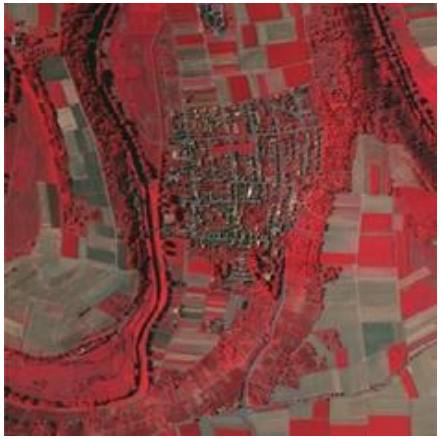


LEICA DMC III GEOMETRIC IN FLIGHT CALIBRATION AND PRACTICAL EXPERIENCES

Christian Mueller Product Manager

15th Annual Civil Commercial Imagery Evaluation Workshop
sponsored by JACIE
April 11-13, 2016
Fort Worth Convention Center

PART OF HEXAGON

- when it has to be right

Leica Geosystems

DMC III Camera

Camera Parameter

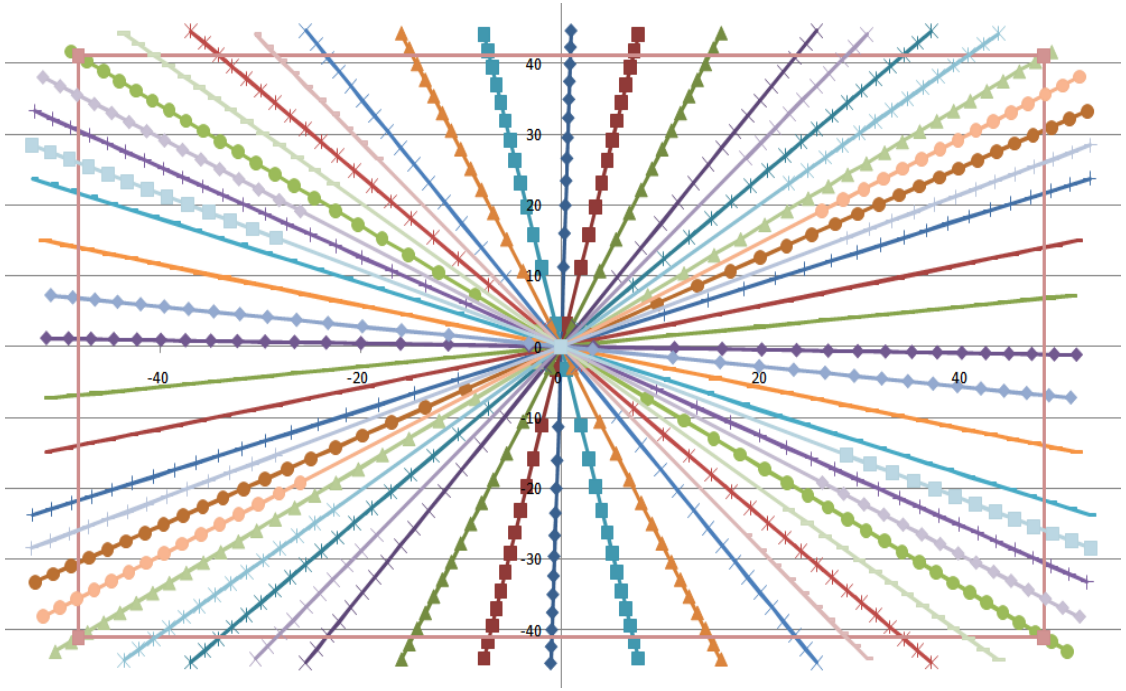
Panchromatic camera – reference camera:

Single CMOS - array

- Nominal focal length 92.0000 mm
- Nominal PPA of 0/0 mm
- Image format:
  - along FD: 14592 pixel * 3.9 µm = 56.9088mm
  - across FD: 25728 pixel * 3.9 µm = 100.3392mm

„SYNTHETIC“ calibration

The “SYNTHETIC” geometric calibration is based on a simulated mathematical lens distortion calculation based on the detailed optical design data of the lens.
It is equivalent to the DMC II collimator calibration procedure, projecting 800 “light targets” on 28 lines that are distributed diagonally on the focal plane.

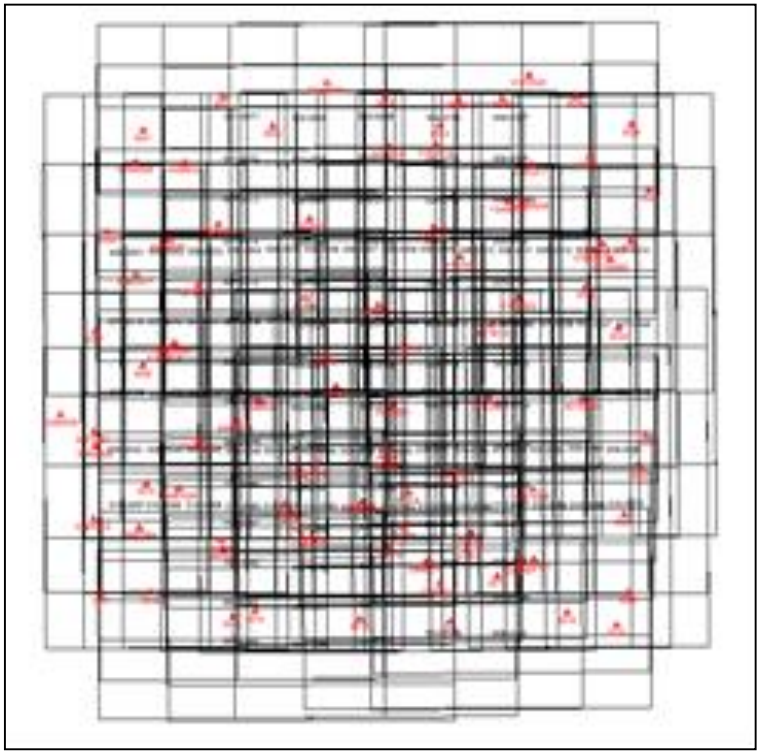


Calibration Flight Procedure

Mission Plan:

- 5 x 5 or 6 x 6 flight lines
- N-S and E-W direction -> grid pattern
- 140 - 168 images
- GSD: 4.7 – 5.0cm
- End lap 75 – 77%
- Side lap 75 – 81%
- > 90 GCPs -> SD X, Y = 3cm

  Z = 4cm

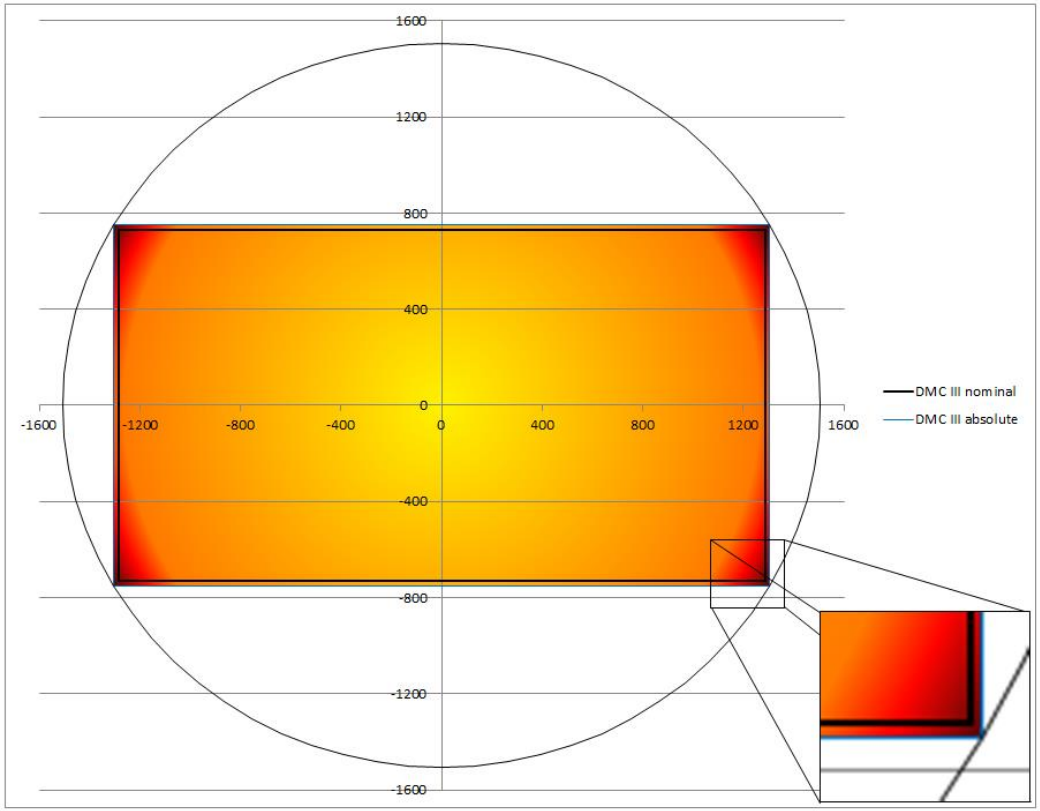


hg = 1178m AGL
Image footprint 749m x 1305m

Calibration Procedure

Panchromatic camera – reference camera:

- Focal length 92.0000 mm
- Full-calibration-frame image format:
  - along FD: 15000 pixel * 3.9 µm = 58.5000mm (14592 pixel * 3.9 µm = 56.9088mm)
  - across FD: 26112 pixel * 3.9 µm = 101.8368mm (25728 pixel * 3.9 µm = 100.3392mm)



- when it has to be right

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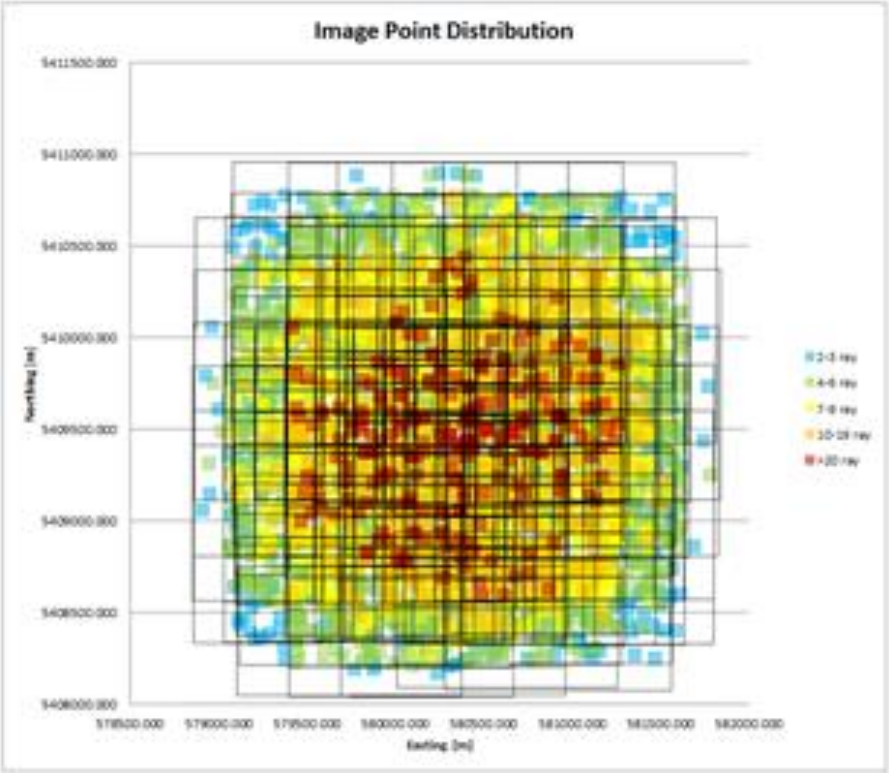
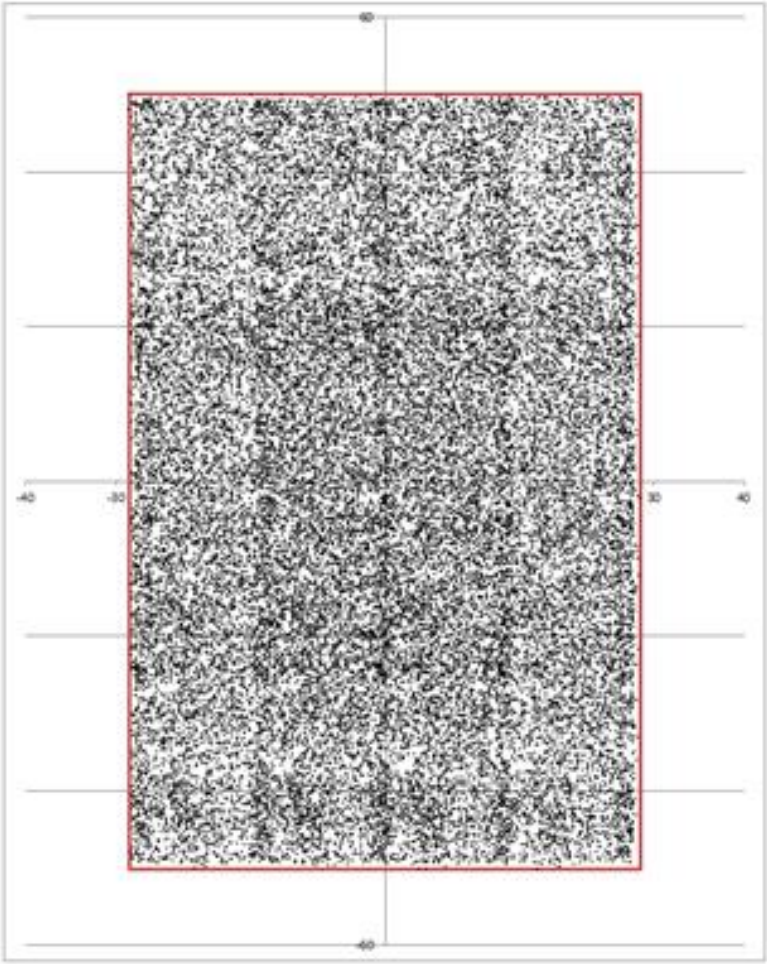
Calibration Procedure





Run APM – Intergraph ISAT was used

- 140 images
- 140 up to 370 points/image
- 275 points/image in average
- All image points overlayed to one image

- when it has to be **right**

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Calibration Procedure

4 Step Calibration method

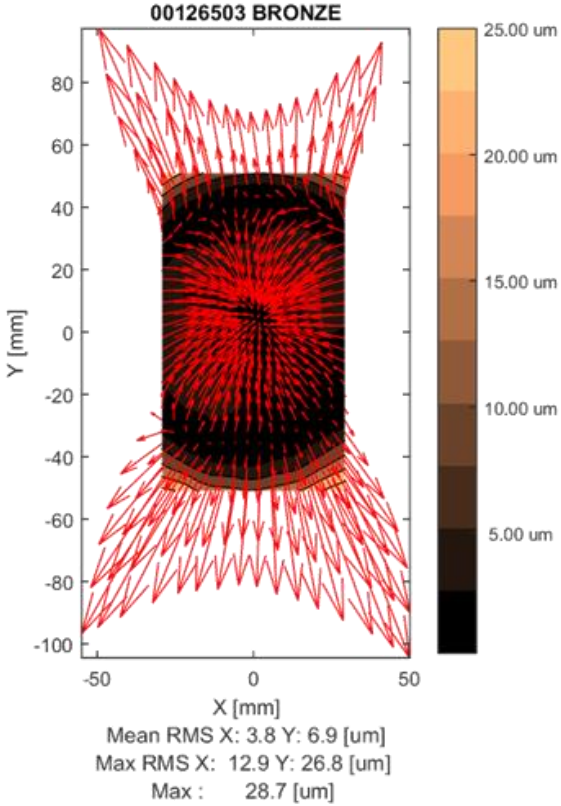
„SYNTHETIC ➔ BRONZE“ calibration

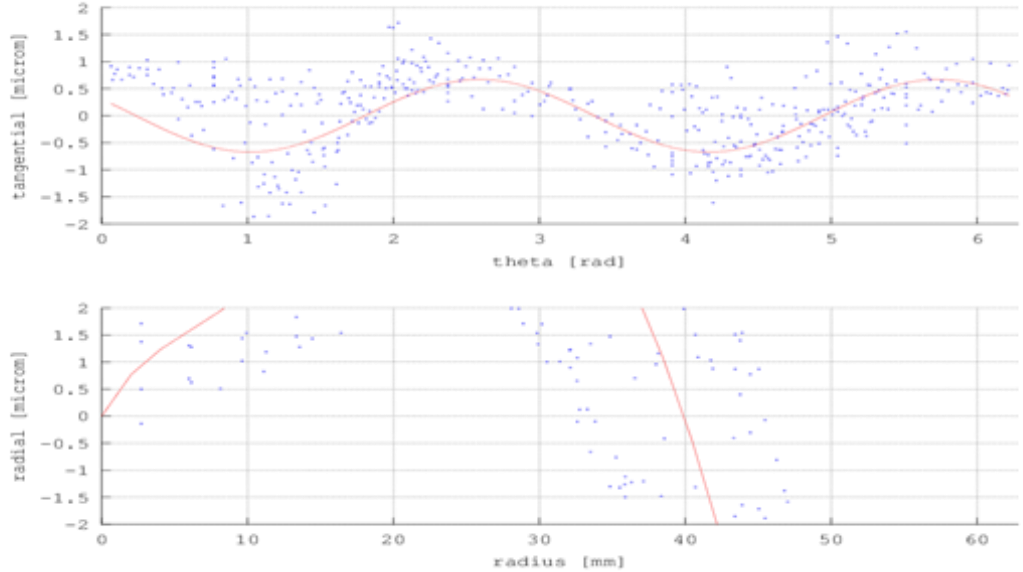
„BRONZE ➔ SILVER“ calibration

„SILVER ➔ GOLD“ calibration

„GOLD ➔ PLATINUM“ calibration

„SYNTHETIC ➔ BRONZE“ calibration procedure





- Remaining non-linear systematic distortion in focal plane

Calibration Step	Mean RMS X	Mean RMS Y	Max RMS X	Max RMS Y	Max
SYNTHETIC→BRONZE	3.8µm	6.9µm	12.9µm	26.8µm	28.7µm

- when it has to be **right**

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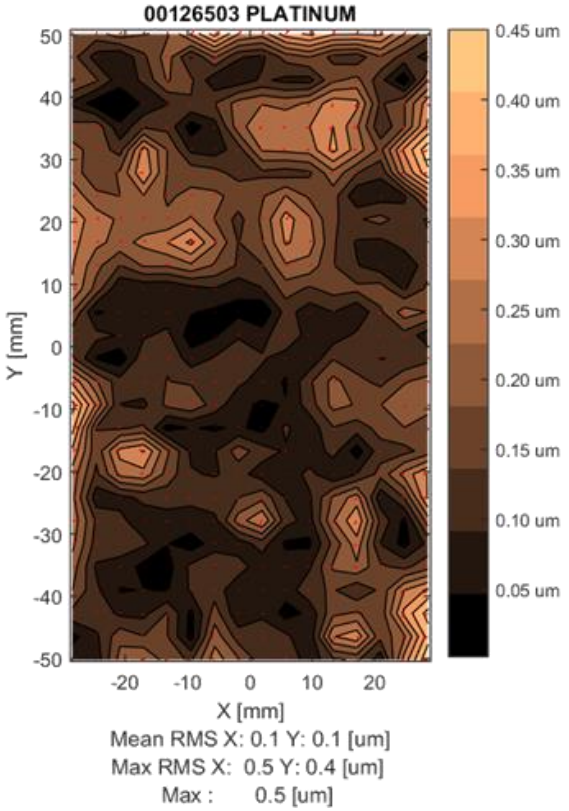
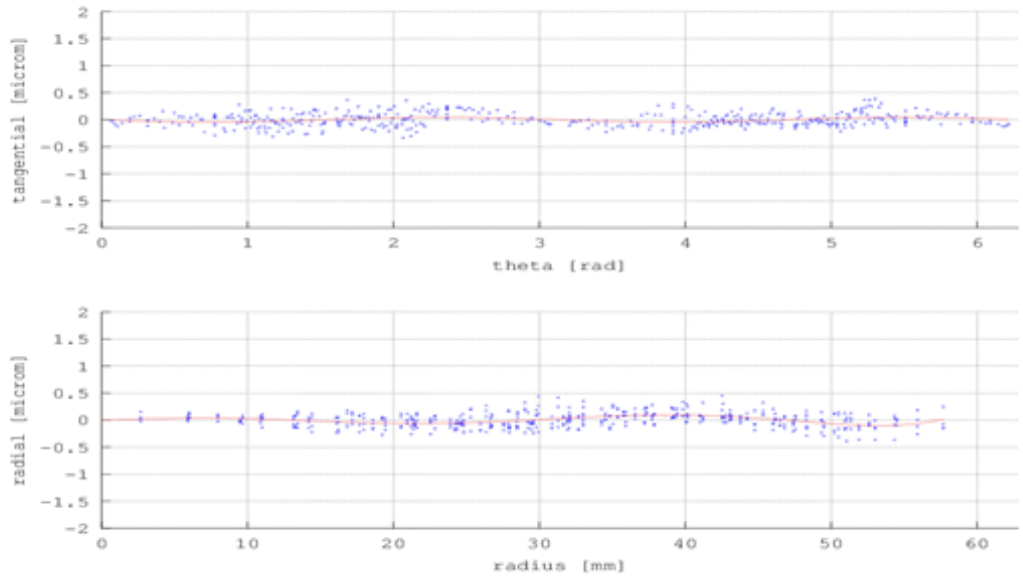
„GOLD ➔ PLATINUM“ calibration procedure

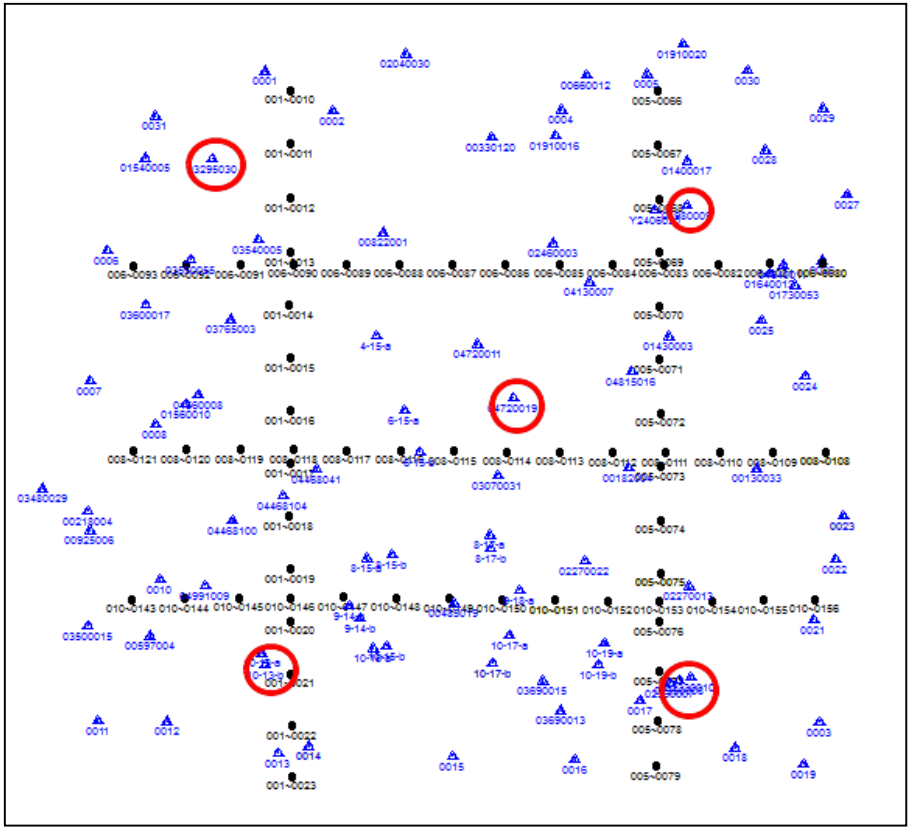




- Remaining non-linear systematic distortion in focal plane

Calibration Step	Mean RMS X	Mean RMS Y	Max RMS X	Max RMS Y	Max
SYNTHETIC→BRONZE	3.8µm	6.9µm	12.9µm	26.8µm	28.7µm
BRONZE → SILVER	0.5µm	0.6µm	4.6µm	2.8µm	5.4µm
SILVER → GOLD	0.2µm	0.2µm	1.2µm	1.1µm	1.6µm
GOLD → PLATINUM	0.1µm	0.1µm	0.5µm	0.4µm	0.5µm

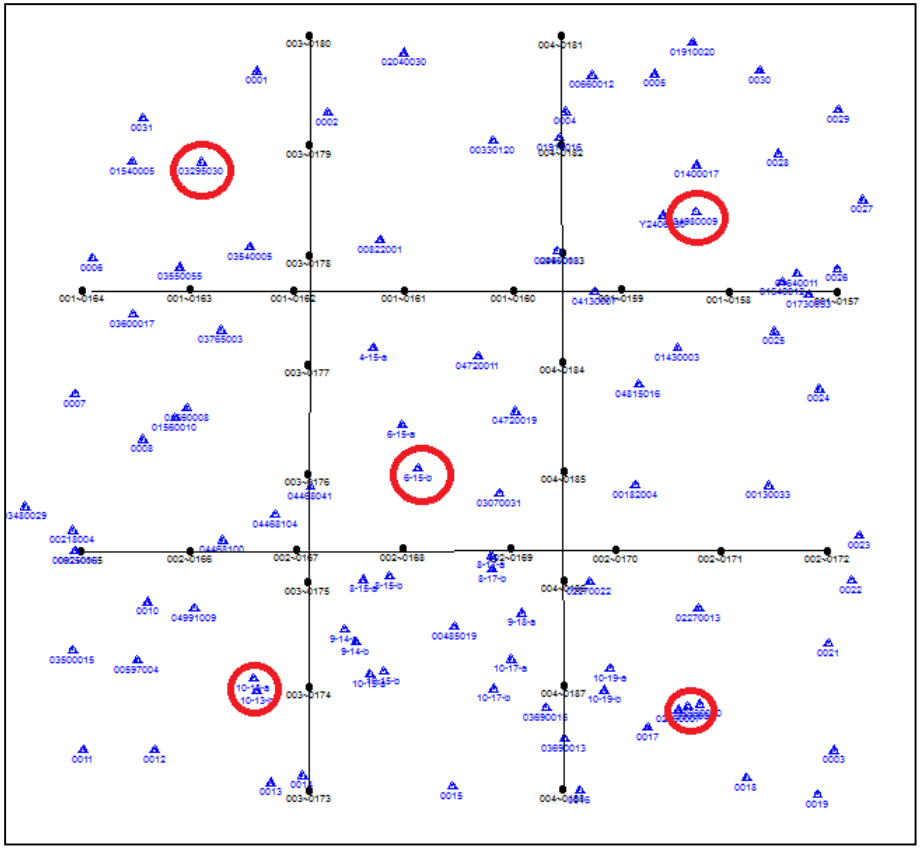
Geometric Accuracy – Calibration QC



Mission Plan:

- 3 + 2 flight lines
- E-W + 2 Cross Strips
- 70 images
- GSD: ≈ 5.0cm
- End lap 75%
- Side lap 30%
- 5 Control Points -> SD X, Y = 3cm
  Z = 4cm
- 75-85 Check Points -> SD X, Y = 3cm
  Z = 4cm
- Flat area: 423 – 484m terrain height

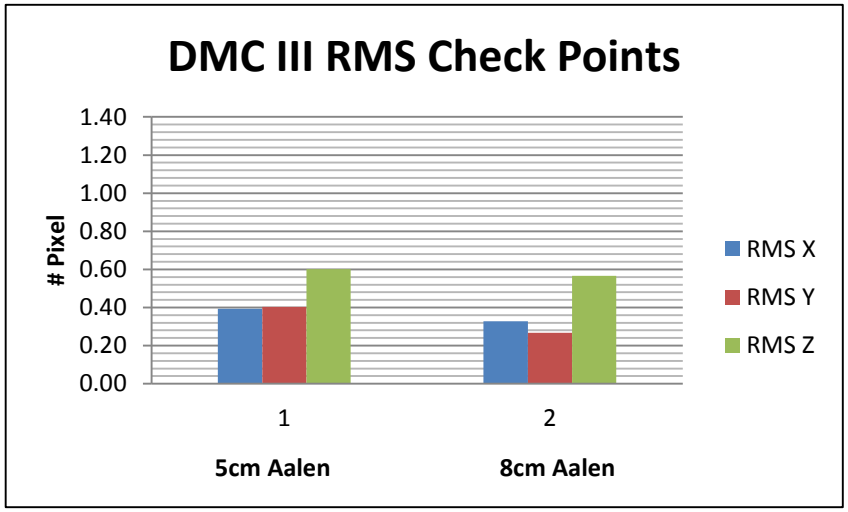
Geometric Accuracy – Calibration QC

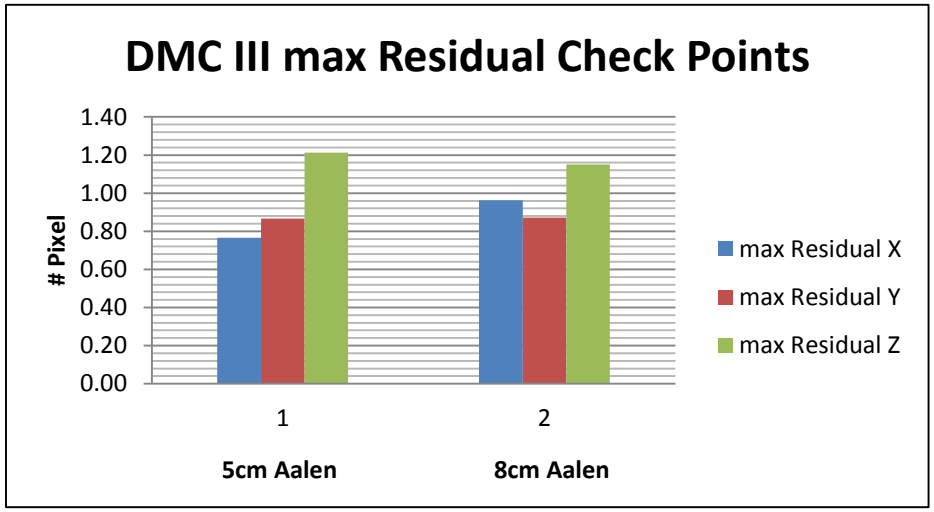


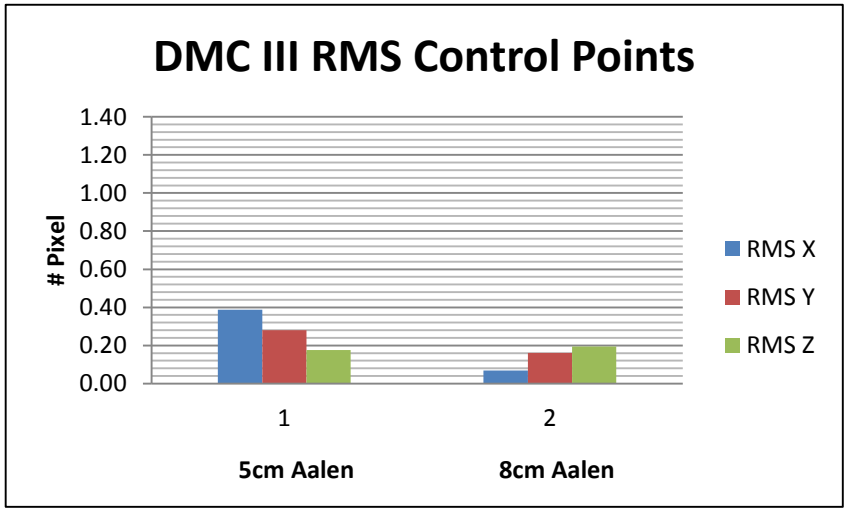
Mission Plan:

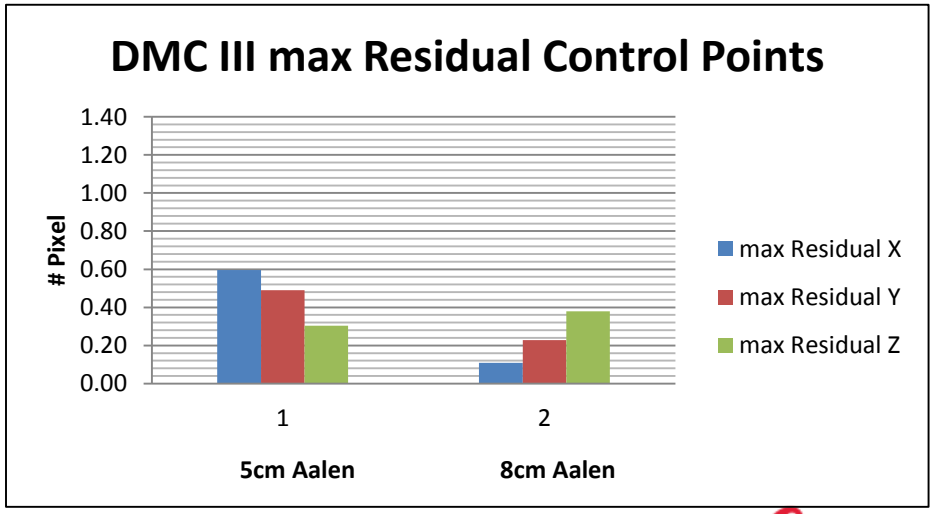
- 2 + 2 flight lines
- E-W + 2 Cross Strips
- 32 images
- GSD: ≈ 8.0cm
- End lap 70%
- Side lap 60%
- 5 Control Points -> SD X, Y = 3cm
  Z = 4cm
- 75-85 Check Points -> SD X, Y = 3cm
  Z = 4cm
- Flat area: 423 – 484m terrain height

Geometric Accuracy – Calibration QC









FMC Accuracy

"The Leica DMC III Pan camera head is equipped with a brushless drive; it is a DC-Motor with a gear and an excentric, that moves the sensor carriage."

- Mechanical FMC
- Nominal STDev = 0.5 – 1.0µm

➢ Linear movement has a small influence on image geometry only

- More important is the constant internal orientation of the sensor
- Nominal sensor position is -200µm
- Differences to the nominal sensor position are corrected during image processing

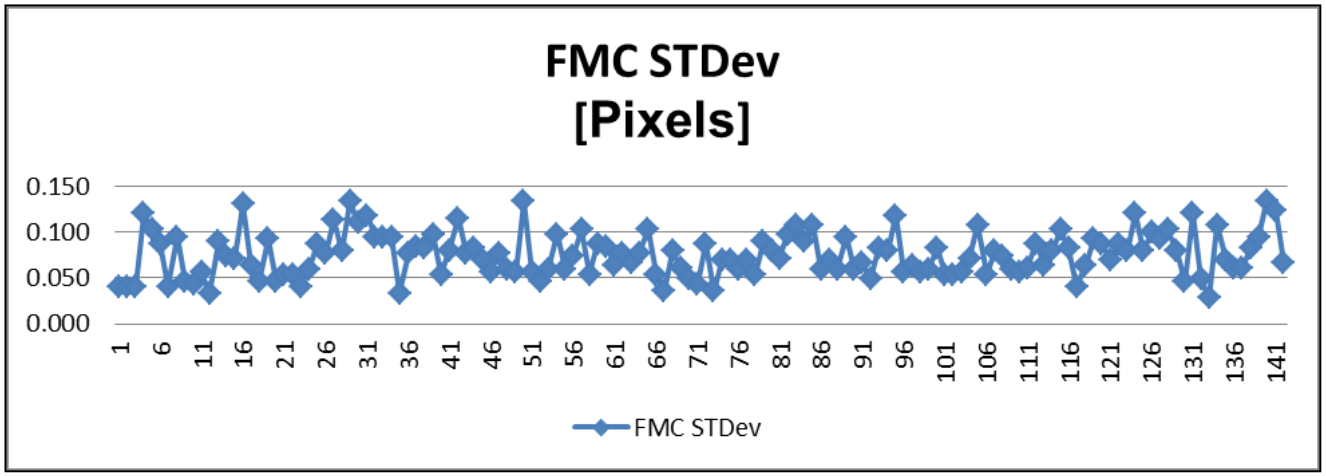
➢ Position accuracy of 1/78 of a pixel

FMC Accuracy

FMC vs TDI

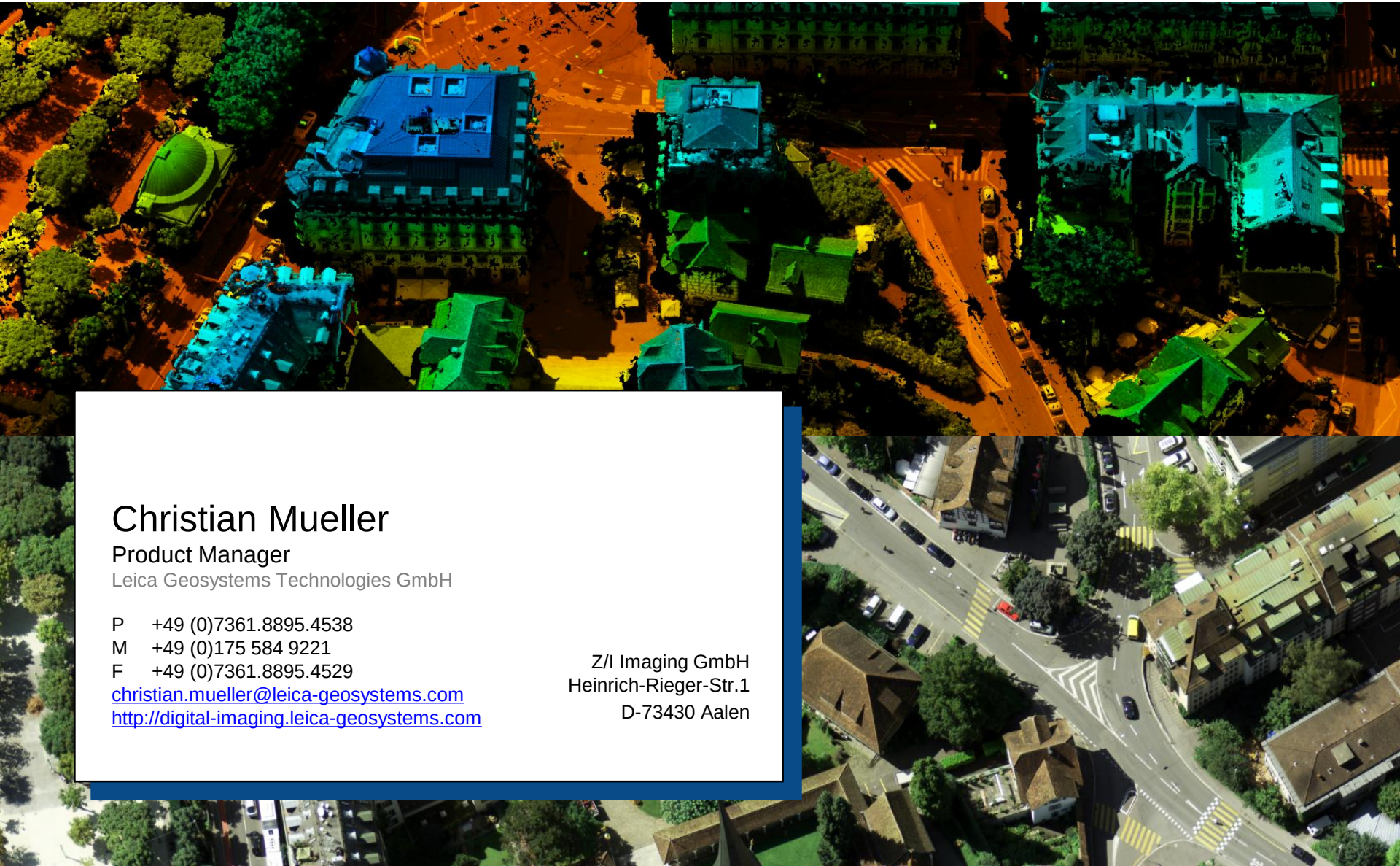
- TDI corrects for full pixels only
- FMC corrects in $^{1}/_{10}$ of a pixel steps with an STDev ¼ - ⅛ (nominal ½ - 1) of a pixel

➢ Practical experiences shows ⅛ of a pixel and better can be achieved



THANK YOU FOR YOUR ATTENTION!

QUESTIONS?



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