



# 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  
**Serial:** UC-E-1-90813658-f80

**Panchromatic Camera:** ck = 79.800 mm  
**Multispectral Camera:** ck = 79.800 mm

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

**Calibration Date:** Jun-15-2018  
**Date of Report:** Jun-20-2018  
**Camera Revision:** Rev01.00  
**Version of Report:** V01



## Panchromatic Camera

### Large Format Panchromatic Output Image

<b>Image Format</b>	long track cross track	68.016mm 104.052mm	13080pixel 20010pixel
<b>Image Extent</b>		(-34.008, -52.026)mm	(34.008, 52.026)mm
<b>Pixel Size</b>		5.200µm*5.200µm	
<b>Focal Length</b>	ck	79.800mm	± 0.002mm
<b>Principal Point (Level 2)</b>	X_ppa	0.000mm	± 0.002mm
	Y_ppa	0.000mm	± 0.002mm
<b>Lens Distortion</b>	Remaining Distortion less than 0.002mm		

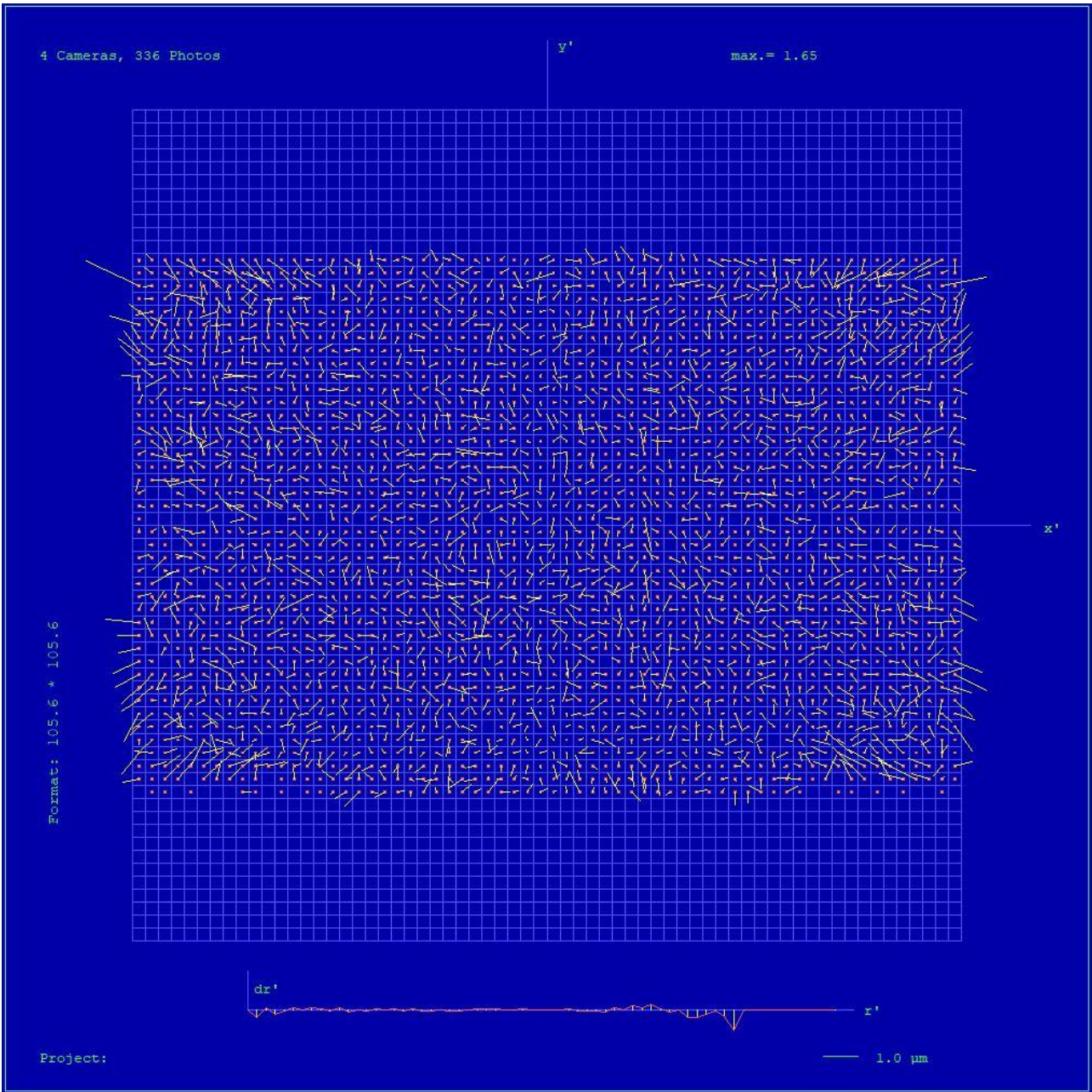
## Multispectral Camera

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

<b>Image Format</b>	long track cross track	68.016mm 104.052mm	4360pixel 6670pixel
<b>Image Extent</b>		(-34.008, -52.026)mm	(34.008, 52.026)mm
<b>Pixel Size</b>		15.600µm*15.600µm	
<b>Focal Length</b>	ck	79.800mm	± 0.002mm
<b>Principal Point (Level 2)</b>	X_ppa	0.000mm	± 0.002mm
	Y_ppa	0.000mm	± 0.002mm
<b>Lens Distortion</b>	Remaining Distortion less than 0.002mm		



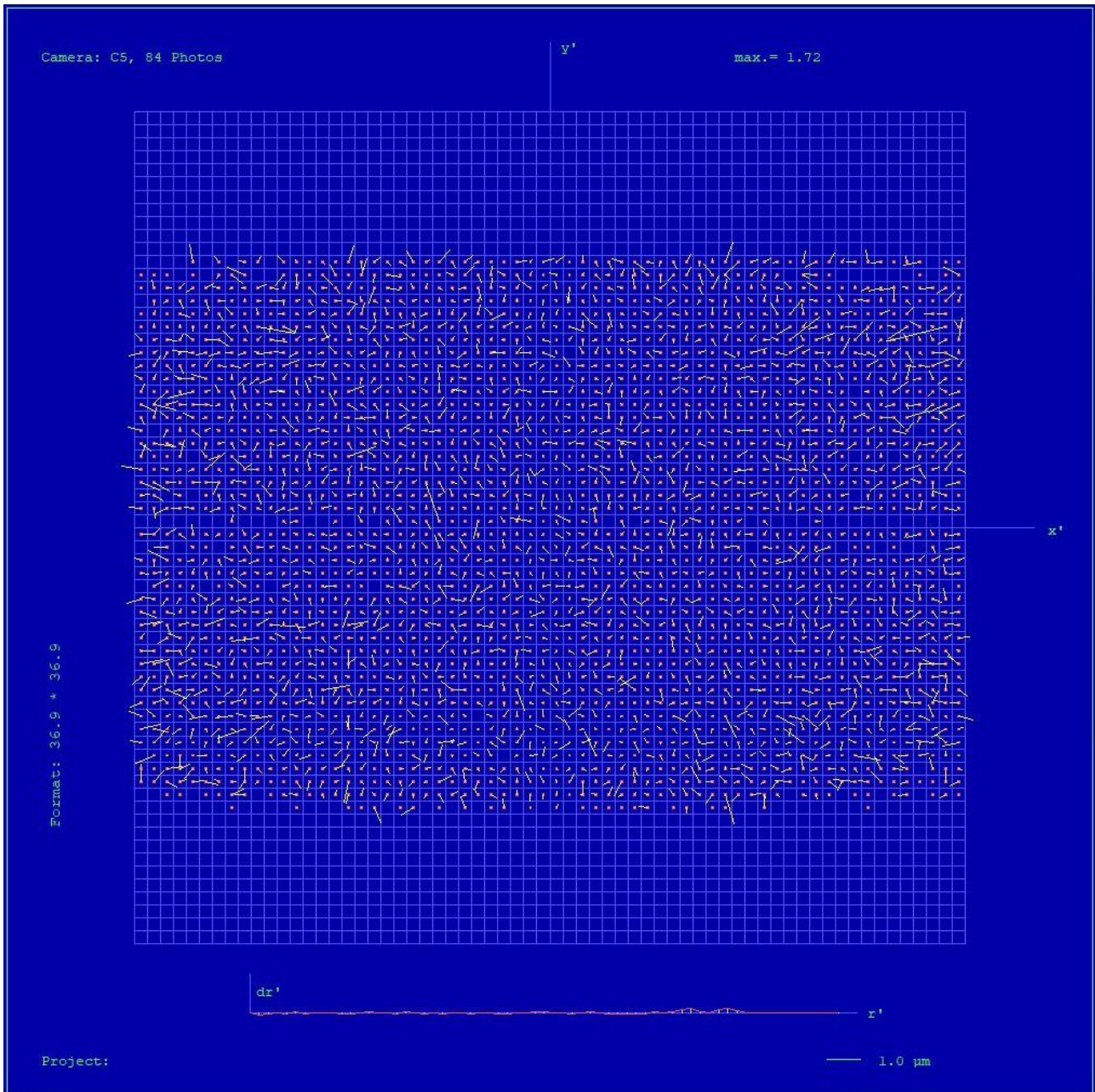
# Full Panchromatic Image, Residual Error Diagram



**Residual Error (RMS):**            **0.59  $\mu\text{m}$**



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



**Residual Error (RMS):**            **0.49  $\mu\text{m}$**



## Explanations

### Calibration Method:

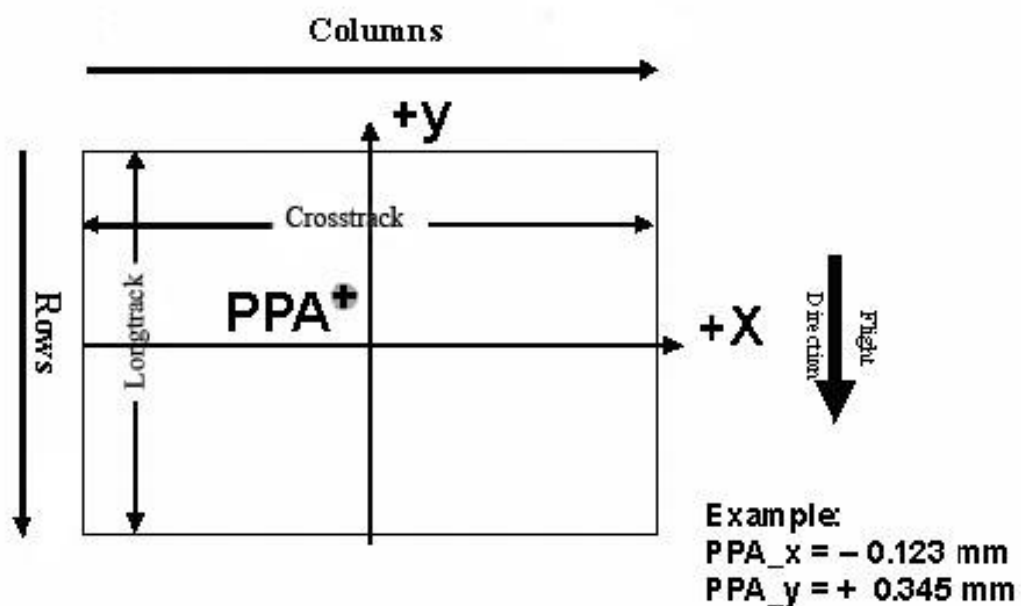
The geometric calibration is based on a set of 84 images of a defined geometry target with 394 GCPs.

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:

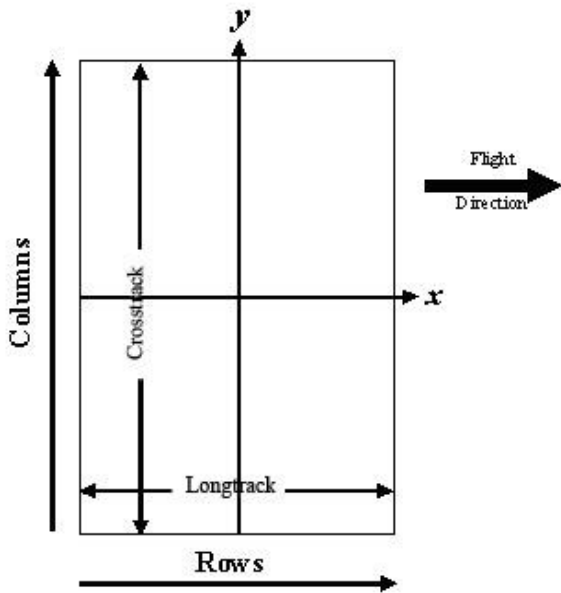
## Lvl2, Camera prop. Orientation



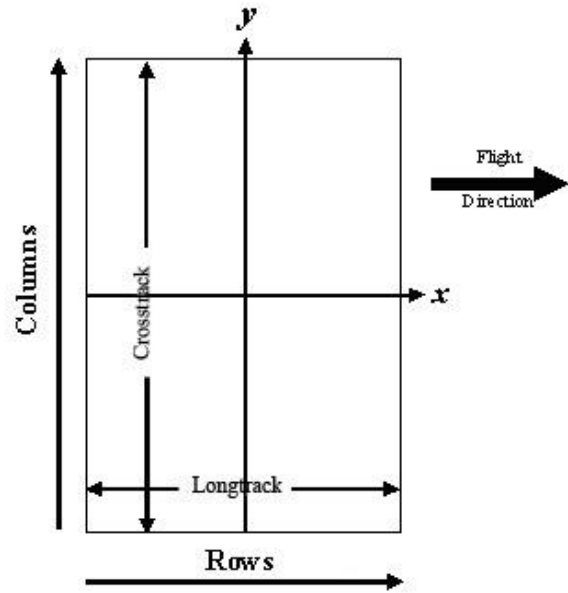
The image coordinate system of the Level 2 images is shown in the above figure. The basic image format and coordinate of the principal point in the level 2 image is given on page 4 of this report. The above figure shows the position of an example principal point at the coordinate (-0.123 / 0.345).



**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.

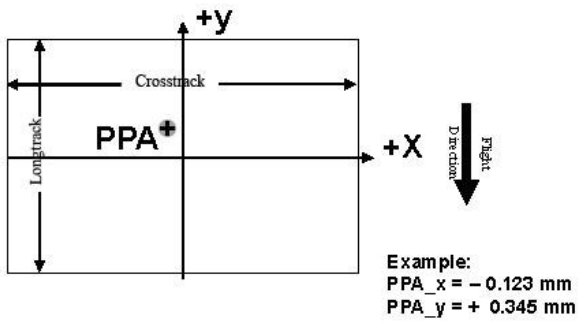
Image Format	Clockwise Rotation (Degree)	PPA	
		X	Y
Level 2	-	0.000	0.000
Level 3	0	0.000	0.000
Level 3	90	0.000	0.000
Level 3	180	0.000	0.000
Level 3	270	0.000	0.000



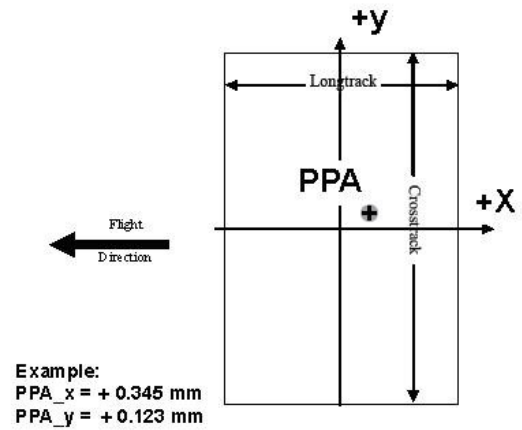


The coordinates in the figure below are only example values to illustrate the effect of image rotation on the principal point position, and do **not** correspond to the camera described in this report.

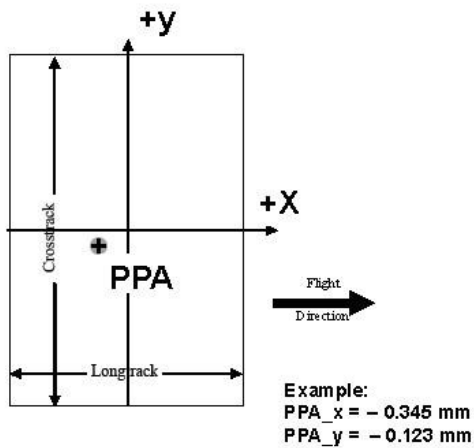
Lvl3, Rotation 0 deg clockwise



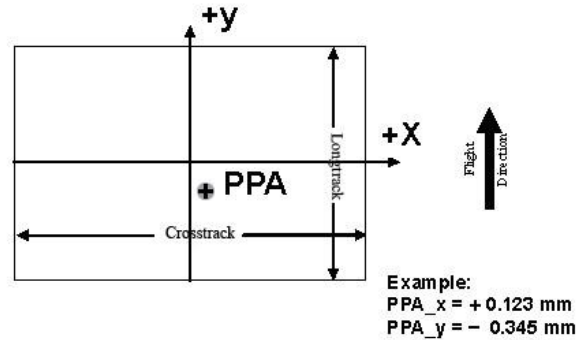
Lvl3, Rotation 90 deg clockwise



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.

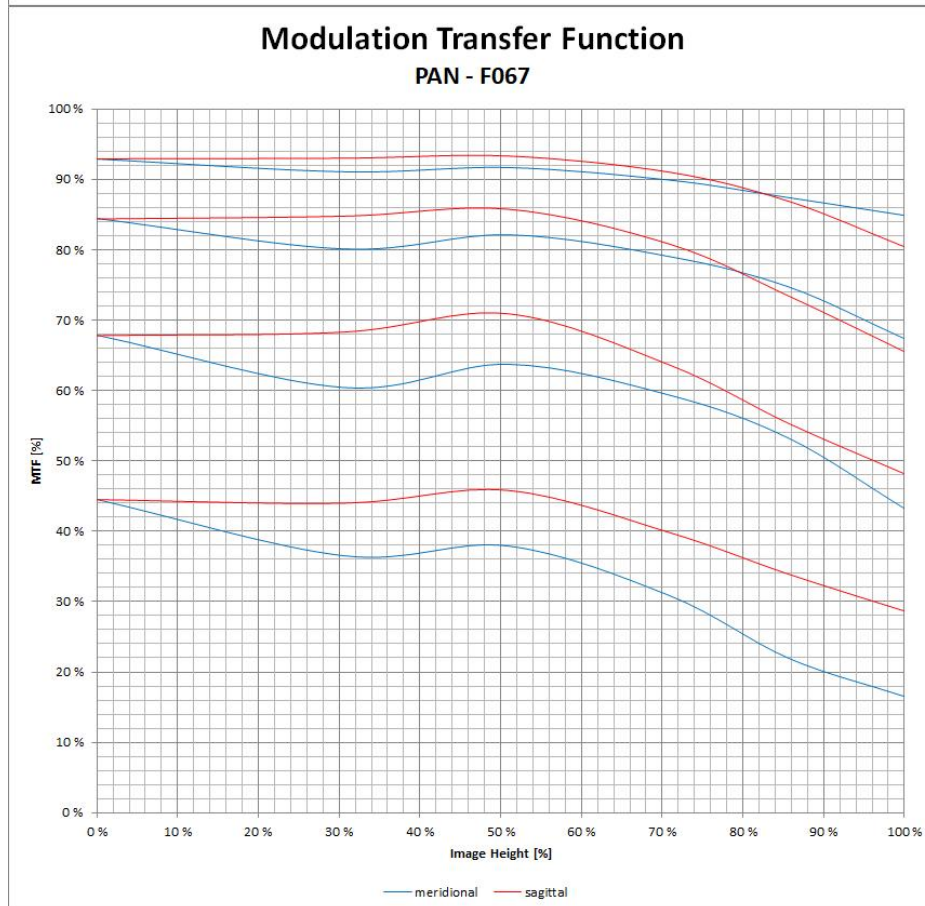
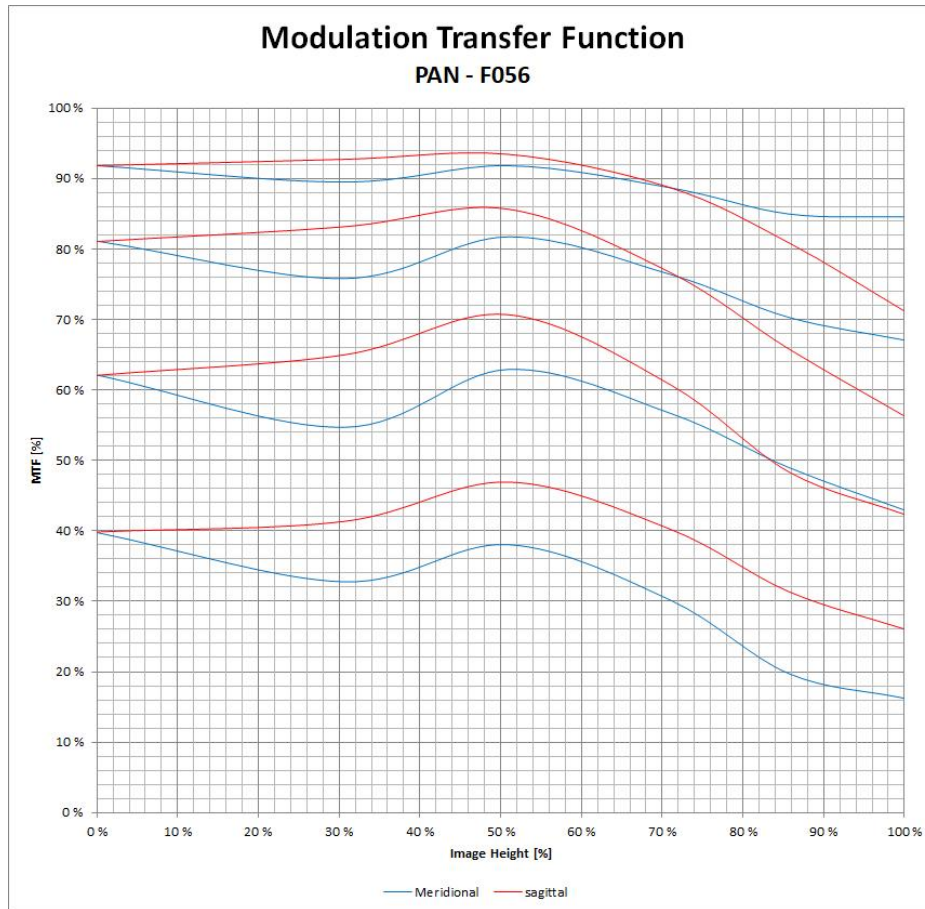
Please note that these values have been calculated and can vary up to 10% with optics from production (especially at high LP's).

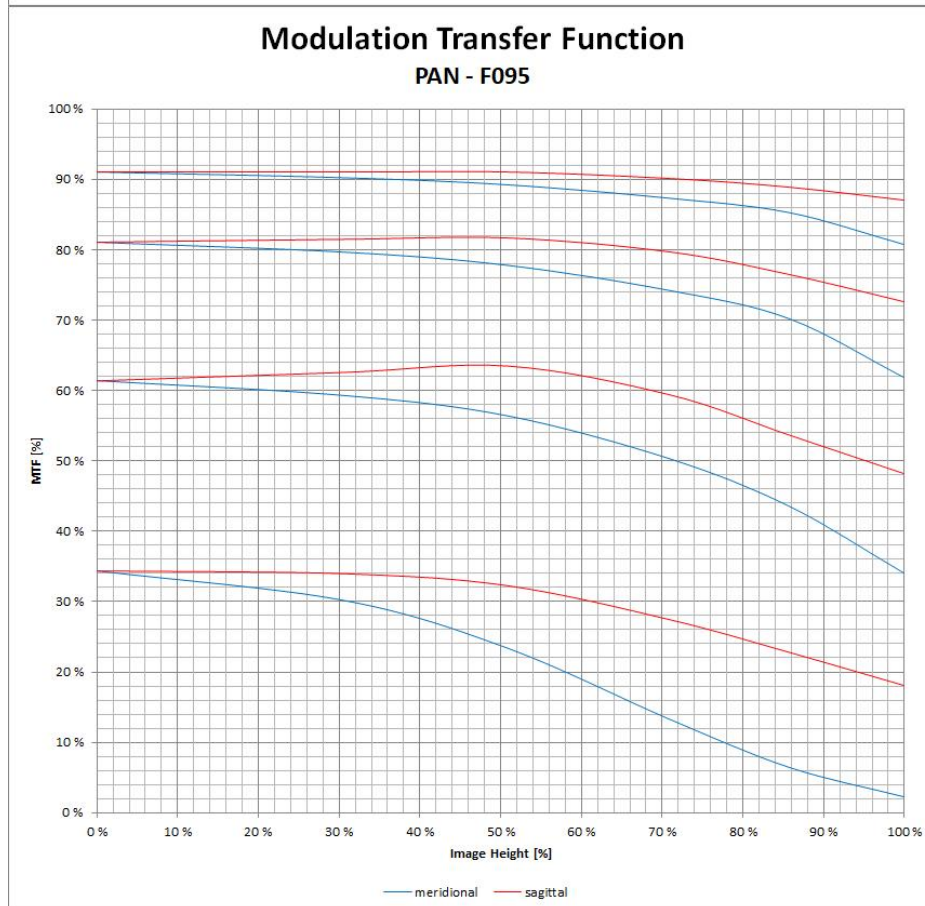
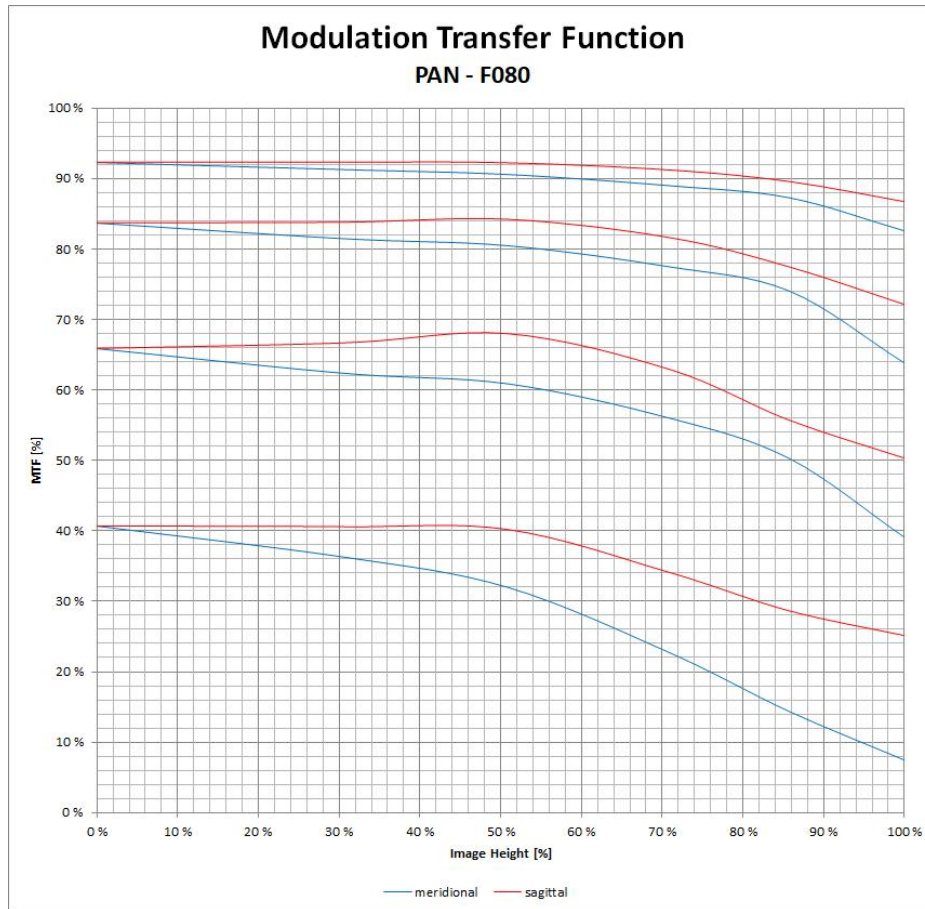
The curves are given for the meridional (tangential) and sagittal (radial) component of signals at frequencies of 12.5, 25, 50 and 100 line pairs per millimeter.

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

### Lens types

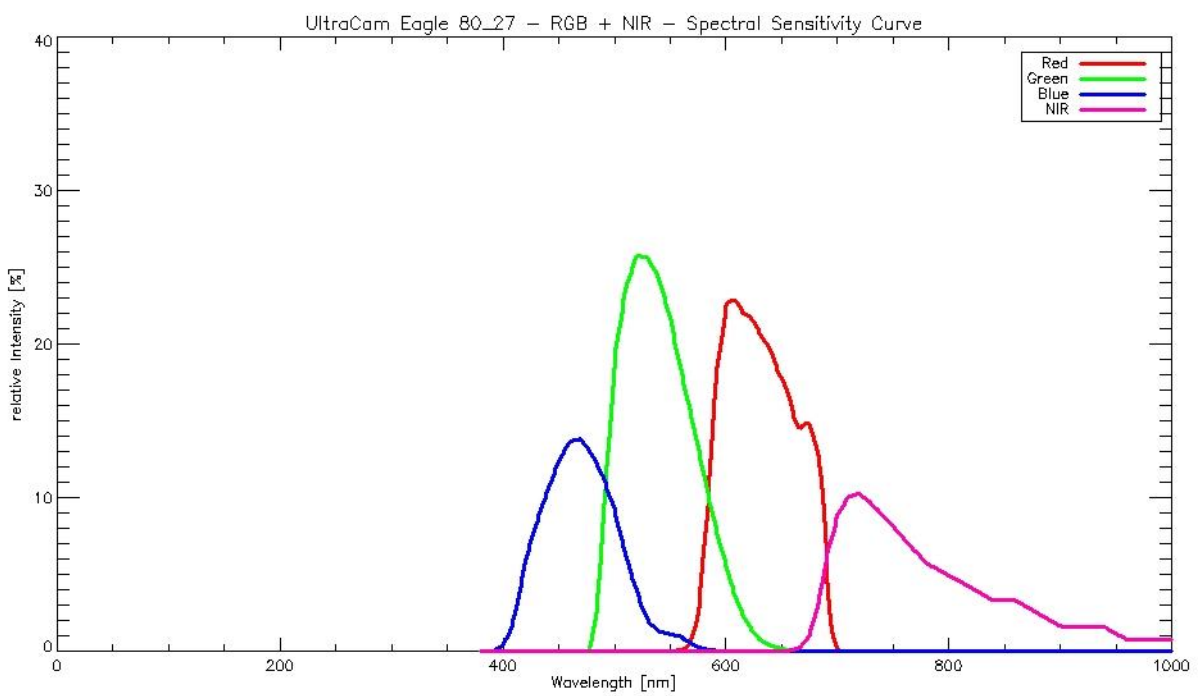
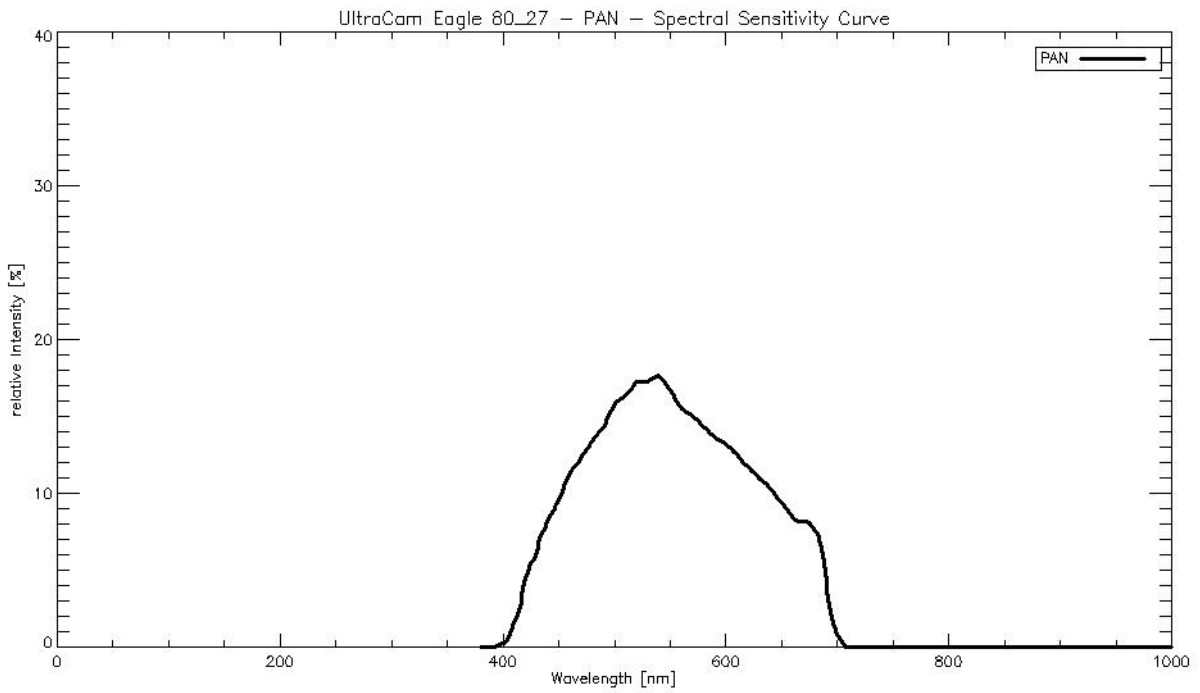
Cone	Lens
C0 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/80mm, Qioptic GmbH, Germany
C1 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/80mm, Qioptic GmbH, Germany
C2 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/80mm, Qioptic GmbH, Germany
C3 (PAN)	Qioptic Vexcel HR Digaron 1:5,6/80mm, Qioptic GmbH, Germany
C4 (RED)	Qioptic Vexcel HR Digaron 1:4/27mm, Qioptic GmbH, Germany
C5 (GREEN)	Qioptic Vexcel HR Digaron 1:4/27mm, Qioptic GmbH, Germany
C6 (BLUE)	Qioptic Vexcel HR Digaron 1:4/27mm, Qioptic GmbH, Germany
C7 (NIR)	Qioptic Vexcel HR Digaron 1:4/27mm, Qioptic GmbH, Germany







# Spectral Sensitivity





# ULTRACAM

## Radiometric Calibration

Camera: UltraCam Eagle  
Serial: UC-E-1-90813658-f80

	PAN	R, G, NIR	B
Used Apertures	F5.6	F4.8	F4.8
	F6.5	F5.4	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

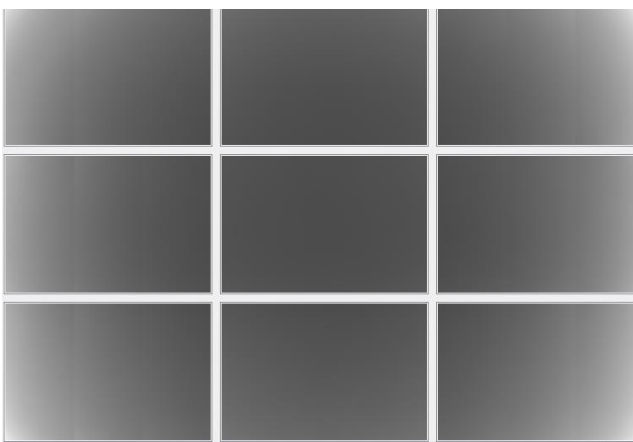
Calibration Date: Jun-15-2018  
Date of Report: Jun-20-2018  
Camera Revision: Rev01.00  
Version of Report: V01



## Calibration of Vignetting for working Aperture F6.7

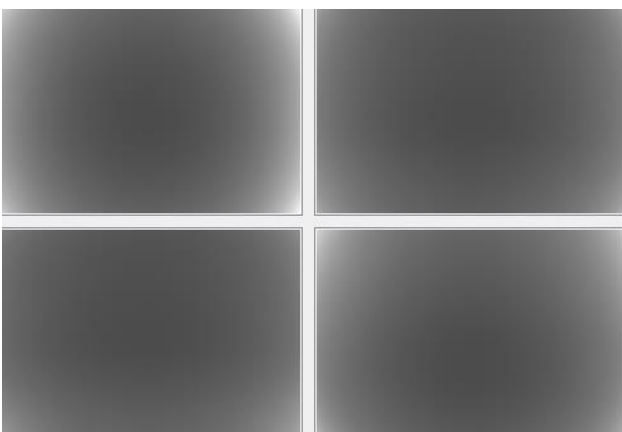
	PAN	R, G, NIR	B
Aperture	F6.5	F5.4	F4.8

### 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)



## Dead Pixel Report:

Sensor number	Anomaly type	X-Coordinate	Y-Coordinate
---------------	--------------	--------------	--------------

### C00-00

- PIXEL: 1451/4310
- PIXEL: 1514/3169
- PIXEL: 1908/3605
- PIXEL: 2446/4131
- PIXEL: 5036/2425
- PIXEL: 6671/3481
- PIXEL: 6364/4516
- PIXEL: 6364/4517
- PIXEL: 6365/4516

### C00-01

- PIXEL: 2330/1060
- PIXEL: 4127/4151
- PIXEL: 4216/1795
- PIXEL: 4554/2272
- PIXEL: 6421/1887
- PIXEL: 6472/1892
- PIXEL: 6876/ 846
- PIXEL: 5888/3737
- PIXEL: 6057/1336
- PIXEL: 6058/1336
- PIXEL: 6315/2228

### C00-02

- PIXEL: 1282/2034
- PIXEL: 1426/1740
- PIXEL: 1649/1374
- PIXEL: 4448/ 14
- PIXEL: 5687/ 810
- PIXEL: 6110/2975
- PIXEL: 6515/2494
- PIXEL: 30/1407
- COLUMN: 4792/2387





**C00-03**

PIXEL: 1195/2428  
PIXEL: 2508/2983  
PIXEL: 3636/ 81  
PIXEL: 6303/2349  
PIXEL: 6464/3628  
PIXEL: 6687/ 268  
PIXEL: 4986/4102  
PIXEL: 5789/3227  
PIXEL: 6564/2906  
PIXEL: 6564/2907

**C01-00**

PIXEL: 1763/ 844  
PIXEL: 2746/ 777  
PIXEL: 2784/2667  
PIXEL: 2817/4316  
PIXEL: 3297/1226  
PIXEL: 3563/4301  
PIXEL: 3939/3004  
PIXEL: 4853/2556  
PIXEL: 5580/ 753  
PIXEL: 6491/2308  
PIXEL: 6556/2977  
PIXEL: 6920/1776  
COLUMN: 3532/2907  
COLUMN: 4447/ 599  
COLUMN: 4373/ 56

**C01-01**

**C02-00**

PIXEL: 167/3501  
PIXEL: 1013/2595  
PIXEL: 1996/2277  
PIXEL: 3016/ 546  
PIXEL: 3964/1549  
PIXEL: 1448/3057  
PIXEL: 1448/3058  
PIXEL: 2855/3349  
PIXEL: 2947/3373  
PIXEL: 2947/3374



**C02-01**

- PIXEL: 53/2223
- PIXEL: 55/2642
- PIXEL: 111/1624
- PIXEL: 119/1810
- PIXEL: 436/2886
- PIXEL: 979/4348
- PIXEL: 1373/3526
- PIXEL: 1896/1633
- PIXEL: 1944/1597
- PIXEL: 2075/4522
- PIXEL: 2121/4349
- PIXEL: 2191/3614
- PIXEL: 2254/3313
- PIXEL: 2702/2031
- PIXEL: 2812/2718
- PIXEL: 2827/ 460
- PIXEL: 2956/4112
- PIXEL: 2956/4113
- PIXEL: 3009/4337
- PIXEL: 3108/ 415
- PIXEL: 3330/1119
- PIXEL: 3336/1280
- PIXEL: 3386/1868
- PIXEL: 3446/1775
- PIXEL: 3580/2111
- PIXEL: 3707/2003
- PIXEL: 3784/ 720
- PIXEL: 3844/1132
- PIXEL: 3927/ 883
- PIXEL: 4474/4473
- PIXEL: 4539/ 357
- PIXEL: 4821/ 272
- PIXEL: 4948/ 389
- PIXEL: 5244/1667
- PIXEL: 5274/1106
- PIXEL: 5338/2821
- PIXEL: 5555/2661
- PIXEL: 5558/2220
- PIXEL: 5767/ 554
- PIXEL: 5808/2468
- PIXEL: 5924/4458
- PIXEL: 5955/1633
- PIXEL: 6178/3758
- PIXEL: 6207/3358
- PIXEL: 6251/3720
- PIXEL: 6326/1148
- PIXEL: 6408/3041
- PIXEL: 6507/3722
- PIXEL: 6700/3476



PIXEL: 6864/2527  
PIXEL: 6949/ 65  
PIXEL: 1395/4336  
PIXEL: 1395/4337  
PIXEL: 1396/4337  
PIXEL: 5181/1740  
PIXEL: 5181/1741  
PIXEL: 5182/1740  
PIXEL: 5182/1741  
PIXEL: 5057/4533  
PIXEL: 771/4594  
PIXEL: 784/4566  
PIXEL: 1498/2337  
PIXEL: 1735/4007  
COLUMN: 3659/1767  
COLUMN: 620/3946  
COLUMN: 1481/ 636  
COLUMN: 1771/ 502  
COLUMN: 4389/ 294  
COLUMN: 5916/3777

**C03-00**

PIXEL: 198/3011  
PIXEL: 228/1617  
PIXEL: 231/3078  
PIXEL: 294/3325  
PIXEL: 417/1518  
PIXEL: 601/ 788  
PIXEL: 994/ 82  
PIXEL: 1162/3398  
PIXEL: 1228/1183  
PIXEL: 1434/ 745  
PIXEL: 1456/3934  
PIXEL: 1459/ 715  
PIXEL: 1558/2665  
PIXEL: 1667/ 902  
PIXEL: 1760/ 498  
PIXEL: 1790/1916  
PIXEL: 1812/2771  
PIXEL: 2004/2505  
PIXEL: 2019/ 529  
PIXEL: 2050/1270  
PIXEL: 2152/4214  
PIXEL: 2244/2404  
PIXEL: 2244/2664  
PIXEL: 2245/1988  
PIXEL: 2296/2022  
PIXEL: 2339/ 358  
PIXEL: 2366/ 653  
PIXEL: 2576/2013



PIXEL: 2585/3456  
PIXEL: 2784/ 451  
PIXEL: 2812/3132  
PIXEL: 2857/3623  
PIXEL: 2887/1123  
PIXEL: 2925/1738  
PIXEL: 3105/1945  
PIXEL: 3229/3152  
PIXEL: 3344/2576  
PIXEL: 3353/2488  
PIXEL: 3392/ 325  
PIXEL: 3478/3642  
PIXEL: 3511/2934  
PIXEL: 3808/1652  
PIXEL: 3925/1316  
PIXEL: 4037/3380  
PIXEL: 4147/1058  
PIXEL: 4372/2380  
PIXEL: 4410/ 568  
PIXEL: 4504/2397  
PIXEL: 4506/3776  
PIXEL: 4510/1842  
PIXEL: 4558/2721  
PIXEL: 4693/4427  
PIXEL: 4789/4154  
PIXEL: 4860/1770  
PIXEL: 4920/1082  
PIXEL: 5018/1471  
PIXEL: 5280/2335  
PIXEL: 5507/4095  
PIXEL: 5592/1188  
PIXEL: 5684/4390  
PIXEL: 5703/1247  
PIXEL: 5981/4055  
PIXEL: 6304/ 481  
PIXEL: 6333/ 802  
PIXEL: 6515/2711  
PIXEL: 6523/ 322  
PIXEL: 6744/4543  
PIXEL: 6745/ 15  
PIXEL: 6807/ 43  
PIXEL: 6873/3891  
COLUMN: 3625/1779  
COLUMN: 5018/2752  
COLUMN: 6707/2655



**C04-00**

- PIXEL: 101/3891
- PIXEL: 245/1319
- PIXEL: 547/1772
- PIXEL: 551/1050
- PIXEL: 571/ 975
- PIXEL: 634/ 774
- PIXEL: 924/4040
- PIXEL: 1067/ 593
- PIXEL: 1255/2592
- PIXEL: 1340/2537
- PIXEL: 1647/4487
- PIXEL: 1711/4292
- PIXEL: 1720/2371
- PIXEL: 1838/1654
- PIXEL: 1872/2124
- PIXEL: 1880/3304
- PIXEL: 2734/3554
- PIXEL: 2760/3362
- PIXEL: 2894/3399
- PIXEL: 3324/3429
- PIXEL: 3627/4199
- PIXEL: 3693/4048
- PIXEL: 4019/4336
- PIXEL: 4308/ 188
- PIXEL: 4347/4419
- PIXEL: 4666/1000
- PIXEL: 4976/1428
- PIXEL: 5062/3091
- PIXEL: 5095/ 902
- PIXEL: 5109/2712
- PIXEL: 5176/3642
- PIXEL: 5297/1778
- PIXEL: 5691/3853
- PIXEL: 5915/1751
- PIXEL: 6179/1116
- PIXEL: 6416/3640
- PIXEL: 6467/4178
- PIXEL: 6689/ 810
- PIXEL: 6760/1856
- PIXEL: 463/3901
- PIXEL: 464/3901
- PIXEL: 4137/ 252
- PIXEL: 5238/1721
- PIXEL: 6224/1794
- PIXEL: 6570/ 297
- COLUMN: 6315/2704
- COLUMN: 6582/3736
- COLUMN: 6614/2569



**C05-00**

- PIXEL: 668/ 685
- PIXEL: 1488/ 587
- PIXEL: 1489/ 587
- PIXEL: 1769/3779
- PIXEL: 1892/1958
- PIXEL: 2312/ 771
- PIXEL: 3503/1298
- PIXEL: 6041/1058
- PIXEL: 6698/1664
- PIXEL: 305/3943
- PIXEL: 306/3943
- PIXEL: 306/3944
- PIXEL: 306/3945
- PIXEL: 5189/3975
- PIXEL: 5189/3976
- PIXEL: 5189/3977

**C06-00**

- PIXEL: 734/ 113
- PIXEL: 6648/1969
- PIXEL: 213/ 156
- PIXEL: 279/3473
- PIXEL: 2999/3210
- PIXEL: 4891/4225
- PIXEL: 4891/4226
- PIXEL: 4892/4225

**C07-00**

- PIXEL: 198/1278
- PIXEL: 362/ 252
- PIXEL: 543/4464
- PIXEL: 644/2452
- PIXEL: 1148/1943
- PIXEL: 1644/1807
- PIXEL: 1909/ 678
- PIXEL: 2109/ 967
- PIXEL: 2181/1691
- PIXEL: 2320/ 566
- PIXEL: 3366/3628
- PIXEL: 3446/ 475
- PIXEL: 3446/ 476
- PIXEL: 4130/ 635
- PIXEL: 4748/1189
- PIXEL: 4850/3851
- PIXEL: 4981/ 144
- PIXEL: 5160/3392
- PIXEL: 5200/4296
- PIXEL: 5212/2846
- PIXEL: 5261/1740



PIXEL: 5321/1633  
PIXEL: 5389/3749  
PIXEL: 5415/1781  
PIXEL: 5596/3584  
PIXEL: 5831/1595  
PIXEL: 6435/1855  
PIXEL: 6669/ 382  
PIXEL: 6691/4542  
PIXEL: 488/1587  
PIXEL: 6135/3597  
COLUMN: 870/3288  
COLUMN: 970/2584  
COLUMN: 1626/2759

**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).



## 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

---

**Camera:** UltraCam Eagle  
**Serial:** UC-E-1-90813658-f80

**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 Date:** Jun-15-2018  
**Date of Report:** Jun-20-2018  
**Camera Revision:** Rev01.00  
**Version of Report:** V01



## 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.

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)	12307904	6.97	7.14	7.48	7.69	7.9	8.03	8.14	8.52	+/- 0.2
C1 (Pan)	12215779	6.03	6.22	6.47	6.67	6.8	6.89	7.02	7.23	+/- 0.2
C2 (Pan)	12191824	6.22	6.39	6.65	6.85	7	7.16	7.24	7.46	+/- 0.2
C3 (Pan)	12215776	6.74	6.97	7.22	7.45	7.64	7.74	7.84	8.11	+/- 0.2
C4 (Red)	12215833	7.5	7.55	7.68	7.75	7.85	7.85	7.86	8.03	+/- 0.2
C5 (Green)	12215821	7.06	7.12	7.26	7.36	7.45	7.47	7.56	7.66	+/- 0.2
C6 (Blue)	12215827	7.2	7.2	7.25	7.25	7.33	7.48	7.59	7.62	+/- 0.2
C7 (NIR)	12197136	7.09	7.14	7.24	7.4	7.5	7.5	7.39	7.25	+/- 0.2



# **ULTRACAM**

## Electronics and Sensor Calibration

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**Camera:** UltraCam Eagle  
**Serial:** UC-E-1-90813658-f80

**Panchromatic Camera:** 9 \* FTF7046-M Area CCD Sensor by DALSA  
**Multispectral Camera:** 4 \* FTF7046-M Area CCD Sensor by DALSA

**Calibration Date:** Jun-15-2018  
**Date of Report:** Jun-20-2018  
**Camera Revision:** Rev01.00  
**Version of Report:** V01



## 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.

Cone_Sensor	Sensor Type	Sensor Serial Number	VNS Voltage [V]
00_00	FTF7046-M	16 1697/012	23.20
00_01	FTF7046-M	16 0925/104	23.80
00_02	FTF7046-M	16 1697/011	23.40
00_03	FTF7046-M	16 1697/023	23.80
01_00	FTF7046-M	16 2469/079	24.60
01_01	FTF7046-M	16 0925/106	23.80
02_00	FTF7046-M	16 1697/043	23.60
02_01	FTF7046-M	16 0925/076	24.20
03_00	FTF7046-M	16 0925/075	24.20
04_00 (red)	FTF7046-M	16 2469/030	24.60
05_00 (green)	FTF7046-M	16 0872/121	24.20
06_00 (blue)	FTF7046-M	16 1697/020	23.60
07_00 (NIR)	FTF7046-M	16 0872/118	24.00



## 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.

Cone_Sensor	Sensor Type	Sensor Serial Number	Intensity Threshold [DN]
00_00	FTF7046-M	16 1697/012	14370
00_01	FTF7046-M	16 0925/104	13780
00_02	FTF7046-M	16 1697/011	14010
00_03	FTF7046-M	16 1697/023	13520
01_00	FTF7046-M	16 2469/079	13800
01_01	FTF7046-M	16 0925/106	13830
02_00	FTF7046-M	16 1697/043	13750
02_01	FTF7046-M	16 0925/076	14220
03_00	FTF7046-M	16 0925/075	14610
04_00 (red)	FTF7046-M	16 2469/030	14110
05_00 (green)	FTF7046-M	16 0872/121	13720
06_00 (blue)	FTF7046-M	16 1697/020	13680
07_00 (NIR)	FTF7046-M	16 0872/118	13040



# ULTRACAM

## Summary

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<b>Camera:</b>	<b>UltraCam Eagle</b>
<b>Serial:</b>	<b>UC-E-1-90813658-f80</b>
<b>Calibration Date:</b>	<b>Jun-15-2018</b>
<b>Date of Report:</b>	<b>Jun-20-2018</b>
<b>Camera Revision:</b>	<b>Rev01.00</b>
<b>Version of Report:</b>	<b>V01</b>

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.

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Vexcel Imaging GmbH

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