

# Quality Report



Generated with Pix4Dmapper version 4.3.31



**Important:** Click on the different icons for:



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Additional information about the sections



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## Summary



Project	eldo_3k_1
Processed	2019-01-13 17:44:07
Camera Model Name(s)	RedEdge_5.5_1280x960 (Blue), RedEdge_5.5_1280x960 (Green), RedEdge_5.5_1280x960 (Red), RedEdge_5.5_1280x960 (NIR), RedEdge_5.5_1280x960 (Red edge), FC350_3.6_4000x3000 (RGB)
Rig name(s)	«McaSense 5 band»
Average Ground Sampling Distance (GSD)	7.41 cm / 2.92 in
Area Covered	0.000 km <sup>2</sup> / 0.0000 ha / 0.00 sq. mi. / 0.0001 acres

## Quality Check



Images	median of 28903 keypoints per image	
Dataset	12077 out of 12417 images calibrated (97%), 5 images disabled	
Camera Optimization	2.32% relative difference between initial and optimized internal camera parameters	
Matching	median of 3097.92 matches per calibrated image	
Georeferencing	yes, no 3D GCP	

## Preview

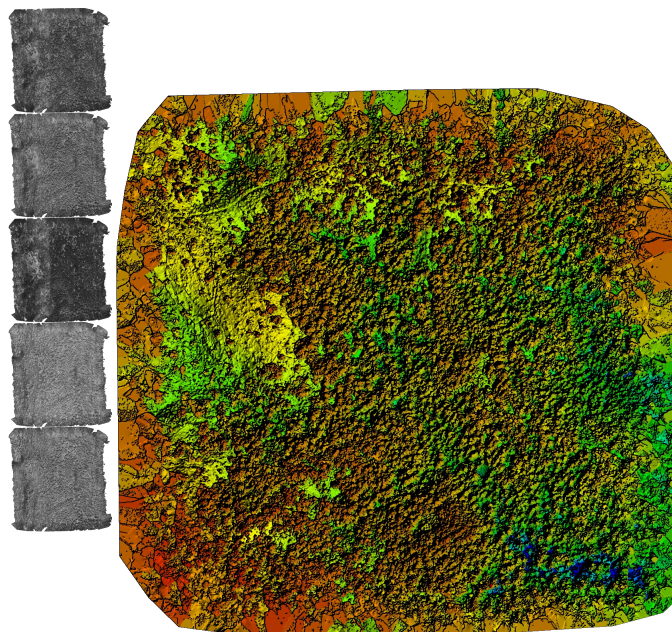


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

# Calibration Details



Number of Calibrated Images	12077 out of 12422
Number of Geolocated Images	12422 out of 12422

## Initial Image Positions

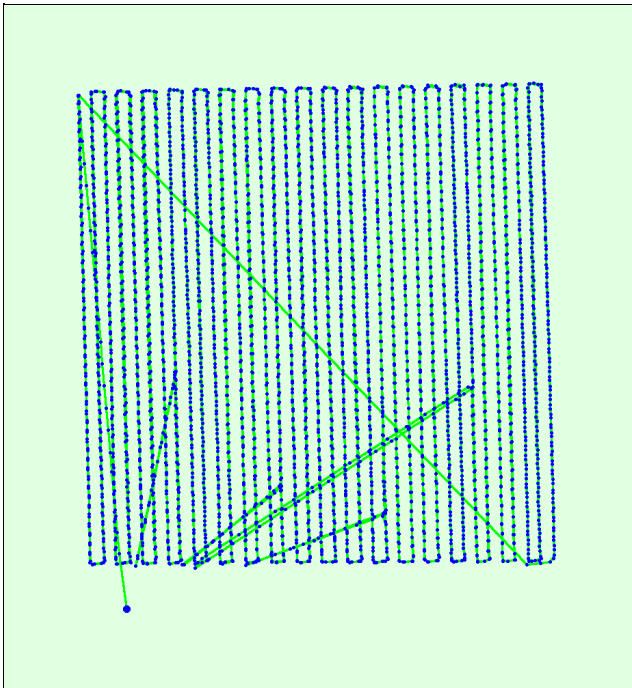
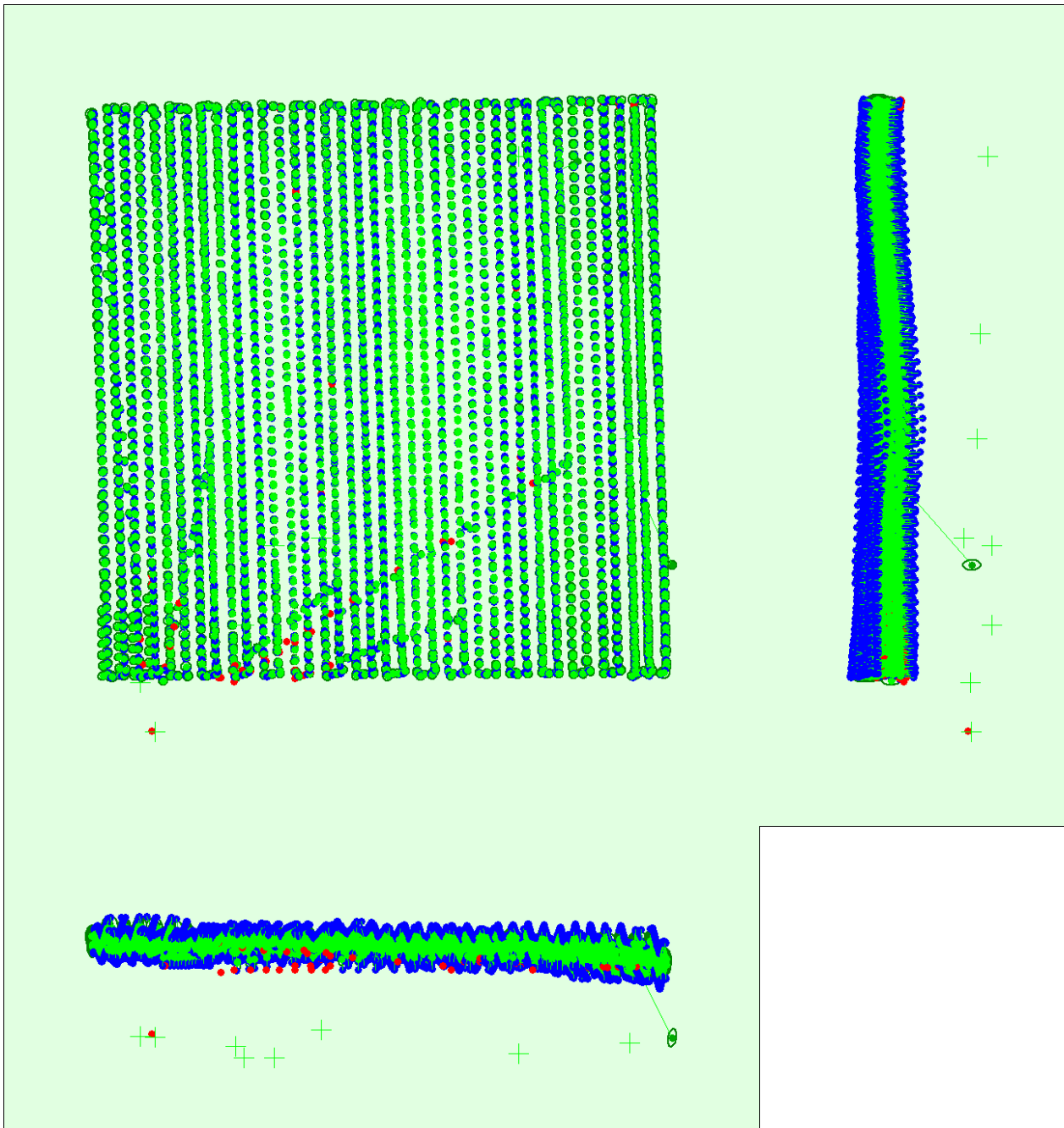


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

## Computed Image/GCPs/Manual Tie Points Positions





Uncertainty ellipses 50x magnified

Figure 3: Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Red dots indicate disabled or uncalibrated images. Dark green ellipses indicate the absolute position uncertainty of the bundle block adjustment result.

**? Absolute camera position and orientation uncertainties**



	X[m]	Y[m]	Z[m]	Omega [degree]	Phi [degree]	Kappa [degree]
Mean	0.076	0.076	0.152	0.032	0.031	0.013
Sigma	0.013	0.013	0.026	0.004	0.004	0.002

**? Overlap**



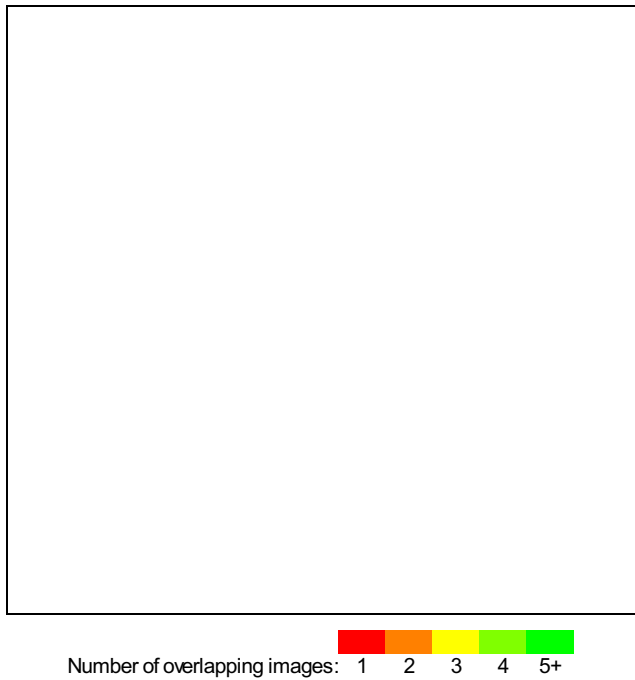



Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint matches is also sufficient for these areas (see Figure 5 for keypoint matches).

## Bundle Block Adjustment Details

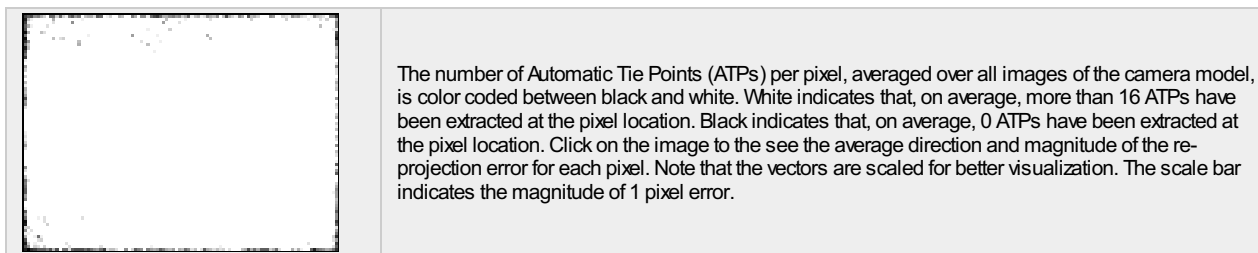
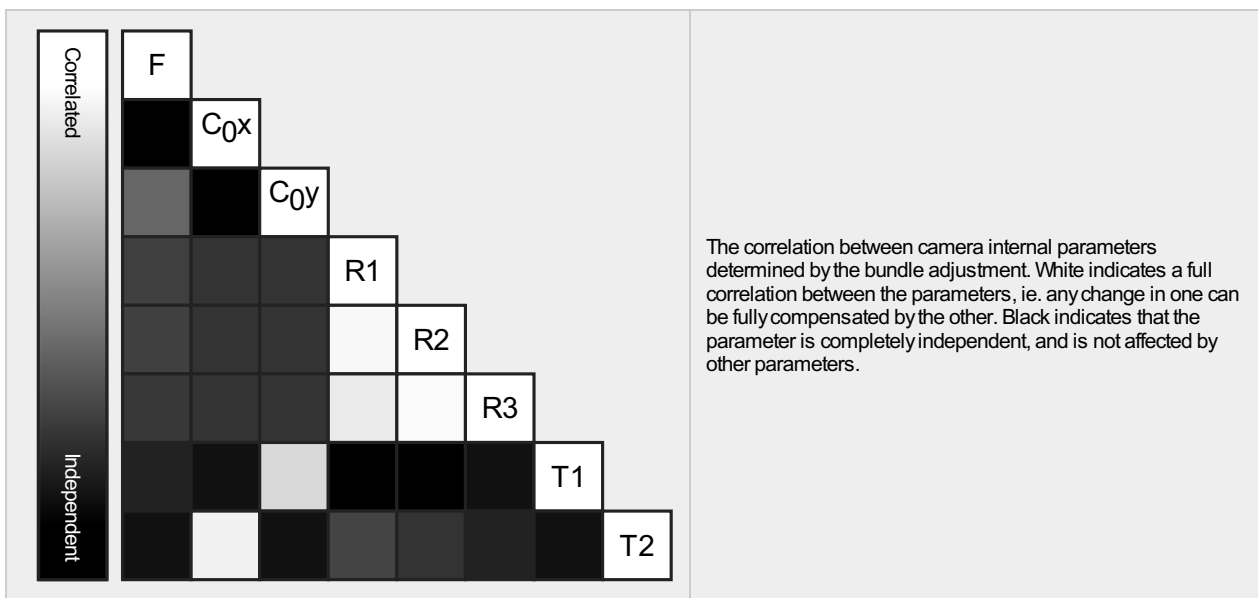
Number of 2D Keypoint Observations for Bundle Block Adjustment	14699057
Number of 3D Points for Bundle Block Adjustment	5893651
Mean Reprojection Error [pixels]	0.197

### Internal Camera Parameters

 RedEdge\_5.5\_1280x960 (Blue). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

EXIF ID: RedEdge\_5.5\_1280x960

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	1466.667 [pixel] 5.500 [mm]	657.605 [pixel] 2.466 [mm]	495.123 [pixel] 1.857 [mm]	-0.097	0.149	-0.017	0.000	0.000
Optimized Values	1448.138 [pixel] 5.431 [mm]	653.784 [pixel] 2.452 [mm]	495.412 [pixel] 1.858 [mm]	-0.093	0.135	-0.008	0.000	-0.001
Uncertainties (Sigma)	0.177 [pixel] 0.001 [mm]	0.142 [pixel] 0.001 [mm]	0.106 [pixel] 0.000 [mm]	0.001	0.007	0.015	0.000	0.000



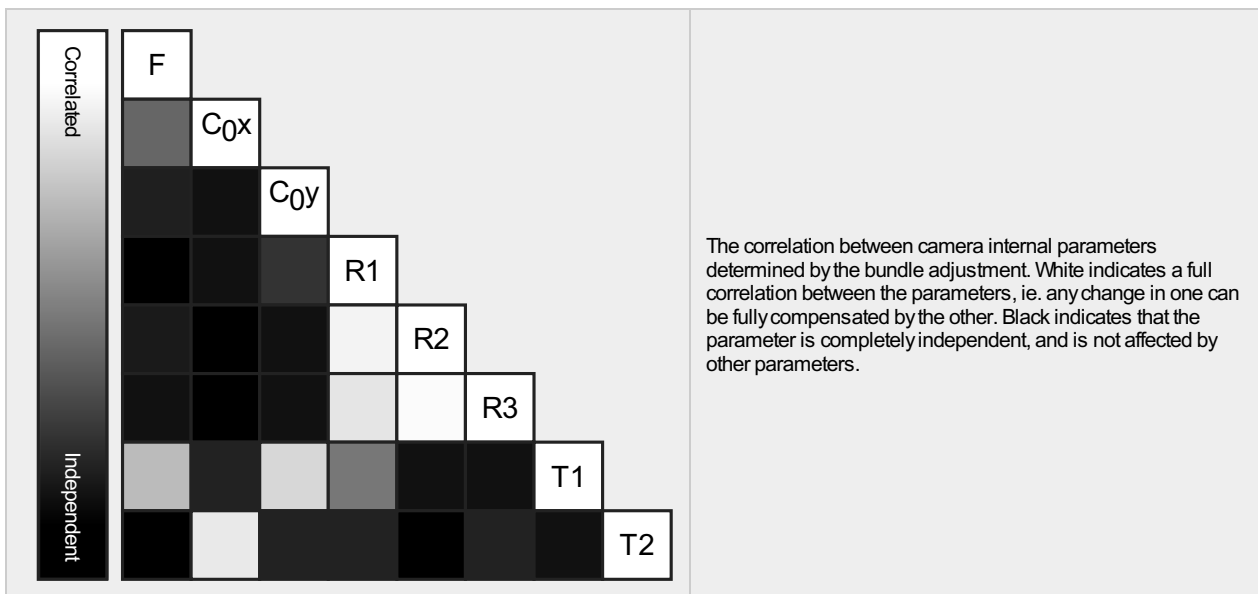
## Internal Camera Parameters

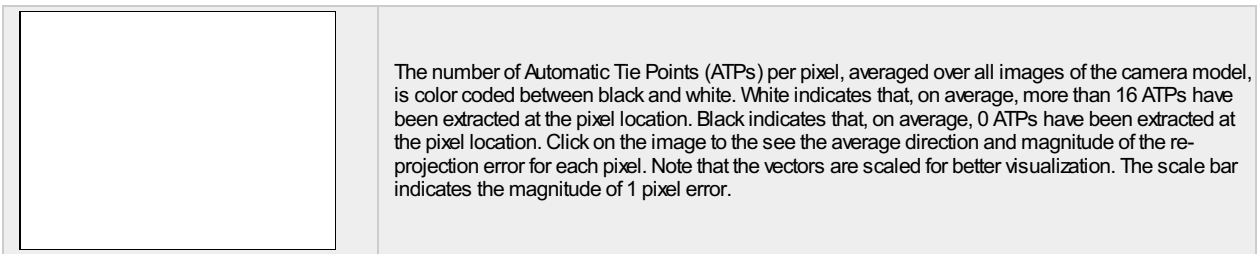
RedEdge\_5.5\_1280x960 (Green). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]



EXIF ID: RedEdge\_5.5\_1280x960

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	1466.667 [pixel] 5.500 [mm]	657.835 [pixel] 2.467 [mm]	481.299 [pixel] 1.805 [mm]	-0.099	0.143	-0.021	0.000	0.001
Optimized Values	1445.137 [pixel] 5.419 [mm]	655.525 [pixel] 2.458 [mm]	481.587 [pixel] 1.806 [mm]	-0.099	0.151	-0.036	0.000	0.000
Uncertainties (Sigma)	0.169 [pixel] 0.001 [mm]	0.043 [pixel] 0.000 [mm]	0.035 [pixel] 0.000 [mm]	0.000	0.002	0.004	0.000	0.000





The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

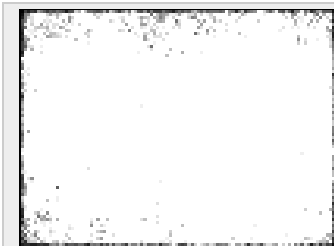
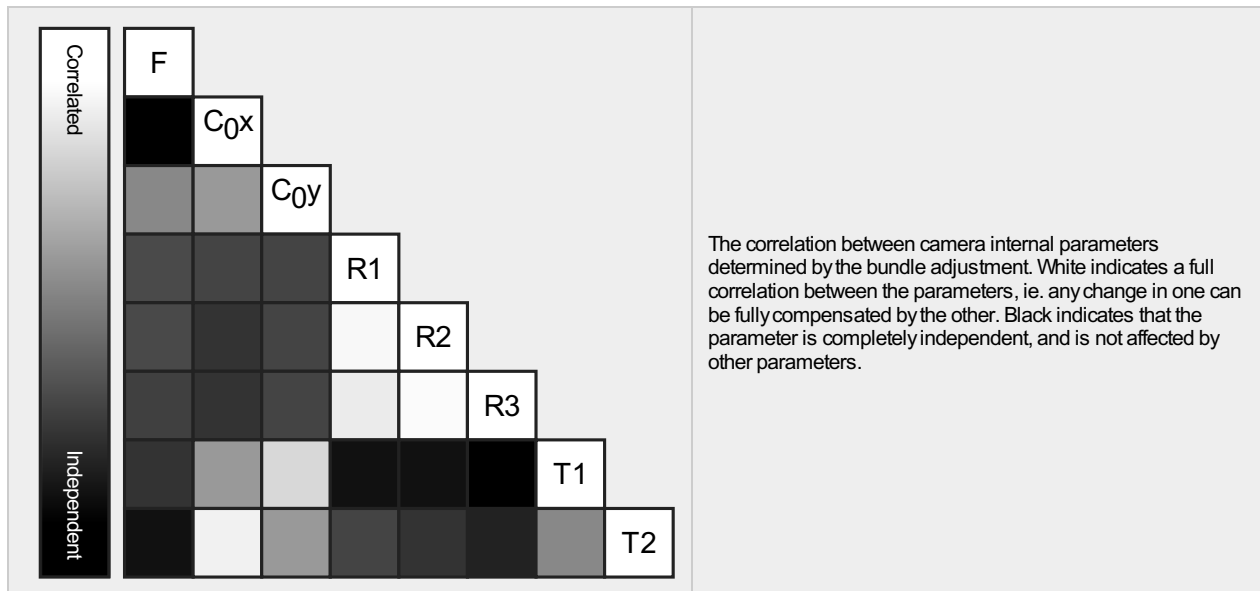
### ? Internal Camera Parameters

**RedEdge\_5.5\_1280x960 (Red).** Sensor Dimensions: 4.800 [mm] x 3.600 [mm]



EXIF ID: RedEdge\_5.5\_1280x960

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	1466.667 [pixel] 5.500 [mm]	657.200 [pixel] 2.465 [mm]	493.864 [pixel] 1.852 [mm]	-0.100	0.131	-0.003	-0.000	0.000
Optimized Values	1450.257 [pixel] 5.438 [mm]	653.014 [pixel] 2.449 [mm]	494.144 [pixel] 1.853 [mm]	-0.096	0.116	0.019	-0.000	-0.000
Uncertainties (Sigma)	0.179 [pixel] 0.001 [mm]	0.163 [pixel] 0.001 [mm]	0.123 [pixel] 0.000 [mm]	0.001	0.008	0.018	0.000	0.000



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

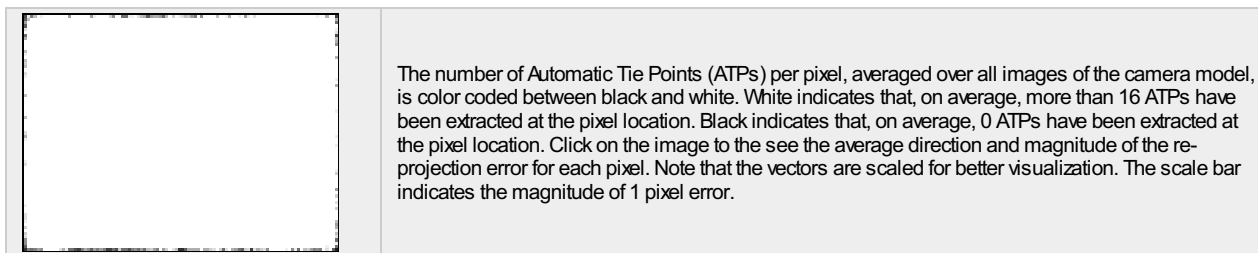
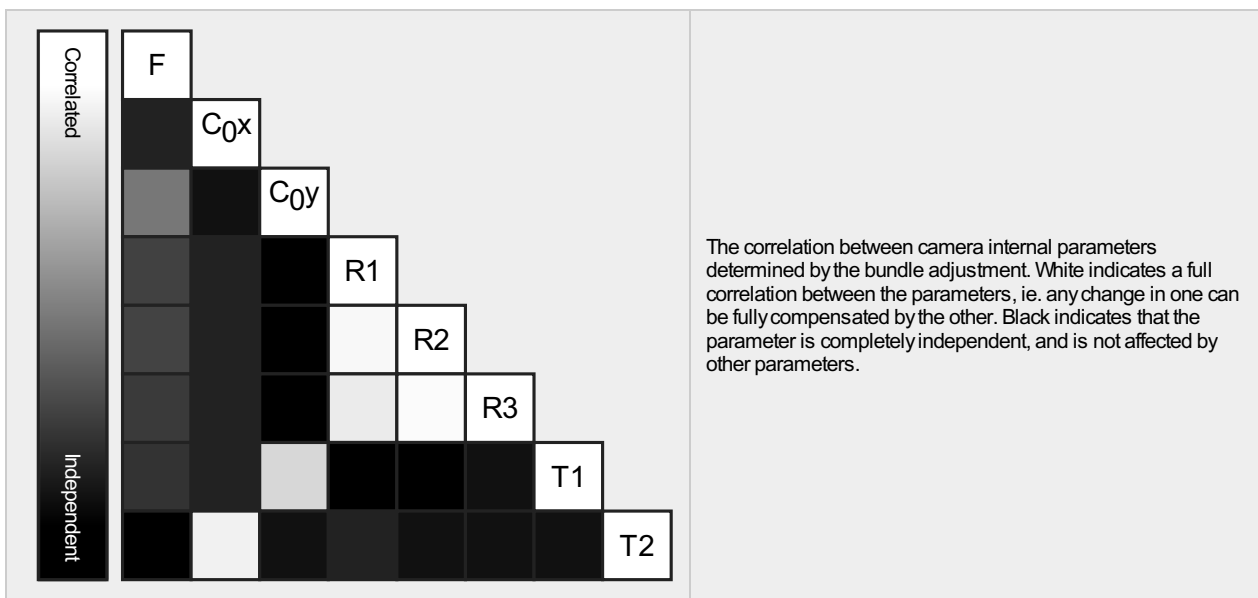
### ? Internal Camera Parameters

**RedEdge\_5.5\_1280x960 (NIR).** Sensor Dimensions: 4.800 [mm] x 3.600 [mm]



EXIF ID: RedEdge\_5.5\_1280x960

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	1466.667 [pixel] 5.500 [mm]	666.605 [pixel] 2.500 [mm]	482.221 [pixel] 1.808 [mm]	-0.105	0.153	-0.045	0.000	0.000
Optimized Values	1451.077 [pixel] 5.442 [mm]	662.215 [pixel] 2.483 [mm]	482.447 [pixel] 1.809 [mm]	-0.102	0.141	-0.019	0.000	-0.000
Uncertainties (Sigma)	0.177 [pixel] 0.001 [mm]	0.138 [pixel] 0.001 [mm]	0.103 [pixel] 0.000 [mm]	0.001	0.007	0.015	0.000	0.000

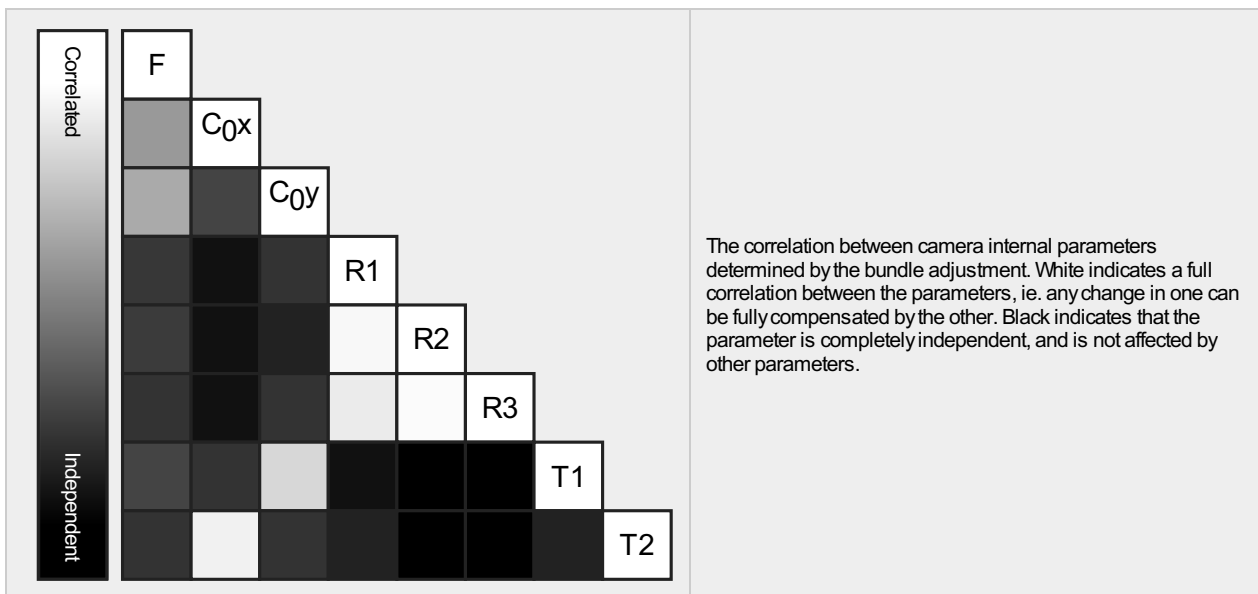


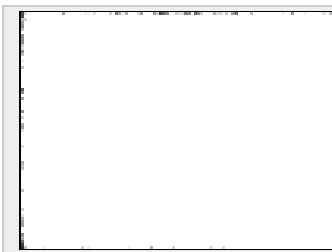
## Internal Camera Parameters

RedEdge\_5.5\_1280x960 (Red edge). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

EXIF ID: RedEdge\_5.5\_1280x960

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	1466.667 [pixel] 5.500 [mm]	661.440 [pixel] 2.480 [mm]	495.379 [pixel] 1.858 [mm]	-0.103	0.155	-0.049	0.000	0.001
Optimized Values	1448.717 [pixel] 5.433 [mm]	657.369 [pixel] 2.465 [mm]	494.094 [pixel] 1.853 [mm]	-0.101	0.152	-0.048	0.000	-0.000
Uncertainties (Sigma)	0.175 [pixel] 0.001 [mm]	0.121 [pixel] 0.000 [mm]	0.090 [pixel] 0.000 [mm]	0.001	0.006	0.013	0.000	0.000





The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

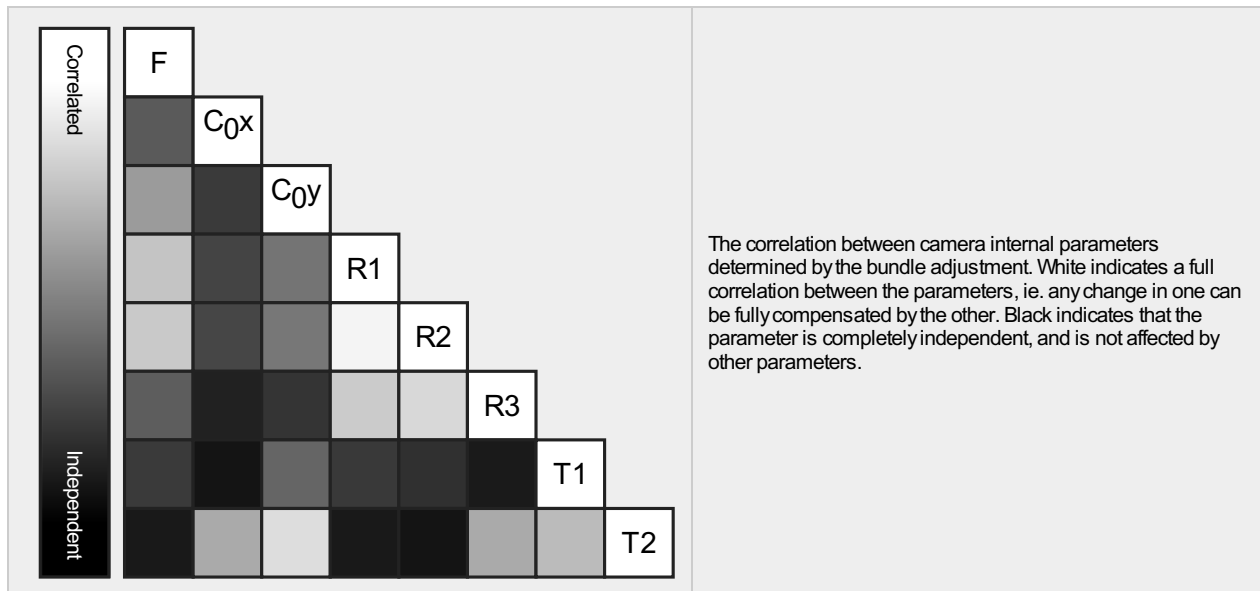
## Internal Camera Parameters

**FC350\_3.6\_4000x3000 (RGB). Sensor Dimensions: 6.317 [mm] x 4.738 [mm]**



EXIF ID: FC350\_3.6\_4000x3000

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	2285.722 [pixel] 3.610 [mm]	2000.006 [pixel] 3.159 [mm]	1500.003 [pixel] 2.369 [mm]	-0.130	0.106	-0.016	-0.000	0.000
Optimized Values	2464.458 [pixel] 3.892 [mm]	1982.942 [pixel] 3.132 [mm]	1499.631 [pixel] 2.368 [mm]	-0.144	0.139	-0.019	0.001	0.000
Uncertainties (Sigma)	1.848 [pixel] 0.003 [mm]	0.073 [pixel] 0.000 [mm]	0.078 [pixel] 0.000 [mm]	0.000	0.001	0.000	0.000	0.000



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

## Camera Rig «MicaSense 5 band\_merge\_eldo\_3k\_1\_re\_merge\_eldo\_3k\_1\_re» Relatives. Images: 10460



	Transl X[m]	Transl Y[m]	Transl Z[m]	Rot X[degree]	Rot Y[degree]	Rot Z[degree]
RedEdge_5.5_1280x960 (Green)	Reference Camera					
RedEdge_5.5_1280x960 (Blue)						
Initial Values	0.030	0.000	0.000	0.000	0.000	0.000
Optimized values	0.030	0.000	0.000	-0.119	0.099	-0.372
Uncertainties (sigma)				0.004	0.006	0.000
RedEdge_5.5_1280x960 (Red)						
Initial Values	0.000	0.022	0.000	0.000	0.000	0.000
Optimized values	0.000	0.022	0.000	0.037	0.061	-0.063
Uncertainties (sigma)				0.005	0.007	0.000
RedEdge_5.5_1280x960 (NIR)						



Initial Values	0.030	0.022	0.000	0.000	0.000	0.000
Optimized values	0.030	0.022	0.000	-0.147	-0.134	0.119
Uncertainties (sigma)				0.004	0.006	0.000
RedEdge_5.5_1280x960 (Red edge)						
Initial Values	0.015	0.011	0.000	0.000	0.000	0.000
Optimized values	0.015	0.011	0.000	-0.060	-0.579	-0.321
Uncertainties (sigma)				0.004	0.005	0.000

## ? 2D Keypoints Table



	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	28903	3098
Min	10567	0
Max	46530	25635
Mean	25107	3064

### 2D Keypoints Table for Camera RedEdge\_5.5\_1280x960 (Blue)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	29223	2381
Min	16935	0
Max	36187	17197
Mean	28585	2715

### 2D Keypoints Table for Camera RedEdge\_5.5\_1280x960 (Green)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	35398	4542
Min	19898	193
Max	46530	25635
Mean	34532	4832

### 2D Keypoints Table for Camera RedEdge\_5.5\_1280x960 (Red)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	21331	1687
Min	15646	0
Max	36031	16274
Mean	22481	2064

### 2D Keypoints Table for Camera RedEdge\_5.5\_1280x960 (NIR)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	35078	3872
Min	18052	0
Max	41054	22284
Mean	34005	4147

### 2D Keypoints Table for Camera RedEdge\_5.5\_1280x960 (Red edge)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	36059	4229
Min	18264	0
Max	41760	23648
Mean	34997	4543

### 2D Keypoints Table for Camera FC350\_3.6\_4000x3000 (RGB)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	13580	1111
Min	10567	464
Max	21103	2659
Mean	13312	1109

#### Median / 75% / Maximal Number of Matches Between Camera Models

	RedEdge_5.5_12... (Blue)	RedEdge_5.5_1... (Green)	RedEdge_5.5_128... (Red)	RedEdge_5.5_128... (NIR)	RedEdge_5... (Red edge)	FC350_3.6_4000x3000 (RGB)
RedEdge_5.5_1280x960 (Blue)	10 / 94 / 12026	9 / 43 / 5041	19 / 258 / 7935	10 / 102 / 3190	11 / 126 / 4212	
RedEdge_5.5_1280x960 (Green)		13 / 69 / 24967	8 / 34 / 4092	7 / 38 / 7012	9 / 47 / 12400	
RedEdge_5.5_1280x960 (Red)			10 / 88 / 12138	9 / 77 / 2641	10 / 92 / 3531	
RedEdge_5.5_1280x960 (NIR)				10 / 178 / 17480	21 / 610 / 10577	
RedEdge_5.5_1280x960 (Red edge)					11 / 104 / 14064	
FC350_3.6_4000x3000 (RGB)						5 / 17 / 1989

#### ? 3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	4447304
In 3 Images	840597
In 4 Images	303352
In 5 Images	128231
In 6 Images	66070
In 7 Images	35992
In 8 Images	21800
In 9 Images	14261
In 10 Images	10051
In 11 Images	6883
In 12 Images	4715
In 13 Images	3184
In 14 Images	2393
In 15 Images	1850
In 16 Images	1422
In 17 Images	1109
In 18 Images	854
In 19 Images	679
In 20 Images	515
In 21 Images	462
In 22 Images	328
In 23 Images	293
In 24 Images	225
In 25 Images	196
In 26 Images	149
In 27 Images	118
In 28 Images	99
In 29 Images	75
In 30 Images	83
In 31 Images	59
In 32 Images	55
In 33 Images	52
In 34 Images	37
In 35 Images	25
In 36 Images	19
In 37 Images	23
In 38 Images	14

In 39 Images	10
In 40 Images	12
In 41 Images	10
In 42 Images	4
In 43 Images	7
In 44 Images	3
In 45 Images	6
In 46 Images	5
In 47 Images	6
In 48 Images	3
In 49 Images	1
In 50 Images	3
In 51 Images	1
In 52 Images	1
In 53 Images	1
In 57 Images	2
In 58 Images	1
In 64 Images	1

## ? 2D Keypoint Matches

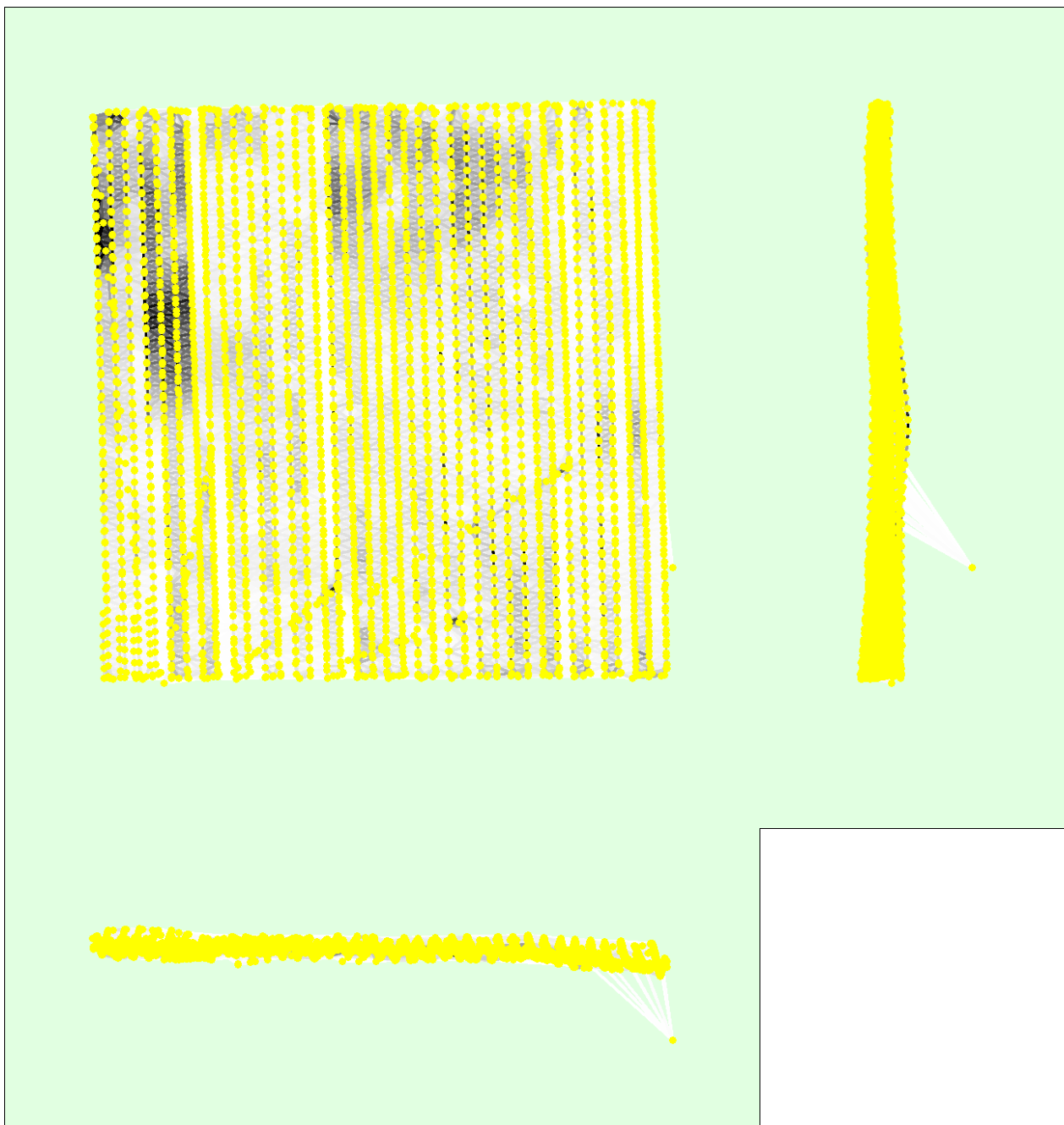




Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

## Manual Tie Points

MTP Name	Projection Error [pixel]	Verified/Marked
mtp5	0.583	25 / 25
mtp6	0.769	16 / 16
mtp7	0.781	34 / 34
mtp1	2.720	47 / 47
mtp8	0.838	17 / 17
mtp3	3.944	24 / 24
mtp4	1.003	24 / 24
mtp2	5.216	21 / 25

Projection errors for manual tie points. The last column counts the number of images where the manual tie point has been automatically verified vs. manually marked.

## Geolocation Details

### Absolute Geolocation Variance

Min Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-15.00	0.00	0.00	12.07
-15.00	-12.00	0.00	0.00	27.38
-12.00	-9.00	0.00	0.00	38.03
-9.00	-6.00	0.00	0.03	6.31
-6.00	-3.00	0.32	2.12	0.00
-3.00	0.00	71.25	55.06	0.00
0.00	3.00	27.06	39.70	0.00
3.00	6.00	1.37	3.00	0.00
6.00	9.00	0.00	0.09	0.14
9.00	12.00	0.00	0.00	5.73
12.00	15.00	0.00	0.00	7.82
15.00	-	0.00	0.00	2.53
Mean [m]		-0.244847	-0.226219	-7.999534
Sigma [m]		0.904762	1.433772	9.491081
RMS Error [m]		0.937307	1.451509	12.412621

Min Error and Max Error represent geolocation error intervals between -1.5 and 1.5 times the maximum accuracy of all the images. Columns X, Y, Z show the percentage of images with geolocation errors within the predefined error intervals. The geolocation error is the difference between the initial and computed image positions. Note that the image geolocation errors do not correspond to the accuracy of the observed 3D points.

### Relative Geolocation Variance

Relative Geolocation Error	Images X [%]	Images Y [%]	Images Z [%]
[-1.00, 1.00]	99.30	99.20	20.39
[-2.00, 2.00]	100.00	100.00	100.00
[-3.00, 3.00]	100.00	100.00	100.00
Mean of Geolocation Accuracy [m]	5.000000	5.000000	10.000000
Sigma of Geolocation Accuracy [m]	0.000000	0.000000	0.000000

Images X, Y, Z represent the percentage of images with a relative geolocation error in X, Y, Z.

Geolocation Orientational Variance	RMS [degree]
Omega	0.868
Phi	1.535
Kappa	6.553

Geolocation RMS error of the orientation angles given by the difference between the initial and computed image orientation angles.

## Initial Processing Details



### System Information



Hardware	CPU: Intel(R) Core(TM) i7-8700K CPU @ 3.70GHz RAM: 64GB GPU: NVIDIA GeForce GTX 1080 Ti (Driver: 25.21.14.1735), Intel(R) UHD Graphics 630 (Driver: 22.20.16.4758)
Operating System	Windows 10 Education, 64-bit

### Coordinate Systems



Image Coordinate System	WGS 84 (EGM96 Geoid)
Output Coordinate System	WGS 84 / UTMzone 10N (EGM96 Geoid)

### Processing Options



Detected Template	No Template Available
Keypoints Image Scale	Custom, Image Scale: 2
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: no
Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Standard Internal Parameters Optimization: All External Parameters Optimization: All Rematch: Custom, yes
Rig «MicaSense 5 band» processing	optimize relative rotation using a subset of secondary cameras

## Point Cloud Densification details



### Processing Options



Image Scale	multiscale, 1/2 (Half image size, Default)
Point Density	Optimal
Minimum Number of Matches	3
3D Textured Mesh Generation	yes
3D Textured Mesh Settings:	Resolution: Medium Resolution (default) Color Balancing: no
LOD	Generated: no
Advanced: 3D Textured Mesh Settings	Sample Density Divider: 1
Advanced: Image Groups	Blue, Green, Red, NIR, Red edge, group1
Advanced: Use Processing Area	yes
Advanced: Use Annotations	yes
Time for Point Cloud Densification	08h:06m:57s
Time for Point Cloud Classification	14m:56s
Time for 3D Textured Mesh Generation	01h:00m:58s

### Results



Number of Processed Clusters	2
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Number of Generated Tiles	5
Number of 3D Densified Points	99139430
Average Density (per m <sup>3</sup> )	12.94

## DSM, Orthomosaic and Index Details



### Processing Options



DSM and Orthomosaic Resolution	1 x GSD (7.41 [cm/pixel])
DSM Filters	Noise Filtering: yes Surface Smoothing: yes, Type: Sharp
Raster DSM	Generated: yes Method: Inverse Distance Weighting Merge Tiles: yes
Orthomosaic	Generated: yes Merge Tiles: yes GeoTIFF Without Transparency: no Google Maps Tiles and KML: no
Radiometric calibration with reflectance target	yes
Index Calculator: Reflectance Map	Generated: yes Resolution: 1 x GSD (7.41 [cm/pixel]) Merge Tiles: yes
Index Calculator: Indices	ndvi
Time for DSM Generation	01h:46m:57s
Time for Orthomosaic Generation	02h:12m:56s
Time for DTM Generation	00s
Time for Contour Lines Generation	00s
Time for Reflectance Map Generation	05h:10m:03s
Time for Index Map Generation	01m:43s

### Camera Radiometric Correction



Camera Name	Band	Radiometric Correction Type	Reflectance target
RedEdge_5.5_1280x960	Blue	Camera and Sun Irradiance	✓
RedEdge_5.5_1280x960	Green	Camera and Sun Irradiance	✓
RedEdge_5.5_1280x960	Red	No Correction	✓
RedEdge_5.5_1280x960	NIR	Camera and Sun Irradiance	✓
RedEdge_5.5_1280x960	Red edge	Camera and Sun Irradiance	✓
FC350_3.6_4000x3000	Red Green Blue	No Correction	n/a