

Protokol o výpočtu

3D virtuálního modelu
PVP Bukov

13 April 2021



Survey Data

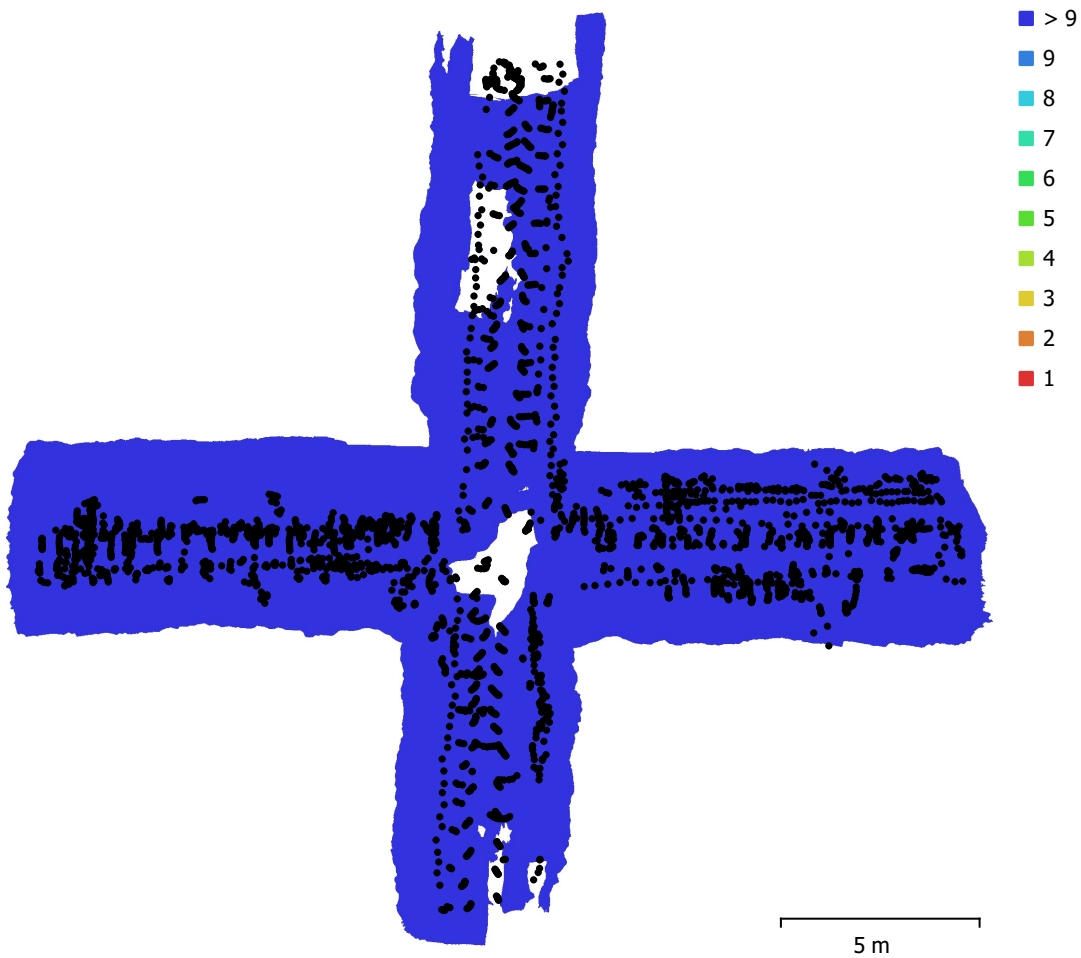


Fig. 1. Camera locations and image overlap.

Number of images:	3,859	Camera stations:	3,730
Flying altitude:	1.75 m	Tie points:	476,533
Ground resolution:	0.624 mm/pix	Projections:	3,862,396
Coverage area:	182 m ²	Reprojection error:	0.545 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
NIKON D3100 (18mm)	3456 x 2304	18 mm	6.94 x 6.94 μm	No
Canon EOS 7D (18mm)	5184 x 3456	18 mm	4.41 x 4.41 μm	No
Canon EOS 7D (18mm)	3456 x 2304	18 mm	6.61 x 6.61 μm	No
NIKON D3100 (30mm)	3456 x 2304	30 mm	6.94 x 6.94 μm	No
Canon EOS 7D (18mm)	2304 x 3456	18 mm	6.61 x 6.61 μm	No

Table 1. Cameras.

Camera Calibration

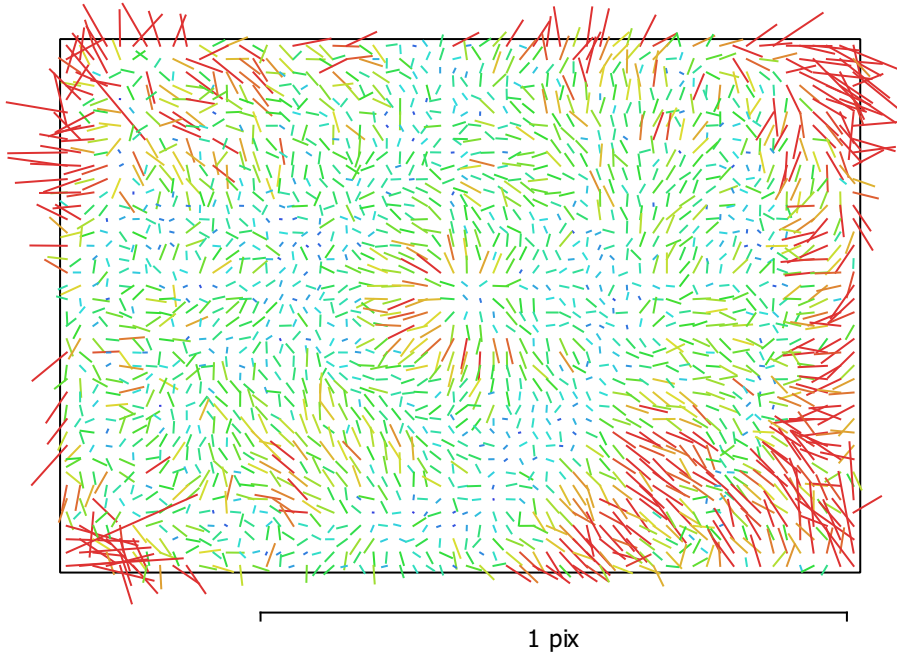


Fig. 2. Image residuals for NIKON D3100 (18mm).

NIKON D3100 (18mm)

2223 images

Type	Resolution	Focal Length	Pixel Size
Frame	3456 x 2304	18 mm	6.94 x 6.94 μm
F:	2750.93		
Cx:	14.6117	B1:	0.0878499
Cy:	6.37629	B2:	-0.172795
K1:	-0.0792385	P1:	0.000430217
K2:	-0.0241636	P2:	0.000303425
K3:	0.0752489	P3:	0
K4:	-0.0488236	P4:	0

Camera Calibration

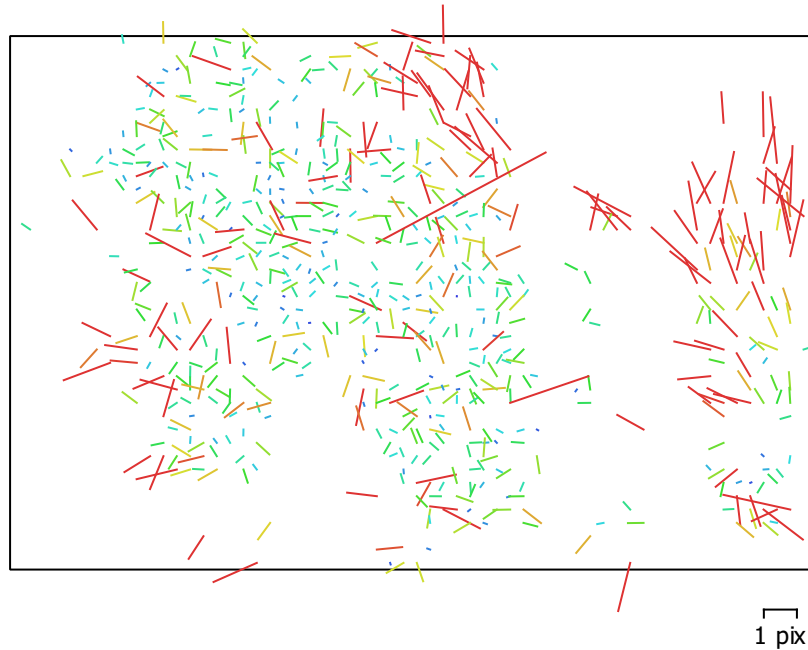


Fig. 3. Image residuals for Canon EOS 7D (18mm).

Canon EOS 7D (18mm)

1 images

Type	Resolution	Focal Length	Pixel Size
Frame	5184 x 3456	18 mm	4.41 x 4.41 μm
F:	4256.68		
Cx:	60.4381	B1:	-0.997759
Cy:	-13.471	B2:	-1.06701
K1:	-0.18522	P1:	-0.00123943
K2:	0.163783	P2:	-0.00140871
K3:	-0.022266	P3:	0
K4:	-0.0434307	P4:	0

Camera Calibration

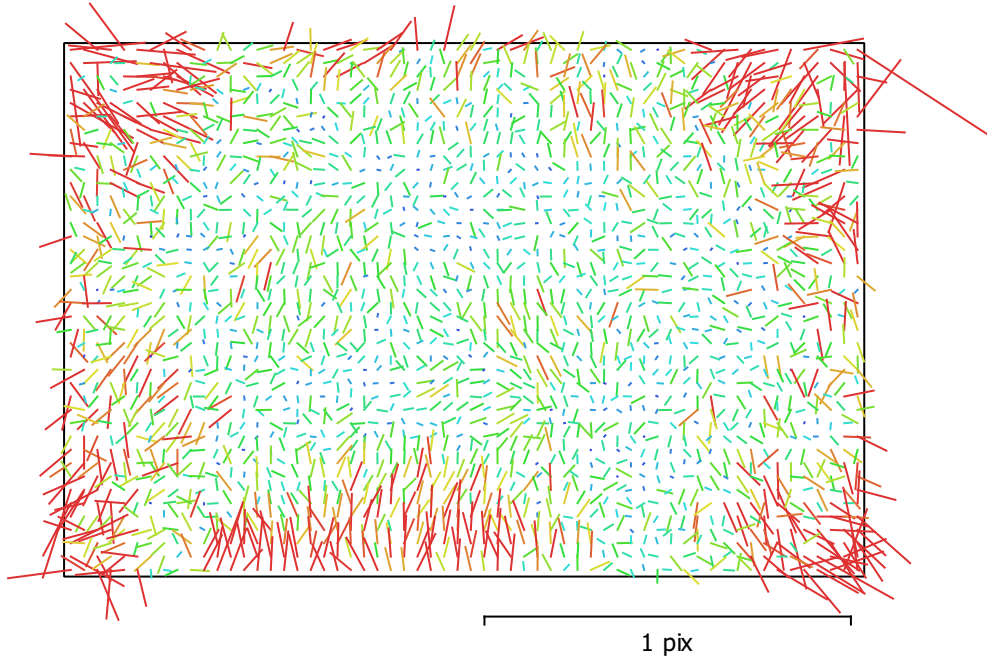


Fig. 4. Image residuals for Canon EOS 7D (18mm).

Canon EOS 7D (18mm)

1619 images

Type	Resolution	Focal Length	Pixel Size
Frame	3456 x 2304	18 mm	6.61 x 6.61 μm
F:	2814.95		
Cx:	46.0025	B1:	0.86139
Cy:	3.45133	B2:	-0.733024
K1:	-0.194043	P1:	0.000125898
K2:	0.184614	P2:	-0.000972121
K3:	-0.124495	P3:	0
K4:	0.0976131	P4:	0

Camera Calibration

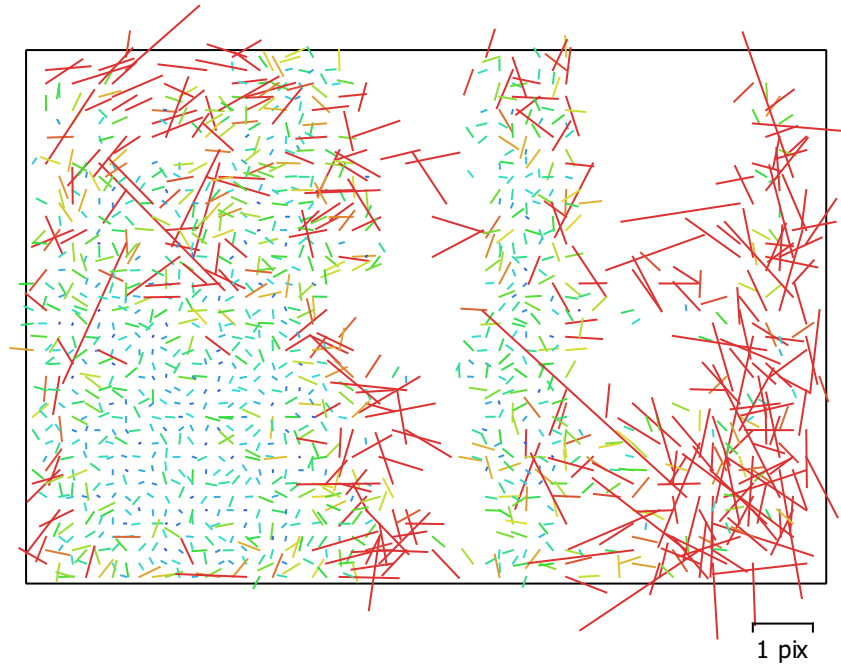


Fig. 5. Image residuals for NIKON D3100 (30mm).

NIKON D3100 (30mm)

9 images

Type	Resolution	Focal Length	Pixel Size
Frame	3456 x 2304	30 mm	6.94 x 6.94 μm
F:	4338.19		
Cx:	5.73526	B1:	2.10571
Cy:	12.2967	B2:	-4.88262
K1:	-0.0377997	P1:	-0.000577728
K2:	-0.0973834	P2:	0.000514948
K3:	0.522475	P3:	0
K4:	-0.849556	P4:	0

Camera Calibration



Fig. 6. Image residuals for Canon EOS 7D (18mm).

Canon EOS 7D (18mm)

7 images

Type	Resolution	Focal Length	Pixel Size
Frame	2304 x 3456	18 mm	6.61 x 6.61 μm
F:	2805.53		
Cx:	-9.55487	B1:	0.0452668
Cy:	43.0604	B2:	0.0412977
K1:	-0.189939	P1:	0.000551767
K2:	0.16489	P2:	-0.000324079
K3:	-0.0874464	P3:	0
K4:	0.0790338	P4:	0

Ground Control Points

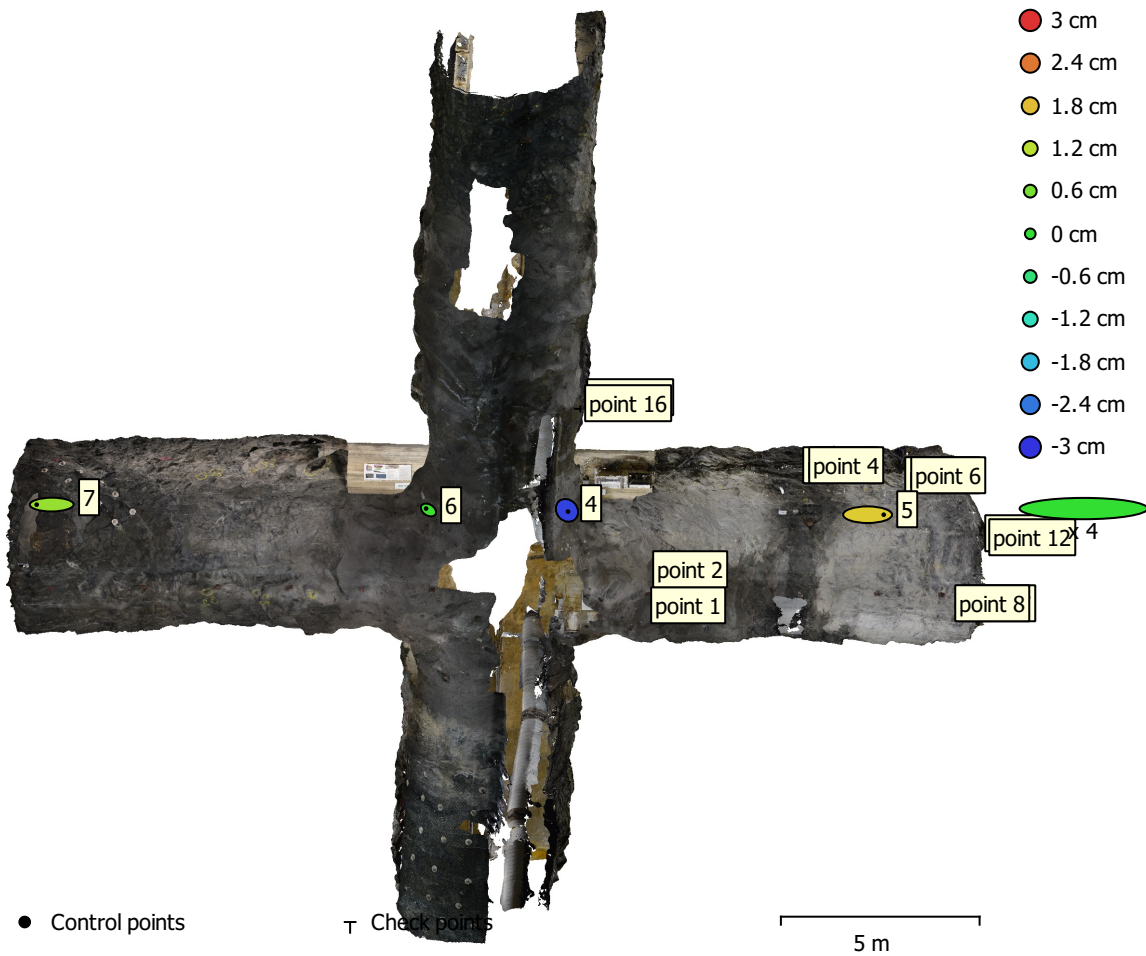


Fig. 7. GCP locations and error estimates.

Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.

Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
4	13.9696	1.19939	1.71456	14.021	14.1255

Table 2. Control points RMSE.

X - Easting, Y - Northing, Z - Altitude.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
6	-2.94836	1.80513	0.119408	3.45913	0.031 (8)
7	-18.8861	-0.102708	0.877648	18.9067	0.134 (27)
4	1.39252	-1.57632	-2.86045	3.5505	0.007 (6)
5	20.3295	-0.0180737	1.67096	20.398	0.170 (27)
Total	13.9696	1.19939	1.71456	14.1255	0.137

Table 3. Control points.
X - Easting, Y - Northing, Z - Altitude.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
point 1					1.533 (45)
point 2					1.282 (37)
point 3					1.129 (28)
point 4					1.376 (20)
point 5					1.414 (16)
point 6					1.089 (17)
point 7					0.578 (8)
point 8					0.549 (12)
point 11					0.420 (19)
point 12					0.550 (14)
point 15					0.949 (23)
point 16					1.234 (17)
Total					

Table 4. Check points.
X - Easting, Y - Northing, Z - Altitude.

Scale Bars

Label	Distance (m)	Error (m)
point 1_point 2	1.78717	-0.0128323
point 3_point 4	0.139771	0.039771
point 5_point 6	0.137211	0.0372108
point 7_point 8	0.139187	0.0391866
point 11_point 12	0.140309	0.0403085
point 15_point 16	0.136186	0.0361863
Total		0.0355923

Table 5. Control scale bars.

Digital Elevation Model

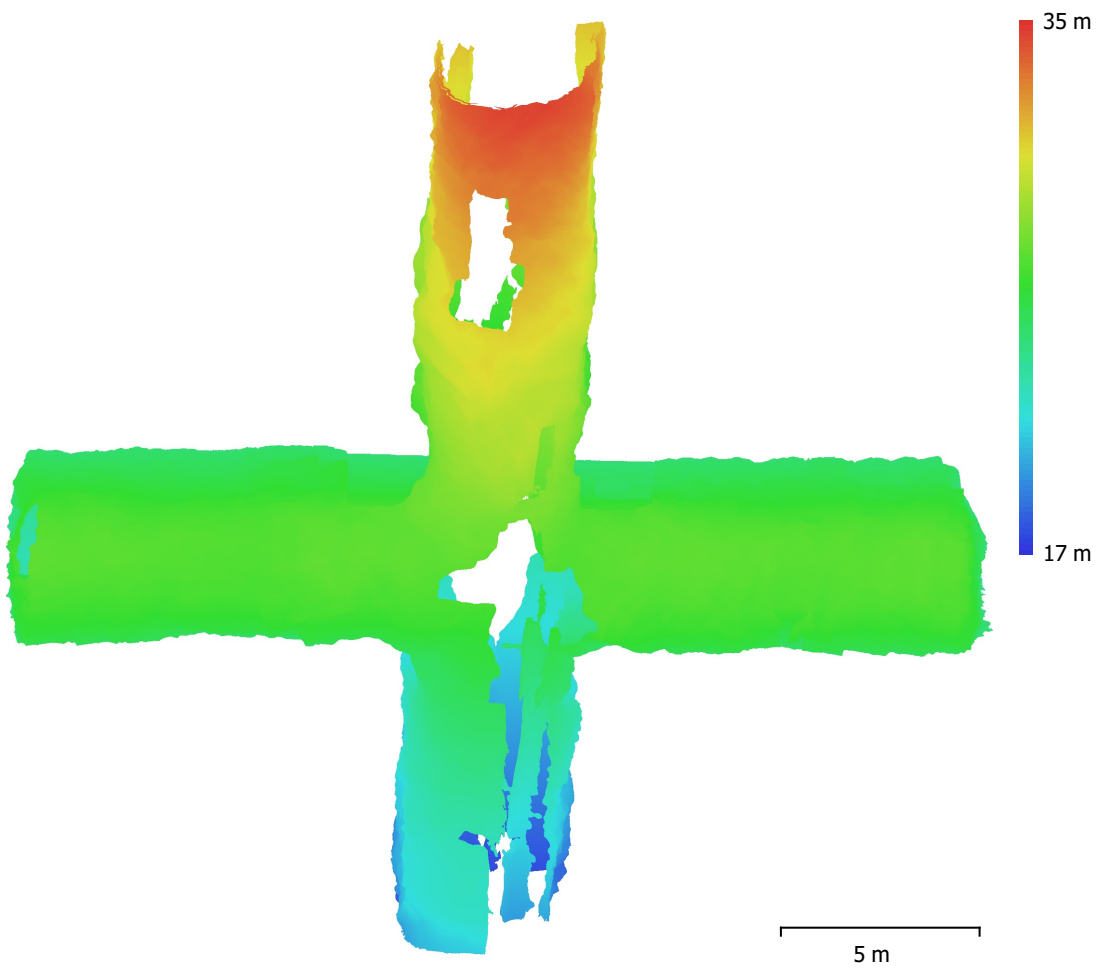


Fig. 8. Reconstructed digital elevation model.

Resolution: 2.5 mm/pix
Point density: 16.1 points/cm²

Processing Parameters

General

Cameras	3859
Aligned cameras	3730
Markers	16
Scale bars	6
Coordinate system	S-JTSK / Krovak East North (EPSG::5514)
Rotation angles	Yaw, Pitch, Roll

Point Cloud

Points	476,533 of 10,754,940
RMS reprojection error	0.193168 (0.54514 pix)
Max reprojection error	4.35598 (14.9065 pix)
Mean key point size	2.80442 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	3.2722

Alignment parameters

Accuracy	High
Generic preselection	Yes
Key point limit	50,000
Tie point limit	0
Adaptive camera model fitting	Yes
Matching time	4 hours 40 minutes
Alignment time	3 hours 53 minutes

Optimization parameters

Parameters	f, b1, b2, cx, cy, k1-k4, p1, p2
Adaptive camera model fitting	No
Optimization time	2 minutes 55 seconds
Software version	1.5.2.7838

Dense Point Cloud

Points	129,809,372
Point colors	3 bands, uint8

Depth maps generation parameters

Quality	Medium
Filtering mode	Mild
Processing time	4 hours 13 minutes

Dense cloud generation parameters

Processing time	5 hours 49 minutes
Software version	1.5.2.7838

Model

Faces	8,622,549
Vertices	4,319,829
Vertex colors	3 bands, uint8
Texture	4,096 x 4,096 x 2, 4 bands, uint8

Depth maps generation parameters

Quality	Medium
Filtering mode	Mild
Processing time	4 hours 13 minutes

Reconstruction parameters

Surface type	Arbitrary
Source data	Dense cloud

General

Interpolation	Enabled
Strict volumetric masks	No
Processing time	2 hours 59 minutes

Texturing parameters

Blending mode	Mosaic
Texture size	4,096
Enable hole filling	No
Enable ghosting filter	No
UV mapping time	9 minutes 36 seconds
Blending time	30 minutes 33 seconds

Software version	1.5.2.7838
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Software

Version	1.5.2 build 7838
Platform	Windows 64