Metadata Report

Project Name

Heave Ho Landslide, Snow Basin Road (UT-226), Morgan County, Utah – Aerial reconnaissance and landslide monitoring project (November 2020)

Summary

The Heave Ho landslide is located along the side of Snow Basin Road (UT-226) in Morgan County, Utah. This was the Utah Geological Survey's (UGS) initial sUAS survey data acquisition for this landslide. Using Structure from Motion (SFM), the landslide was surveyed in November 2020. The UGS received field assistance from Weber State University (WSU) for this survey campaign.

Personnel

- PI(s)

Adam I. Hiscock (adamhiscock@utah.gov)

- Field staff

Adam I. Hiscock, Ben E. Erickson, Jessica Castleton, Brooklyn Smout

- Additional team members

Dr. Michael W. Hernandez (WSU)

Site Information

- Site description

Landslide along Snow Basin Road (Utah Highway 226) in Morgan County, Utah.

- Site objective

Collect SFM data for the active landslide to assist in landslide monitoring and movement.

- Site location (GPS cords and/or map)

41.210288°, -111.843369°

- Site conditions

Mid-morning, cool temperature, clear skies

- Date/time spent at each site

Flights conducted on 11/4/2020 at approximately 10:20 AM

Survey Results

- Equipment used

DJI Mavic 2 Pro drone with 20 MP camera and fixed 10.26 mm focal length for image collection. Trimble R8 GNSS unit for Ground Control Point (GCP) survey data collection.

- GPS solutions

6 GCPs were surveyed using the Utah Reference Network (TURN) real-time kinematic network and processed in WGS 84.

- Errors

Overall point cloud error was 5.48 cm using all 6 GCPs. GCP error was 5.45 cm horizontal and 0.65 cm vertical.

- Alignments
- Collection methods

468 images were acquired from 130 ft (40 m) altitude at nadir. Camera positions, overlaps, and orientations were controlled automatically using Pix4D software running on an iPad. Images were processed using Agisoft Metashape Professional (see below for processing details). GCPs were provided by installing orange, black, and white bucket lid targets for visibility in images. GCPs were surveyed and processed in UTM North Zone 12, WGS 84 Datum, g20aus geoid.

Products

- Date of dataset collection

11/4/2020

- Coordinate system of datasets

WGS 84 datum (EPSG::4326)

- Spatial resolution

Ground resolution – 8.86 mm/pix, DEM resolution 3.54 cm/pix, Point density – 797 points/m^2

- Horizontal Accuracy

5.45 cm

- Vertical Accuracy

0.65 cm

- Data formats

Raw point cloud is provided in .LAZ format. DEM and orthomosaic are provided as geotiff.

- Data processing methods

Point cloud, DEM, and orthomosaic data were generated by Agisoft Metashape Professional.

Misc Notes

Please send any questions about this dataset to adamhiscock@utah.gov

Agisoft Metashape Metadata Report

Processing Report
Heave-Ho Landslide, November 2020, Snowbasin Road, Morgan County, Utah
10 November 2021

Survey Data

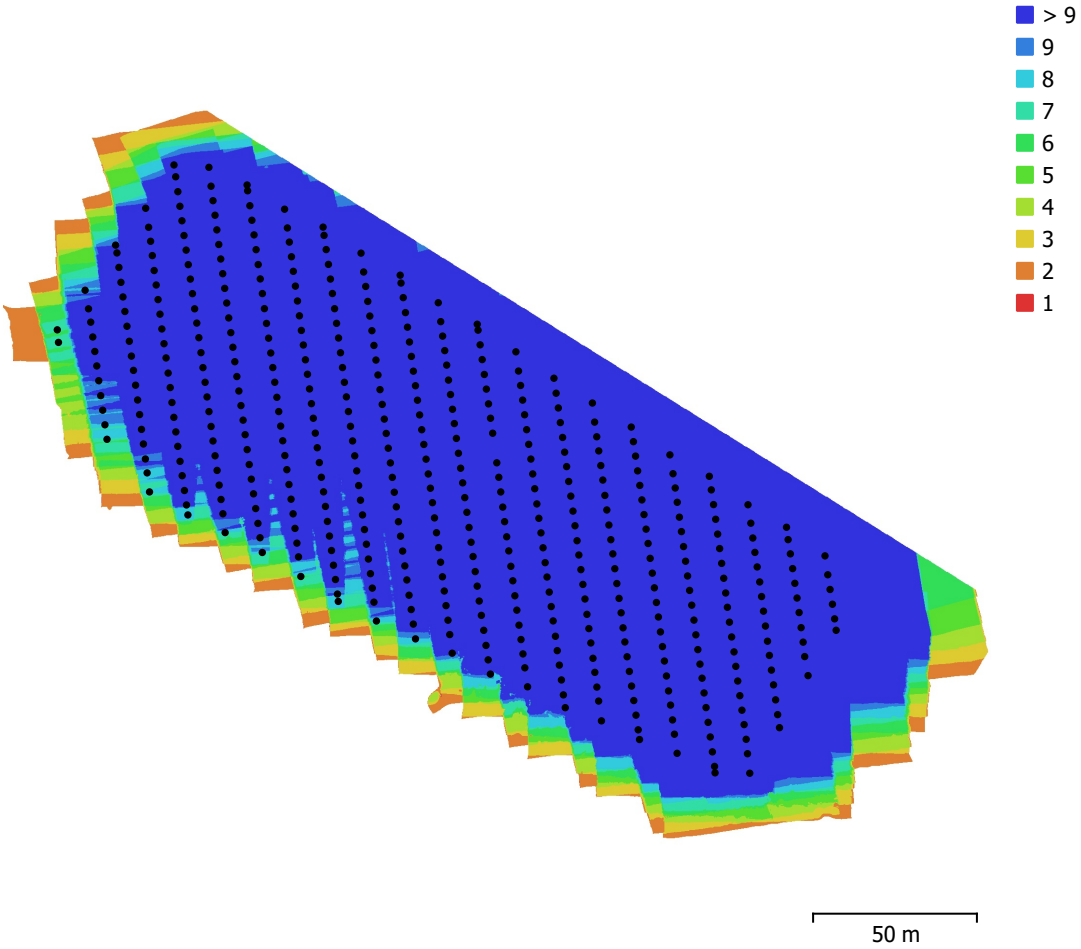

Fig. 1. Camera locations and image overlap.

Number of images:	468	Camera stations:	468
Flying altitude:	39.1 m	Tie points:	500,995
Ground resolution:	8.86 mm/pix	Projections:	1,794,182
Coverage area:	0.0324 km²	Reprojection error:	0.588 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
L1D-20c (10.26mm)	5472 x 3648	10.26 mm	2.41 x 2.41 µm	No

Table 1. Cameras.

Camera Calibration

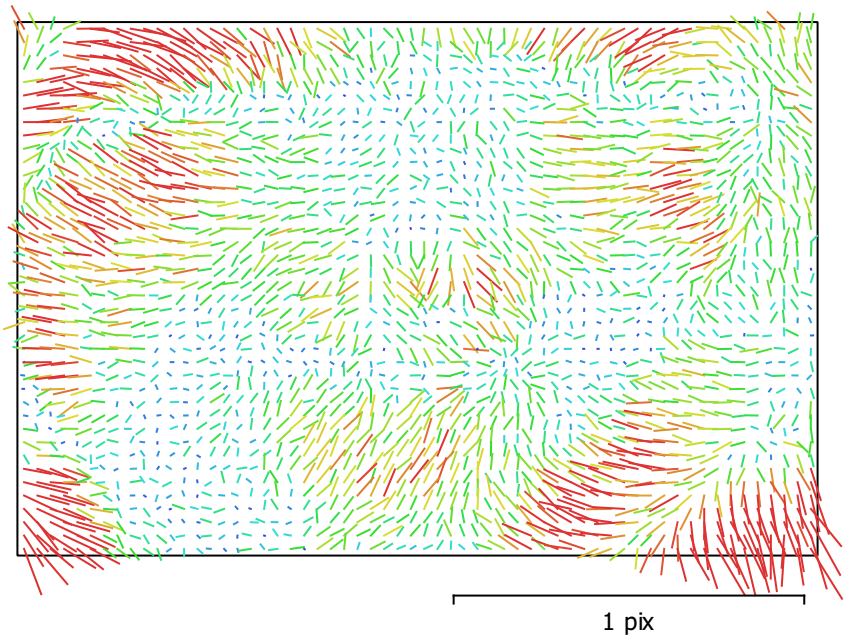

Fig. 2. Image residuals for L1D-20c (10.26mm).

L1D-20c (10.26mm)

468 images

Type	Resolution	Focal Length	Pixel Size
Frame	**5472 x 3648**	**10.26 mm**	**2.41 x 2.41 µm**

	Value	Error	F	Cx	Cy	K1	K2	K3	P1	P2
F	**4269.51**	0.75	1.00	-0.89	0.80	-0.31	0.15	-0.24	0.11	-0.11
Cx	**2.74062**	0.047		1.00	-0.72	0.27	-0.13	0.20	0.24	0.09
Cy	**-20.4024**	0.032			1.00	-0.25	0.12	-0.18	0.07	0.30
K1	**-0.0155421**	2.8e-05				1.00	-0.93	0.89	-0.06	0.04
K2	**0.0202362**	9.9e-05					1.00	-0.98	0.03	-0.01
K3	**-0.0252084**	0.00011						1.00	-0.03	0.02
P1	**-0.00017808**	1.6e-06							1.00	-0.04
P2	**-0.000113633**	1.4e-06								1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Locations

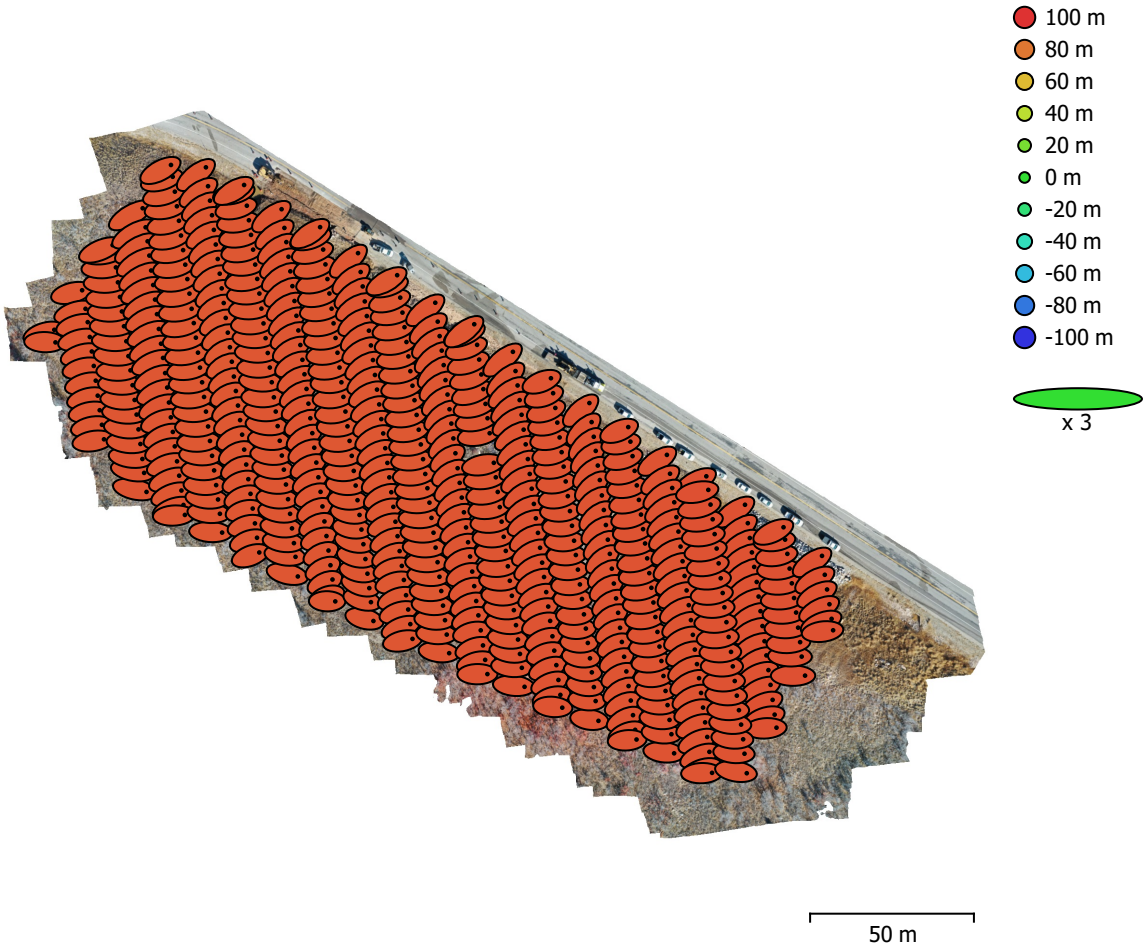

Fig. 3. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
2.03286	0.781575	89.8192	2.17793	89.8456

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

Ground Control Points

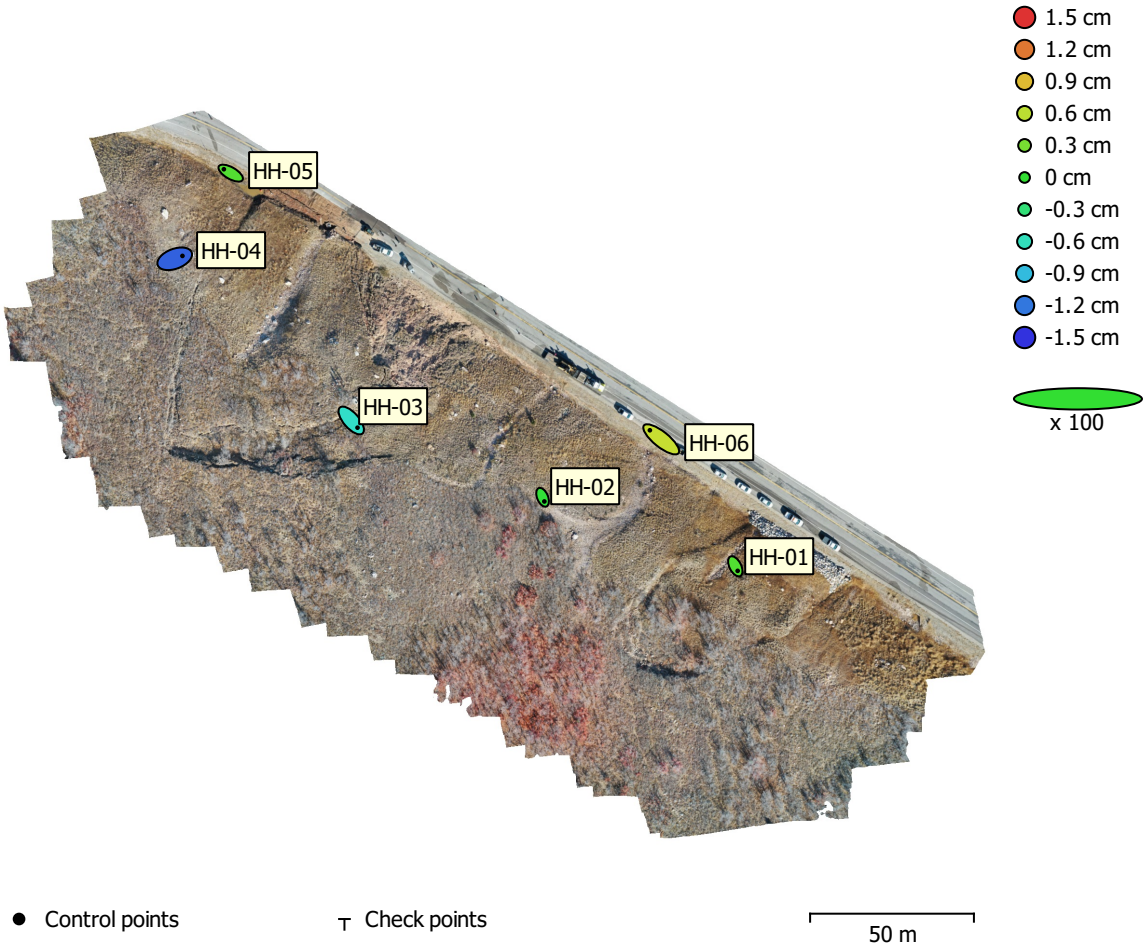

Fig. 4. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
6	4.18915	3.4868	0.654098	5.45039	5.4895

Table 4. Control points RMSE.
X - Longitude, Y - Latitude, Z - Altitude.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
HH-01	1.43791	-2.77185	0.137523	3.12564	1.149 (37)
HH-02	1.08113	-2.5474	-0.0300313	2.76749	1.057 (38)
HH-03	3.83728	-4.38656	-0.654671	5.86475	0.964 (22)
HH-04	4.70453	1.77314	-1.29487	5.19166	0.845 (19)
HH-05	-4.16989	2.38539	0.141638	4.80605	0.862 (18)
HH-06	-6.91463	5.5406	0.649547	8.88439	0.961 (20)
Total	**4.18915**	**3.4868**	**0.654098**	**5.4895**	**1.010**

Table 5. Control points.
X - Longitude, Y - Latitude, Z - Altitude.

Digital Elevation Model

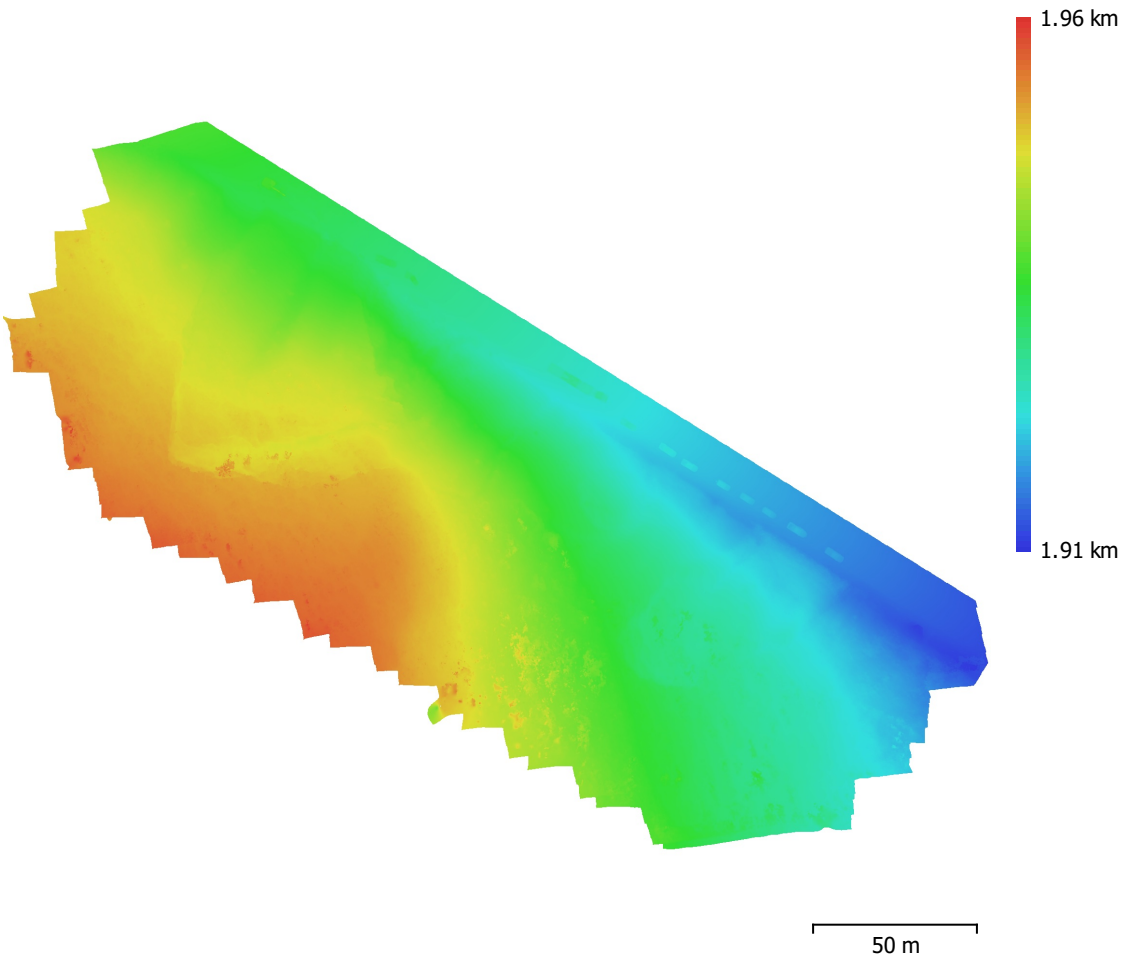

Fig. 5. Reconstructed digital elevation model.

Resolution:	3.54 cm/pix
Point density:	797 points/m²

Processing Parameters

General	
Cameras	468
Aligned cameras	468
Markers	6
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	500,995 of 579,389
RMS reprojection error	0.131546 (0.587705 pix)
Max reprojection error	0.404574 (44.2709 pix)
Mean key point size	3.46361 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	4.71618
Alignment parameters	
Accuracy	High
Generic preselection	Yes
Reference preselection	Estimated
Key point limit	40,000
Tie point limit	6,000
Exclude stationary tie points	Yes
Guided image matching	No
Adaptive camera model fitting	No
Matching time	8 minutes 58 seconds
Matching memory usage	1.09 GB
Alignment time	9 minutes 28 seconds
Alignment memory usage	347.20 MB
Date created	2021:03:12 02:58:02
Software version	1.7.1.11797
File size	54.88 MB
Dense Point Cloud	
Points	37,288,059
Point colors	3 bands, uint8
Depth maps generation parameters	
Quality	Medium
Filtering mode	Mild
Processing time	52 minutes 10 seconds
Memory usage	2.68 GB
Dense cloud generation parameters	
Processing time	36 minutes 31 seconds
Memory usage	5.17 GB
Date created	2021:03:12 05:04:31
Software version	1.7.1.11797
File size	486.55 MB
Model	
Faces	7,457,578
Vertices	3,736,941
Vertex colors	3 bands, uint8
Texture	4,096 x 4,096, 4 bands, uint8
Depth maps generation parameters	

Quality	Medium
Filtering mode	Mild
Processing time	52 minutes 10 seconds
Memory usage	2.68 GB
Reconstruction parameters	
Surface type	Arbitrary
Source data	Dense cloud
Interpolation	Enabled
Strict volumetric masks	No
Processing time	21 minutes 26 seconds
Memory usage	18.98 GB
Texturing parameters	
Mapping mode	Adaptive orthophoto
Blending mode	Mosaic
Texture size	4,096
Enable hole filling	Yes
Enable ghosting filter	Yes
UV mapping time	54 seconds
UV mapping memory usage	3.01 GB
Blending time	6 minutes 47 seconds
Blending memory usage	3.26 GB
Date created	2021:03:12 05:04:32
Software version	1.7.1.11797
File size	340.48 MB
DEM	
Size	10,325 x 8,407
Coordinate system	WGS 84 (EPSG::4326)
Reconstruction parameters	
Source data	Dense cloud
Interpolation	Enabled
Processing time	39 seconds
Memory usage	305.69 MB
Date created	2021:11:10 18:31:51
Software version	1.7.4.13028
File size	87.04 MB
Orthomosaic	
Size	34,025 x 25,305
Coordinate system	WGS 84 (EPSG::4326)
Colors	3 bands, uint8
Reconstruction parameters	
Blending mode	Mosaic
Surface	Mesh
Enable hole filling	Yes
Enable ghosting filter	No
Processing time	14 minutes 13 seconds
Memory usage	3.11 GB
Date created	2021:11:10 17:37:01
Software version	1.7.4.13028
File size	13.65 GB
System	
Software name	Agisoft Metashape Professional
Software version	1.7.4 build 13028
OS	Windows 64 bit
RAM	31.92 GB
CPU	Intel(R) Xeon(R) CPU E5-1630 v4 @ 3.70GHz
GPU(s)	Quadro M4000