                  |                      |
|------------------|----------------------|
| Quality          | High                 |
| Filtering mode   | Mild                 |
| Max neighbors    | 16                   |
| Processing time  | 19 minutes 6 seconds |
| Memory usage     | 3.10 GB              |
| Date created     | 2026:07:13 18:17:54  |
| Software version | 2.1.3.18670          |
| File size        | 3.36 GB              |

## Model

|               |                |
|---------------|----------------|
| Faces         | 9,616,897      |
| Vertices      | 4,813,545      |
| Vertex colors | 3 bands, uint8 |

|                                         |                                        |
|-----------------------------------------|----------------------------------------|
| Texture                                 | 8,192 x 8,192 x 4, 3 bands, uint8      |
| <b>Depth maps generation parameters</b> |                                        |
| Quality                                 | High                                   |
| Filtering mode                          | Mild                                   |
| Max neighbors                           | 16                                     |
| Processing time                         | 19 minutes 6 seconds                   |
| Memory usage                            | 3.10 GB                                |
| <b>Reconstruction parameters</b>        |                                        |
| Surface type                            | Arbitrary                              |
| Source data                             | Depth maps                             |
| Interpolation                           | Enabled                                |
| Strict volumetric masks                 | No                                     |
| Processing time                         | 9 minutes 5 seconds                    |
| Memory usage                            | 18.93 GB                               |
| <b>Texturing parameters</b>             |                                        |
| Mapping mode                            | Generic                                |
| Blending mode                           | Mosaic                                 |
| Texture size                            | 8,192                                  |
| Enable hole filling                     | Yes                                    |
| Enable ghosting filter                  | Yes                                    |
| UV mapping time                         | 1 minutes 15 seconds                   |
| UV mapping memory usage                 | 2.25 GB                                |
| Blending time                           | 23 minutes 33 seconds                  |
| Blending memory usage                   | 29.70 GB                               |
| Date created                            | 2026:07:13 21:18:32                    |
| Software version                        | 2.1.3.18670                            |
| File size                               | 729.77 MB                              |
| <b>Additional Parameters</b>            |                                        |
| Source images                           | 432 / 432 aligned                      |
| Depth maps                              | Preserved High quality, Mild filtering |
| Mesh                                    | High — 9,616,897 faces                 |
| Texture                                 | 4 x 8192px, Mosaic, AA2                |
| Accuracy caveat                         | No independent checkpoint/GCP test     |
| <b>System</b>                           |                                        |
| Software name                           | Agisoft Metashape Professional         |
| Software version                        | 2.1.3 build 18670                      |
| OS                                      | Mac OS 64 bit                          |
| RAM                                     | 64.00 GB                               |
| CPU                                     |                                        |
| GPU(s)                                  | Apple M4 Max                           |