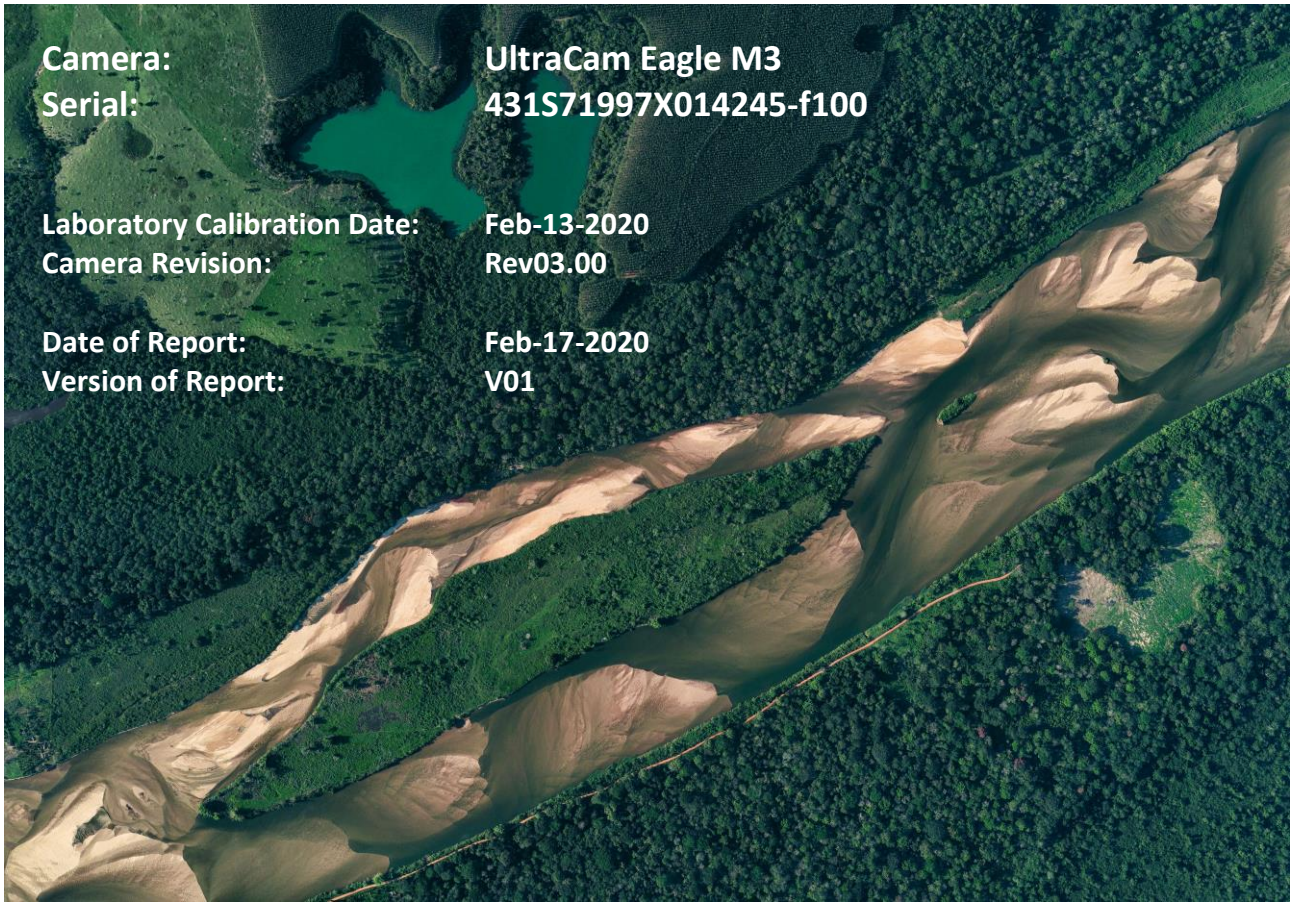
VEXCEL
IMAGING

ULTRACAM

Calibration Report



Bahia, Brasil 2013

Photo on page 1 courtesy of Hiparc Geotecnologia, Brasil

www.hiparc.com

UltraCam Lp, GSD25 cm, RGB

ULTRACAM

Geometric Calibration

Camera:	**UltraCam Eagle M3**
Serial:	**431S71997X014245-f100**
Panchromatic Camera:	**ck = 100.500 mm**
Multispectral Camera:	**ck = 100.500 mm**
PPA Information:	**X: -0.120 mm**
	Y: 0.000 mm

Panchromatic Camera

Large Format Panchromatic Output Image

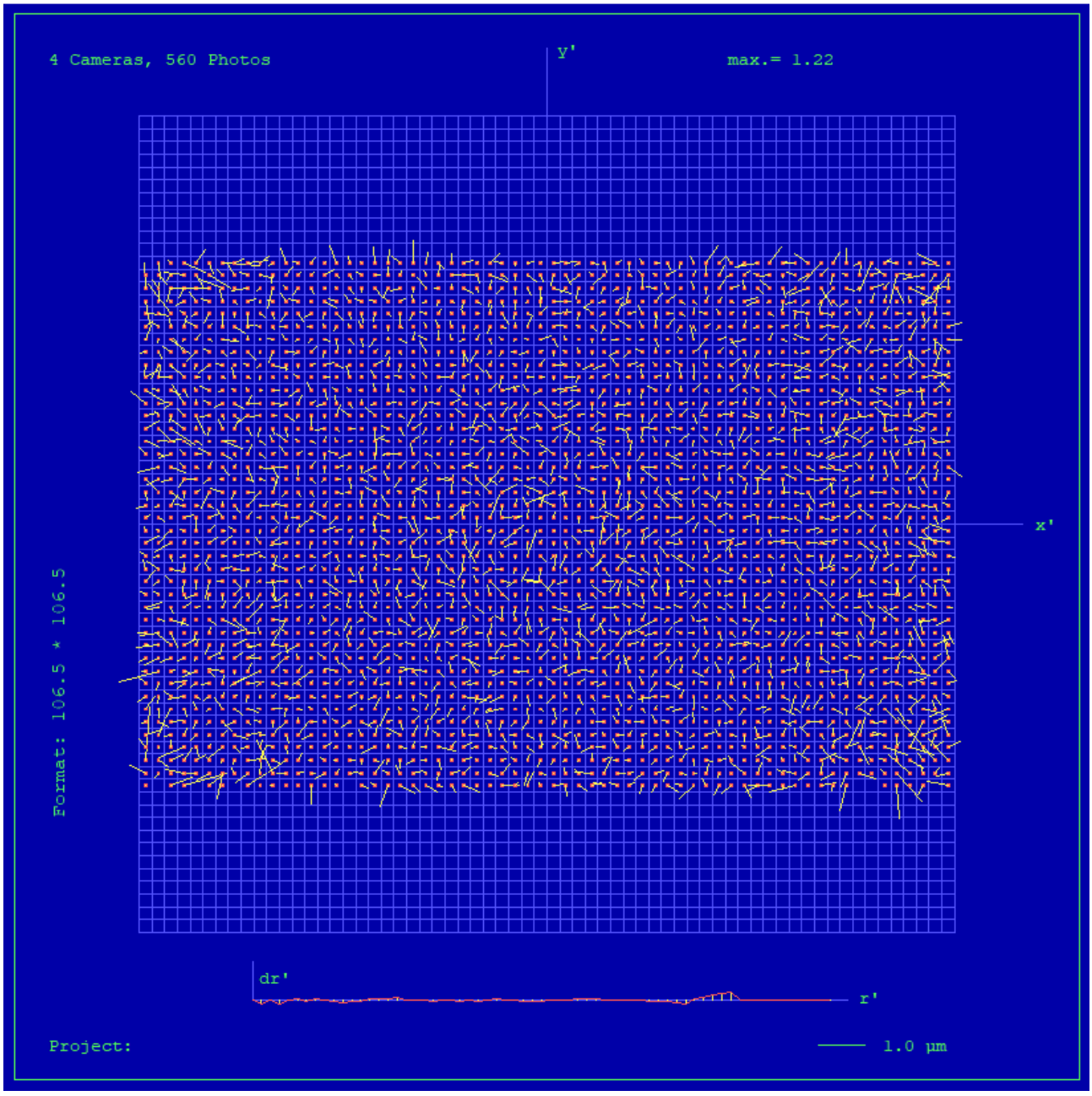
Image Format	long track cross track	68.016mm 105.840mm	17004pixel 26460pixel
Image Extent		(-34.008, -52.920)mm	(34.008, 52.920)mm
Pixel Size		4.000µm*4.000µm	
Focal Length	ck	100.500mm	± 0.002mm
Principal Point (Level 2)	X_ppa	-0.120mm	± 0.002mm
	Y_ppa	0.000mm	± 0.002mm
Lens Distortion	Remaining Distortion less than 0.002mm		

Multispectral Camera

Medium Format Multispectral Output Image (Upscaled to panchromatic image format)

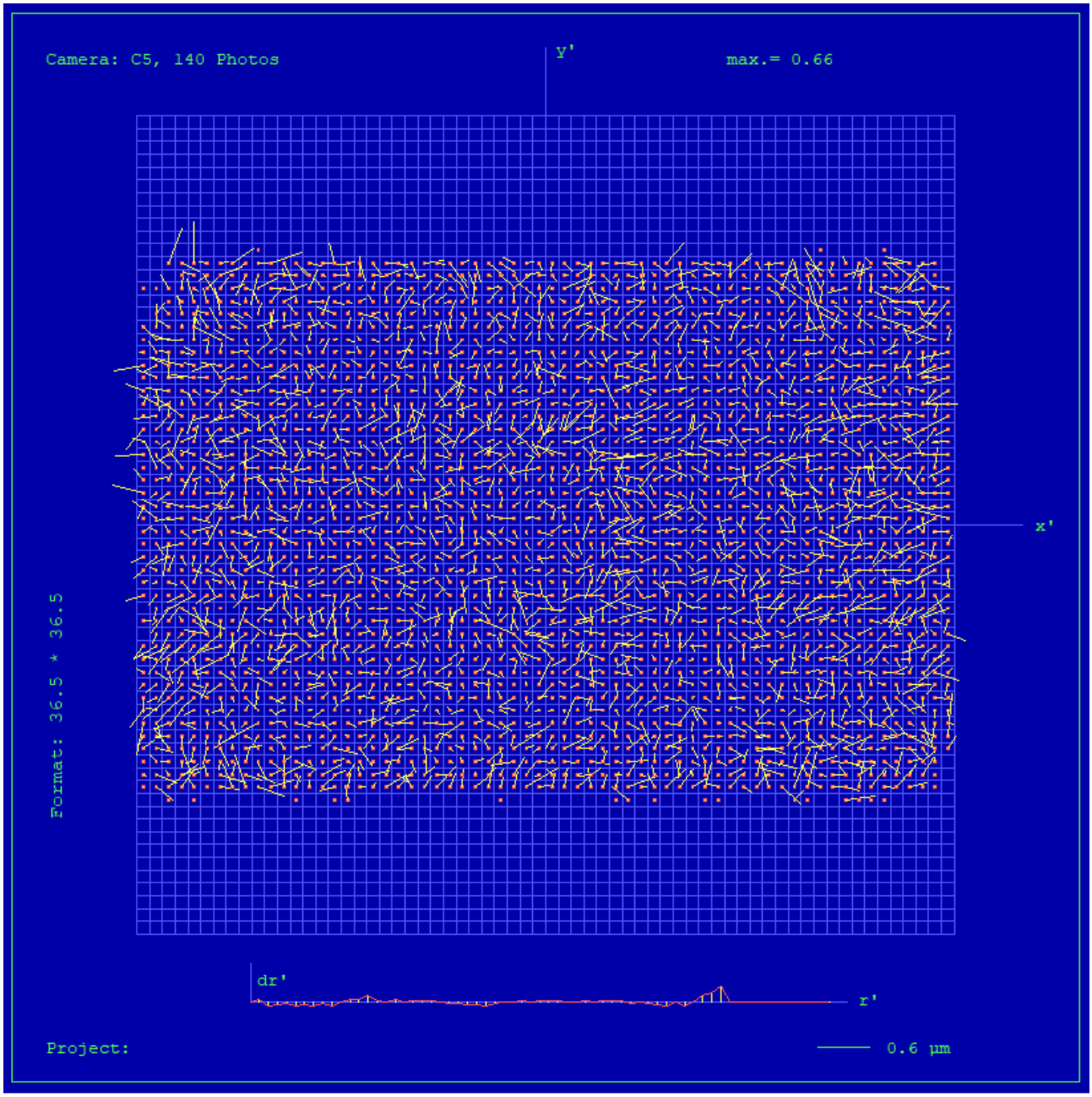
Image Format	long track cross track	68.016mm 105.840mm	5668pixel 8820pixel
Image Extent		(-34.008, -52.920)mm	(34.008, 52.920)mm
Pixel Size		12.000µm*12.000µm	
Focal Length	ck	100.500mm	± 0.002mm
Principal Point (Level 2)	X_ppa	-0.120mm	± 0.002mm
	Y_ppa	0.000mm	± 0.002mm
Lens Distortion	Remaining Distortion less than 0.002mm		

Full Panchromatic Image, Residual Error Diagram



Residual Error (RMS): **0.54 µm**

Green Cone (Cone 5), Residual Error Diagram



Residual Error (RMS): **0.46 µm**

Explanations

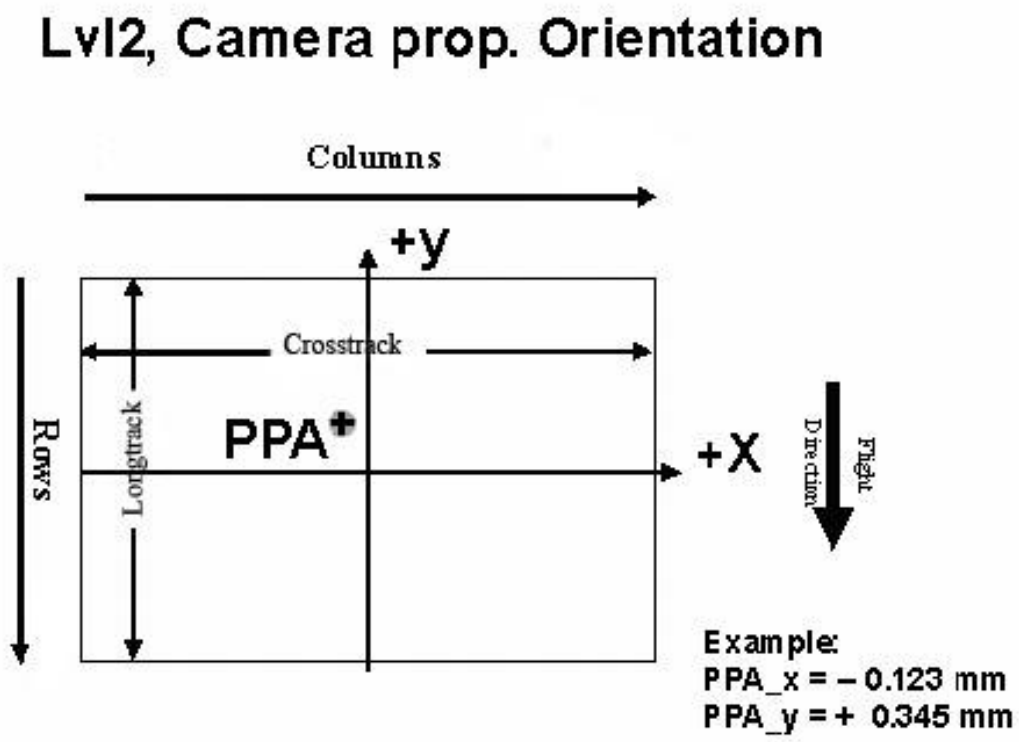
Calibration Method:

The geometric calibration is based on a set of 140 images of a defined geometry target with 394 GCPs.

Number of point measurements for the panchromatic camera : >16000
Number of point measurements for the multispectral camera : >60000

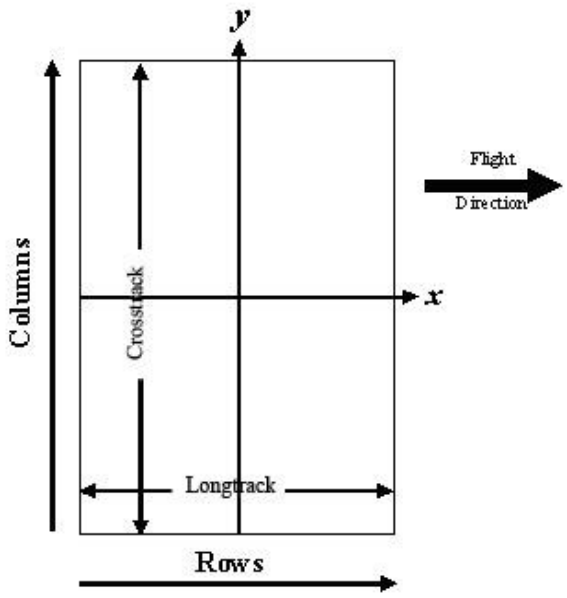
Determination of the image parameters by Least Squares Adjustment.
Software used for the adjustment: BINGO (GIP Eng. Aalen, Germany)

Level 2 Image Coordinate System:

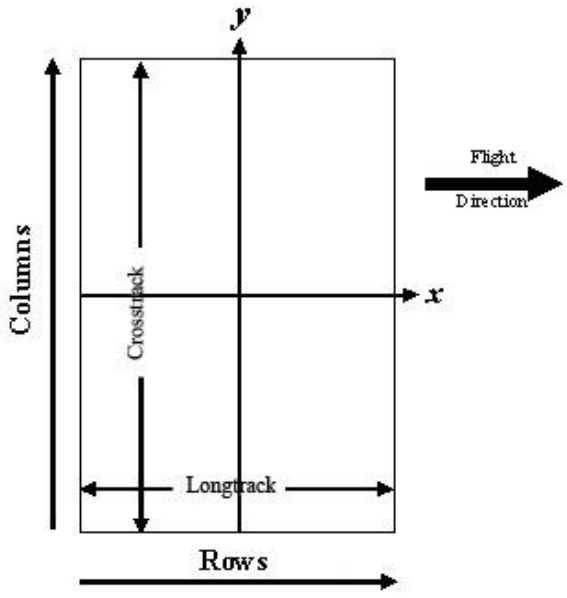


The image coordinate system of the Level 2 images is shown in the above figure. The basic image format and coordinate of the principal point in the level 2 image is given on page 4 of this report. The above figure shows the position of an example principal point at the coordinate (-0.123 / 0.345).

Level 3 Image Coordinate System:
(after rotation of 270° CW)



Panchromatic Image Format



Multispectral Image Format

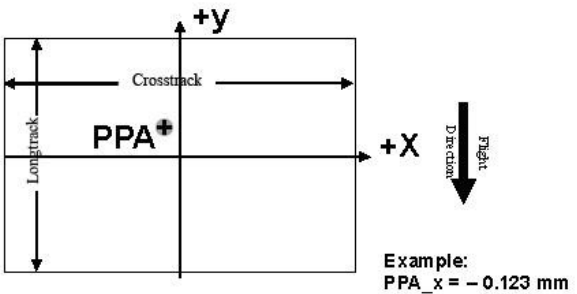
Position of Principal Point in Level 3 Image

The position of the principal point in the level 3 image depends on the “rotation” setting used in UltraMap during the pan-sharpening step. The exact position relative to the image center is given in the table below as a function of the rotation setting used in UltraMap. The coordinates are specified for clockwise (CW) rotation in steps of 90 degrees, according to the principal point coordinate given on page 4 for high- and low resolution images.

Image Format	Clockwise Rotation (Degree)	PPA	
		X	Y
Level 2	-	-0.120	0.000
Level 3	0	-0.120	0.000
Level 3	90	0.000	0.120
Level 3	180	0.120	0.000
Level 3	270	0.000	-0.120

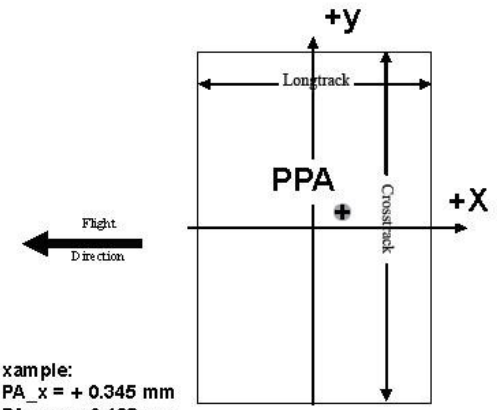
The coordinates in the figure below are only example values to illustrate the effect of image rotation on the principal point position, and do **not** correspond to the camera described in this report.

Lvl3, Rotation 0 deg clockwise



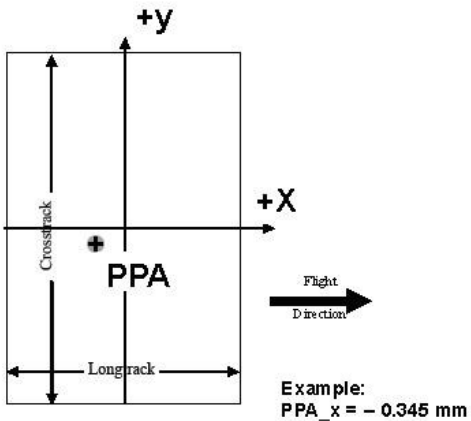
Example:
PPA_x = – 0.123 mm
PPA_y = + 0.345 mm

Lvl3, Rotation 90 deg clockwise



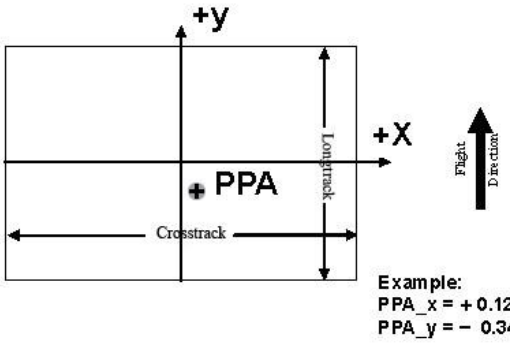
Example:
PPA_x = + 0.345 mm
PPA_y = + 0.123 mm

Lvl3, Rotation 270 deg clockwise



Example:
PPA_x = – 0.345 mm
PPA_y = – 0.123 mm

Lvl3, Rotation 180 deg clockwise



Example:
PPA_x = + 0.123 mm
PPA_y = – 0.345 mm

Lens Resolving Power

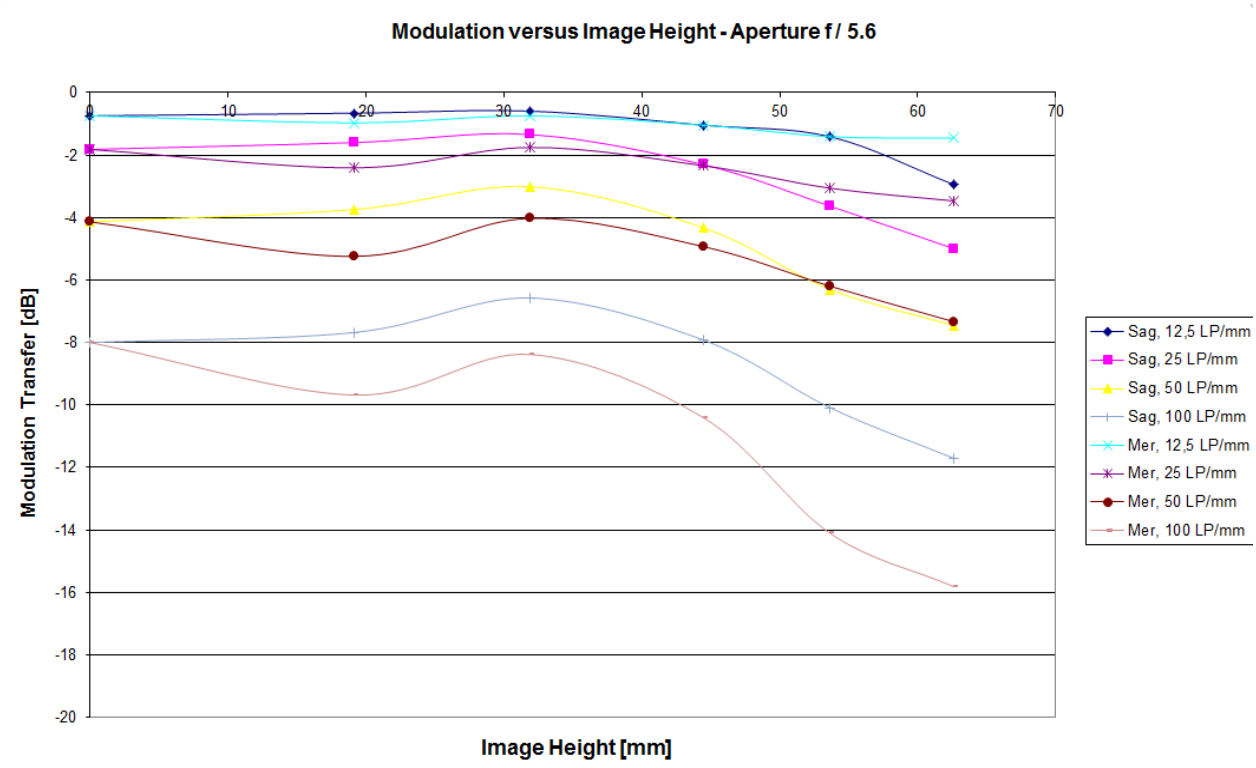
The following curves show the development of the modulation transfer function across different image heights of the panchromatic cones.
Please note that these values have been calculated and can vary up to 10% with optics from production (especially at high LP's).

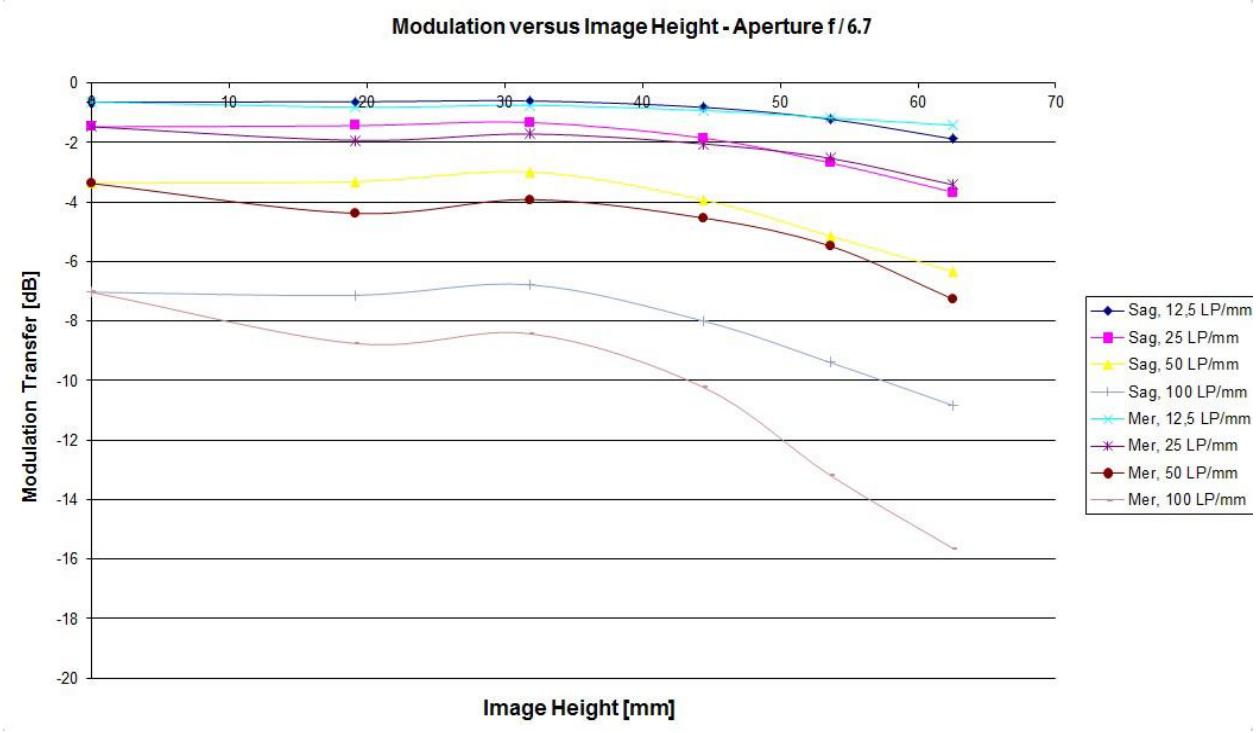
The curves are given for the meridonial (tangential) and sagital (radial) component of signals at frequencies of 12.5, 25, 50 and 100 line pairs per millimeter.

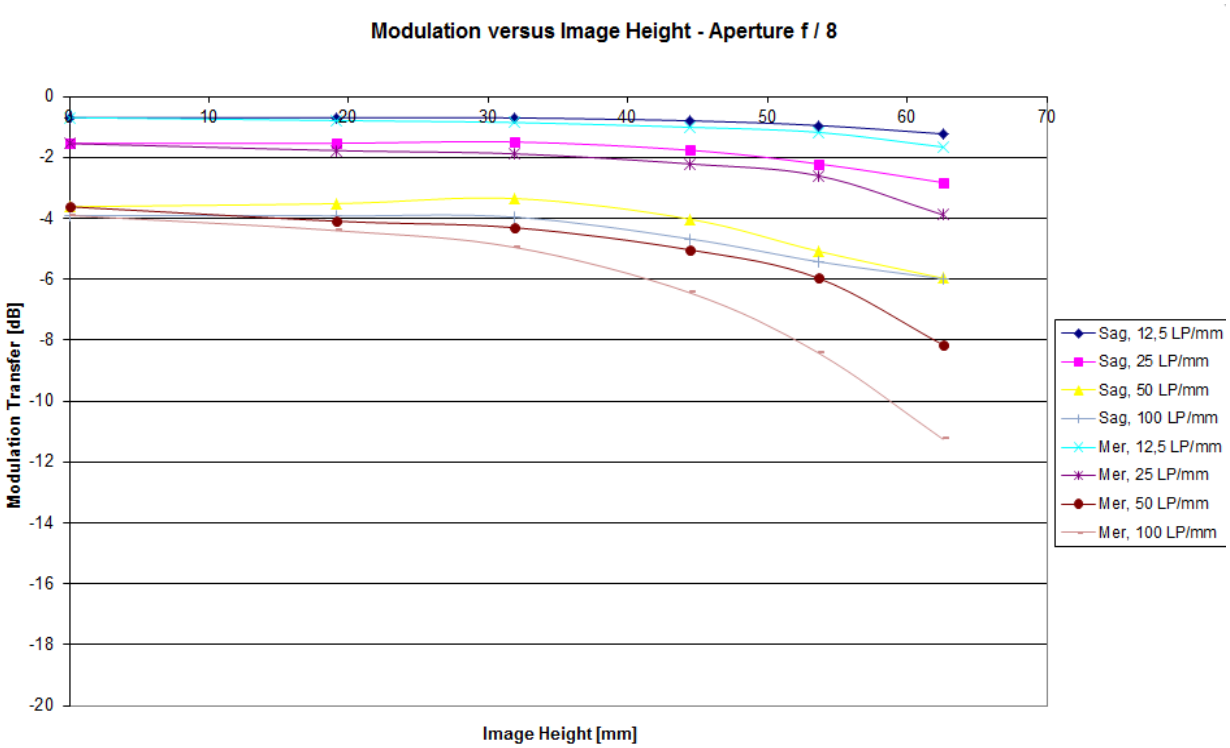
As the MTF is a function of the specific aperture size used, one set of curves is given for each aperture size.

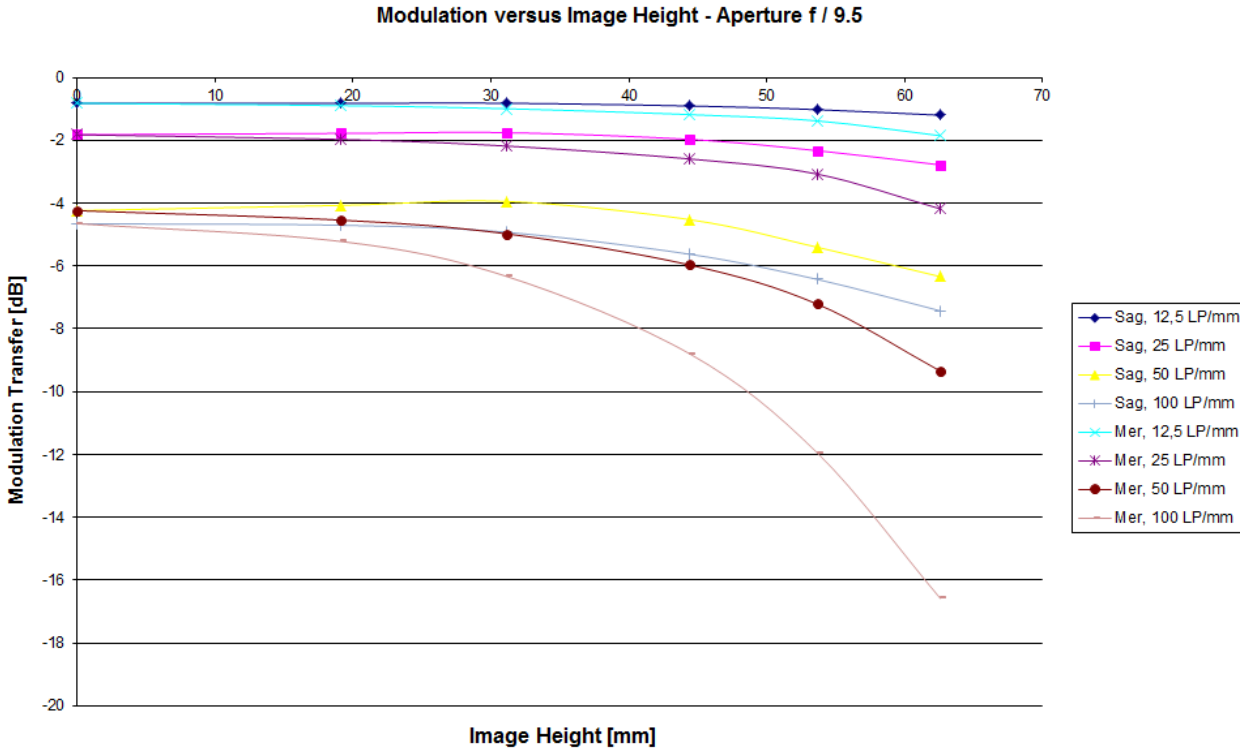
Lens types

Cone	Lens
C0 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/100mm, Qioptic GmbH, Germany
C1 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/100mm, Qioptic GmbH, Germany
C2 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/100mm, Qioptic GmbH, Germany
C3 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/100mm, Qioptic GmbH, Germany
C4 (RED)	Qioptic Vexcel HR Digaron 1:4/33mm, Qioptic GmbH, Germany
C5 (GREEN)	Qioptic Vexcel HR Digaron 1:4/33mm, Qioptic GmbH, Germany
C6 (BLUE)	Qioptic Vexcel HR Digaron 1:4/33mm, Qioptic GmbH, Germany
C7 (NIR)	Qioptic Vexcel HR Digaron 1:4/33mm, Qioptic GmbH, Germany

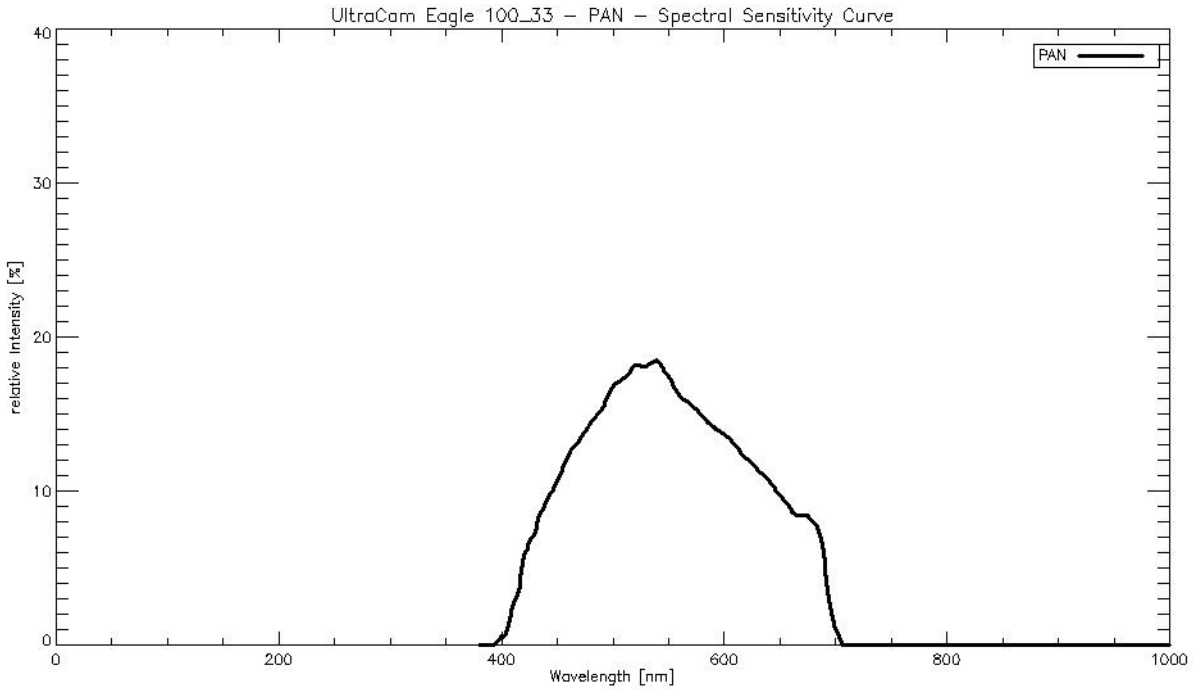

Modulation versus Image Height - Aperture f / 5.6
Modulation Transfer [dB]
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
0
10
20
30
40
50
60
70
Image Height [mm]
Sag, 12,5 LP/mm
Sag, 25 LP/mm
Sag, 50 LP/mm
Sag, 100 LP/mm
Mer, 12,5 LP/mm
Mer, 25 LP/mm
Mer, 50 LP/mm
Mer, 100 LP/mm

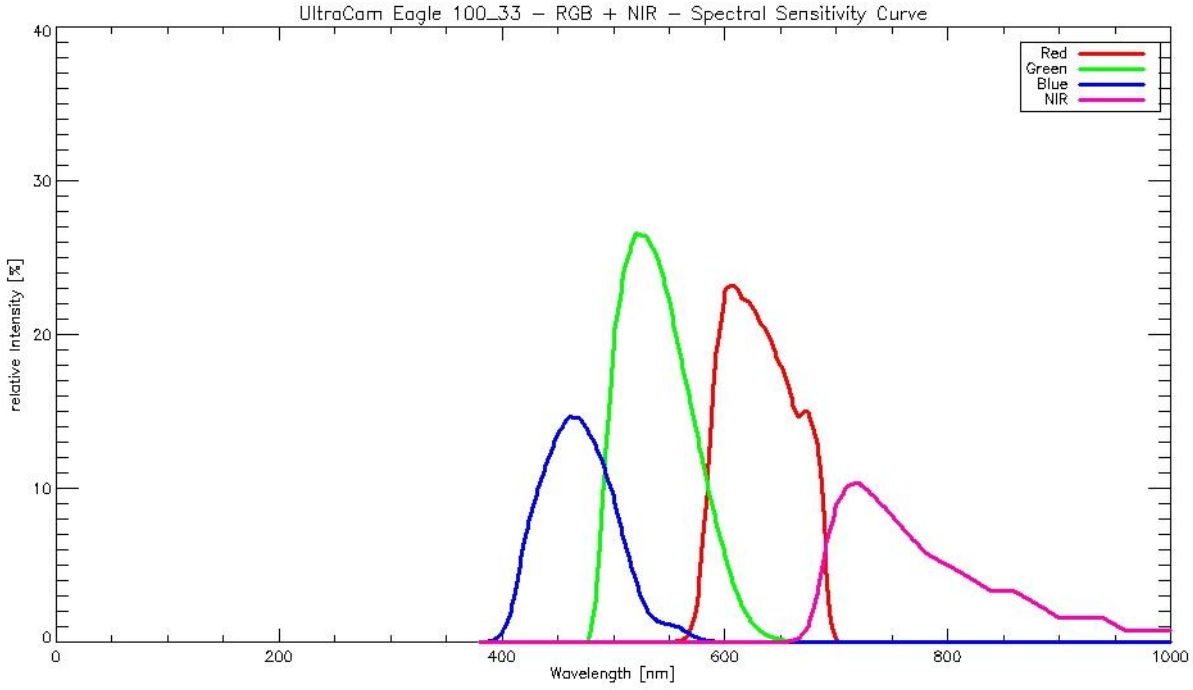

Modulation versus Image Height - Aperture f / 6.7
Modulation Transfer [dB]
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
0
10
20
30
40
50
60
70
Image Height [mm]
Sag, 12,5 LP/mm
Sag, 25 LP/mm
Sag, 50 LP/mm
Sag, 100 LP/mm
Mer, 12,5 LP/mm
Mer, 25 LP/mm
Mer, 50 LP/mm
Mer, 100 LP/mm


Modulation versus Image Height - Aperture f / 8
Modulation Transfer [dB]
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
0
10
20
30
40
50
60
70
Image Height [mm]
Sag, 12,5 LP/mm
Sag, 25 LP/mm
Sag, 50 LP/mm
Sag, 100 LP/mm
Mer, 12,5 LP/mm
Mer, 25 LP/mm
Mer, 50 LP/mm
Mer, 100 LP/mm


Modulation versus Image Height - Aperture f / 9.5
Modulation Transfer [dB]
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
0
10
20
30
40
50
60
70
Image Height [mm]
Sag, 12,5 LP/mm
Sag, 25 LP/mm
Sag, 50 LP/mm
Sag, 100 LP/mm
Mer, 12,5 LP/mm
Mer, 25 LP/mm
Mer, 50 LP/mm
Mer, 100 LP/mm

Spectral Sensitivity





ULTRACAM

Radiometric Calibration

Camera: **UltraCam Eagle M3**
Serial: **431S71997X014245-f100**

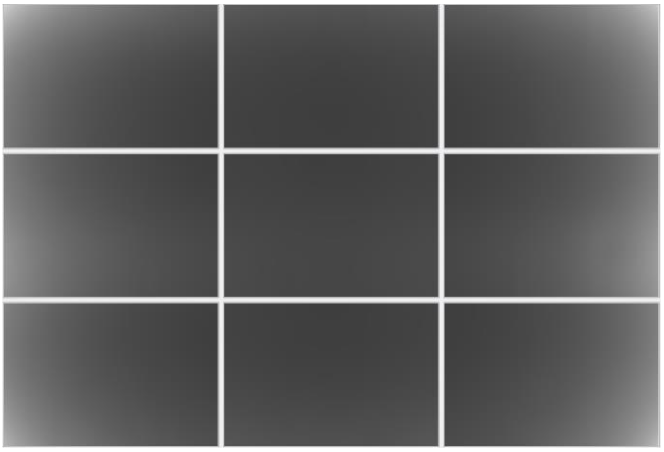
	PAN	R, G, NIR	B
Used Apertures	F5.6	F4.8	F4.8
	F6.7	F5.6	F4.8
	F8	F6.7	F4.8
	F9.5	F8	F5.6
	F11	F9.5	F6.7
	F13	F11	F8
	F16	F13	F9.5
	F22	F19	F13

Dead Pixel Report: see Appendix I

Calibration of Vignetting for working Aperture F6.7

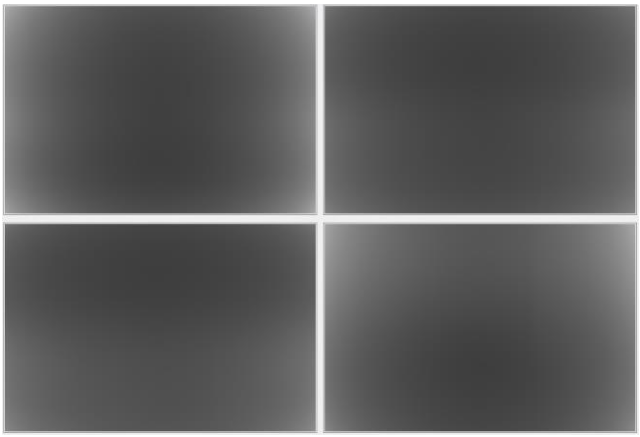
	PAN	R, G, NIR	B
Aperture	F6.7	F5.6	F4.8

Graphical Overview of Pan Sensors:



00_00	01_00	00_01
02_00	03_00	02_01
00_02	01_01	00_03

Graphical Overview of Multispectral Sensors:



04_00 (RED)	06_00 (BLUE)
05_00 (GREEN)	07_00 (NIR)

Explanations

Calibration Method:

The radiometric calibration is based on a series of 50 flat field images for each aperture size and sensor. The flat field is illuminated by eight normal light lamps with known spectral illumination curves.

These images are used to calculate the specific sensitivity of each pixel to compensate local as well as global variations in sensitivity. Sensitivity tables are calculated for each sensor and aperture setting, and applied during post processing from level 0 to level 1.

Outlier Pixels that do not have a linear behavior as described in the CCD specifications are marked as defective during the calibration procedure. These pixels are not used or only partially used during post processing and the information is restored by interpolation between the neighborhood pixels surrounding the defective pixels.

Certain pixels that are named Qmax pixels due to the fact that they can only store and transfer charge up to a certain maximum amount are detected in an additional calibration step. These pixels are treated differently during post processing, since their behavior can affect not only single pixel values but whole columns.

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Shutter Calibration

Camera:	**UltraCam Eagle M3**
Serial:	**431S71997X014245-f100**
Panchromatic Camera:	**4 * Prontor Magnetic 0 HS** **Prontor-Werk Alfred Gauthier GmbH, Germany**
Multispectral Camera:	**4 * Prontor Magnetic 0 HS** **Prontor-Werk Alfred Gauthier GmbH, Germany**

Calibration of Shutter Release Times:

The shutter release times measured during the calibration describe the time from the moment when the electrical current through the shutter is turned off by the electronics, until the shutter is mechanically closed.

This time is relevant for the exposure control and needs to be known before image recording can take place.

Currently used SRT values (operation values):

Cone Number	Lens Serial Number	SRT F5.6 [ms]	SRT F6.7 [ms]	SRT F8 [ms]	SRT F9.5 [ms]	SRT F11 [ms]	SRT F13 [ms]	SRT F16 [ms]	SRT F22 [ms]	Measurement Tolerance [ms]
C0 (Pan)	12 51 78 43	6.47	6.70	7.00	7.24	7.44	7.53	7.68	8.01	+/- 0.2
C1 (Pan)	12 51 53 72	6.28	6.45	6.71	6.96	7.14	7.27	7.45	7.75	+/- 0.2
C2 (Pan)	12 51 78 45	6.31	6.58	6.88	7.12	7.32	7.43	7.52	7.95	+/- 0.2
C3 (Pan)	12 51 53 53	6.15	6.34	6.65	6.85	7.07	7.23	7.37	7.66	+/- 0.2
C4 (Red)	12 51 53 87	7.00	7.07	7.26	7.37	7.52	7.69	7.69	8.30	+/- 0.2
C5 (Green)	12 51 53 95	6.87	7.02	7.20	7.34	7.45	7.62	7.77	8.03	+/- 0.2
C6 (Blue)	12 51 53 96	6.80	6.86	6.86	6.98	7.15	7.24	7.31	7.66	+/- 0.2
C7 (NIR)	12 51 54 09	7.10	7.24	7.49	7.66	7.74	7.85	7.95	8.20	+/- 0.2

ULTRACAM

Electronics and Sensor Calibration

Camera:	**UltraCam Eagle M3**
Serial:	**431S71997X014245-f100**
Panchromatic Camera:	**9 * FTF9060-M Area CCD Sensor by DALSA**
Multispectral Camera:	**4 * FTF9060-M Area CCD Sensor by DALSA**

Calibration of Negative Substrate Voltage (VNS):

For optimum performance of the DALSA CCD sensors, the negative substrate voltage is adjusted to a value specified by DALSA.

This voltage value is measured to achieve the best anti-blooming performance possible for each particular sensor.

Currently used VNS and VOG values (operation values):

Cone_Sensor	Sensor Type	Sensor Serial Number	VNS Voltage [V]	VOG Voltage [V]
00_00	FTF9060-M	19 6256/054	21.80	6.12
00_01	FTF9060-M	19 6256/049	21.60	6.14
00_02	FTF9060-M	19 6255/037	21.60	6.45
00_03	FTF9060-M	19 6256/005	22.20	6.55
01_00	FTF9060-M	19 6256/046	22.20	6.85
01_01	FTF9060-M	19 6255/054	22.20	6.22
02_00	FTF9060-M	19 6256/040	21.80	6.79
02_01	FTF9060-M	19 6256/008	21.60	6.58
03_00	FTF9060-M	19 6256/042	21.60	6.75
04_00 (red)	FTF9060-M	19 6256/053	21.60	7.22
05_00 (green)	FTF9060-M	19 6256/037	21.60	6.42
06_00 (blue)	FTF9060-M	19 6255/058	21.60	6.24
07_00 (NIR)	FTF9060-M	19 6255/045	22.20	6.65

Calibration of Intensity Threshold for Exposure Control:

Each CCD sensor and electronics module varies slightly in global sensitivity and intensity scale.

Therefore the maximum possible intensity of each sensor needs to be measured to evaluate the sensitivity behavior of the CCD and electronics.

This value is used as a threshold for the exposure control dialogue shown in the in-flight user interface of the Eagle.

Currently used Threshold values (operation values):

Cone_Sensor	Sensor Type	Sensor Serial Number	Intensity Threshold [DN]	
			Tap 1	Tap2
00_00	FTF9060-M	19 6256/054	13350	12430
00_01	FTF9060-M	19 6256/049	13920	13220
00_02	FTF9060-M	19 6255/037	13510	12650
00_03	FTF9060-M	19 6256/005	13790	12750
01_00	FTF9060-M	19 6256/046	13600	12990
01_01	FTF9060-M	19 6255/054	13640	12760
02_00	FTF9060-M	19 6256/040	14040	12400
02_01	FTF9060-M	19 6256/008	14010	12760
03_00	FTF9060-M	19 6256/042	14050	13540
04_00 (red)	FTF9060-M	19 6256/053	13900	12620
05_00 (green)	FTF9060-M	19 6256/037	14090	13150
06_00 (blue)	FTF9060-M	19 6255/058	13800	13030
07_00 (NIR)	FTF9060-M	19 6255/045	13170	12520

ULTRACAM

Summary

Camera:	**UltraCam Eagle M3**
Serial:	**431S71997X014245-f100**
Laboratory Calibration Date:	**Feb-13-2020**
Camera Revision:	**Rev03.00**
Date of Report:	**Feb-17-2020**
Version of Report:	**V01**

The following calibrations have been performed for the above mentioned digital aerial mapping camera:

- Geometric Calibration
- Radiometric Calibration
- Shutter Calibration
- Sensor and Electronics Calibration

This equipment is operating fully within specification as defined by Vexcel Imaging GmbH.

Dr. Michael Gruber
Chief Scientist, Photogrammetry
Vexcel Imaging GmbH

Dipl. Ing. (FH) Helmut Jauk
Senior Project Engineer R&D
Vexcel Imaging GmbH

Appendix I

Dead Pixel Report:

Sensor number		
Anomaly type	X-Coordinate	Y-Coordinate

C00-00

PIXEL: 496/1963
PIXEL: 940/2647
PIXEL: 1363/4668
PIXEL: 2185/5605
PIXEL: 5172/3233
PIXEL: 6266/3649
PIXEL: 6453/2711
PIXEL: 6569/2936
PIXEL: 6569/3053
PIXEL: 6569/3208
PIXEL: 6569/3211
PIXEL: 6569/3359
PIXEL: 6569/3468
PIXEL: 6569/3595
PIXEL: 6569/3615
PIXEL: 6569/3642
PIXEL: 6569/3675
PIXEL: 6569/3694
PIXEL: 6569/3738
PIXEL: 6569/3741
PIXEL: 6569/3750
PIXEL: 6569/3787
PIXEL: 6569/3789
PIXEL: 6569/3801
PIXEL: 6569/3803
PIXEL: 6569/3860
PIXEL: 6569/3889
PIXEL: 6569/3934
PIXEL: 6569/3947
PIXEL: 6569/4030
PIXEL: 6569/4099
PIXEL: 6569/4102
PIXEL: 6569/4112
PIXEL: 6569/4117
PIXEL: 6569/4150
PIXEL: 6569/4198
PIXEL: 6569/4233

PIXEL: 6569/4258
PIXEL: 6569/4259
PIXEL: 6569/4273
PIXEL: 6569/4278
PIXEL: 6569/4299
PIXEL: 6569/4304
PIXEL: 6569/4323
PIXEL: 6569/4358
PIXEL: 6569/4371
PIXEL: 6569/4405
PIXEL: 6569/4431
PIXEL: 6569/4442
PIXEL: 6569/4446
PIXEL: 6569/4463
PIXEL: 6569/4481
PIXEL: 6569/4518
PIXEL: 6569/4540
PIXEL: 6569/4546
PIXEL: 6569/4547
PIXEL: 6569/4573
PIXEL: 6569/4582
PIXEL: 6569/4585
PIXEL: 6569/4660
PIXEL: 6569/4661
PIXEL: 6569/4676
PIXEL: 6569/4719
PIXEL: 6569/4721
PIXEL: 6569/4734
PIXEL: 6569/4761
PIXEL: 6569/4846
PIXEL: 6569/4852
PIXEL: 6569/4854
PIXEL: 6569/4887
PIXEL: 6569/4888
PIXEL: 6569/4902
PIXEL: 6569/4944
PIXEL: 6569/4983
PIXEL: 6569/4986
PIXEL: 6569/5033
PIXEL: 6569/5037
PIXEL: 6569/5045
PIXEL: 6569/5048
PIXEL: 6569/5151
PIXEL: 6569/5153
PIXEL: 6569/5158
PIXEL: 6569/5161
PIXEL: 6569/5164
PIXEL: 6569/5169
PIXEL: 6569/5206
PIXEL: 6569/5210
PIXEL: 6569/5225

PIXEL: 6569/5234
PIXEL: 6569/5261
PIXEL: 6569/5268
PIXEL: 6569/5287
PIXEL: 6569/5300
PIXEL: 6569/5308
PIXEL: 6569/5347
PIXEL: 6569/5364
PIXEL: 6569/5366
PIXEL: 6569/5374
PIXEL: 6569/5386
PIXEL: 6569/5387
PIXEL: 6569/5436
PIXEL: 6569/5467
PIXEL: 6569/5479
PIXEL: 6569/5509
PIXEL: 6569/5533
PIXEL: 6569/5573
PIXEL: 6569/5596
PIXEL: 6569/5603
PIXEL: 6569/5617
PIXEL: 6569/5640
PIXEL: 6569/5647
PIXEL: 6569/5656
PIXEL: 6569/5659
PIXEL: 6569/5676
PIXEL: 6569/5681
PIXEL: 6569/5709
PIXEL: 6569/5732
PIXEL: 6569/5737
PIXEL: 6569/5739
PIXEL: 6569/5778
PIXEL: 6569/5811
PIXEL: 6569/5813
PIXEL: 6569/5817
PIXEL: 6569/5846
PIXEL: 6569/5847
PIXEL: 6569/5851
PIXEL: 6569/5853
PIXEL: 6569/5871
PIXEL: 6569/5922
PIXEL: 6569/5938
PIXEL: 6569/5975
PIXEL: 6569/6002
PIXEL: 6569/6009
PIXEL: 6569/6011
PIXEL: 7950/5148
PIXEL: 8699/4260
PIXEL: 704/4983
PIXEL: 704/4984
PIXEL: 716/2139

PIXEL: 2069/1071
PIXEL: 2073/1751
PIXEL: 2073/1752
PIXEL: 2074/1751
PIXEL: 2074/1752
PIXEL: 2591/4709
PIXEL: 4453/ 317
PIXEL: 6552/1678
PIXEL: 715/2139
PIXEL: 4452/ 317

C00-01

PIXEL: 2236/4137
PIXEL: 2421/3991
PIXEL: 4304/5301
PIXEL: 4775/2259
PIXEL: 6458/ 199
PIXEL: 6458/ 278
PIXEL: 6458/ 719
PIXEL: 6458/ 814
PIXEL: 6458/ 886
PIXEL: 6458/ 972
PIXEL: 6458/1001
PIXEL: 6458/1084
PIXEL: 6458/1168
PIXEL: 6458/1229
PIXEL: 6458/1233
PIXEL: 6458/1255
PIXEL: 6458/1272
PIXEL: 6458/1348
PIXEL: 6458/1364
PIXEL: 6458/1628
PIXEL: 6458/1638
PIXEL: 6458/1673
PIXEL: 6458/1708
PIXEL: 6458/1743
PIXEL: 6458/1762
PIXEL: 6458/1783
PIXEL: 6458/1832
PIXEL: 6458/1934
PIXEL: 6458/1956
PIXEL: 6458/2048
PIXEL: 6458/2120
PIXEL: 6458/2144
PIXEL: 6458/2200
PIXEL: 6458/2242
PIXEL: 6458/2249
PIXEL: 6458/2286
PIXEL: 6458/2452
PIXEL: 6458/2488

PIXEL: 6458/2502
PIXEL: 6458/2527
PIXEL: 6458/2537
PIXEL: 6458/2623
PIXEL: 6458/2628
PIXEL: 6458/2712
PIXEL: 6458/2753
PIXEL: 6458/2866
PIXEL: 6458/2884
PIXEL: 6458/2890
PIXEL: 6458/2957
PIXEL: 6458/2983
PIXEL: 6458/3004
PIXEL: 6458/3020
PIXEL: 6458/3037
PIXEL: 6458/3061
PIXEL: 6458/3079
PIXEL: 6458/3101
PIXEL: 6458/3104
PIXEL: 6458/3194
PIXEL: 6458/3212
PIXEL: 6458/3271
PIXEL: 6458/3279
PIXEL: 6458/3398
PIXEL: 6458/3411
PIXEL: 6458/3421
PIXEL: 6458/3433
PIXEL: 6458/3454
PIXEL: 6458/3463
PIXEL: 6458/3485
PIXEL: 6458/3513
PIXEL: 6458/3517
PIXEL: 6458/3572
PIXEL: 6458/3576
PIXEL: 6458/3586
PIXEL: 6458/3600
PIXEL: 6458/3609
PIXEL: 6458/3621
PIXEL: 6458/3698
PIXEL: 6458/3704
PIXEL: 6458/3714
PIXEL: 6458/3726
PIXEL: 6458/3728
PIXEL: 6458/3772
PIXEL: 6458/3786
PIXEL: 6458/3813
PIXEL: 6458/3823
PIXEL: 6458/3849
PIXEL: 6458/3872
PIXEL: 6458/3947
PIXEL: 6458/4036

PIXEL: 6458/4110
PIXEL: 6458/4144
PIXEL: 6458/4148
PIXEL: 6458/4149
PIXEL: 6458/4151
PIXEL: 6458/4186
PIXEL: 6458/4243
PIXEL: 6458/4248
PIXEL: 6458/4273
PIXEL: 6458/4345
PIXEL: 6458/4356
PIXEL: 6458/4432
PIXEL: 6458/4475
PIXEL: 6458/4485
PIXEL: 6458/4562
PIXEL: 6458/4588
PIXEL: 6458/4592
PIXEL: 6458/4600
PIXEL: 6458/4612
PIXEL: 6458/4642
PIXEL: 6458/4712
PIXEL: 6458/4731
PIXEL: 6458/4737
PIXEL: 6458/4774
PIXEL: 6458/4810
PIXEL: 6458/4828
PIXEL: 6458/4838
PIXEL: 6458/4842
PIXEL: 6458/4843
PIXEL: 6458/4851
PIXEL: 6458/4877
PIXEL: 6458/4880
PIXEL: 6458/4883
PIXEL: 6458/4915
PIXEL: 6458/4920
PIXEL: 6458/4927
PIXEL: 6458/4934
PIXEL: 6458/4959
PIXEL: 6458/4961
PIXEL: 6458/4970
PIXEL: 6458/4984
PIXEL: 6458/4995
PIXEL: 6458/5016
PIXEL: 6458/5036
PIXEL: 6458/5069
PIXEL: 6458/5071
PIXEL: 6458/5102
PIXEL: 6458/5158
PIXEL: 6458/5162
PIXEL: 6458/5165
PIXEL: 6458/5166

PIXEL: 6458/5179
PIXEL: 6458/5187
PIXEL: 6458/5225
PIXEL: 6458/5226
PIXEL: 6458/5230
PIXEL: 6458/5237
PIXEL: 6458/5241
PIXEL: 6458/5244
PIXEL: 6458/5252
PIXEL: 6458/5259
PIXEL: 6458/5305
PIXEL: 6458/5318
PIXEL: 6458/5351
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PIXEL: 6458/5439
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PIXEL: 6458/5537
PIXEL: 6458/5587
PIXEL: 6458/5589
PIXEL: 6458/5628
PIXEL: 6458/5633
PIXEL: 6458/5647
PIXEL: 6458/5651
PIXEL: 6458/5663
PIXEL: 6458/5690
PIXEL: 6458/5772
PIXEL: 6458/5780
PIXEL: 6458/5790
PIXEL: 6458/5800
PIXEL: 6458/5821
PIXEL: 6458/5841
PIXEL: 6458/5861
PIXEL: 6458/5874
PIXEL: 6458/5877
PIXEL: 6458/5900
PIXEL: 6458/5913
PIXEL: 6458/5954
PIXEL: 6458/5957
PIXEL: 6458/5978
PIXEL: 6458/5994
PIXEL: 7746/5290
PIXEL: 7771/4858
PIXEL: 7827/3628
PIXEL: 5027/3590
PIXEL: 6060/3513
PIXEL: 8133/2163
PIXEL: 8133/2164

PIXEL: 8970/5108
PIXEL: 9014/4967
PIXEL: 9014/4968

C00-02

PIXEL: 601/4553
PIXEL: 664/4216
PIXEL: 808/2034
PIXEL: 2744/1521
PIXEL: 6339/4659
PIXEL: 7158/3071
PIXEL: 2342/ 137
PIXEL: 3638/ 371
PIXEL: 5349/3120
PIXEL: 5349/3121
PIXEL: 5350/3120
PIXEL: 5350/3121
PIXEL: 7926/1013
PIXEL: 7926/1014
PIXEL: 8598/4616
PIXEL: 8599/4616
PIXEL: 8768/4540
PIXEL: 8768/4541
PIXEL: 8769/4540
PIXEL: 8769/4541
PIXEL: 8998/5921

C00-03

PIXEL: 432/1227
PIXEL: 551/2060
PIXEL: 1634/4200
PIXEL: 1894/5849
PIXEL: 1895/5850
PIXEL: 2069/5701
PIXEL: 2428/1501
PIXEL: 2635/2484
PIXEL: 2658/ 524
PIXEL: 2952/5780
PIXEL: 3869/2820
PIXEL: 5679/3803
PIXEL: 6723/2729
PIXEL: 8132/ 467
PIXEL: 203/4525
PIXEL: 203/4526
PIXEL: 572/5476
PIXEL: 1041/4644
PIXEL: 2293/2470
PIXEL: 2551/1525
PIXEL: 4264/2218
PIXEL: 4282/2138

PIXEL: 5101/2798
PIXEL: 5122/ 856
PIXEL: 8310/1666
PIXEL: 8390/5245
PIXEL: 8986/3857

C01-00

PIXEL: 5408/5401
PIXEL: 6063/ 167
PIXEL: 6405/1575
PIXEL: 6679/5941
PIXEL: 8826/2624
PIXEL: 1245/2603
PIXEL: 1246/2602
PIXEL: 1246/2603
PIXEL: 1567/4366
PIXEL: 2476/3908
PIXEL: 4104/1261
PIXEL: 4592/ 161
PIXEL: 7699/ 49
PIXEL: 7699/ 50
PIXEL: 7700/ 50
PIXEL: 8007/1677
PIXEL: 4103/1262
PIXEL: 4593/ 161
PIXEL: 8008/1676

C01-01

PIXEL: 113/ 860
PIXEL: 229/1571
PIXEL: 400/5216
PIXEL: 1362/ 515
PIXEL: 2512/ 811
PIXEL: 2721/4757
PIXEL: 6597/3901
PIXEL: 8482/ 577
PIXEL: 2994/1790
PIXEL: 3690/1812
PIXEL: 8662/5374

C02-00

PIXEL: 2687/3007
PIXEL: 2856/2982
PIXEL: 2857/2982
PIXEL: 2858/2982
PIXEL: 4967/4052
PIXEL: 8362/5354
PIXEL: 84/ 77
PIXEL: 175/2138
PIXEL: 424/5256

PIXEL: 534/ 215
PIXEL: 755/4786
PIXEL: 867/2731
PIXEL: 1081/4837
PIXEL: 1296/3664
PIXEL: 2667/5979
PIXEL: 8021/ 975
PIXEL: 84/ 78
PIXEL: 83/ 77
PIXEL: 755/4785
PIXEL: 1082/4837
PIXEL: 1081/4836
PIXEL: 2670/5941

C02-01

PIXEL: 3439/5871
PIXEL: 3010/3694
PIXEL: 3446/3118
PIXEL: 4181/5971
PIXEL: 4746/5626
PIXEL: 5892/3488
PIXEL: 7780/2802
PIXEL: 742/ 564
PIXEL: 2383/4075
PIXEL: 3906/3971
PIXEL: 3907/3971
PIXEL: 3907/3972
PIXEL: 5702/2060
PIXEL: 5777/4758
PIXEL: 6034/5194
PIXEL: 6621/1894
PIXEL: 8848/5948
PIXEL: 8847/5948
PIXEL: 8849/5949

C03-00

PIXEL: 3667/4516
PIXEL: 3773/3438
PIXEL: 5984/5143
PIXEL: 6525/2537
PIXEL: 6986/ 890
PIXEL: 7098/3241
PIXEL: 8222/5832
PIXEL: 152/5670
PIXEL: 1362/1604

C04-00

PIXEL: 468/3886
PIXEL: 1500/4897
PIXEL: 5571/4266

PIXEL: 5571/4267
PIXEL: 7995/5455
PIXEL: 429/4182
PIXEL: 733/2000
PIXEL: 808/4200
PIXEL: 1255/4189
PIXEL: 1255/4190
PIXEL: 1256/4190
PIXEL: 2199/3383
PIXEL: 3079/1587
PIXEL: 4480/1633
PIXEL: 6742/5969
PIXEL: 8382/4174
PIXEL: 8683/5540
PIXEL: 8778/ 422
PIXEL: 8795/5554
PIXEL: 8882/ 196
PIXEL: 8991/5871
PIXEL: 732/2000

C05-00

PIXEL: 2672/4160
PIXEL: 4262/3825
PIXEL: 6819/2790
PIXEL: 7140/3731
PIXEL: 7662/2793
PIXEL: 2257/1296
PIXEL: 2437/2765
PIXEL: 2674/3856
PIXEL: 2674/3857
PIXEL: 2675/3856
PIXEL: 2675/3857
PIXEL: 4804/2420
PIXEL: 5813/5850

C06-00

PIXEL: 4563/4372
PIXEL: 5556/3032
PIXEL: 253/ 286
PIXEL: 5546/ 332
PIXEL: 5547/ 332
PIXEL: 5700/1920
PIXEL: 5700/1921

C07-00

PIXEL: 2679/3857
PIXEL: 7540/5757
PIXEL: 7540/5758
PIXEL: 7540/5759
PIXEL: 7541/5757

PIXEL: 7555/5775
PIXEL: 8481/ 233
PIXEL: 381/5367
PIXEL: 432/ 599
PIXEL: 453/ 410
PIXEL: 697/5079
PIXEL: 697/5080
PIXEL: 698/5079
PIXEL: 698/5080
PIXEL: 2999/2058
PIXEL: 3657/6016
PIXEL: 6207/5483
PIXEL: 8147/3598
PIXEL: 8336/5242
PIXEL: 8337/5242
PIXEL: 8417/4868

Notes

COLUMN anomaly: all pixels below the Qmax detector at location (X,Y) may be affected.
PIXEL anomaly: single detector at location (X,Y) is not functioning within normal range

The Level0 coordinates exclude the two leftmost pixels containing the line index: the corresponding pixel can therefore be located at column (X+2,Y).

Appendix II

Calibration and Modification Dates

Type of Calibration	Laboratory Calibration Date	Modification Date	Modification Reason
Geometric Calibration	**13.Feb.2020**	**13.Feb.2020**	
Radiometric Calibration	**13.Feb.2020**	**13.Feb.2020**	
Shutter Calibration	**13.Feb.2020**	**13.Feb.2020**	
Electronics and Sensor Calibration	**13.Feb.2020**	**13.Feb.2020**	

Note: The above-mentioned Laboratory Calibration Dates represent the dates the camera was calibrated in one of our calibration labs for a full Laboratory Calibration. The Modification date represents a date on which the calibration has been modified due to a calibration enhancement or part exchange. It is an additional information and does not replace the Laboratory Calibration date in any way. With the Modification Reason, always the last modification to the calibration is highlighted.