



# ULTRACAM

## Calibration Report

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Bahia, Brasil 2013

Photo on page 1 courtesy of Hiparc Geotecnologia, Brasil

[www.hiparc.com](http://www.hiparc.com)

UltraCam Lp, GSD25 cm, RGB



# **ULTRACAM**

## Geometric Calibration

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**Camera:** UltraCam Eagle M3  
**Serial:** 431S51176X010093-f100

**Panchromatic Camera:** ck = 100.500 mm  
**Multispectral Camera:** ck = 100.500 mm

**PPA Information:** X: -0.080 mm  
Y: 0.000 mm



## Panchromatic Camera

### Large Format Panchromatic Output Image

<b>Image Format</b>	long track cross track	68.016mm 105.840mm	17004pixel 26460pixel
<b>Image Extent</b>		(-34.008, -52.920)mm	(34.008, 52.920)mm
<b>Pixel Size</b>		4.000μm*4.000μm	
<b>Focal Length</b>	ck	100.500mm	± 0.002mm
<b>Principal Point (Level 2)</b>	X_ppa	-0.080mm	± 0.002mm
	Y_ppa	0.000mm	± 0.002mm
<b>Lens Distortion</b>	Remaining Distortion less than 0.002mm		

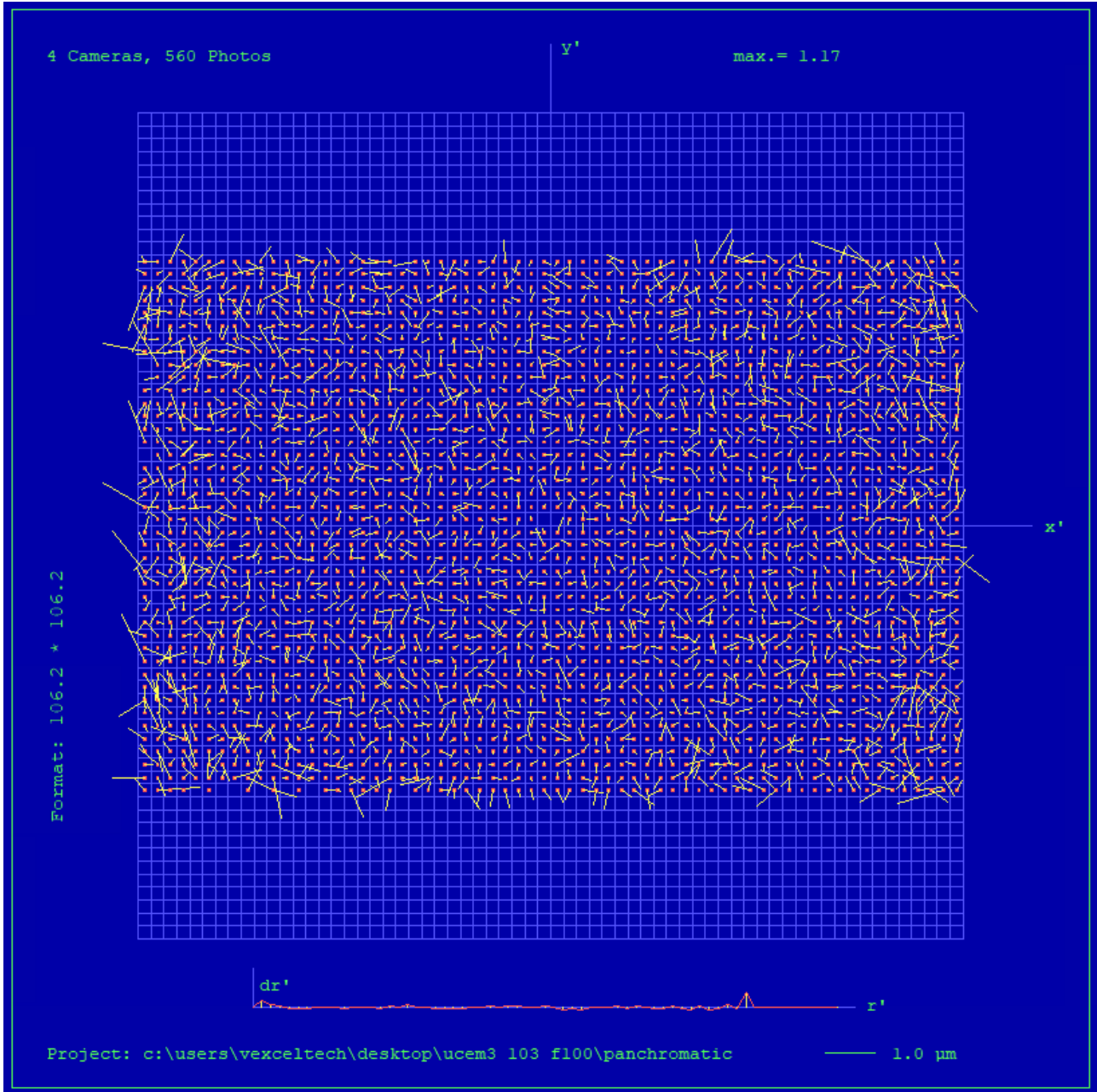
## Multispectral Camera

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

<b>Image Format</b>	long track cross track	68.016mm 105.840mm	5668pixel 8820pixel
<b>Image Extent</b>		(-34.008, -52.920)mm	(34.008, 52.920)mm
<b>Pixel Size</b>		12.000μm*12.000μm	
<b>Focal Length</b>	ck	100.500mm	± 0.002mm
<b>Principal Point (Level 2)</b>	X_ppa	-0.080mm	± 0.002mm
	Y_ppa	0.000mm	± 0.002mm
<b>Lens Distortion</b>	Remaining Distortion less than 0.002mm		



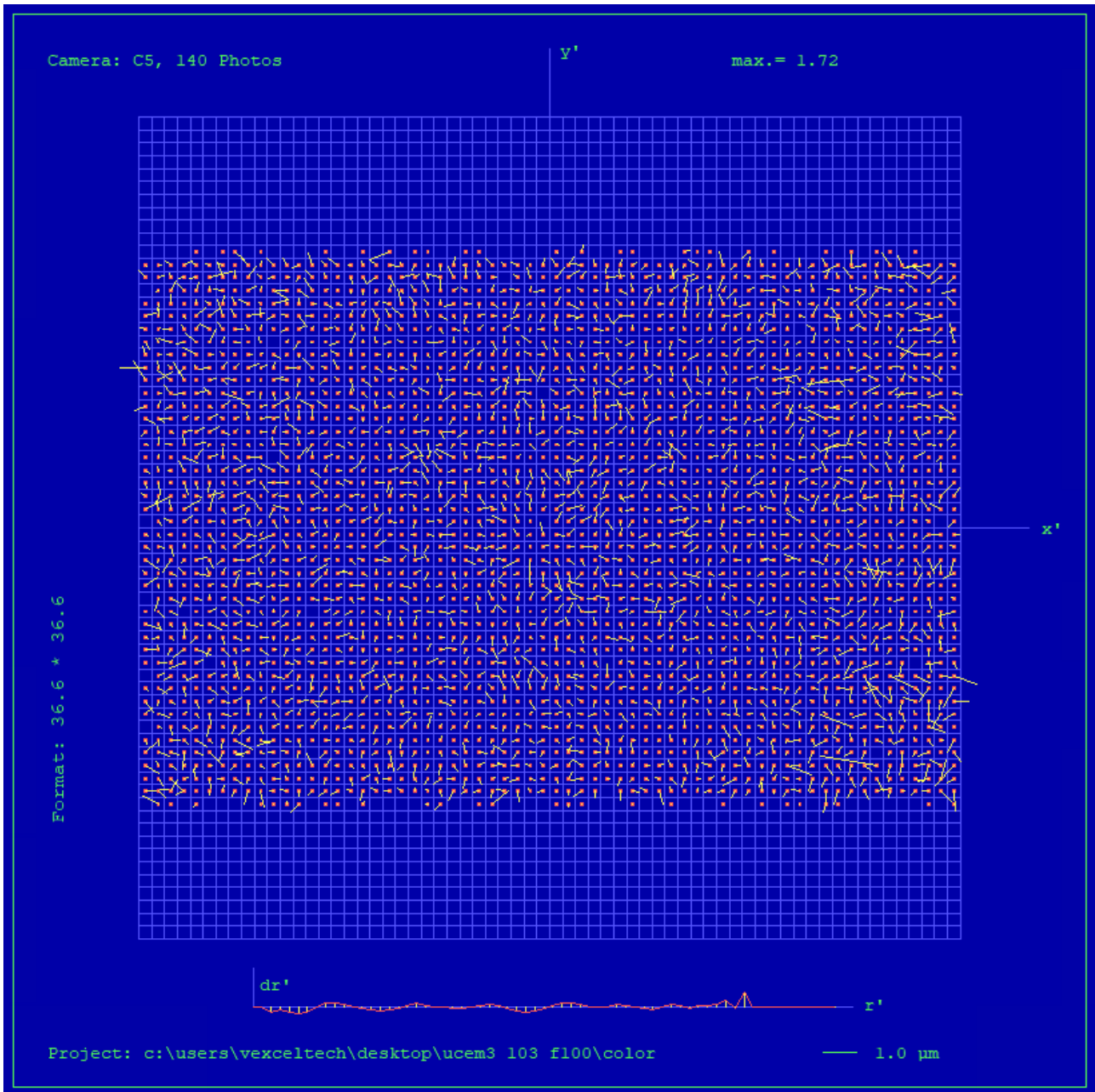
## Full Panchromatic Image, Residual Error Diagram



**Residual Error (RMS):**            **0.64  $\mu\text{m}$**



### Green Cone (Cone 5), Residual Error Diagram



**Residual Error (RMS):**            **0.57  $\mu\text{m}$**



## 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

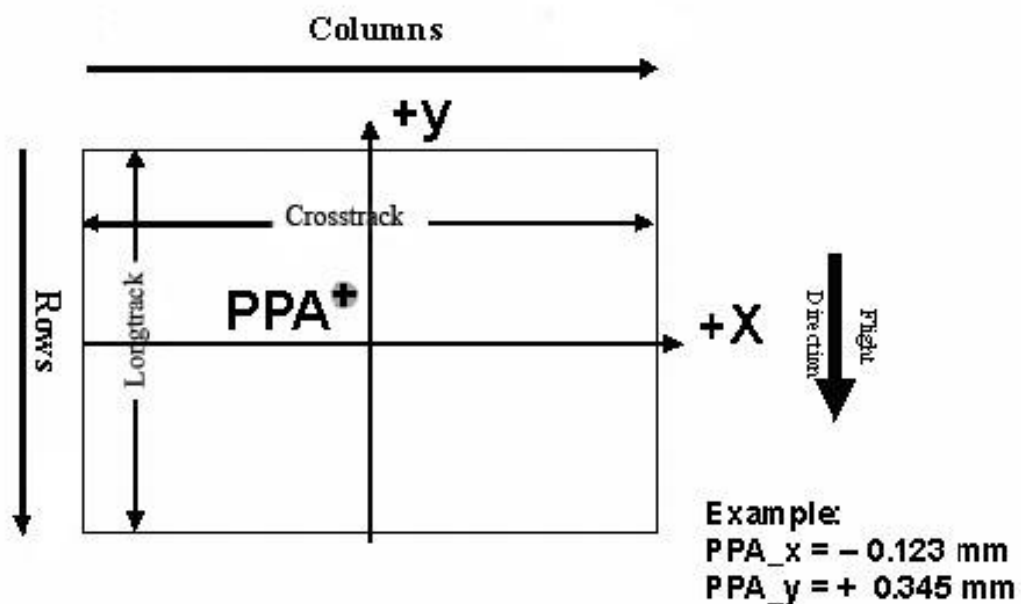
Number of point measurements for the multispectral camera : >60000

Determination of the image parameters by Least Squares Adjustment.

Software used for the adjustment: BINGO (GIP Eng. Aalen, Germany)

### Level 2 Image Coordinate System:

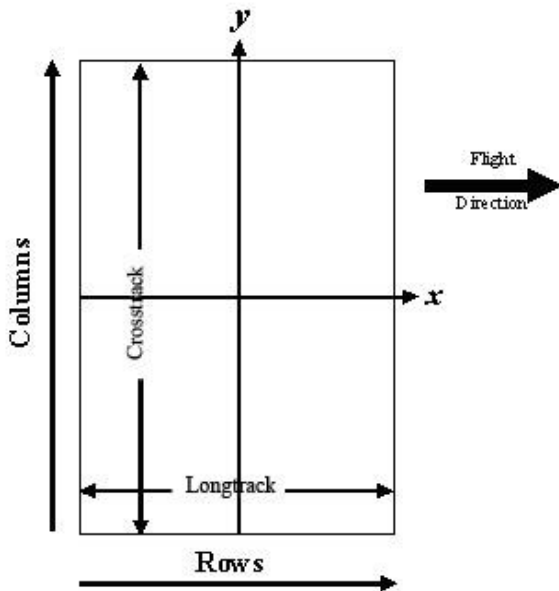
## Lvl2, Camera prop. Orientation



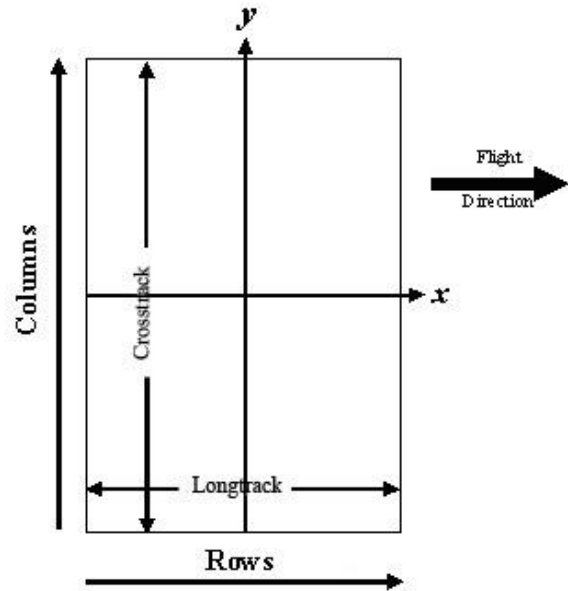
The image coordinate system of the Level 2 images is shown in the above figure. The basic image format and coordinate of the principal point in the level 2 image is given on page 4 of this report. The above figure shows the position of an example principal point at the coordinate (-0.123 / 0.345).



**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.

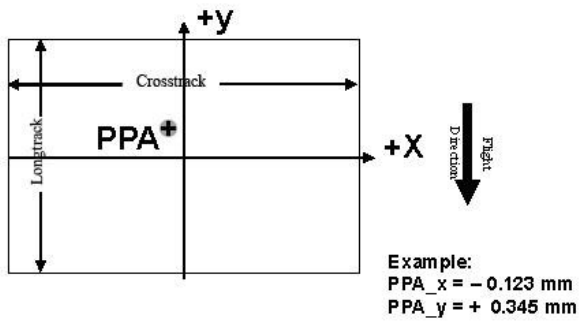
Image Format	Clockwise Rotation (Degree)	PPA	
		X	Y
Level 2	-	-0.080	0.000
Level 3	0	-0.080	0.000
Level 3	90	0.000	0.080
Level 3	180	0.080	0.000
Level 3	270	0.000	-0.080



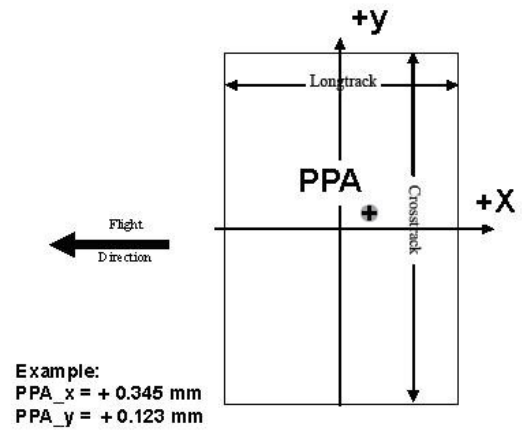


The coordinates in the figure below are only example values to illustrate the effect of image rotation on the principal point position, and do **not** correspond to the camera described in this report.

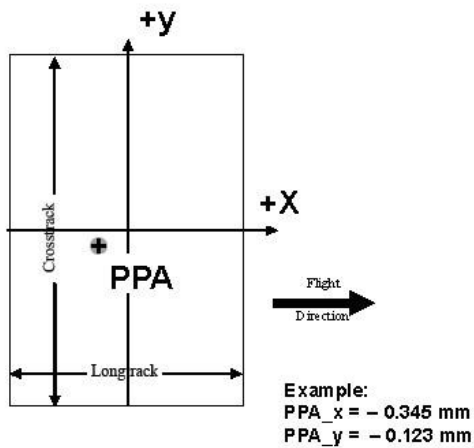
Lvl3, Rotation 0 deg clockwise



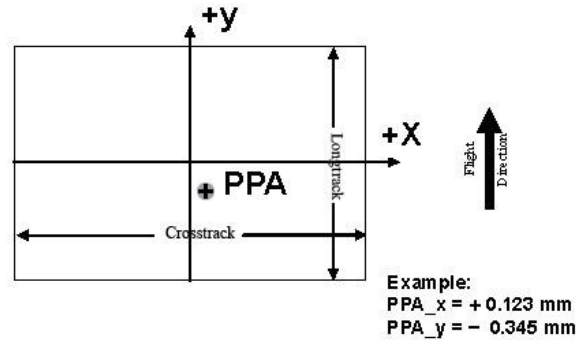
Lvl3, Rotation 90 deg clockwise



Lvl3, Rotation 270 deg clockwise



Lvl3, Rotation 180 deg clockwise





## 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 meridional (tangential) and sagital (radial) component of signals at frequencies of 12.5, 25, 50 and 100 line pairs per millimeter.

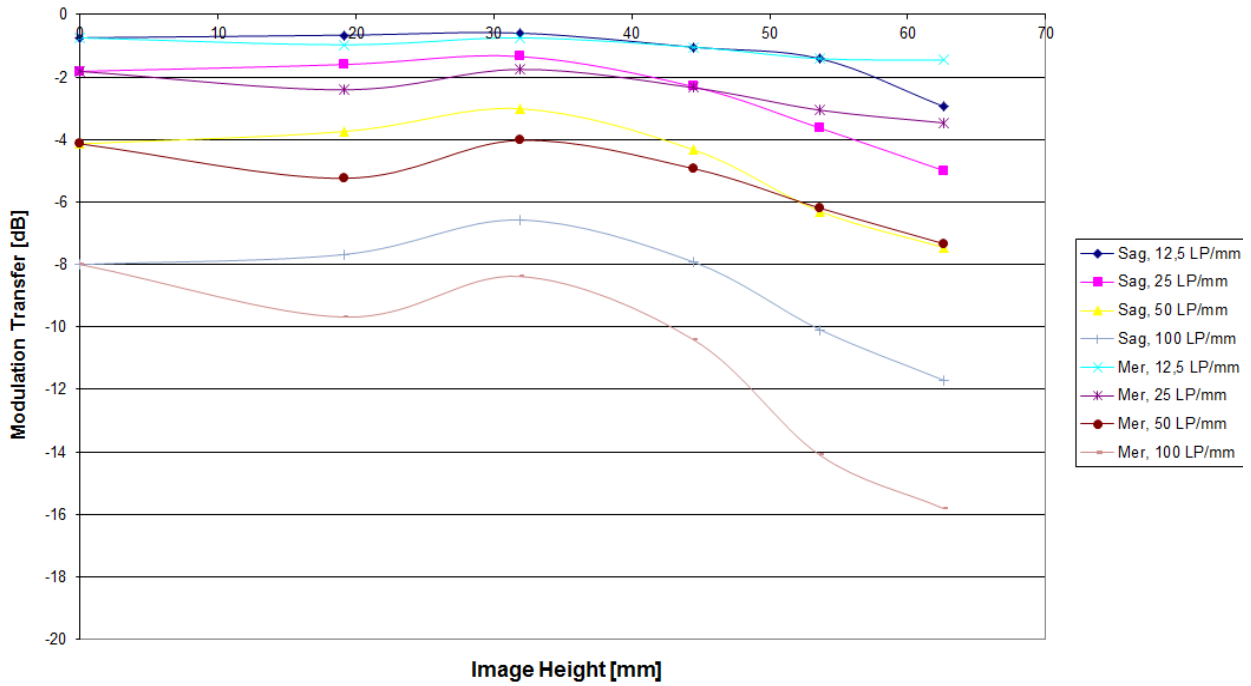
As the MTF is a function of the specific aperture size used, one set of curves is given for each aperture size.

### Lens types

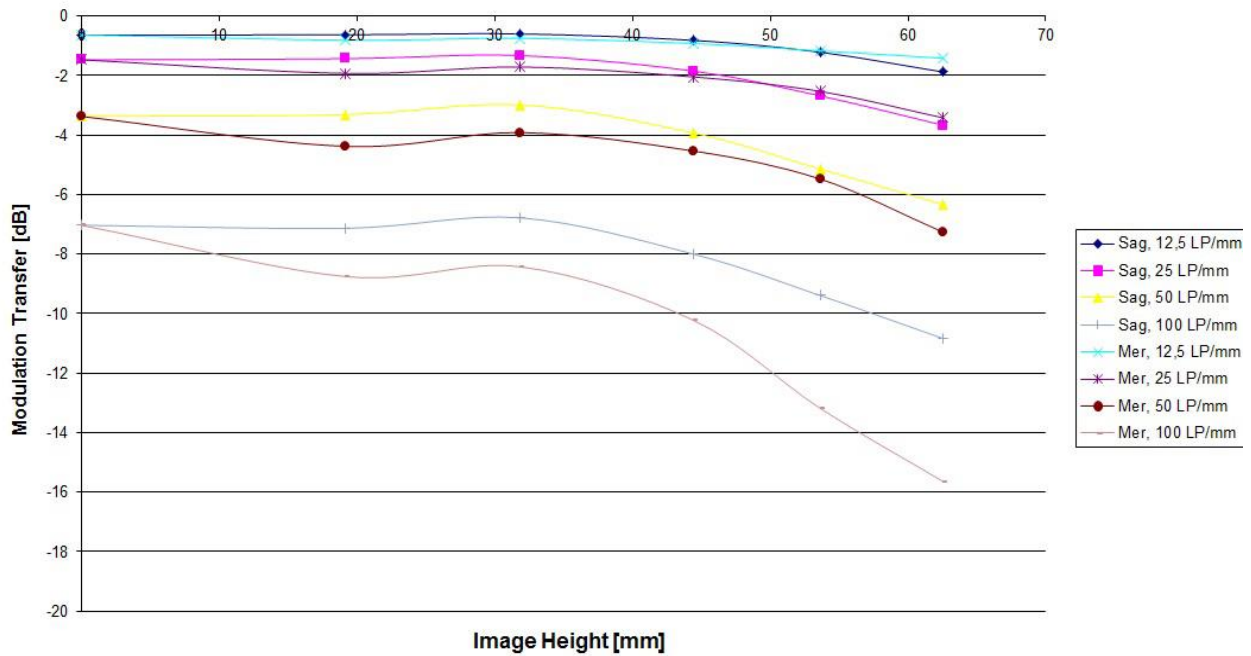
Cone	Lens
C0 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/100mm, Qioptic GmbH, Germany
C1 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/100mm, Qioptic GmbH, Germany
C2 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/100mm, Qioptic GmbH, Germany
C3 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/100mm, Qioptic GmbH, Germany
C4 (RED)	Qioptic 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

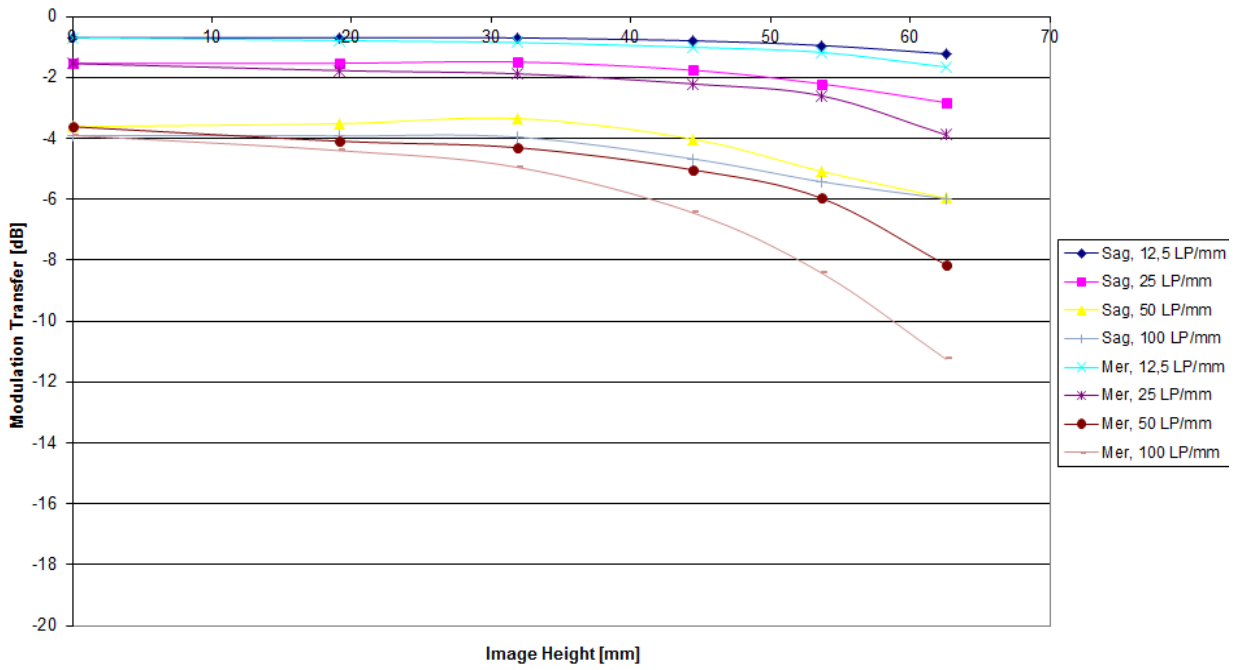


Modulation versus Image Height - Aperture f / 6.7

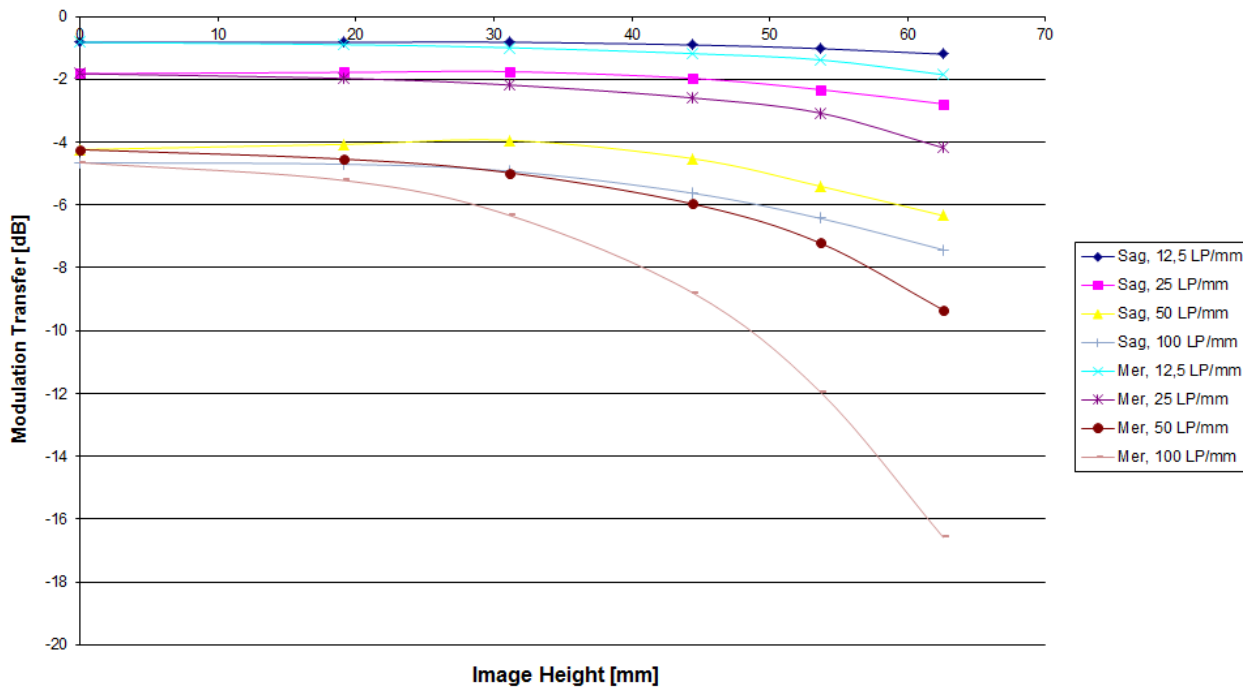




Modulation versus Image Height - Aperture f / 8

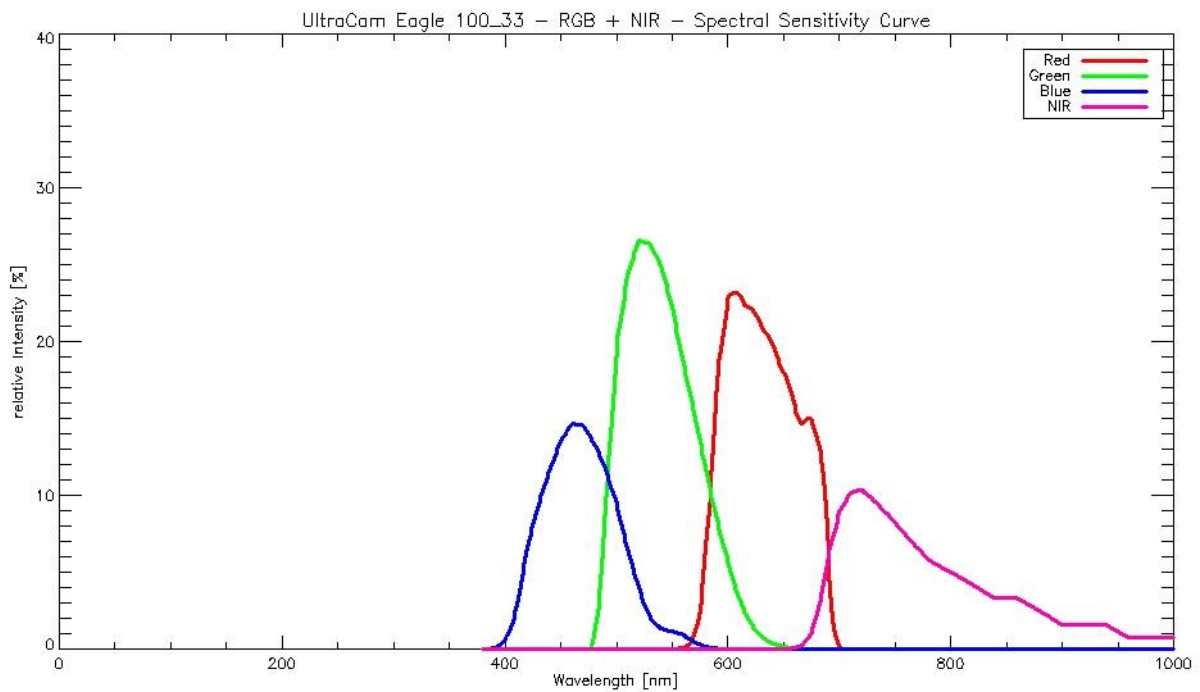
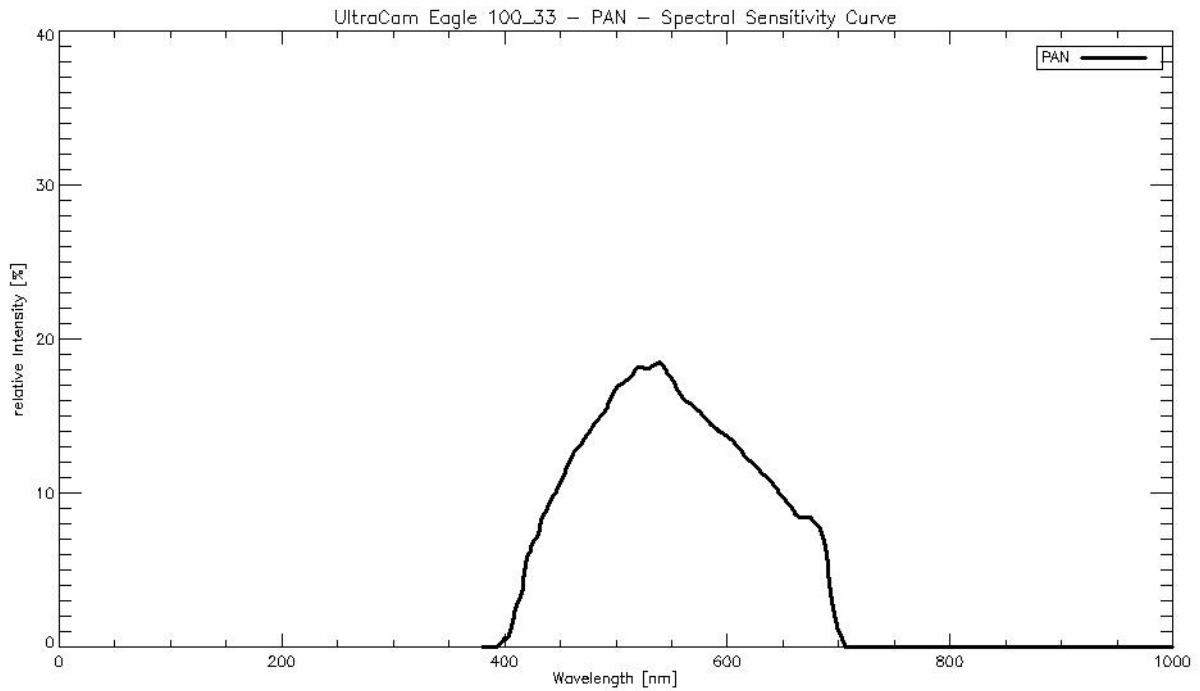


Modulation versus Image Height - Aperture f / 9.5





# Spectral Sensitivity





# ULTRACAM

## Radiometric Calibration

Camera: UltraCam Eagle M3  
Serial: 431S51176X010093-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

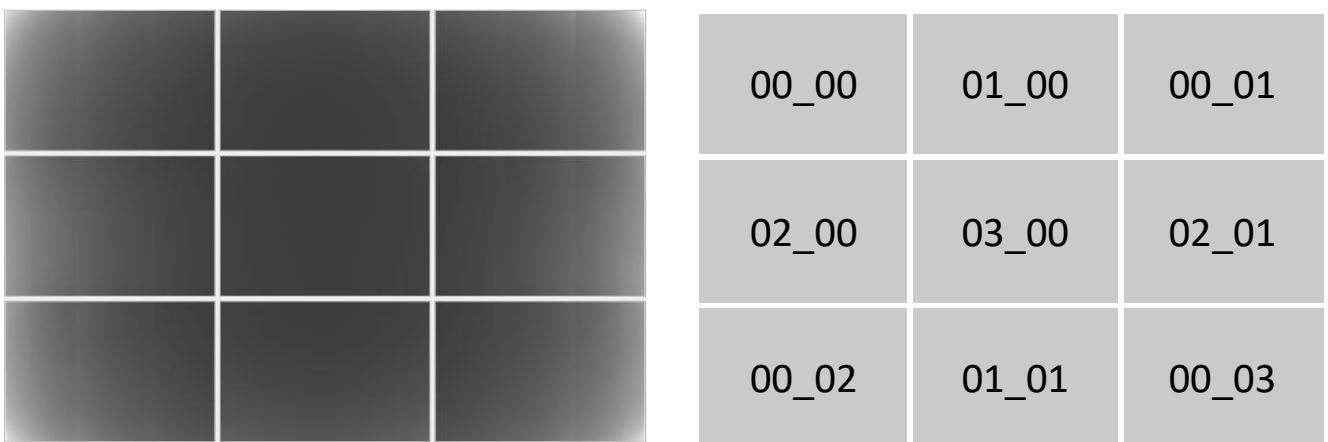
Dead Pixel Report: see Appendix I



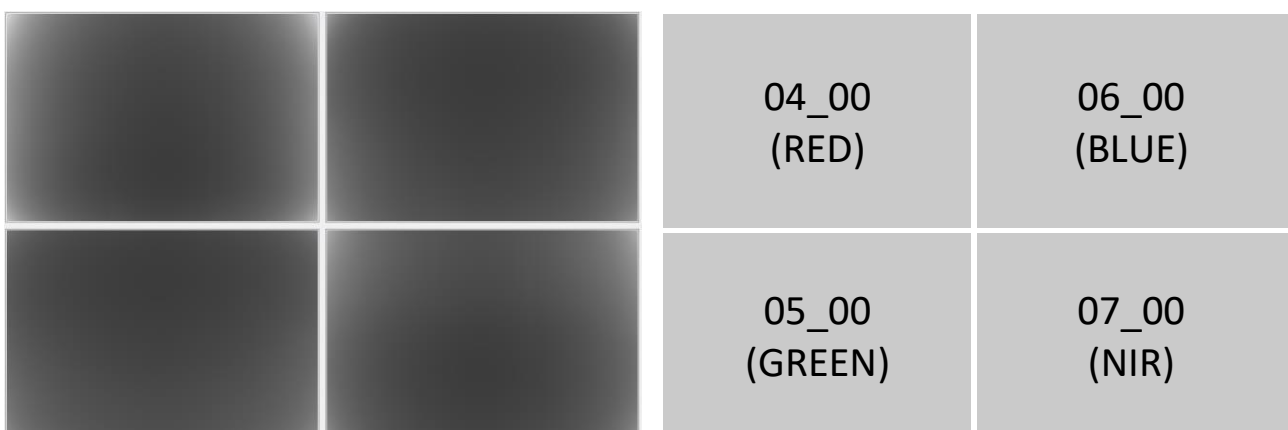
## Calibration of Vignetting for working Aperture F6.7

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

### Graphical Overview of Pan Sensors:



### Graphical Overview of Multispectral Sensors:





## 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.





# **ULTRACAM**

## Shutter Calibration

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**Camera:** UltraCam Eagle M3  
**Serial:** 431S51176X010093-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 36 14 16	6.37	6.61	6.93	7.16	7.37	7.43	7.64	7.92	+/- 0.2
C1 (Pan)	12 38 09 83	7.08	7.37	7.77	8.03	8.16	8.34	8.55	8.85	+/- 0.2
C2 (Pan)	12 38 09 89	6.72	6.95	7.32	7.53	7.80	7.90	8.00	8.30	+/- 0.2
C3 (Pan)	12 38 09 77	6.81	7.06	7.33	7.65	7.84	7.92	8.09	8.48	+/- 0.2
C4 (Red)	12 36 53 21	7.73	7.82	8.03	8.22	8.30	8.39	8.52	8.70	+/- 0.2
C5 (Green)	12 36 53 29	7.18	7.30	7.41	7.54	7.59	7.73	7.89	8.12	+/- 0.2
C6 (Blue)	12 36 53 27	7.29	7.29	7.23	7.43	7.63	7.68	7.91	8.12	+/- 0.2
C7 (NIR)	12 36 53 28	7.15	7.26	7.53	7.68	7.84	7.84	7.80	8.26	+/- 0.2



# **ULTRACAM**

## Electronics and Sensor Calibration

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**Camera:** UltraCam Eagle M3  
**Serial:** 431S51176X010093-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	18 0770/037	22.40	6.17
00_01	FTF9060-M	18 1922/005	22.60	6.58
00_02	FTF9060-M	18 1922/020	22.80	6.27
00_03	FTF9060-M	18 1922/029	23.00	6.12
01_00	FTF9060-M	18 0770/036	22.80	6.75
01_01	FTF9060-M	18 0770/029	22.20	6.22
02_00	FTF9060-M	18 0770/034	22.00	6.17
02_01	FTF9060-M	18 1922/036	23.60	6.48
03_00	FTF9060-M	18 1922/039	23.20	6.41
04_00 (red)	FTF9060-M	18 1922/024	23.20	6.41
05_00 (green)	FTF9060-M	18 1922/011	23.00	5.98
06_00 (blue)	FTF9060-M	18 1922/009	22.80	6.32
07_00 (NIR)	FTF9060-M	18 1922/027	22.80	6.78



## 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	18 0770/037	13080	12460
00_01	FTF9060-M	18 1922/005	13260	12520
00_02	FTF9060-M	18 1922/020	14020	12540
00_03	FTF9060-M	18 1922/029	13080	12410
01_00	FTF9060-M	18 0770/036	12310	12220
01_01	FTF9060-M	18 0770/029	13350	12430
02_00	FTF9060-M	18 0770/034	13460	12590
02_01	FTF9060-M	18 1922/036	12800	12110
03_00	FTF9060-M	18 1922/039	13640	12410
04_00 (red)	FTF9060-M	18 1922/024	13510	12290
05_00 (green)	FTF9060-M	18 1922/011	13200	12560
06_00 (blue)	FTF9060-M	18 1922/009	13480	12600
07_00 (NIR)	FTF9060-M	18 1922/027	13260	12240



# ULTRACAM

## Summary

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**Camera:** UltraCam Eagle M3  
**Serial:** 431S51176X010093-f100

**Laboratory Calibration Date:** Aug-08-2023  
**Camera Revision:** Rev03.00

**Date of Report:** Aug-17-2023  
**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: 94/ 124	PIXEL: 4081/ 214	PIXEL: 4134/ 269	
PIXEL: 8328/ 397	PIXEL: 4309/ 424	PIXEL: 5455/ 622	PIXEL: 4169/ 625
PIXEL: 6960/ 626	PIXEL: 8797/ 784	PIXEL: 1130/ 973	PIXEL: 3371/1066
PIXEL: 8012/1251	PIXEL: 8136/1266	PIXEL: 724/1338	PIXEL: 3675/1527
PIXEL: 3052/1593	PIXEL: 4925/1753	PIXEL: 734/2354	PIXEL: 6421/2559
PIXEL: 6454/3242	PIXEL: 4352/3273	PIXEL: 7659/3284	PIXEL: 2015/3314
PIXEL: 5519/3533	PIXEL: 4922/3571	PIXEL: 1284/3591	PIXEL: 1284/3592
PIXEL: 8897/3657	PIXEL: 2247/3694	PIXEL: 8124/3848	PIXEL: 8786/4153
PIXEL: 4336/4438	PIXEL: 690/4443	PIXEL: 5613/4526	PIXEL: 7170/4662
PIXEL: 1316/4788	PIXEL: 5674/5028	PIXEL: 5751/5035	PIXEL: 1323/5049
PIXEL: 1161/5067	PIXEL: 3673/5136	PIXEL: 2946/5294	PIXEL: 4165/5320
PIXEL: 5133/5329	PIXEL: 6538/5387	PIXEL: 94/5530	PIXEL: 2827/5676
PIXEL: 7335/5696	PIXEL: 1100/5753	PIXEL: 8801/5756	PIXEL: 6200/5760
PIXEL: 4576/5848	PIXEL: 5558/5851	PIXEL: 1527/5856	PIXEL: 8786/5864
PIXEL: 365/6004	PIXEL: 6185/ 19	PIXEL: 1059/ 633	PIXEL: 7563/1823
PIXEL: 7563/1824	PIXEL: 7564/1824	PIXEL: 7563/1825	PIXEL: 7564/1825
PIXEL: 236/2714	PIXEL: 878/3248	PIXEL: 267/3340	PIXEL: 1288/4677
PIXEL: 362/5517	PIXEL: 8723/5609	PIXEL: 491/5998	PIXEL: 490/5998
PIXEL: 4390/5947	PIXEL: 4390/5946	COLUMN: 9001/ 238	COLUMN: 7179/1272
COLUMN: 4812/4359			
C00-01			
PIXEL: 144/ 53			
PIXEL: 4413/ 157	PIXEL: 6483/ 203	PIXEL: 6251/ 229	PIXEL: 7740/ 361
PIXEL: 2357/ 429	PIXEL: 6892/ 924	PIXEL: 8565/1134	PIXEL: 3508/1216
PIXEL: 8048/1289	PIXEL: 5509/1446	PIXEL: 3715/1610	PIXEL: 3691/1622
PIXEL: 4247/1680	PIXEL: 2830/1814	PIXEL: 3471/1837	PIXEL: 5788/2051
PIXEL: 5639/2087	PIXEL: 28/2092	PIXEL: 5238/2094	PIXEL: 7440/2257
PIXEL: 3158/2588	PIXEL: 5958/2630	PIXEL: 1678/2722	PIXEL: 8387/2892
PIXEL: 843/2922	PIXEL: 4001/3022	PIXEL: 5200/3188	PIXEL: 7159/3255
PIXEL: 1768/3282	PIXEL: 8815/3460	PIXEL: 4922/3653	PIXEL: 4455/3723
PIXEL: 6983/3964	PIXEL: 1677/3986	PIXEL: 1585/4120	PIXEL: 5291/4220
PIXEL: 4277/4457	PIXEL: 7840/4490	PIXEL: 8192/4506	PIXEL: 7939/4588
PIXEL: 5312/4606	PIXEL: 5238/4687	PIXEL: 5408/4717	PIXEL: 5590/4956
PIXEL: 1028/4998	PIXEL: 6600/5071	PIXEL: 2946/5379	PIXEL: 382/5391



PIXEL: 4277/5474	PIXEL: 8862/5489	PIXEL: 4642/5707	PIXEL: 5030/5844
PIXEL: 3007/5897	PIXEL: 6873/5904	PIXEL: 3890/5924	PIXEL: 8191/ 336
PIXEL: 419/ 468	PIXEL: 6821/ 669	PIXEL: 8309/ 943	PIXEL: 8217/1149
PIXEL: 6748/2840	COLUMN: 4847/2968		

C00-02

PIXEL: 959/ 26	PIXEL: 8584/ 86	PIXEL: 882/ 213	PIXEL: 3486/ 231
PIXEL: 993/ 427	PIXEL: 2012/ 429	PIXEL: 479/ 474	PIXEL: 7392/ 585
PIXEL: 6810/ 609	PIXEL: 6844/ 754	PIXEL: 5728/ 840	PIXEL: 6377/ 864
PIXEL: 7873/1171	PIXEL: 3911/1387	PIXEL: 2081/1478	PIXEL: 8461/1586
PIXEL: 6474/1615	PIXEL: 496/1669	PIXEL: 4220/1698	PIXEL: 4163/1786
PIXEL: 2672/1803	PIXEL: 7696/1803	PIXEL: 4364/1969	PIXEL: 1454/1975
PIXEL: 7271/2015	PIXEL: 7305/2027	PIXEL: 5980/2285	PIXEL: 6961/2294
PIXEL: 5635/2369	PIXEL: 8752/2391	PIXEL: 8220/2450	PIXEL: 6217/2522
PIXEL: 3327/2578	PIXEL: 4722/2852	PIXEL: 5758/2869	PIXEL: 1956/2885
PIXEL: 3911/2971	PIXEL: 4537/3017	PIXEL: 3911/3096	PIXEL: 2265/3131
PIXEL: 7833/3376	PIXEL: 6515/3449	PIXEL: 4204/3574	PIXEL: 7241/3690
PIXEL: 4924/3847	PIXEL: 8699/3869	PIXEL: 813/3873	PIXEL: 1122/3894
PIXEL: 7681/4024	PIXEL: 3209/4043	PIXEL: 6356/4170	PIXEL: 6684/4231
PIXEL: 2490/4267	PIXEL: 4788/4398	PIXEL: 7473/4535	PIXEL: 1264/4770
PIXEL: 5007/4799	PIXEL: 3911/5002	PIXEL: 5623/5114	PIXEL: 5683/5136
PIXEL: 8423/5164	PIXEL: 8423/5165	PIXEL: 6243/5195	PIXEL: 4714/5240
PIXEL: 1841/5282	PIXEL: 6657/5316	PIXEL: 1072/5547	PIXEL: 6763/5606
PIXEL: 898/5716	PIXEL: 5474/5792	PIXEL: 2360/5937	PIXEL: 5120/5987
PIXEL: 1285/1013	PIXEL: 5228/2020	PIXEL: 5229/2020	PIXEL: 4663/2493
PIXEL: 6397/4519	COLUMN: 6404/3380		

C00-03

PIXEL: 5249/ 133	PIXEL: 4523/ 148	PIXEL: 3882/ 234	PIXEL: 8666/ 271
PIXEL: 8331/ 296	PIXEL: 3339/ 403	PIXEL: 7978/ 563	PIXEL: 147/ 726
PIXEL: 7852/ 905	PIXEL: 2776/ 921	PIXEL: 470/ 942	PIXEL: 1748/1124
PIXEL: 2236/1155	PIXEL: 8810/1246	PIXEL: 5195/1439	PIXEL: 6933/1470
PIXEL: 6589/1501	PIXEL: 876/1701	PIXEL: 876/1702	PIXEL: 4789/2006
PIXEL: 647/2209	PIXEL: 5724/2624	PIXEL: 5800/2693	PIXEL: 3118/2756
PIXEL: 5710/2838	PIXEL: 330/2981	PIXEL: 2016/3312	PIXEL: 4984/3497
PIXEL: 2681/3502	PIXEL: 1192/3589	PIXEL: 7790/3776	PIXEL: 7716/3899
PIXEL: 883/4016	PIXEL: 103/4071	PIXEL: 5926/4205	PIXEL: 926/4749
PIXEL: 5134/4779	PIXEL: 891/4846	PIXEL: 1943/5273	PIXEL: 5134/5375
PIXEL: 5838/5434	PIXEL: 5134/5710	PIXEL: 1339/5733	PIXEL: 5134/5909
PIXEL: 5134/5953	PIXEL: 533/5968	PIXEL: 3245/ 917	PIXEL: 8854/1192
PIXEL: 4005/2495	PIXEL: 8400/2744	PIXEL: 8277/3732	PIXEL: 1898/3733
PIXEL: 8019/5333	PIXEL: 8020/5333	PIXEL: 7691/5347	PIXEL: 9012/5937
PIXEL: 427/5904			

C01-00

PIXEL: 6151/ 496			
PIXEL: 1297/ 785	PIXEL: 6907/1096	PIXEL: 7639/1109	PIXEL: 8721/1152
PIXEL: 6711/1154	PIXEL: 6748/1168	PIXEL: 73/1301	PIXEL: 553/1363
PIXEL: 468/1434	PIXEL: 5075/1641	PIXEL: 2220/1646	PIXEL: 1332/1977
PIXEL: 2532/2052	PIXEL: 3939/2155	PIXEL: 6786/2160	PIXEL: 2054/2248
PIXEL: 4988/2342	PIXEL: 2901/2518	PIXEL: 149/2577	PIXEL: 5612/2696





PIXEL: 8733/2741	PIXEL: 8192/2928	PIXEL: 8686/3000	PIXEL: 6755/3079
PIXEL: 6423/3110	PIXEL: 3629/3113	PIXEL: 3531/3126	PIXEL: 7743/3147
PIXEL: 4480/3387	PIXEL: 4221/3672	PIXEL: 578/3786	PIXEL: 7589/4148
PIXEL: 1052/4342	PIXEL: 4758/4352	PIXEL: 7215/4552	PIXEL: 6026/4577
PIXEL: 4839/4617	PIXEL: 3971/4698	PIXEL: 6927/4700	PIXEL: 3492/4887
PIXEL: 6444/5084	PIXEL: 4516/5480	PIXEL: 4042/ 321	PIXEL: 7341/ 943
PIXEL: 4707/1276	PIXEL: 2870/5697	COLUMN: 1083/3734	COLUMN: 5747/2221
COLUMN: 5344/5030	COLUMN: 5348/1271		

C01-01

PIXEL: 4096/5947	PIXEL: 4473/ 145	PIXEL: 6717/ 242	PIXEL: 4067/ 448
PIXEL: 3033/ 813	PIXEL: 6885/ 821	PIXEL: 6885/ 822	PIXEL: 6358/ 851
PIXEL: 6374/1082	PIXEL: 8514/1093	PIXEL: 4129/1587	PIXEL: 4646/2100
PIXEL: 4516/2123	PIXEL: 7456/2237	PIXEL: 5205/2371	PIXEL: 3151/2509
PIXEL: 4622/2724	PIXEL: 84/2732	PIXEL: 2723/2796	PIXEL: 7304/2800
PIXEL: 6900/2820	PIXEL: 7256/2880	PIXEL: 3072/3017	PIXEL: 5917/3022
PIXEL: 4134/3050	PIXEL: 2964/3237	PIXEL: 817/3412	PIXEL: 2773/3787
PIXEL: 4134/3873	PIXEL: 5827/4308	PIXEL: 2094/4704	PIXEL: 4648/4724
PIXEL: 4786/4765	PIXEL: 3116/5152	PIXEL: 1904/5683	PIXEL: 7748/5728
PIXEL: 157/5618	PIXEL: 303/5847	COLUMN: 4096/5946	

C02-00

PIXEL: 4106/ 281	PIXEL: 4025/ 373	PIXEL: 5600/ 441	
PIXEL: 6216/ 646	PIXEL: 152/ 803	PIXEL: 3944/1006	PIXEL: 621/1506
PIXEL: 4426/1921	PIXEL: 7640/1961	PIXEL: 1730/2092	PIXEL: 301/2131
PIXEL: 7984/2587	PIXEL: 6852/2614	PIXEL: 2489/2734	PIXEL: 5780/2781
PIXEL: 6377/2790	PIXEL: 5898/2830	PIXEL: 2604/3199	PIXEL: 1900/3251
PIXEL: 635/3353	PIXEL: 4508/3458	PIXEL: 5940/3565	PIXEL: 4593/3655
PIXEL: 5223/3665	PIXEL: 6802/4048	PIXEL: 1136/4232	PIXEL: 596/4369
PIXEL: 8681/4441	PIXEL: 684/4497	PIXEL: 6186/4600	PIXEL: 7541/4722
PIXEL: 8676/4988	PIXEL: 8622/4998	PIXEL: 7984/5004	PIXEL: 7500/5280
PIXEL: 6874/5398	PIXEL: 5524/5417	PIXEL: 7742/5540	PIXEL: 1231/5634
PIXEL: 7984/5645	PIXEL: 8028/5863	PIXEL: 5056/5934	PIXEL: 8843/5961
PIXEL: 2380/6007	PIXEL: 6175/6013	PIXEL: 505/2047	PIXEL: 2873/2167
PIXEL: 518/4515	PIXEL: 326/5876	PIXEL: 327/5876	PIXEL: 326/5877
PIXEL: 8309/5985			

C02-01

PIXEL: 1694/ 244			
PIXEL: 6902/ 793	PIXEL: 6149/ 900	PIXEL: 5789/ 971	PIXEL: 5789/ 972
PIXEL: 938/1150	PIXEL: 8120/1152	PIXEL: 5812/1351	PIXEL: 206/1428
PIXEL: 1396/1680	PIXEL: 5327/1738	PIXEL: 2784/1764	PIXEL: 2962/1944
PIXEL: 2358/2141	PIXEL: 4890/2370	PIXEL: 5617/2395	PIXEL: 8708/2432
PIXEL: 2423/2705	PIXEL: 4461/2887	PIXEL: 5406/3048	PIXEL: 4811/3058
PIXEL: 6871/3158	PIXEL: 7710/3356	PIXEL: 949/3416	PIXEL: 6405/3613
PIXEL: 2962/3700	PIXEL: 8363/3922	PIXEL: 5146/4112	PIXEL: 3984/4168
PIXEL: 6438/4233	PIXEL: 4103/4272	PIXEL: 4103/4273	PIXEL: 9036/4728
PIXEL: 6014/4735	PIXEL: 323/4976	PIXEL: 1826/5042	PIXEL: 6958/5407
PIXEL: 7375/5468	PIXEL: 5555/5572	PIXEL: 7174/5950	PIXEL: 3575/5993
PIXEL: 5388/ 886	PIXEL: 566/5539	PIXEL: 8947/5926	COLUMN: 4985/ 737



C03-00

PIXEL: 4676/ 100	PIXEL: 8797/ 418		
PIXEL: 2520/ 440	PIXEL: 8711/ 611	PIXEL: 3799/ 695	PIXEL: 6328/1084
PIXEL: 5433/1280	PIXEL: 870/1297	PIXEL: 657/1303	PIXEL: 1081/1426
PIXEL: 7869/1519	PIXEL: 1612/1753	PIXEL: 8956/1973	PIXEL: 4127/2031
PIXEL: 494/2236	PIXEL: 7069/2504	PIXEL: 6701/2601	PIXEL: 3847/2674
PIXEL: 5628/2773	PIXEL: 3131/2817	PIXEL: 6782/2824	PIXEL: 3961/2826
PIXEL: 7710/3292	PIXEL: 698/3465	PIXEL: 4706/3710	PIXEL: 5476/3904
PIXEL: 4520/4179	PIXEL: 6194/4267	PIXEL: 7496/4409	PIXEL: 2212/4719
PIXEL: 7381/4726	PIXEL: 4222/4997	PIXEL: 7162/5076	PIXEL: 3339/5243
PIXEL: 1905/5246	PIXEL: 1940/5650	PIXEL: 344/5657	PIXEL: 1940/5717
PIXEL: 2370/5767	PIXEL: 1940/5768	PIXEL: 6596/5804	PIXEL: 1940/5879
PIXEL: 1940/5917	PIXEL: 9021/5924	PIXEL: 1940/5945	PIXEL: 3088/5960
PIXEL: 1940/5980	PIXEL: 8289/5980	PIXEL: 5935/3024	PIXEL: 3696/3594
PIXEL: 3697/3594	PIXEL: 3697/3595	PIXEL: 3698/3595	PIXEL: 8155/4341
PIXEL: 8155/4342	PIXEL: 51/4871	PIXEL: 7143/5083	COLUMN: 8149/ 274

C04-00

PIXEL: 885/ 124	PIXEL: 2282/ 145		
PIXEL: 6126/ 177	PIXEL: 2125/ 330	PIXEL: 7759/ 383	PIXEL: 6817/ 777
PIXEL: 5080/ 931	PIXEL: 623/1035	PIXEL: 3775/1038	PIXEL: 1771/1319
PIXEL: 4842/1448	PIXEL: 501/1465	PIXEL: 6343/1927	PIXEL: 1703/2253
PIXEL: 4451/2519	PIXEL: 2059/2739	PIXEL: 2059/2740	PIXEL: 7157/2810
PIXEL: 4894/3482	PIXEL: 8091/3765	PIXEL: 8449/4006	PIXEL: 5974/4026
PIXEL: 8418/4116	PIXEL: 8525/4167	PIXEL: 4262/4275	PIXEL: 1035/4712
PIXEL: 4058/4769	PIXEL: 3354/5075	PIXEL: 499/5408	PIXEL: 3864/5456
PIXEL: 2382/5543	PIXEL: 5871/5906	PIXEL: 7779/5951	PIXEL: 8319/5968
PIXEL: 6458/6009	PIXEL: 51/ 158	PIXEL: 724/ 327	PIXEL: 8939/1167
PIXEL: 560/1546	PIXEL: 47/1698		

C05-00

PIXEL: 3636/ 294	PIXEL: 5570/ 331	PIXEL: 5738/ 426	PIXEL: 1238/ 688
PIXEL: 4262/ 710	PIXEL: 3981/ 725	PIXEL: 3823/ 740	PIXEL: 5936/ 747
PIXEL: 1475/1491	PIXEL: 2770/1635	PIXEL: 3969/1688	PIXEL: 7792/1729
PIXEL: 2873/1869	PIXEL: 6796/1947	PIXEL: 504/2643	PIXEL: 4051/2696
PIXEL: 5472/2721	PIXEL: 5462/3542	PIXEL: 3977/3545	PIXEL: 1627/3827
PIXEL: 1747/4226	PIXEL: 5112/4260	PIXEL: 4709/4375	PIXEL: 6054/4437
PIXEL: 2942/4471	PIXEL: 220/4651	PIXEL: 8593/4802	PIXEL: 5984/4932
PIXEL: 4402/4976	PIXEL: 5709/5031	PIXEL: 7341/5109	PIXEL: 2713/5325
PIXEL: 369/5432	PIXEL: 6045/5541	PIXEL: 4619/5554	PIXEL: 3227/5789
PIXEL: 4709/5871	PIXEL: 7882/5959	PIXEL: 4112/5962	PIXEL: 1721/1061
PIXEL: 8285/2677	PIXEL: 1518/3997	PIXEL: 8599/4135	PIXEL: 6711/4883
PIXEL: 6712/4883	PIXEL: 6711/4884	PIXEL: 6712/4884	

C06-00

PIXEL: 7962/ 27	PIXEL: 4895/ 39	PIXEL: 7545/ 504	
PIXEL: 6643/ 848	PIXEL: 7893/1094	PIXEL: 6708/1305	PIXEL: 4873/1412
PIXEL: 7610/1794	PIXEL: 261/1981	PIXEL: 1065/2105	PIXEL: 8101/2218
PIXEL: 6038/2273	PIXEL: 8755/2462	PIXEL: 659/2501	PIXEL: 8864/2503
PIXEL: 5038/2829	PIXEL: 6222/3556	PIXEL: 1471/3695	PIXEL: 986/3827
PIXEL: 1292/3863	PIXEL: 6301/3942	PIXEL: 7271/4048	PIXEL: 650/4067



PIXEL: 7742/4076	PIXEL: 2890/4172	PIXEL: 2692/4363	PIXEL: 5613/4412
PIXEL: 4153/4415	PIXEL: 4106/4606	PIXEL: 2435/4607	PIXEL: 5513/4742
PIXEL: 5266/4790	PIXEL: 955/4920	PIXEL: 7869/4984	PIXEL: 6979/5127
PIXEL: 1361/5269	PIXEL: 6740/5310	PIXEL: 7780/5769	PIXEL: 4959/5806
PIXEL: 8299/ 406	PIXEL: 337/ 920	PIXEL: 1736/1271	PIXEL: 8062/2294
PIXEL: 5852/3210	PIXEL: 7821/3942	PIXEL: 622/5141	PIXEL: 391/5499

C07-00

PIXEL: 7058/ 496	PIXEL: 3524/ 531		
PIXEL: 1126/ 716	PIXEL: 3226/1756	PIXEL: 3226/1757	PIXEL: 3227/1757
PIXEL: 3227/1758	PIXEL: 8501/2480	PIXEL: 4797/2515	PIXEL: 9041/2856
PIXEL: 1881/3496	PIXEL: 6363/3499	PIXEL: 4829/3774	PIXEL: 6177/4189
PIXEL: 4952/4272	PIXEL: 3776/4283	PIXEL: 7975/4523	PIXEL: 681/4615
PIXEL: 682/4616	PIXEL: 683/4617	PIXEL: 684/4618	PIXEL: 685/4618
PIXEL: 826/4621	PIXEL: 826/4622	PIXEL: 2385/4774	PIXEL: 3933/5846
PIXEL: 799/5943	PIXEL: 8962/5950	PIXEL: 6664/ 37	PIXEL: 968/ 76
PIXEL: 6911/ 214	PIXEL: 6535/ 263	PIXEL: 2364/ 350	PIXEL: 3955/ 443
PIXEL: 795/ 527	PIXEL: 705/ 530	PIXEL: 3509/ 753	PIXEL: 8433/ 822
PIXEL: 6452/1009	PIXEL: 3828/1465	PIXEL: 3828/1466	PIXEL: 6077/1543
PIXEL: 3379/1791	PIXEL: 3595/2316	PIXEL: 919/3429	PIXEL: 102/3659
PIXEL: 7620/3793	PIXEL: 8350/3835	PIXEL: 1877/4196	PIXEL: 7473/4331
PIXEL: 4197/4344	PIXEL: 844/5041	PIXEL: 8154/5342	PIXEL: 572/5470
PIXEL: 44/5992	PIXEL: 4207/6003	PIXEL: 4208/6003	PIXEL: 94/5904
PIXEL: 119/5875			

**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 correspond-  
ing 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	08.Aug.2023	N/A	
Radiometric Calibration	08.Aug.2023	N/A	
Shutter Calibration	08.Aug.2023	N/A	
Electronics and Sensor Calibration	08.Aug.2023	N/A	

**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.