



Calibration Protocol
DMC01 - 0037



Calibration Certificate

Digital Mapping Camera (DMC)

DMC Serial Number: **DMC01-0037**

CBU Serial Number: **0100037**

For

STEREOCARTO, S.L.

Pº de la Habana. 200

28036 Madrid

Spain

System Overview

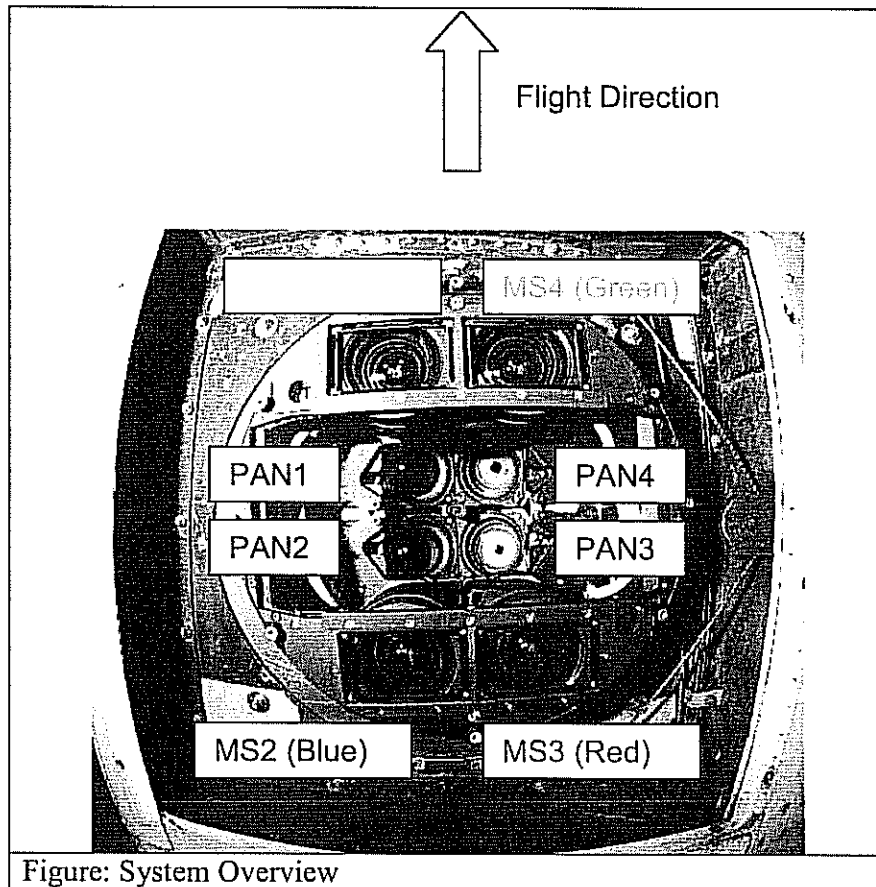
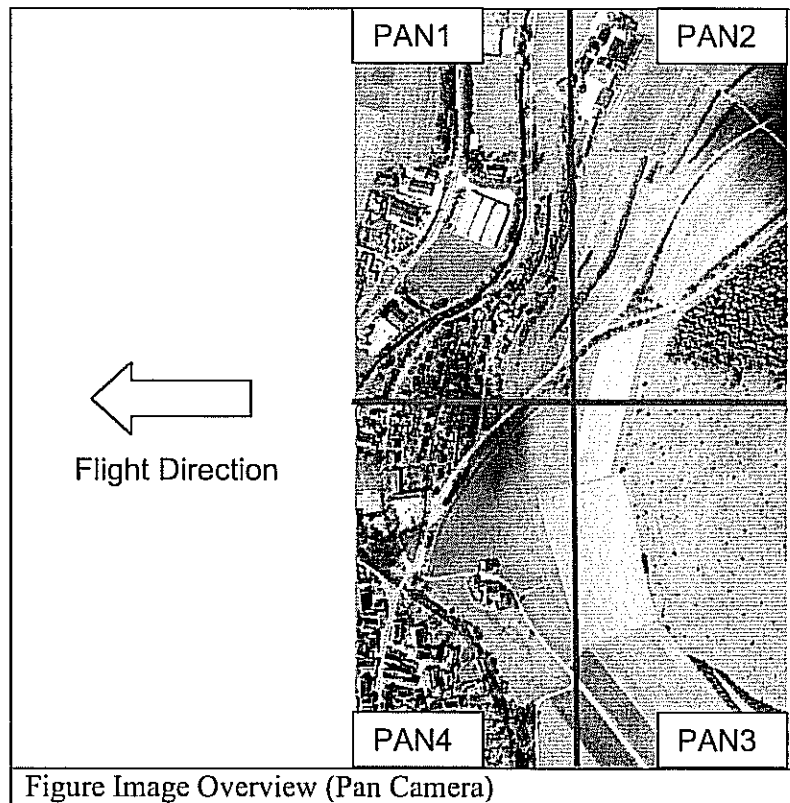


Figure: System Overview



Camera Parameter for Virtual Image (High Resolution)

Virtual Focal Length [m]	0.12
Virtual Sensor Size [Pixel]	13824 x 7680
Virtual Pixel Size [μm]	12
Virtual Principle Point [mm]	X = 0.0 Y = 0.0
Distortion Parameter	Distortion Free

Camera Parameter for Virtual Image (Color Resolution) before Version PPS 5.0.10.3

Virtual Focal Length [m]	0.12 / 4.75
Virtual Sensor Size [Pixel]	3072 x 2048
Virtual Pixel Size [μm]	12
Virtual Principle Point [mm]	X= -0.646 Y=0.646
Distortion Parameter	Distortion Free



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INTERGRAPH

***Camera Parameter for Virtual Image (Color Resolution) after
Version PPS 5.0.10.3***

Virtual Focal Length [m]	0.030
Virtual Sensor Size [Pixel]	3456x1920
Virtual Pixel Size [μm]	12
Virtual Principle Point [mm]	X = 0.0 Y = 0.0
Distortion Parameter	Distortion Free



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Camera Serial Number and Burn-In flights

	Burn In Flight: 10.07.2006					
Camera	Serial Number	Calib. Date				
PAN1	00111724	15.06.2006				
PAN2	00113785	08.06.2006				
PAN3	00113787	09.06.2006				
PAN4	00113793	12.06.2006				
MS1 (NIR)	00114313	04.05.2006				
MS2 (Blue)	00114298	31.05.2006				
MS3 (Red)	00114292	05.05.2006				
MS4 (Green)	00114297	20.06.2006				

Camera Orientation PAN-Cameras (Burn-In Flight 10.07.2006)

Camera (Serial Number)	X [m] (Accuracy)	Y [m] (Accuracy)	Z [m] (Accuracy)	Omega [Deg] (Accuracy)	Phi [Deg] (Accuracy)	Kappa [Deg] (Accuracy)
PAN1 (00111724)	0.064 (0)	-0.079 (0)	1000 (0)	18.031 (0.001)	10.009 (0.001)	86.434 (0.001)
PAN2 (0111726)	-0.064 (0)	-0.079 (0)	1000 (0)	17.872 (0.001)	-10.278 (0.001)	93.620 (0.001)
PAN3 (0211172)	-0.064 (0)	0.079 (0)	1000 (0)	-18.009 (0.001)	-10.005 (0.001)	-93.275 (0.001)
PAN4 (02111731)	0.064 (0)	0.079 (0)	1000 (0)	-17.893 (0.001)	10.272 (0.001)	-86.899 (0.001)

The data is connected to the virtual projection center of the virtual image.

The above Platform calibration values are initial values and are liable to slight fluctuations between project images and between different projects. The position is fix and error free. The rotation axes of the angles are (in this order)

Omega	x-Axis
Phi	y-Axis
Kappa	z-Axis

The results of the Platform calibration were generated with DMC Postprocessing SW (PPS), Version 5.0, from Intergraph Z/I Imaging photogrammetric product suite.

Platform calibration performed by


Dipl. Ing. C. Müller

12.07.2006
Date



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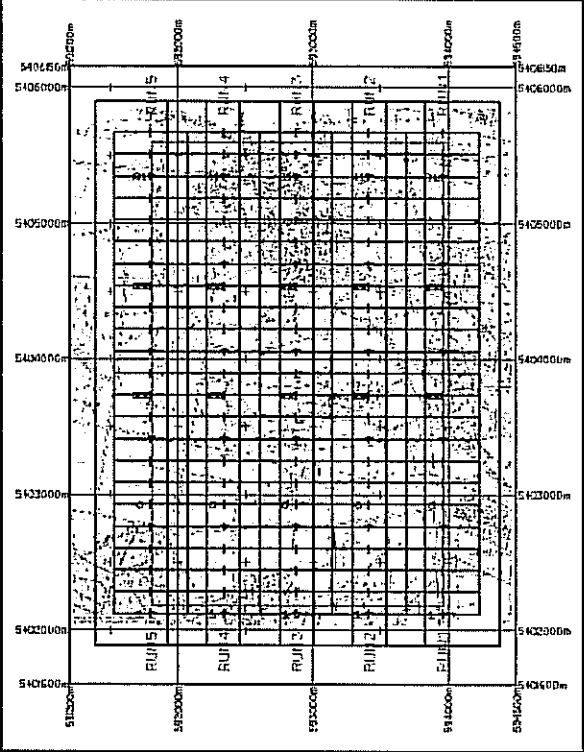


DATE: 10/10/2014

TIME: 10:00

1. The purpose of this protocol is to ensure that the calibration of the DMC01 - 0037 is accurate and reliable.

Aerotriangulation Results (Burn-In Flight 12.07.2006)

	Photo Scale	1:5000
	Flying Height [m]	600 AGL
	Flying Altitude [m]	1200 AMSL
	Run-Spacing [m]	539.1
	Base-Length [m]	161.3
	Number of Exposures	115
	Side-lap [%]	35
	End-lap [%]	65
	Terrain Height [m]	600
	Number of strips	5
	Photos in one strip	23
	Photos Used	115
	Control Points Used	7
	Check Points Used	33
	GSD [cm]	6

Statistic results:

Matching results: 0 Weak Areas - covered with clouds	
Whole Block	115 exposures used
	0 exposures not used
Whole Block	Sigma relativ: 1.907 um
Whole Block	Sigma absolut: 1.899 um
Whole Block	
Photo-T Parameters and Results for Project EL5000_n	
PhotoT Triangulation Options	
Adjustment Mode	: Absolute
Precision Computation	: Enabled
Error Detection	: Enabled
Camera Calibration	: Disabled
Self-Calibration	: Disabled
Given EO/GPS	: Disabled
Antenna Offsets	: Disabled
GPS Shift/Drift Correction	: Disabled
INS Shift/Drift Correction	: Disabled



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Parameters					
	Parameter	X/Omega	Y/Phi	Z/Kappa	XY
	RMS Control	0.070	0.049	0.416	0.061
	RMS Check	0.059	0.041	0.401	0.051
	RMS Limits				
	Max Ground Residual	0.133	0.100	0.569	
	Residual Limits				
	Mean Std Dev Object	0.097	0.097	0.119	
	RMS Photo Position				
	RMS Photo Attitude				
	Mean Std Dev Photo Position	0.111	0.108	0.121	
	Mean Std Dev Photo Attitude	0.005	0.004	0.003	
Key Statistics					
	Sigma:	1.9	um		
	Number of iterations:	4			
	Degrees of Freedom:	26127			

The results of the Aerotriangulation were generated with ImageStation Automatic Triangulation (ISAT), Version 5.0, from Intergraph Z/I Imaging photogrammetric product suite.

Aerotriangulation performed by


Dipl. Ing. C. Müller

13.07.2006
Date



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Calibration Certificate

N^o 00111724

Object Digital Aerial Survey Camera

Manufacturer Z/I Imaging D-73431 Aalen

Type DMC-Panchromatic

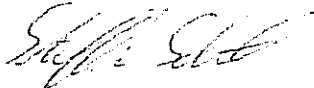
Serial Number 00111724

Calibration performed at:

Carl Zeiss Jena

Number of pages of the certificate 76

Date of Calibration 18.Jul.2006

Certified	Date	Division Head	Person in Charge
	01.Aug.2006	 (H. Sohnle)	 (S. Schröder)

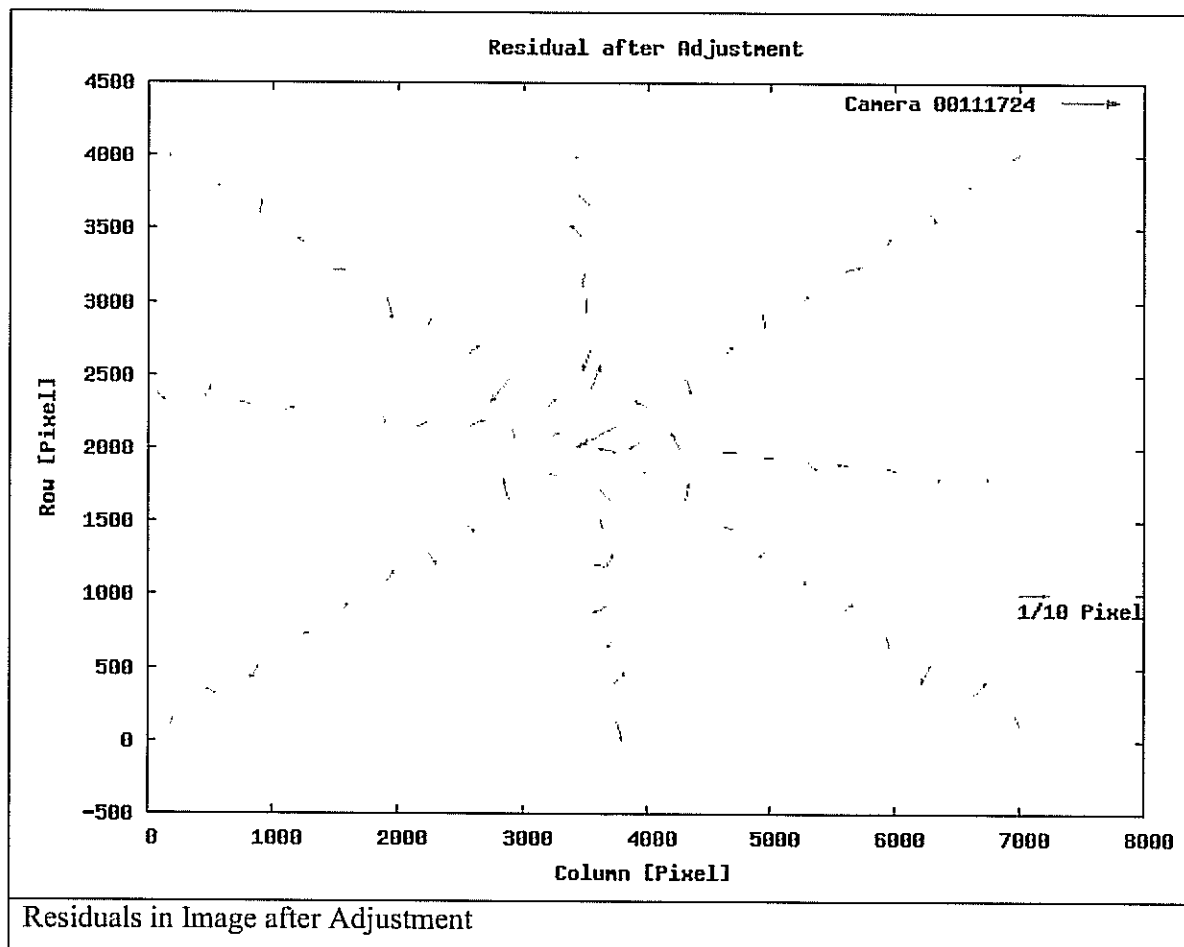
Geometric Calibration Protocol

Calibration Parameters for single camera head

Camera Type	DMC-Panchromatic
Nominal Focal Length	0.12 m
Serial Number	00111724

	Param	Adjusted	Std.dev.
Principal Point [m]	x_0	0.0001271	6.767E-06
	y_0	-0.0001664	4.096E-06
Focal Length [m]	Δf	-0.0003802	1.185E-06
Radial Distortion	K_1	0.6139	0.03081
	K_2	-337.6	27.86
	K_3	-11570	7354
Decentring distortion	P_1	7.323E-05	0.0001542
	P_2	-1.747E-06	7.782E-05
In Plane Distortion	B_1	-5.643E-05	8.091E-06
	B_2	1.24E-05	4.688E-06

Adjusted Focal length = 0.12+ dc =0.1196198 [m]



Max Residual [μm]: 1.6

Threshold [μm]: 8.5

Remarks:

The images after the post processing are distortion free. For interior orientation parameters of the DMC virtual image see section: "Calibration Parameter of the virtual images".

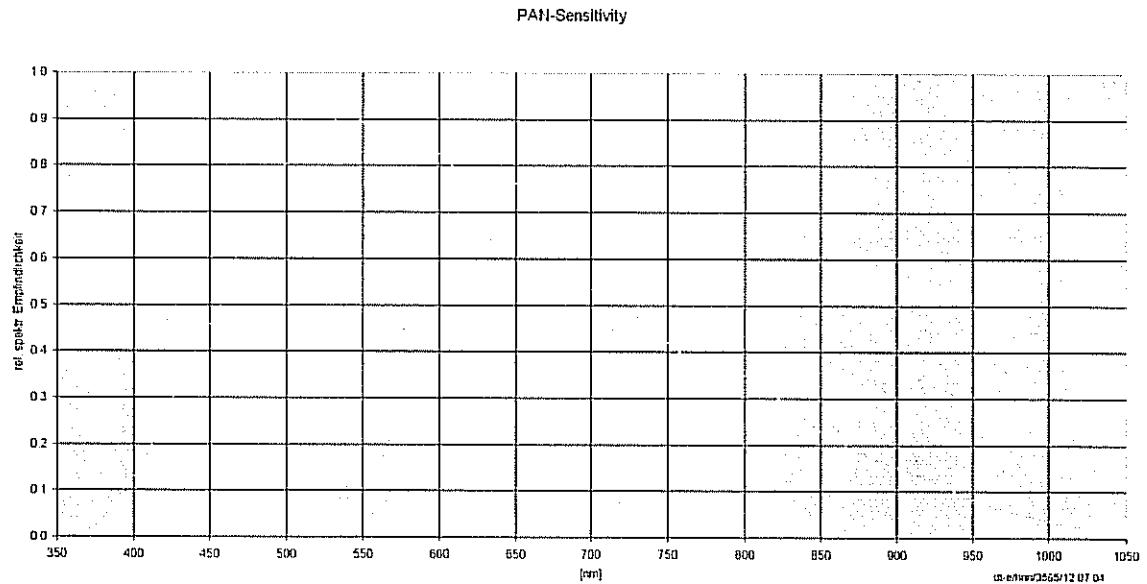
The calibration model is explained in the section "Calibration Model" at the end of this documentation.

Radiometric Calibration Protocol

In this section you'll find the radiometric calibration results.

Camera ID	00111724
Sensor Revision Number	2
Lens Revision Number	1
Filter Revision Number	-
Aperture Revision Number	1

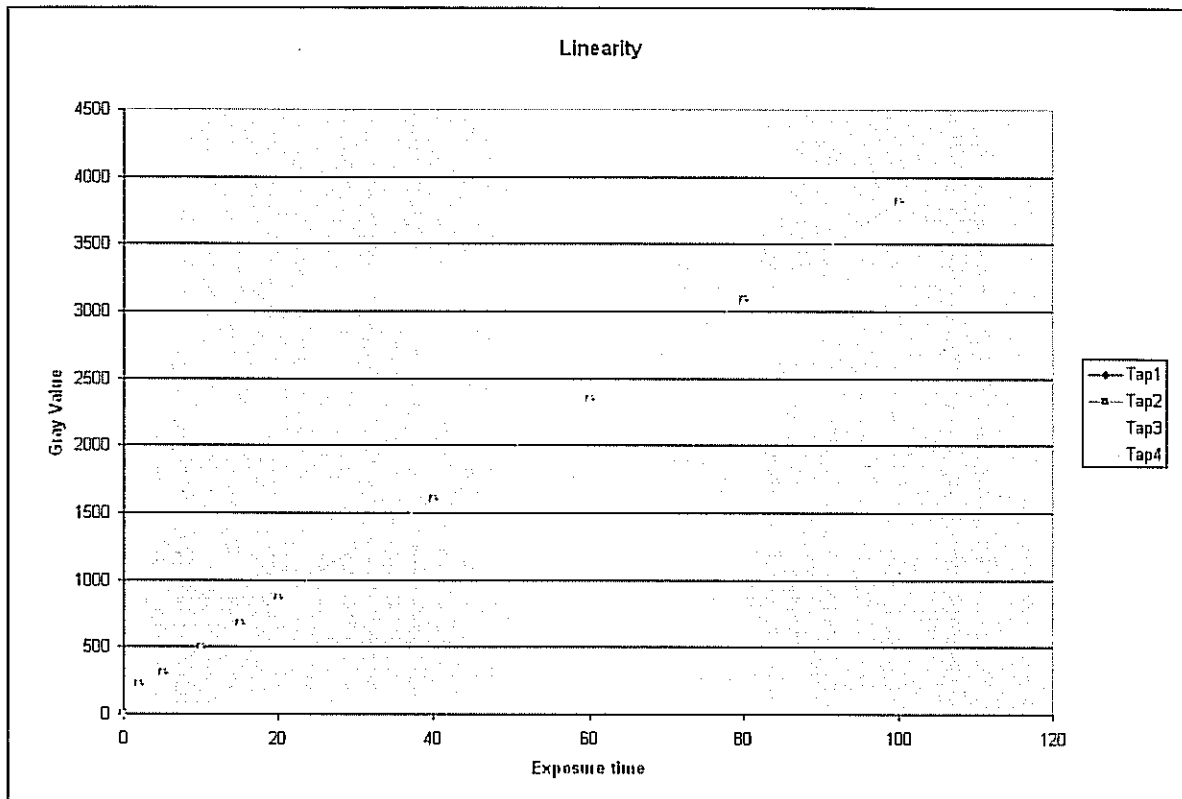
Sensitivity of camera



Remark:

Measurement is done without the influence of the shutter and the Analog/Digital converter. This graph is similar for the same lens and filter revision numbers. For more details see Appendix: "Radiometric Calibration Model".

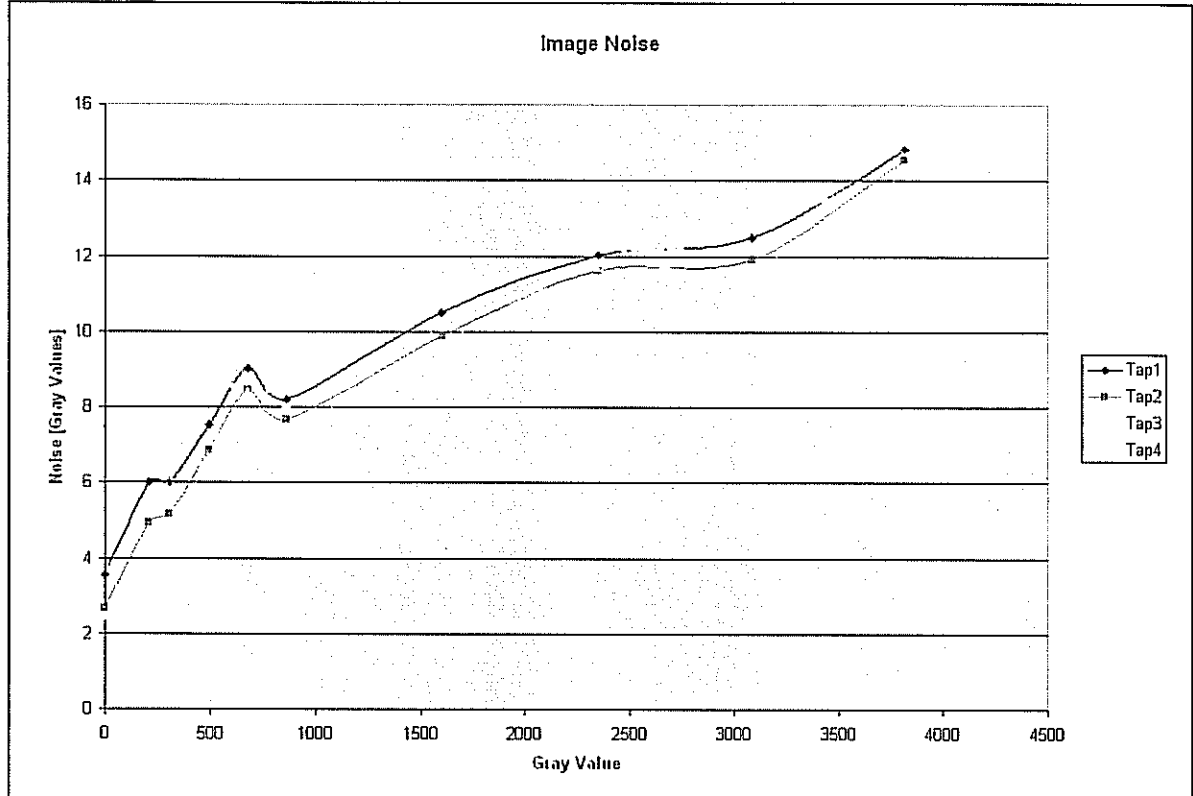
Sensor Linearity



Remark:

The sensor linearity is measured for each camera. For more details see Appendix: "Radiometric Calibration Model".

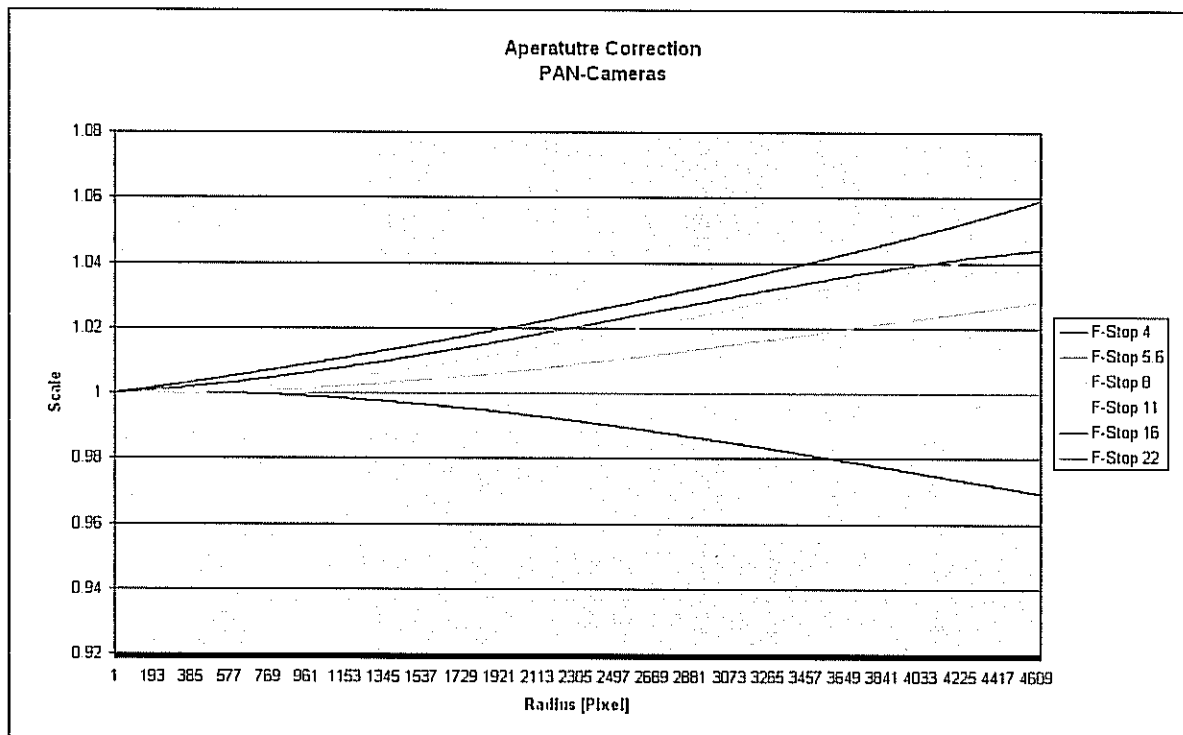
Sensor Noise



Remark:

The sensor noise is measured for each camera. For more details see Appendix: "Radiometric Calibration Model".

Aperture Correction



Remark:

This measurement is similar for the same aperture revision number. For more details see Appendix: "Radiometric Calibration Model".

Defect Pixel List

Number of defect pixels: 30
Number of defect clusters: 0
Number of defect columns: 1

Nr	Row	Column
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0	3165	1939
1	3165	1940
2	3166	1940
3	3167	1940
4	3167	1941
5	3338	3654



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6	3339	3654			
7	3340	3654			
8	3337	3655			
9	3338	3655			
10	3339	3655			
11	3340	3655			
12	3338	3656			
13	3339	3656			
14	3340	3656			
15	1432	4272			
16	1432	4273			
17	2941	4789			
18	2942	4789			
19	2941	4790			
20	2942	4790			
21	2367	4941			
22	2943	5192			
23	2944	5192			
24	643	5289			
25	643	5290			
26	644	5290			
27	643	5291			
28	644	5291			
29	2029	5394			
Defect Column	RowStart	ColumnStart	RowEnd	ColumnEnd	
0	821	2525	2047	2525	

Remark

See Appendix for definition of defect pixels and maximal allowed numbers.



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Calibration Certificate

N^o 00113785

Object Digital Aerial Survey Camera

Manufacturer Z/I Imaging D-73431 Aalen

Type DMC-Panchromatic

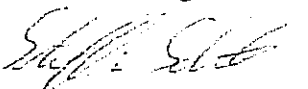
Serial Number 00113785

Calibration performed at:

Carl Zeiss Jena

Number of pages of the certificate 76

Date of Calibration 19.Jul.2006

Certified	Date	Division Head	Person in Charge
	01.Aug.2006	 (H. Sohnle)	 (S. Schröder)



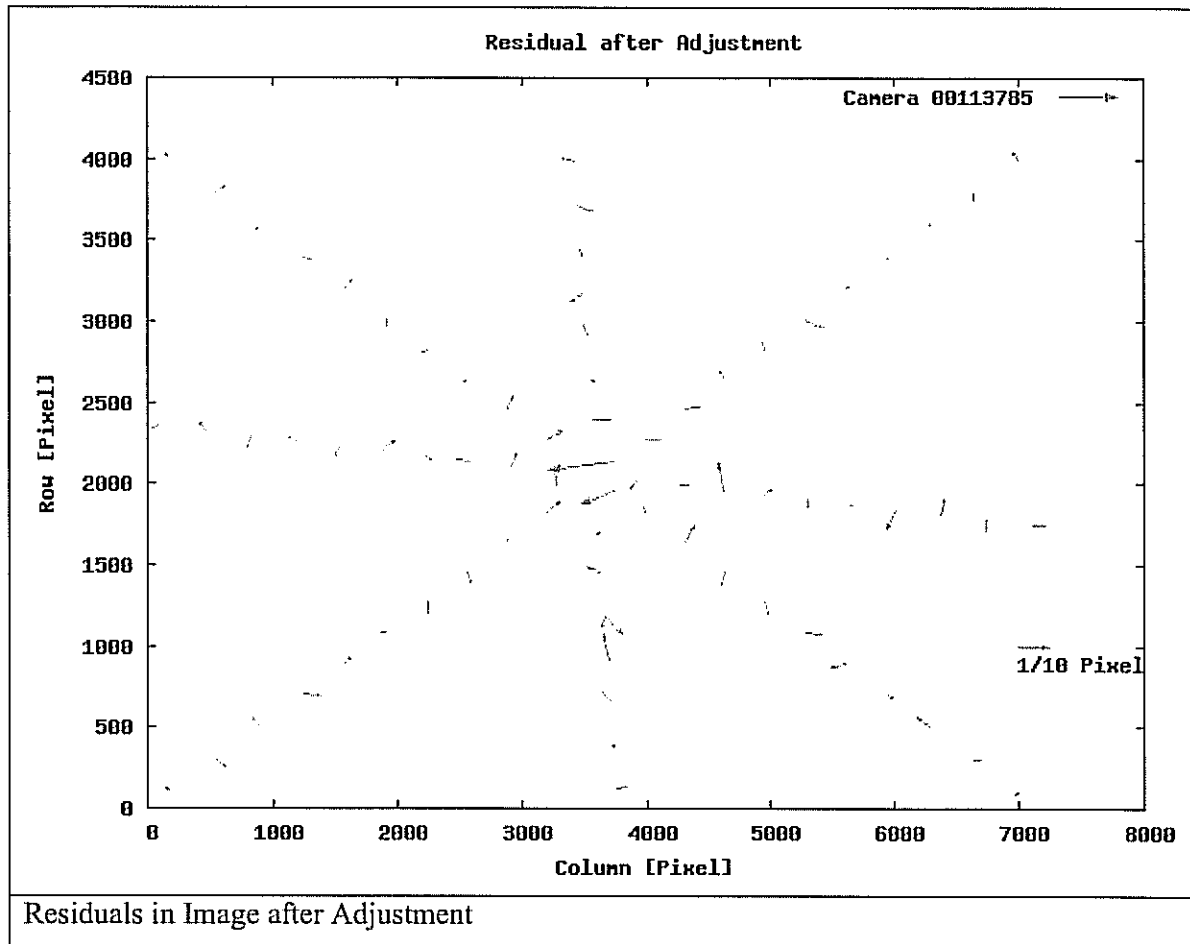
Geometric Calibration Protocol

Calibration Parameters for single camera head

Camera Type	DMC-Panchromatic
Nominal Focal Length	0.12 m
Serial Number	00113785

	Param	Adjusted	Std.dev.
Principal Point [m]	x_0	0.000139	7.725E-06
	y_0	-5.758E-05	4.676E-06
Focal Length [m]	Δf	-0.0004582	1.352E-06
Radial Distortion	K_1	0.6677	0.03517
	K_2	-304	31.8
	K_3	-22060	8395
Decentring distortion	P_1	-0.0003634	0.0001761
	P_2	0.0002102	8.884E-05
In Plane Distortion	B_1	-2.072E-05	9.236E-06
	B_2	-9.377E-06	5.352E-06

Adjusted Focal length = $0.12 + \Delta f = 0.1195418$ [m]



Max Residual [μm]: 2.7

Threshold [μm]: 8.5

Remarks:

The images after the post processing are distortion free. For interior orientation parameters of the DMC virtual image see section: "Calibration Parameter of the virtual images".

The calibration model is explained in the section "Calibration Model" at the end of this documentation.

Radiometric Calibration Protocol

In this section you'll find the radiometric calibration results.

Camera ID	00113785
Sensor Revision Number	2
Lens Revision Number	1
Filter Revision Number	-
Aperture Revision Number	1