



VEXCEL
IMAGING

ULTRACAM

Calibration Report

Camera:
Serial:

UltraCam Xp
UC-SXp-1-20615550

Calibration Date:
Date of Report:
Camera Revision:
Version of Report:

Feb-08-2018
Feb-21-2018
Rev05.00
V01



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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 Xp
Serial:	UC-SXp-1-20615550

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

PPA Information:	X: 0.000
	Y: 0.240

Calibration Date:	Feb-08-2018
Date of Report:	Feb-21-2018
Camera Revision:	Rev05.00
Version of Report:	V01



Panchromatic Camera

Large Format Panchromatic Output Image

Image Format	long track	67.860mm	11310pixel
	cross track	103.860mm	17310pixel
Image Extent		(-33.930, -51.930)mm	(33.9300, 51.930)mm
Pixel Size		6.000μm*6.000μm	
Focal Length	ck	100.500mm	± 0.002mm
Principal Point (Level 2)	X_ppa	0.000mm	± 0.002mm
	Y_ppa	0.240mm	± 0.002mm
Lens Distortion	Remaining Distortion less than 0.002mm		

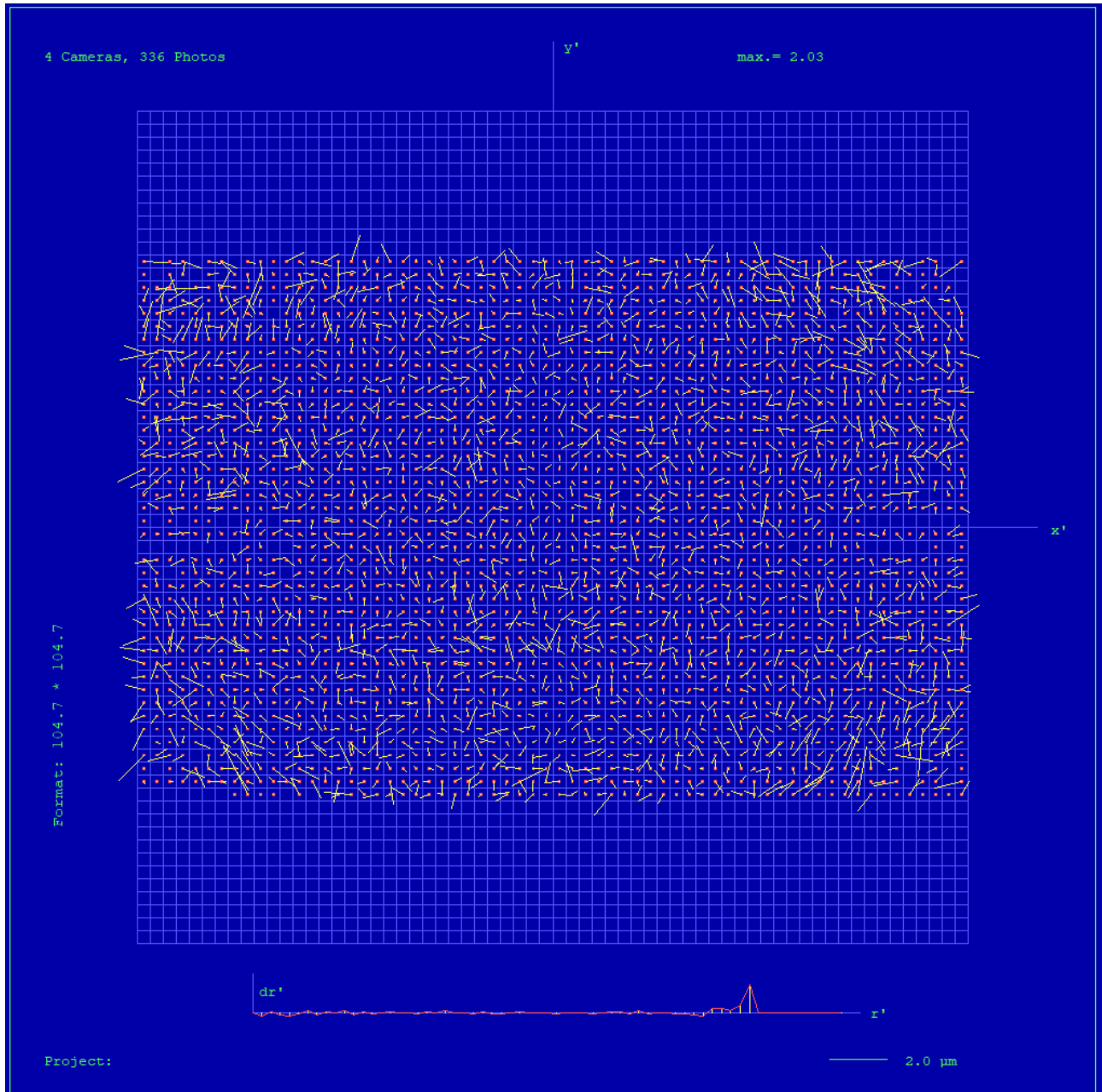
Multispectral Camera

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

Image Format	long track	67.860mm	3770pixel
	cross track	103.860mm	5770pixel
Image Extent		(-33.930, -51.930)mm	(33.930, 51.930)mm
Pixel Size		18.000μm*18.000μm	
Focal Length	ck	100.500mm	± 0.002mm
Principal Point (Level 2)	X_ppa	0.000mm	± 0.002mm
	Y_ppa	0.240mm	± 0.002mm
Lens Distortion	Remaining Distortion less than 0.002mm		



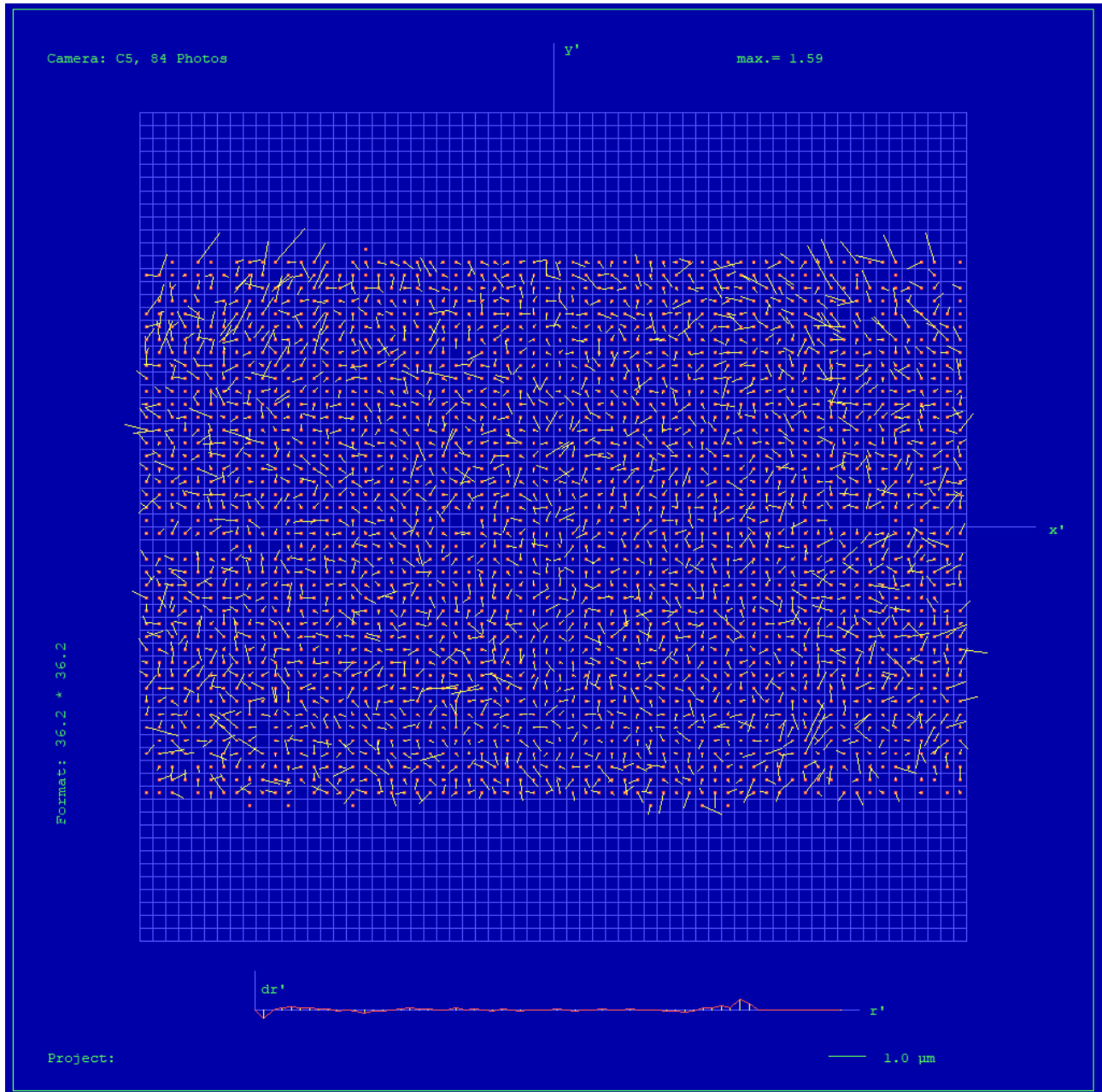
Full Panchromatic Image, Residual Error Diagram



Residual Error (RMS): 1.17 μm



Green Cone (Cone 5), Residual Error Diagram



Residual Error (RMS): **0.95 μm**



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

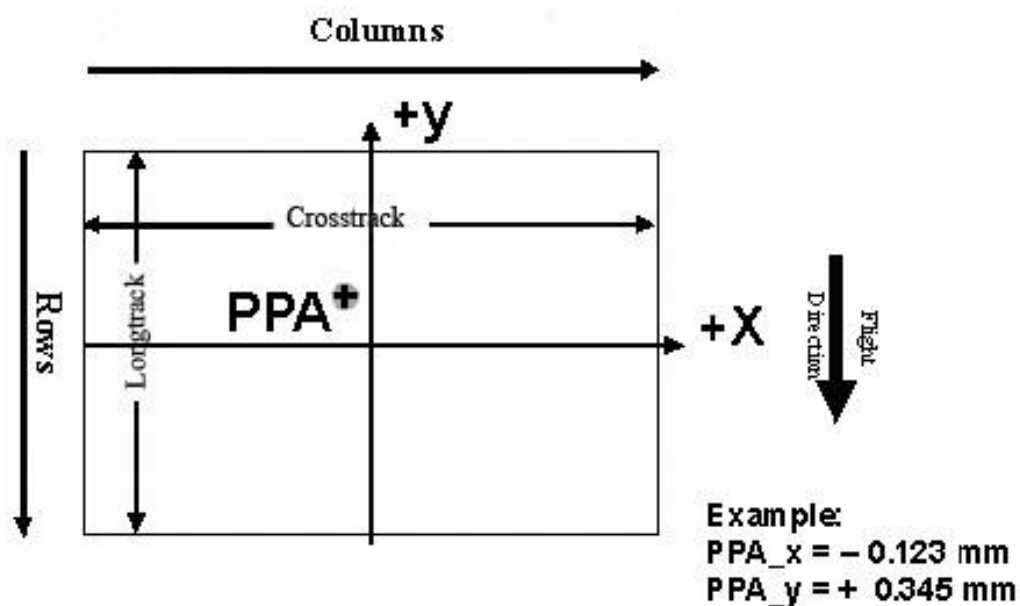
Number of point measurements for the multispectral camera : >60000

Determination of the image parameters by Least Squares Adjustment.

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

Level 2 Image Coordinate System:

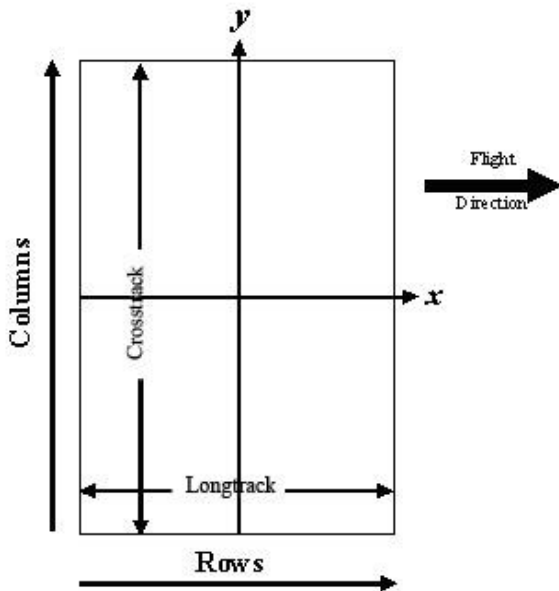
Lvl2, Camera prop. Orientation



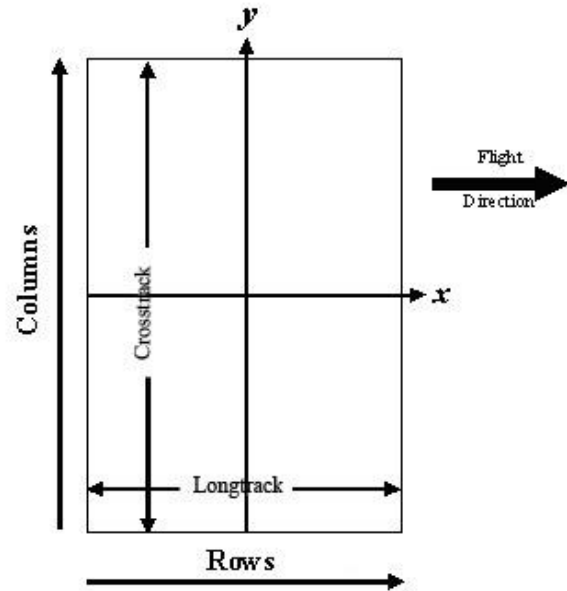
The image coordinate system of the Level 2 images is shown in the above figure. The basic image format and coordinate of the principal point in the level 2 image is given on page 4 of this report. The above figure shows the position of an example principal point at the coordinate (-0.123 / 0.345).



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



Panchromatic Image Format



Multispectral Image Format

Position of Principal Point in Level 3 Image

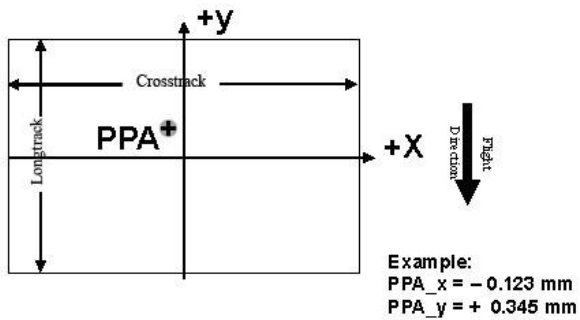
The position of the principal point in the level 3 image depends on the “rotation” setting used in UltraMap during the pan-sharpening step. The exact position relative to the image center is given in the table below as a function of the rotation setting used in UltraMap. The coordinates are specified 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	0.240
Level 3	0	0.000	0.240
Level 3	90	0.240	0.000
Level 3	180	0.000	-0.240
Level 3	270	-0.240	0.000

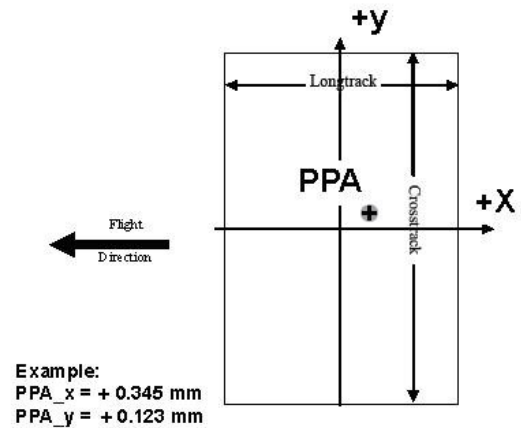


The coordinates in the figure below are only example values to illustrate the effect of image rotation on the principal point position, and do **not** correspond to the camera described in this report.

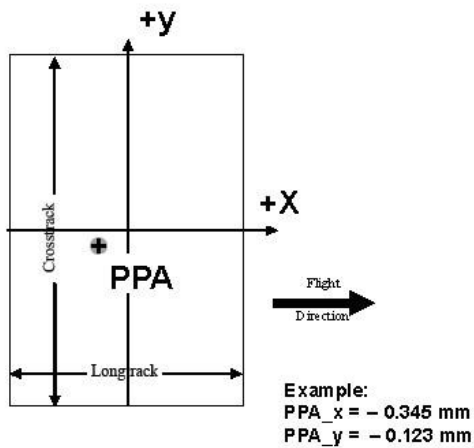
Lvl3, Rotation 0 deg clockwise



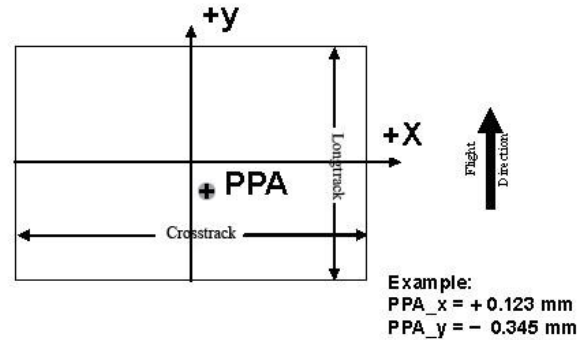
Lvl3, Rotation 90 deg clockwise



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.

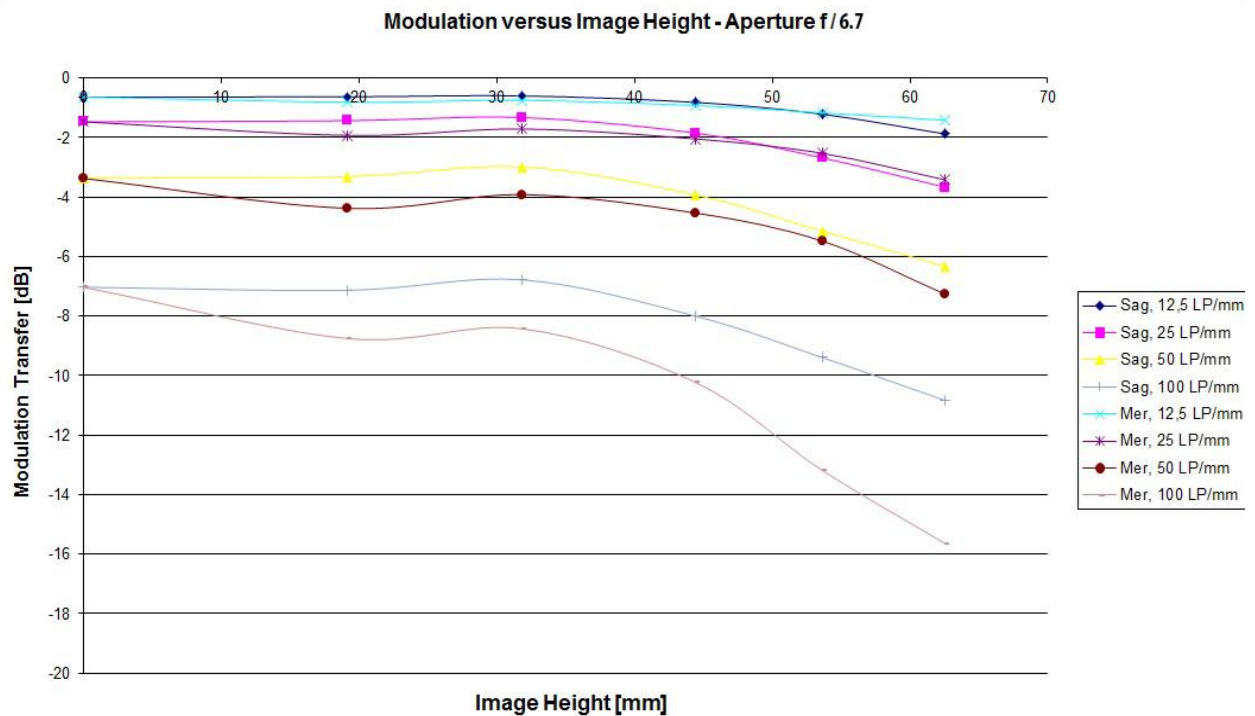
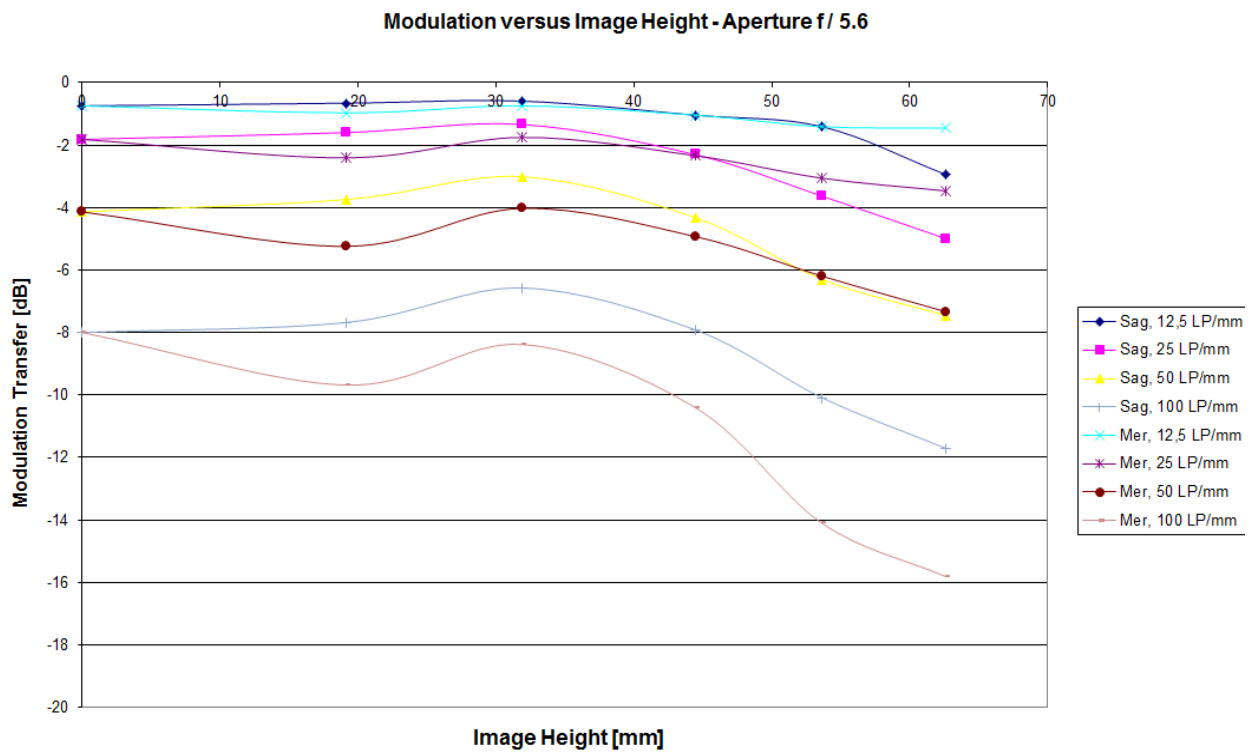
Please note that these values have been calculated and can vary up to 10% with optics from production (especially at high LP's).

The curves are given for the meridional (tangential) and 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.

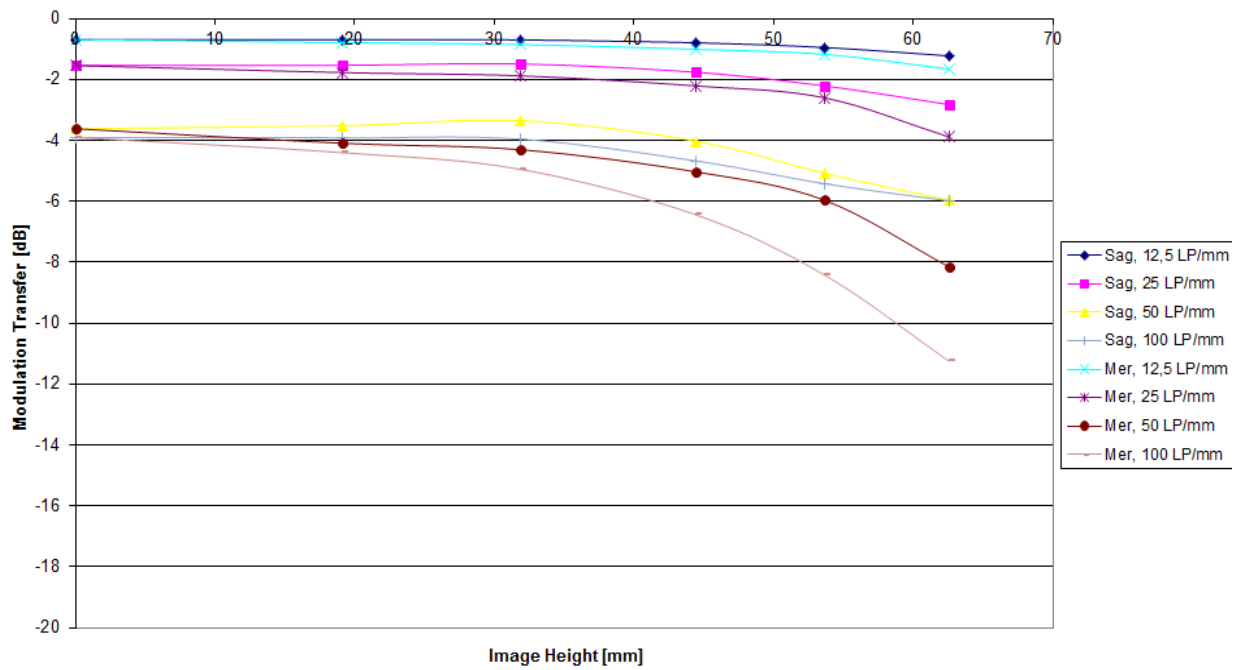
Lens types

Cone	Lens
C0	Linos Vexcel Apo-Sironar Digital HR 1:5,6/100mm, Linos GmbH, Germany
C1	Linos Vexcel Apo-Sironar Digital HR 1:5,6/100mm, Linos GmbH, Germany
C2	Linos Vexcel Apo-Sironar Digital HR 1:5,6/100mm, Linos GmbH, Germany
C3	Linos Vexcel Apo-Sironar Digital HR 1:5,6/100mm, Linos GmbH, Germany
C4 (RED)	Linos Vexcel Apo-Sironar Digital HR 1:4/33mm, Linos GmbH, Germany
C5 (GREEN)	Linos Vexcel Apo-Sironar Digital HR 1:4/33mm, Linos GmbH, Germany
C6 (BLUE)	Linos Vexcel Apo-Sironar Digital HR 1:4/33mm, Linos GmbH, Germany
C7 (NIR)	Linos Vexcel Apo-Sironar Digital HR 1:4/33mm, Linos GmbH, Germany

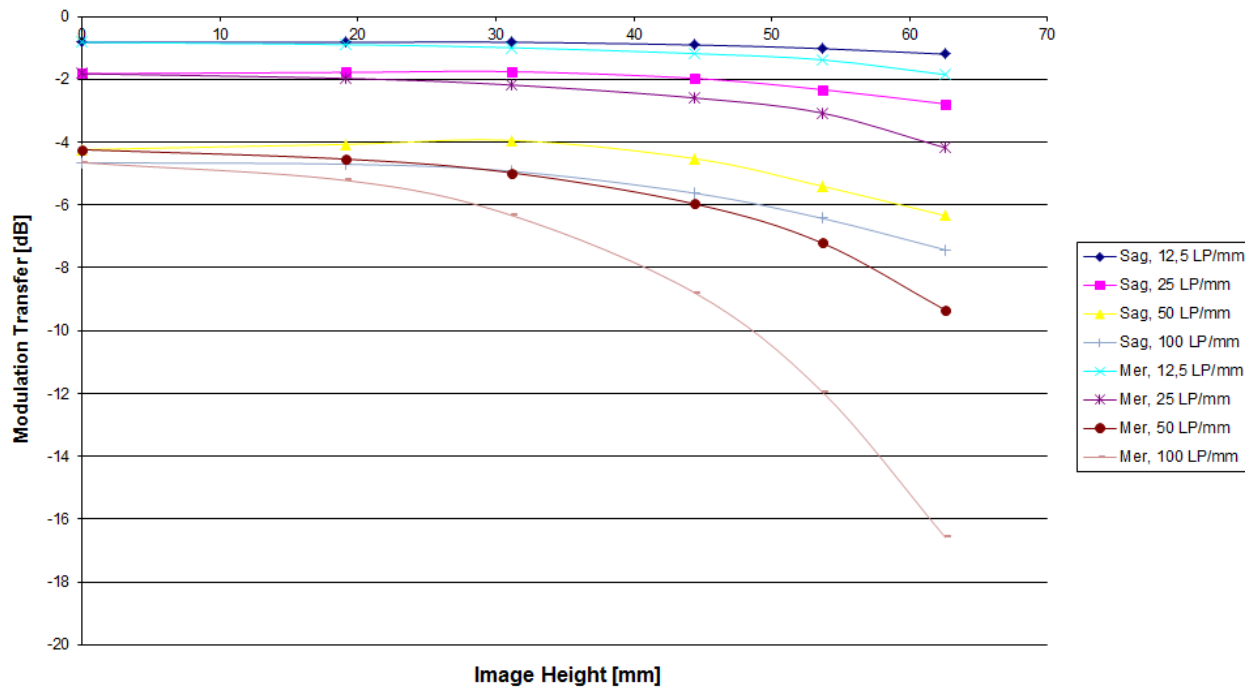




Modulation versus Image Height - Aperture f / 8

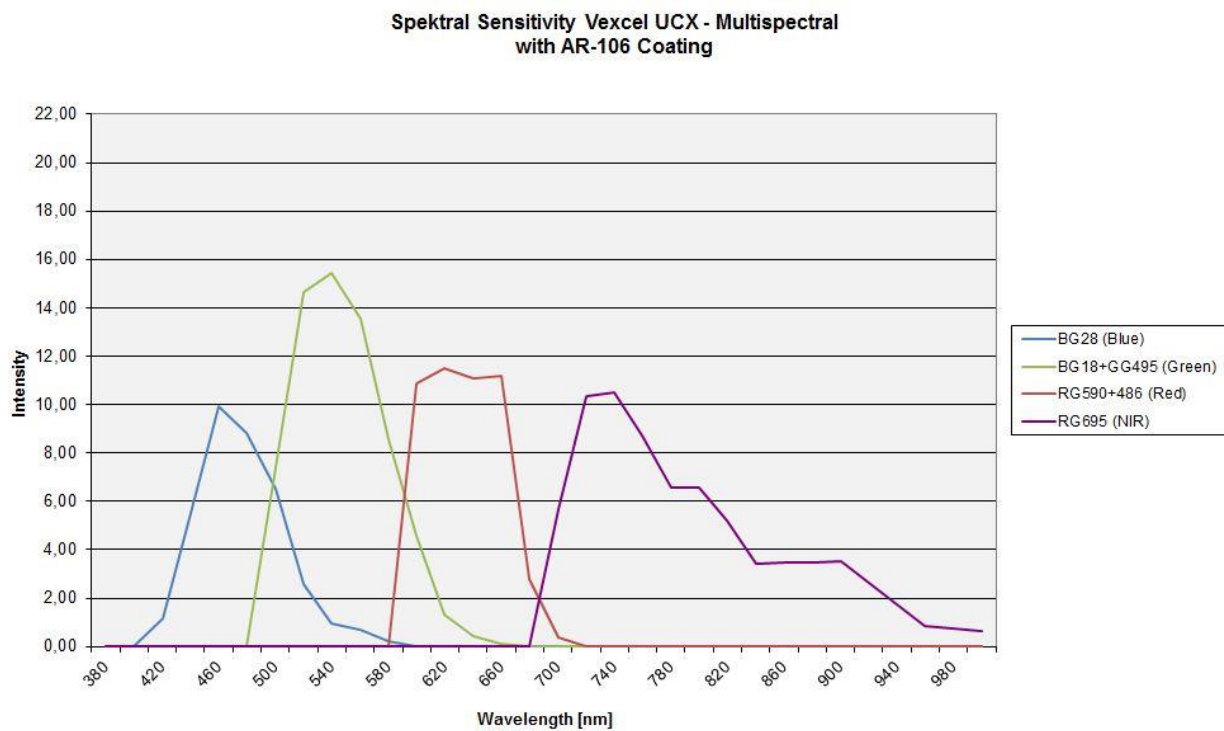
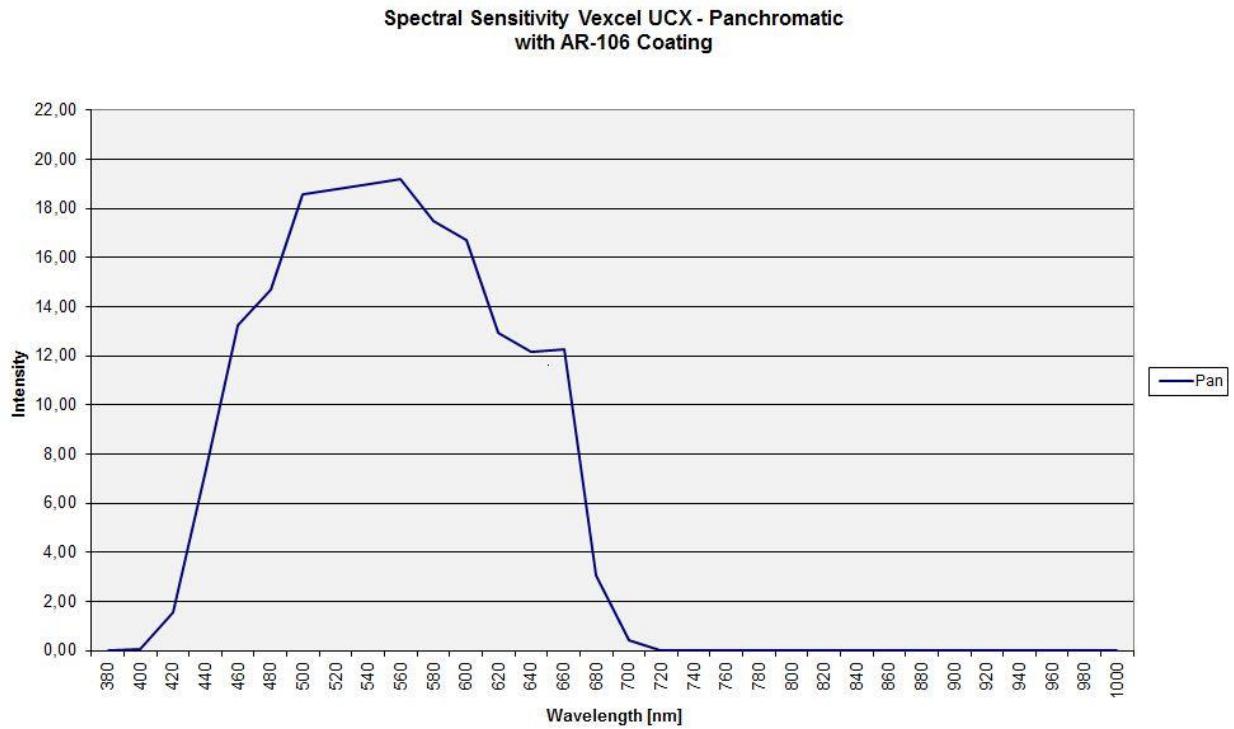


Modulation versus Image Height - Aperture f / 9.5





Spectral Sensitivity





ULTRACAM

Radiometric Calibration

Camera: UltraCam Xp
Serial: UC-SXp-1-20615550

Used Apertures	PAN	R, G, NIR	B
	F5.6	F4	F2.8
	F8	F5.6	F4
	F11	F8	F5.6
	F16	F11	F8
	F22	F16	F11

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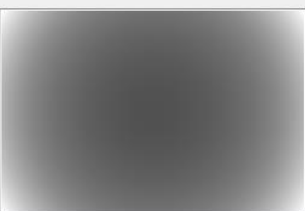
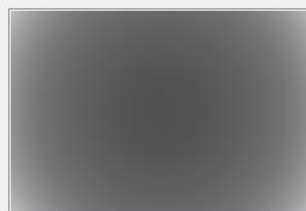
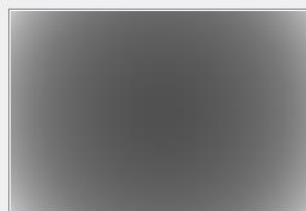
Calibration of Vignetting for working Aperture F8

	PAN	R, G, NIR	B
Aperture	F8	F5.6	F4

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: 85/3406
PIXEL: 115/2083
PIXEL: 423/ 997
PIXEL: 493/ 366
PIXEL: 564/ 965
PIXEL: 571/1885
PIXEL: 584/ 931
PIXEL: 670/2609
PIXEL: 691/ 443
PIXEL: 691/ 444
PIXEL: 711/1316
PIXEL: 1041/2241
PIXEL: 1118/1531
PIXEL: 1619/ 244
PIXEL: 1713/2464
PIXEL: 1734/ 387
PIXEL: 1815/3142
PIXEL: 1825/1838
PIXEL: 1901/2974
PIXEL: 2054/1440
PIXEL: 2139/1166
PIXEL: 2284/ 397
PIXEL: 2324/3419
PIXEL: 2324/3420
PIXEL: 2356/3467
PIXEL: 2473/ 85
PIXEL: 2692/1243
PIXEL: 3011/ 650
PIXEL: 3025/1322
PIXEL: 3191/3340
PIXEL: 3422/ 66
PIXEL: 3508/1368
PIXEL: 3516/3531
PIXEL: 3555/2649
PIXEL: 3702/3533
PIXEL: 3714/2803
PIXEL: 3803/ 225
PIXEL: 3828/2879
PIXEL: 3832/3727
PIXEL: 3942/3387
PIXEL: 3987/3054
PIXEL: 3994/2225
PIXEL: 3995/ 411
PIXEL: 4059/3285



PIXEL: 4301/3777
PIXEL: 4531/1261
PIXEL: 4553/3947
PIXEL: 4733/3515
PIXEL: 4736/ 639
PIXEL: 4815/3535
PIXEL: 4841/3864
PIXEL: 4880/1560
PIXEL: 4937/2195
PIXEL: 5095/3266
PIXEL: 5096/ 938
PIXEL: 5131/ 962
PIXEL: 5226/3667
PIXEL: 5306/ 938
PIXEL: 5306/1951
PIXEL: 5504/3205
PIXEL: 5625/3874
PIXEL: 5732/1204
PIXEL: 5732/1205
PIXEL: 5835/ 759
PIXEL: 5961/2194
PIXEL: 5966/2242
PIXEL: 5999/2048
PIXEL: 2622/3956
PIXEL: 4898/3886
PIXEL: 4928/3893

C00-01

PIXEL: 246/2324
PIXEL: 250/3155
PIXEL: 429/ 817
PIXEL: 510/2805
PIXEL: 512/ 217
PIXEL: 631/ 243
PIXEL: 820/3117
PIXEL: 854/3898
PIXEL: 1086/1307
PIXEL: 1112/ 283
PIXEL: 1206/1170
PIXEL: 1554/1856
PIXEL: 1809/ 804
PIXEL: 1858/2860
PIXEL: 2084/1371
PIXEL: 2322/1685
PIXEL: 2362/3693
PIXEL: 2410/2698
PIXEL: 2442/1082
PIXEL: 2751/ 582
PIXEL: 3128/2191
PIXEL: 3295/ 418
PIXEL: 3422/1184
PIXEL: 3741/3196
PIXEL: 3955/ 184
PIXEL: 3989/3955
PIXEL: 4253/1315



PIXEL: 4309/2205
PIXEL: 4447/2782
PIXEL: 4454/3577
PIXEL: 4480/2329
PIXEL: 4490/2174
PIXEL: 4582/3384
PIXEL: 4724/1645
PIXEL: 4926/3164
PIXEL: 4982/2193
PIXEL: 5073/1584
PIXEL: 5211/1380
PIXEL: 5341/ 463
PIXEL: 5343/ 544
PIXEL: 5619/ 278
PIXEL: 5743/ 367
PIXEL: 5867/1385
PIXEL: 112/ 263
PIXEL: 335/3509
PIXEL: 1797/3938

C00-02

PIXEL: 74/1843
PIXEL: 467/2866
PIXEL: 527/ 370
PIXEL: 672/1491
PIXEL: 701/ 92
PIXEL: 771/3688
PIXEL: 991/ 29
PIXEL: 1034/3856
PIXEL: 1257/3059
PIXEL: 1260/1566
PIXEL: 1330/1831
PIXEL: 1494/ 189
PIXEL: 1509/ 117
PIXEL: 1553/ 51
PIXEL: 1592/1021
PIXEL: 1684/3850
PIXEL: 1716/2809
PIXEL: 2355/3454
PIXEL: 2404/2238
PIXEL: 2476/1597
PIXEL: 2774/ 952
PIXEL: 2983/3212
PIXEL: 3113/3494
PIXEL: 3363/1878
PIXEL: 3447/1106
PIXEL: 3460/2774
PIXEL: 3538/ 51
PIXEL: 3618/ 649
PIXEL: 3944/ 277
PIXEL: 4077/2512
PIXEL: 4086/1031
PIXEL: 4405/3459
PIXEL: 4417/2598
PIXEL: 4549/1824



PIXEL: 4637/3007
PIXEL: 4651/ 720
PIXEL: 4770/ 627
PIXEL: 5258/1237
PIXEL: 5348/1494
PIXEL: 5380/2274
PIXEL: 5427/1160
PIXEL: 5590/ 856
PIXEL: 5679/ 52
PIXEL: 5702/2172
PIXEL: 5873/3811
PIXEL: 5955/ 539
PIXEL: 316/ 36
PIXEL: 1104/ 118
PIXEL: 1563/3199
PIXEL: 1564/3198
PIXEL: 5848/ 526
PIXEL: 5849/ 526
PIXEL: 1566/3198
PIXEL: 1565/3198
PIXEL: 1563/3197
PIXEL: 1564/3199

C00-03

PIXEL: 93/3654
PIXEL: 95/1450
PIXEL: 147/2824
PIXEL: 207/ 483
PIXEL: 768/1562
PIXEL: 787/ 98
PIXEL: 825/2249
PIXEL: 897/3416
PIXEL: 904/2113
PIXEL: 937/3288
PIXEL: 957/ 961
PIXEL: 968/2906
PIXEL: 1019/3613
PIXEL: 1170/3929
PIXEL: 1320/ 368
PIXEL: 1516/3554
PIXEL: 1561/1628
PIXEL: 1587/1092
PIXEL: 1632/2493
PIXEL: 1663/3086
PIXEL: 1688/1552
PIXEL: 1754/1201
PIXEL: 1919/1769
PIXEL: 1972/ 489
PIXEL: 2137/ 72
PIXEL: 2185/ 516
PIXEL: 2938/1044
PIXEL: 3014/2858
PIXEL: 3116/ 566
PIXEL: 3244/2895
PIXEL: 3322/1252



PIXEL: 3641/1266
PIXEL: 3710/2701
PIXEL: 4048/ 286
PIXEL: 4088/2772
PIXEL: 4105/ 330
PIXEL: 4132/2221
PIXEL: 4518/1114
PIXEL: 4617/2967
PIXEL: 4733/1179
PIXEL: 4939/3134
PIXEL: 5041/1528
PIXEL: 5132/1701
PIXEL: 5156/1862
PIXEL: 5200/2497
PIXEL: 5380/2163
PIXEL: 5400/3669
PIXEL: 5427/3907
PIXEL: 5686/3479
PIXEL: 5808/2366
PIXEL: 5830/2643

C01-00

PIXEL: 42/3673
PIXEL: 343/ 421
PIXEL: 514/ 482
PIXEL: 680/1821
PIXEL: 749/ 221
PIXEL: 906/3217
PIXEL: 972/3826
PIXEL: 1079/ 727
PIXEL: 1551/2390
PIXEL: 1615/3064
PIXEL: 1753/2413
PIXEL: 1825/2375
PIXEL: 1847/3814
PIXEL: 2085/1431
PIXEL: 2470/3857
PIXEL: 2529/3003
PIXEL: 2566/1100
PIXEL: 2754/2346
PIXEL: 2780/1988
PIXEL: 2923/2428
PIXEL: 3005/3089
PIXEL: 3083/1257
PIXEL: 3101/1096
PIXEL: 3143/3266
PIXEL: 3192/ 61
PIXEL: 3671/2169
PIXEL: 3734/3458
PIXEL: 3947/3910
PIXEL: 4017/2121
PIXEL: 4050/3795
PIXEL: 4152/3166
PIXEL: 4178/1832
PIXEL: 4182/1028



PIXEL: 4272/1380
PIXEL: 4316/ 98
PIXEL: 4434/3754
PIXEL: 4523/3147
PIXEL: 4560/2441
PIXEL: 4697/ 860
PIXEL: 4840/ 662
PIXEL: 5017/3536
PIXEL: 5053/ 33
PIXEL: 5155/2302
PIXEL: 5801/3354
PIXEL: 5324/3640

C01-01

PIXEL: 30/1135
PIXEL: 365/2410
PIXEL: 581/3324
PIXEL: 587/ 866
PIXEL: 812/2657
PIXEL: 884/3067
PIXEL: 924/3824
PIXEL: 1169/2058
PIXEL: 1352/3217
PIXEL: 1633/1294
PIXEL: 1721/1444
PIXEL: 1745/ 286
PIXEL: 1835/2285
PIXEL: 1999/3615
PIXEL: 2037/3103
PIXEL: 2321/2358
PIXEL: 2368/2535
PIXEL: 2623/1282
PIXEL: 2657/3784
PIXEL: 2808/2955
PIXEL: 2960/2255
PIXEL: 3080/3114
PIXEL: 3153/ 978
PIXEL: 3404/1229
PIXEL: 3752/3793
PIXEL: 3786/ 947
PIXEL: 4301/3861
PIXEL: 4589/ 631
PIXEL: 4631/1642
PIXEL: 4954/ 922
PIXEL: 4957/3580
PIXEL: 5315/2144
PIXEL: 5338/1716
PIXEL: 5411/1011
PIXEL: 5428/ 428
PIXEL: 5809/3507
PIXEL: 5998/3389
PIXEL: 6018/1566
PIXEL: 2751/2414



C02-00

PIXEL: 149/3827
PIXEL: 171/3772
PIXEL: 244/2684
PIXEL: 294/3718
PIXEL: 379/1344
PIXEL: 777/1896
PIXEL: 886/3467
PIXEL: 982/2239
PIXEL: 1063/3602
PIXEL: 1285/3392
PIXEL: 1287/ 203
PIXEL: 1508/2324
PIXEL: 1699/3307
PIXEL: 1898/2119
PIXEL: 1940/ 776
PIXEL: 1962/ 933
PIXEL: 2041/2851
PIXEL: 2224/2505
PIXEL: 2347/ 120
PIXEL: 2504/3164
PIXEL: 2948/ 693
PIXEL: 3130/ 753
PIXEL: 3136/3417
PIXEL: 3469/2413
PIXEL: 3578/1973
PIXEL: 3712/1733
PIXEL: 3727/ 982
PIXEL: 3775/ 77
PIXEL: 3865/1086
PIXEL: 3918/2951
PIXEL: 3951/2728
PIXEL: 4003/1284
PIXEL: 4262/ 354
PIXEL: 4373/2506
PIXEL: 4384/2962
PIXEL: 4457/ 829
PIXEL: 4817/3738
PIXEL: 4898/3884
PIXEL: 5004/2392
PIXEL: 5053/1998
PIXEL: 5411/3837
PIXEL: 5416/2688
PIXEL: 5450/2493
PIXEL: 5762/2494
PIXEL: 5872/2119
PIXEL: 3630/2285
PIXEL: 5448/ 115
PIXEL: 5482/ 52
PIXEL: 5496/ 376
PIXEL: 5656/ 897
PIXEL: 5665/ 570
PIXEL: 5747/ 272
PIXEL: 5772/ 345
PIXEL: 5778/ 344



PIXEL: 5859/ 328
PIXEL: 5895/ 75
PIXEL: 5944/1901
PIXEL: 5482/ 53
PIXEL: 5693/ 300
PIXEL: 5854/ 365
PIXEL: 5912/ 328
PIXEL: 5912/ 290
PIXEL: 5858/ 224
PIXEL: 5891/ 123
PIXEL: 5874/ 391
PIXEL: 5985/ 841

C02-01

PIXEL: 52/1702
PIXEL: 232/1759
PIXEL: 266/2750
PIXEL: 324/ 910
PIXEL: 435/1358
PIXEL: 601/ 948
PIXEL: 724/2262
PIXEL: 783/1909
PIXEL: 852/3939
PIXEL: 881/2343
PIXEL: 1142/3473
PIXEL: 1148/3119
PIXEL: 1151/ 994
PIXEL: 1195/3394
PIXEL: 1221/2887
PIXEL: 1679/ 621
PIXEL: 1683/2797
PIXEL: 1690/ 377
PIXEL: 1765/1883
PIXEL: 1802/1207
PIXEL: 1880/3008
PIXEL: 2281/3328
PIXEL: 2461/ 773
PIXEL: 2762/2448
PIXEL: 2843/3418
PIXEL: 3082/3423
PIXEL: 3109/ 514
PIXEL: 3130/3223
PIXEL: 3236/1865
PIXEL: 3717/3135
PIXEL: 4087/3961
PIXEL: 4186/2346
PIXEL: 4189/1257
PIXEL: 4303/1150
PIXEL: 4324/ 209
PIXEL: 4355/3878
PIXEL: 4492/1766
PIXEL: 4853/ 900
PIXEL: 4855/ 469
PIXEL: 4975/ 216
PIXEL: 5098/2743



PIXEL: 5362/3446
PIXEL: 5423/ 580
PIXEL: 5456/ 292
PIXEL: 5546/1147
PIXEL: 5725/2964
PIXEL: 5761/1225
PIXEL: 5793/1420
PIXEL: 5928/ 247
PIXEL: 5726/ 395

C03-00

PIXEL: 129/3703
PIXEL: 377/3358
PIXEL: 750/ 381
PIXEL: 890/1119
PIXEL: 979/ 991
PIXEL: 1076/2767
PIXEL: 1285/1215
PIXEL: 1368/2834
PIXEL: 1368/3228
PIXEL: 1565/3176
PIXEL: 1883/2992
PIXEL: 2059/1551
PIXEL: 2104/3193
PIXEL: 2497/ 859
PIXEL: 2762/1976
PIXEL: 2823/3415
PIXEL: 2921/2686
PIXEL: 2926/2909
PIXEL: 2964/1600
PIXEL: 3287/3472
PIXEL: 3364/3558
PIXEL: 3568/ 432
PIXEL: 3570/2540
PIXEL: 3639/3669
PIXEL: 3769/1705
PIXEL: 3870/2153
PIXEL: 4372/3315
PIXEL: 4558/ 904
PIXEL: 4719/3245
PIXEL: 4918/ 323
PIXEL: 5188/ 769
PIXEL: 5250/ 772
PIXEL: 5573/2606
PIXEL: 5647/ 804
PIXEL: 5661/2936
PIXEL: 5848/ 257
PIXEL: 5981/1268

C04-00

PIXEL: 185/3396
PIXEL: 406/2247
PIXEL: 431/1988
PIXEL: 443/1517



PIXEL: 740/1636
PIXEL: 754/1404
PIXEL: 1198/ 492
PIXEL: 1278/2532
PIXEL: 1358/ 805
PIXEL: 1462/1822
PIXEL: 1547/1038
PIXEL: 1711/3762
PIXEL: 1937/3861
PIXEL: 2164/ 578
PIXEL: 2474/ 63
PIXEL: 2548/2676
PIXEL: 2591/ 211
PIXEL: 3400/2046
PIXEL: 3671/ 587
PIXEL: 3848/2607
PIXEL: 4276/1511
PIXEL: 4505/2987
PIXEL: 4782/1759
PIXEL: 4952/1592
PIXEL: 4986/1163
PIXEL: 5157/1903
PIXEL: 5197/1693
PIXEL: 5247/1215
PIXEL: 5542/3200
PIXEL: 5836/2097
PIXEL: 2909/2337
PIXEL: 2909/2338
PIXEL: 2910/2338

C05-00

PIXEL: 770/3064
PIXEL: 839/2350
PIXEL: 882/3834
PIXEL: 1731/1513
PIXEL: 2142/2707
PIXEL: 2396/3476
PIXEL: 2409/ 21
PIXEL: 2687/1751
PIXEL: 2742/ 201
PIXEL: 2855/2259
PIXEL: 2911/2377
PIXEL: 3777/3701
PIXEL: 3990/2579
PIXEL: 4942/2158
PIXEL: 4976/ 385
PIXEL: 5714/3951
PIXEL: 302/ 150

C06-00

PIXEL: 28/3334
PIXEL: 90/2106
PIXEL: 250/2889
PIXEL: 276/1471



PIXEL: 321/ 830
PIXEL: 361/ 996
PIXEL: 540/1493
PIXEL: 578/3217
PIXEL: 649/ 300
PIXEL: 836/1257
PIXEL: 896/ 692
PIXEL: 896/ 693
PIXEL: 923/2216
PIXEL: 959/1069
PIXEL: 1219/2132
PIXEL: 1925/3069
PIXEL: 2705/1634
PIXEL: 3222/ 861
PIXEL: 3252/3108
PIXEL: 3673/2315
PIXEL: 3705/1295
PIXEL: 3884/2628
PIXEL: 4337/1528
PIXEL: 4571/1707
PIXEL: 4741/2876
PIXEL: 5179/1364
PIXEL: 5426/3245
PIXEL: 5497/ 32
PIXEL: 5551/ 646
PIXEL: 5561/ 238
PIXEL: 5789/1339
PIXEL: 5828/ 149
PIXEL: 5941/2451
PIXEL: 5981/3920
PIXEL: 6022/ 651
PIXEL: 5699/ 978

C07-00

PIXEL: 56/1839
PIXEL: 84/2201
PIXEL: 131/1264
PIXEL: 220/2754
PIXEL: 499/1620
PIXEL: 740/2408
PIXEL: 740/2409
PIXEL: 815/2705
PIXEL: 1107/2878
PIXEL: 1199/1365
PIXEL: 2094/2529
PIXEL: 2311/3607
PIXEL: 2525/3352
PIXEL: 3166/2484
PIXEL: 3222/ 259
PIXEL: 3477/ 906
PIXEL: 3519/ 855
PIXEL: 3834/ 936
PIXEL: 3871/2415
PIXEL: 4324/1981
PIXEL: 5730/3975



PIXEL: 162/ 173
PIXEL: 2511/2292
PIXEL: 3825/1823
PIXEL: 3825/1824
PIXEL: 3826/1824
PIXEL: 5625/3712
PIXEL: 163/ 173

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 Xp
Serial: UC-SXp-1-20615550

Panchromatic Camera: 4 * Prontor Magnetic 0
Prontor-Werk Alfred Gauthier GmbH, Germany
Multispectral Camera: 4 * Prontor Magnetic 0
Prontor-Werk Alfred Gauthier GmbH, Germany

Calibration Date: Feb-08-2018
Date of Report: Feb-21-2018
Camera Revision: Rev05.00
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 F8 [ms]	SRT F11 [ms]	SRT F16 [ms]	SRT F22 [ms]	Measurement Tolerance [ms]
C0 (Pan)	12 06 89 94	10.50	11.25	12.27	12.87	13.26	+/- 0.2
C1 (Pan)	12 06 89 99	9.68	10.23	10.93	11.41	11.72	+/- 0.2
C2 (Pan)	12 03 71 96	10.45	11.06	11.90	12.44	12.86	+/- 0.2
C3 (Pan)	12 07 06 83	10.23	10.86	11.73	12.18	12.57	+/- 0.2
C4 (Red)	12 04 99 06	10.66	11.06	11.74	12.12	12.40	+/- 0.2
C5 (Green)	12 04 99 16	11.85	12.31	13.04	13.57	13.86	+/- 0.2
C6 (Blue)	12 06 64 52	11.91	11.98	12.95	13.29	13.74	+/- 0.2
C7 (NIR)	12 04 99 25	11.64	12.16	12.94	12.97	13.43	+/- 0.2



ULTRACAM

Electronics and Sensor Calibration

Camera: UltraCam Xp
Serial: UC-SXp-1-20615550

Panchromatic Camera: 9 * FTF6040-M Area CCD Sensor by DALSA
Multispectral Camera: 4 * FTF6040-M Area CCD Sensor by DALSA

Calibration Date: Feb-08-2018
Date of Report: Feb-21-2018
Camera Revision: Rev05.00
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	FTF6040-M	14 3178/102	22.00
00_01	FTF6040-M	14 3293/071	22.00
00_02	FTF6040-M	14 3293/032	23.00
00_03	FTF6040-M	14 3293/035	23.10
01_00	FTF6040-M	14 3178/078	22.10
01_01	FTF6040-M	14 3178/080	22.00
02_00	FTF6040-M	14 3293/034	23.30
02_01	FTF6040-M	14 3293/082	23.00
03_00	FTF6040-M	14 3178/127	22.00
04_00 (red)	FTF6040-M	14 3178/081	22.00
05_00 (green)	FTF6040-M	14 3178/071	22.00
06_00 (blue)	FTF6040-M	13 1039/070	21.80
07_00 (NIR)	FTF6040-M	14 3293/031	22.80



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	FTF6040-M	14 3178/102	7340
00_01	FTF6040-M	14 3293/071	6420
00_02	FTF6040-M	14 3293/032	5900
00_03	FTF6040-M	14 3293/035	6450
01_00	FTF6040-M	14 3178/078	7440
01_01	FTF6040-M	14 3178/080	6950
02_00	FTF6040-M	14 3293/034	6540
02_01	FTF6040-M	14 3293/082	6020
03_00	FTF6040-M	14 3178/127	6680
04_00 (red)	FTF6040-M	14 3178/081	6700
05_00 (green)	FTF6040-M	14 3178/071	7220
06_00 (blue)	FTF6040-M	13 1039/070	7510
07_00 (NIR)	FTF6040-M	14 3293/031	5940



ULTRACAM

Summary

Camera:	UltraCam Xp
Serial:	UC-SXp-1-20615550
Calibration Date:	Feb-08-2018
Date of Report:	Feb-21-2018
Camera Revision:	Rev05.00
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.

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Vexcel Imaging GmbH

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