CALIBRATING THE NEW ULTRACAM OSPREY OBLIQUE AERIAL SENSOR

EuroCOW 2014

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UltraCam Osprey

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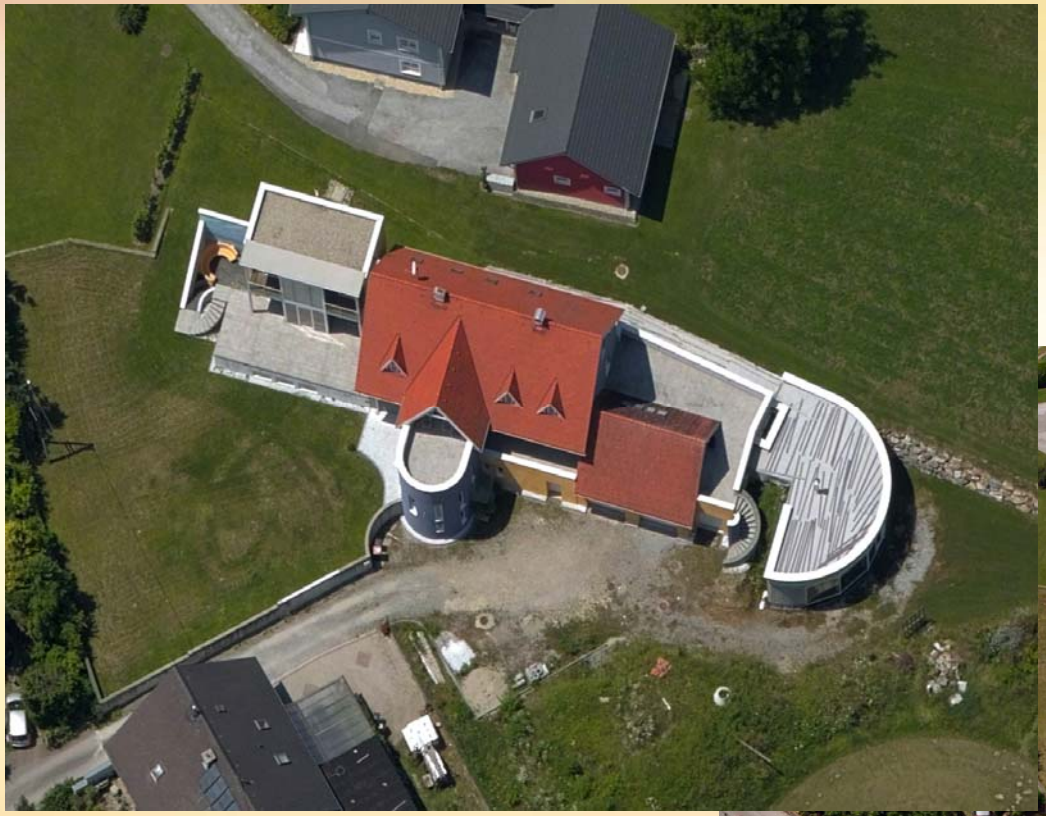
Combine Nadir and Oblique



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UltraCam Osprey

- Camera design
  - 3rd generation UltraCam architecture
  - 2.0 seconds frame rate
  - 3.3 TB SSD storage

- Camera Operation
  - 10cm GSD (nadir) @ 850m AGL
  - Wing image GSD between 7.5cm (inner) and 12.5cm (outer) on a flat terrain
  - 80% frontlap @ 145kts

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UltraCam Osprey

	Focal Lens/ Pixel Size	
Nadir PAN	51.0 mm	6.0 µm
Nadir RGB and NIR	25.5 mm	5.2 µm
Oblique Sensor Heads	80.0 mm	5.2 µm

	Frame Format / Pixel Size	
Nadir PAN	11674 * 7514	6.0 µm
Nadir RGB and NIR	6735 * 4335	5.2 µm
Oblique Sensor Heads	6870 * 4520	5.2 µm
Fwd/Bwd (together)	13490 * 4520	

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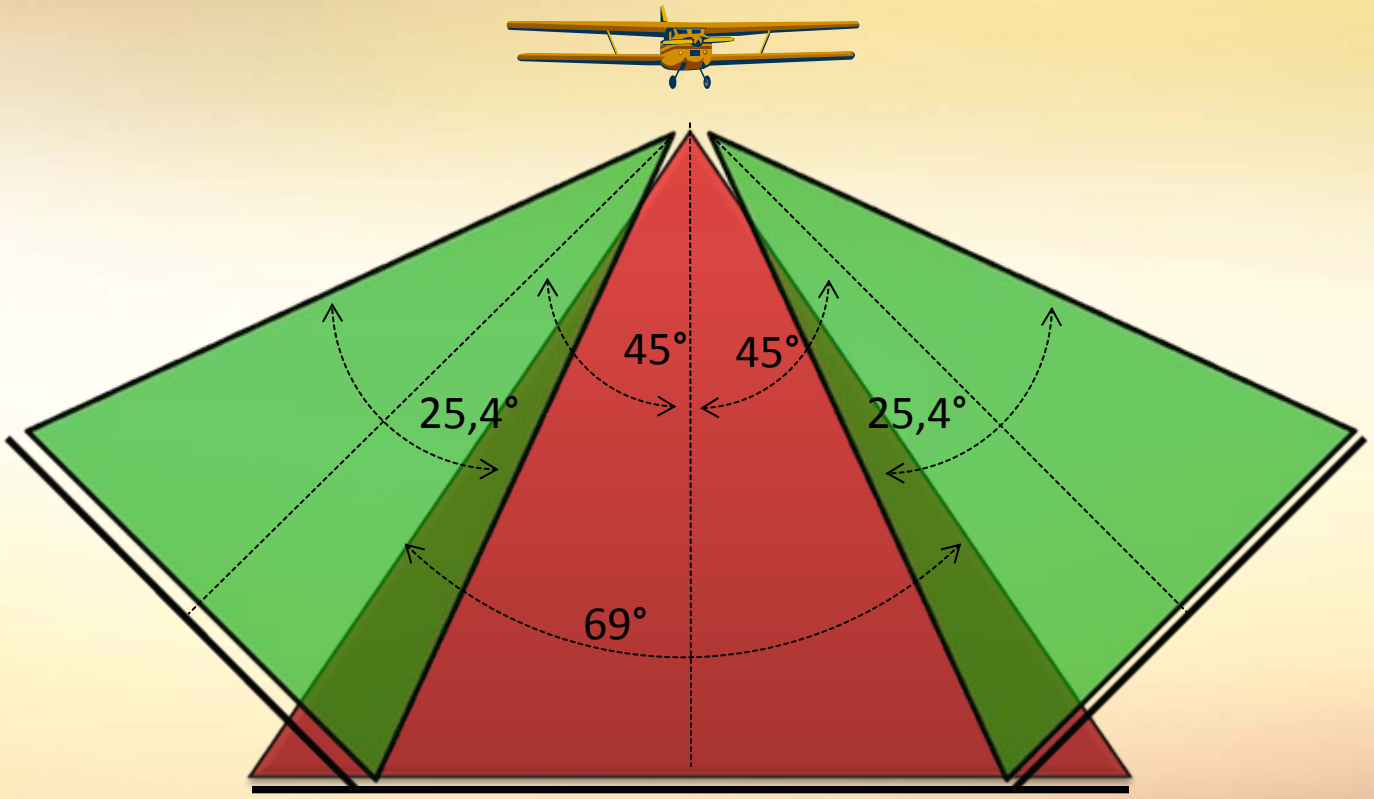
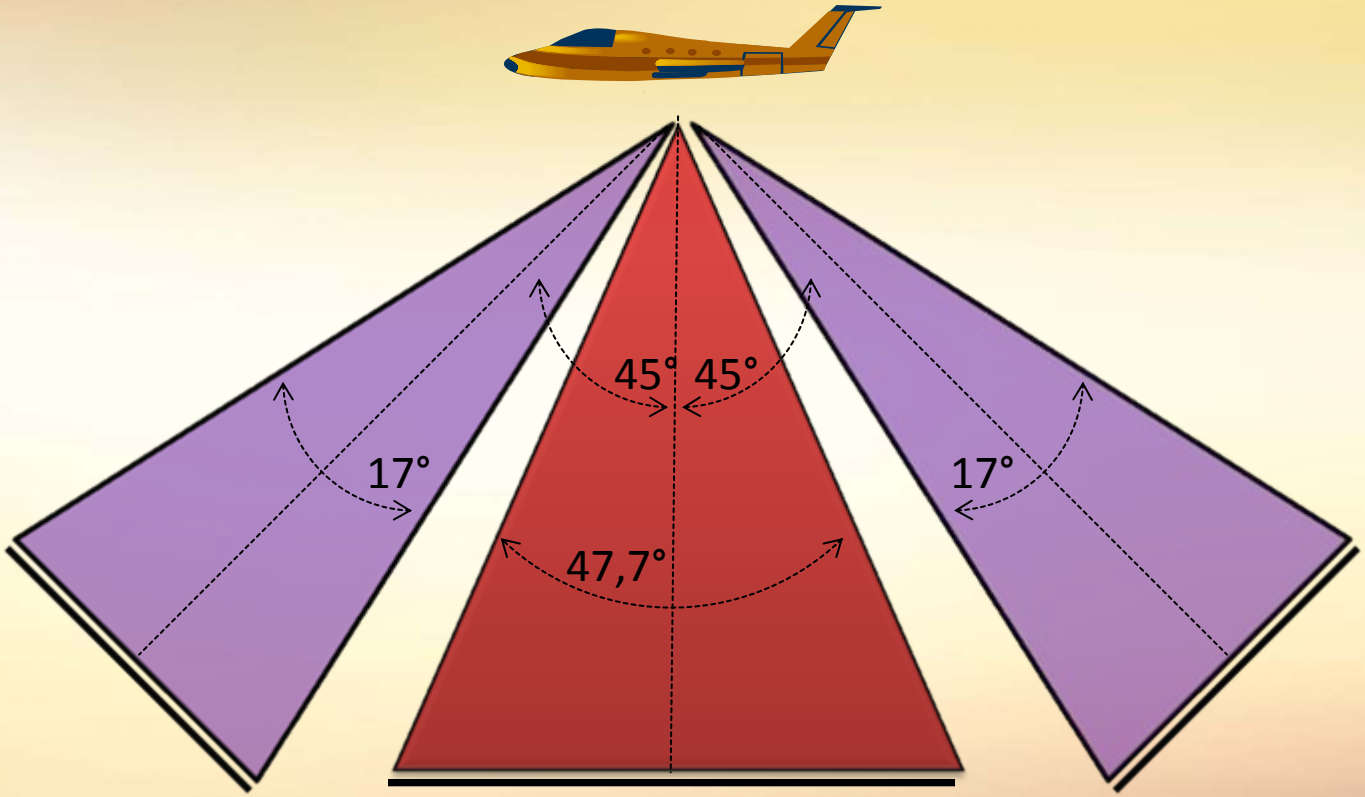
UltraCam Osprey

Nadir and L/R wing cross flight direction



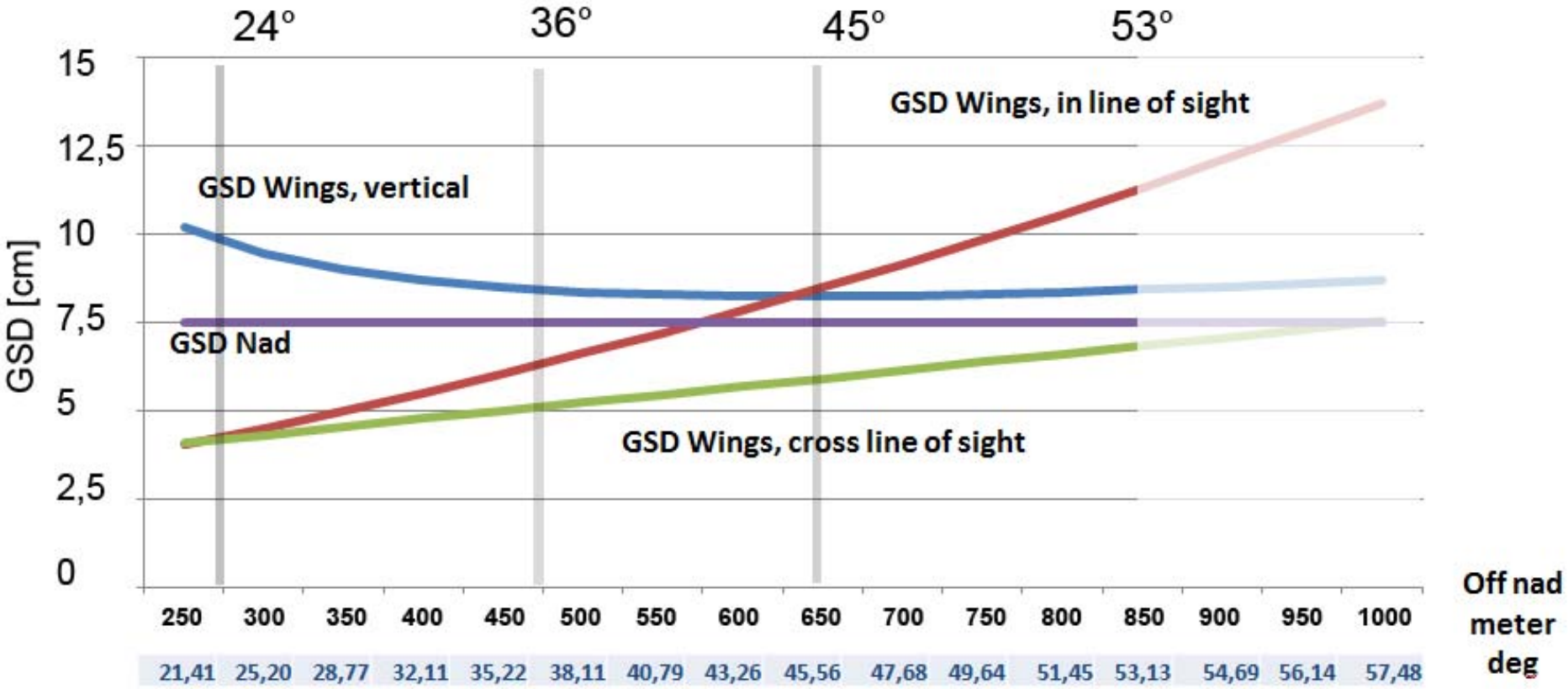
UltraCam Osprey

Nadir and F/B wing along flight direction



Spacial Resolution UltraCam O

GSD Nad = 7,5 cm, H_agl 637 m



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City of Graz, 900 m AGL, Nadir GSD 10,5 cm

Footprint 1230 m by 800 m

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Forward Wing, 13490 Pixel cross track

Footprint ~1100 m cross track

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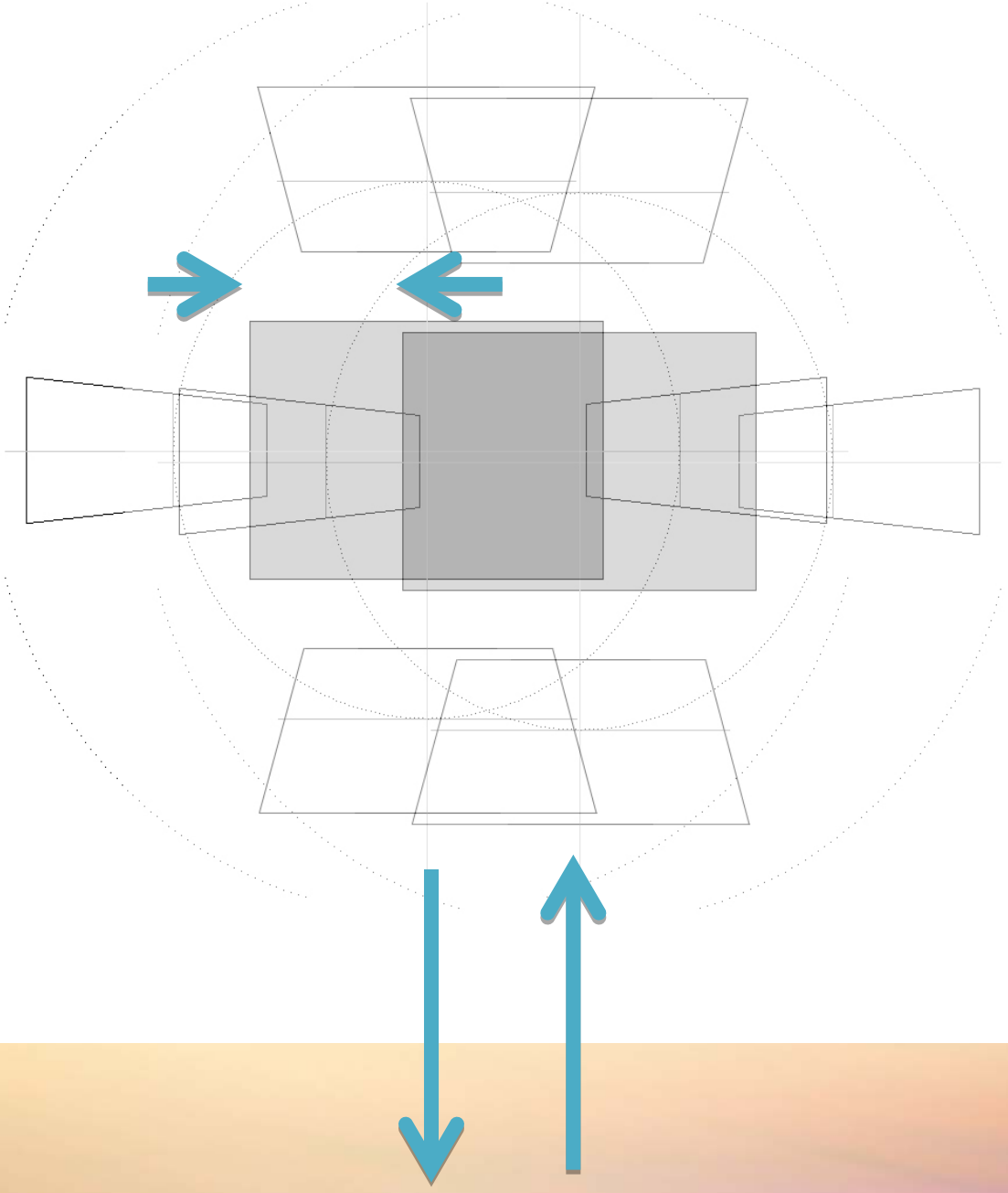

Ideal Flightpattern
60% cross track (Nadir)

Linespacing 500m
@ 900 m AGL

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UltraCam Osprey Calibration

Extended Calibration Lab
RMSE of Image Points < 0,5 Pixel
Redundant set of images
Single Head Calibration and Platform Calibration
Nadir EO results used for eccentricity computation

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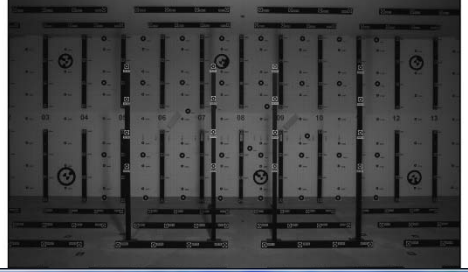
06



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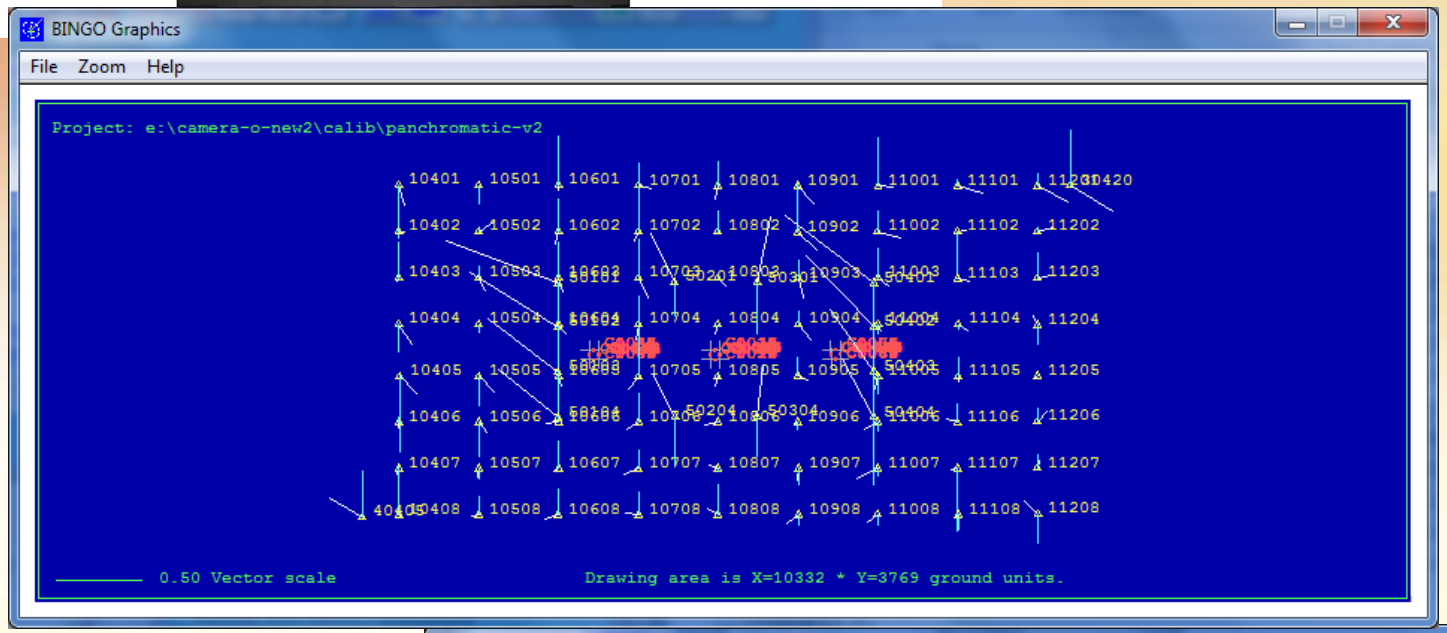

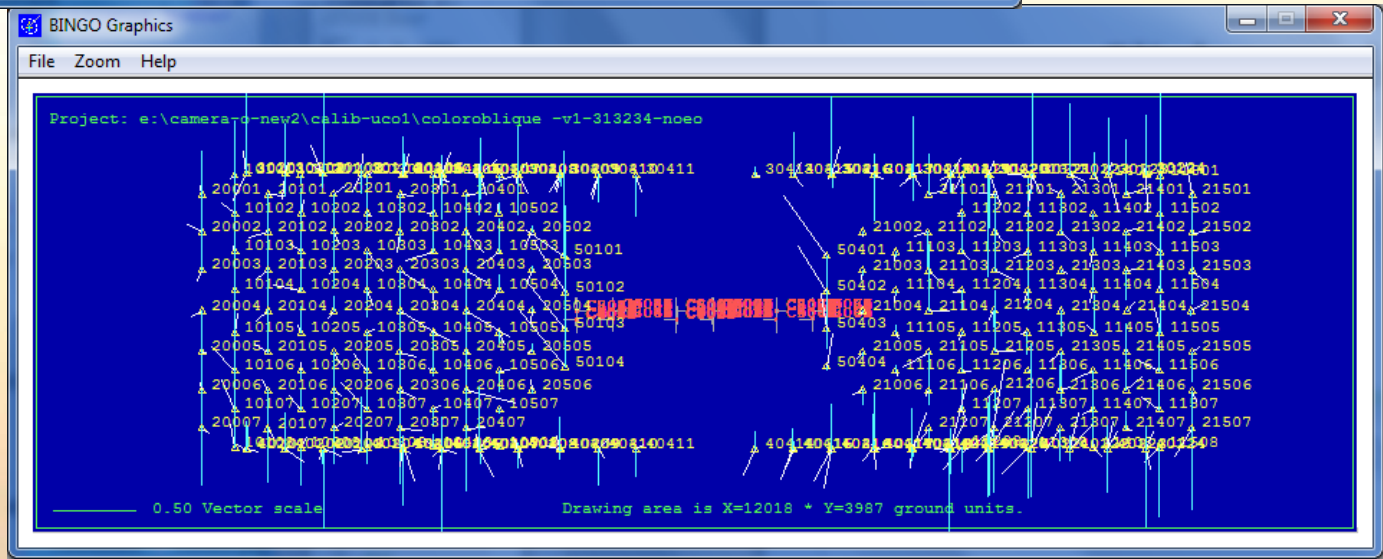

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RESULTS OF ADJUSTMENT              SIGMA 0 =          0.95
Nadir PAN                          SIGMA 0 =          0.79

RMS precision values of photo orientations from Qxx matrix
(X,Y,Z,phi,omega,kappa): (1/1000)
200.          99.       204.       3.6       2.9       1.6

Poorest precision values of photo orientations from Qxx matrix
(X,Y,Z,phi,ome,kap): (1/1000)
324.         135.       314.      12.3      10.1       9.7

Eccentricities of oblique cameras wrt nadir

C4  -37.9675  124.4535 -103.4782    0.1110  -49.8492    0.0290
C5   36.6477  124.0719 -103.2620    0.4059  -50.0955   -0.0748
C6 -125.7413  -37.9701 -106.0217  -49.9858   -0.0584   -0.0007
C7  125.6432  -37.8230 -105.9708   50.0001    0.0764    0.0367
C8  -37.4731 -124.2071 -104.4258   -0.3107   49.9585   -0.1362
C9   37.0895 -124.1808 -103.8412    0.0621   49.9728   -0.1330
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RESULTS from oblique cameras

RMS control point residuals:	184.	175.	469. (1/1000)
Maximum control point residuals:	1073.	637.	2182. (1/1000)
RMS position residuals:	77.	64.	71. (1/1000)
Maximum position residual:	329.	255.	263. (1/1000)
RMS orientation residuals:	1.3	2.6	4.4 (1/1000)
Maximum orientation residuals:	3.5	7.8	12.8 (1/1000)

Nadir

RMS control point residuals:	114.	154.	176. (1/1000)
Maximum control point residuals:	599.	822.	656. (1/1000)

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UltraCam Osprey Aerotriangulation

Project Area Graz
GSD Nadir 10 cm

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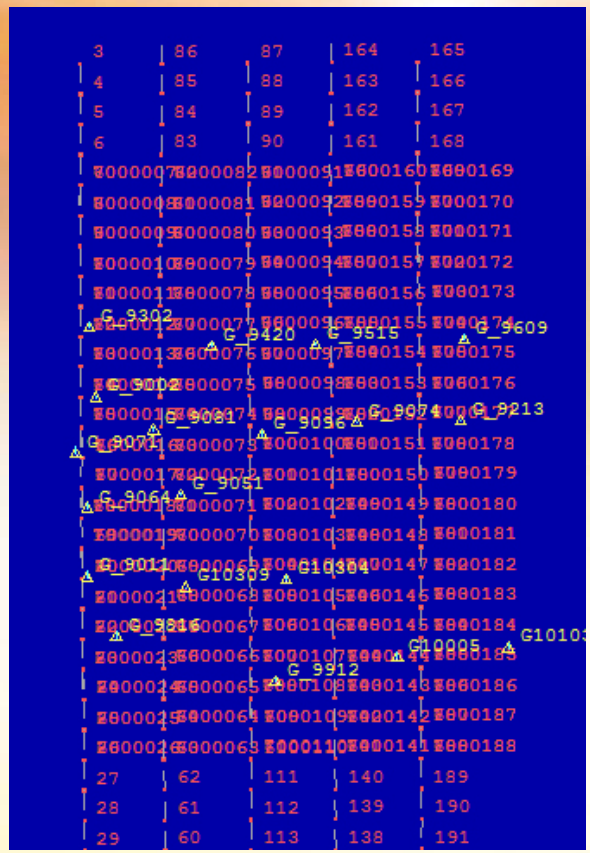

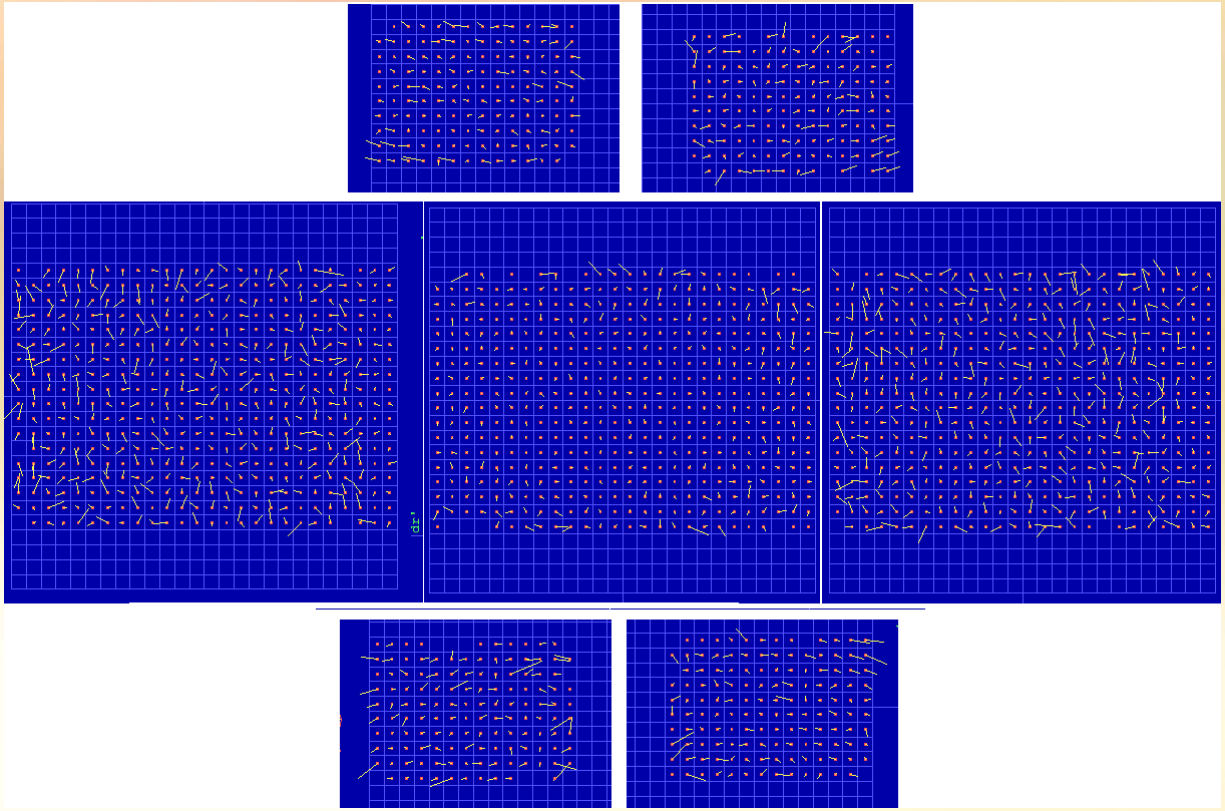

RESULTS OF ADJUSTMENT SIGMA 0 = 2.82

RMS control point residuals: 34. 33. 43. (mm)

Maximum control point residuals: 76. 72. 93. (mm)

Residuals of photo measurements (x', y') in photo space:

RMS 1.9 2.4

MAX 19.1 19.3

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Oblique Registration Investigations

by Andreas Klaus & Joachim Bauer

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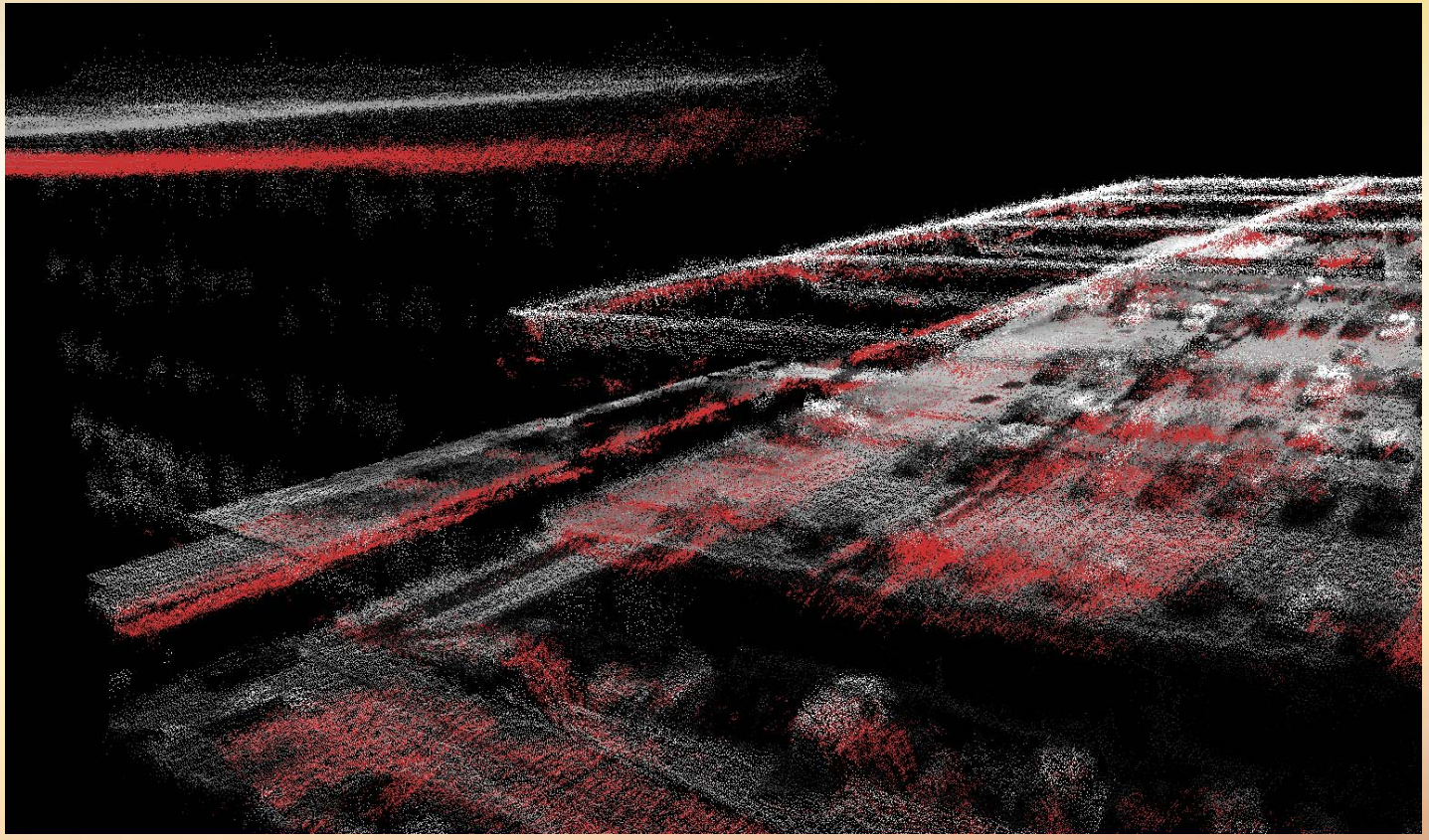
Traced reason for double structures: systematic depth offset between nadir and oblique images



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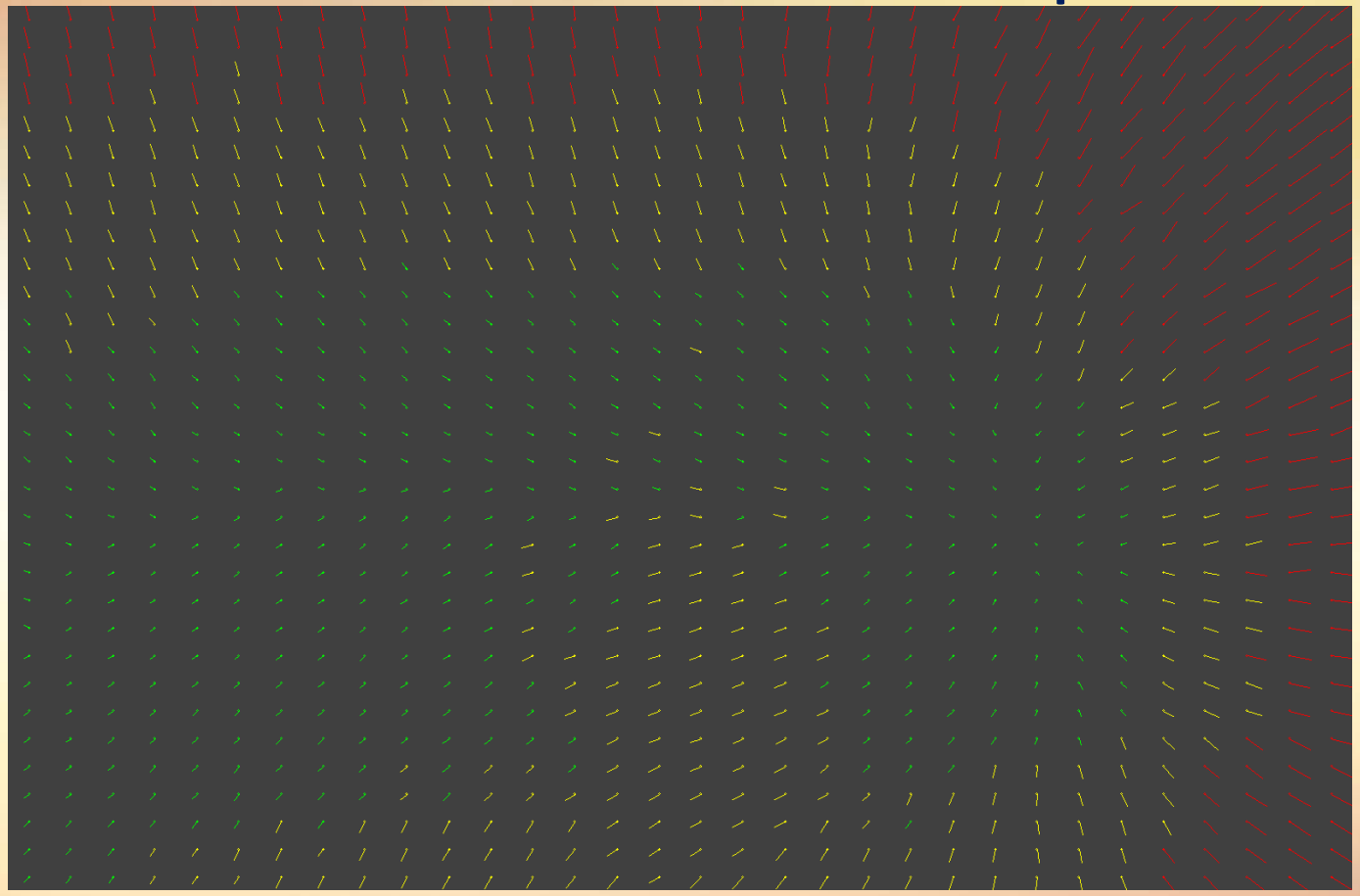
Salzburg UCO cam 17 before update

mean error = 1.6 max error = 7.1 pixel



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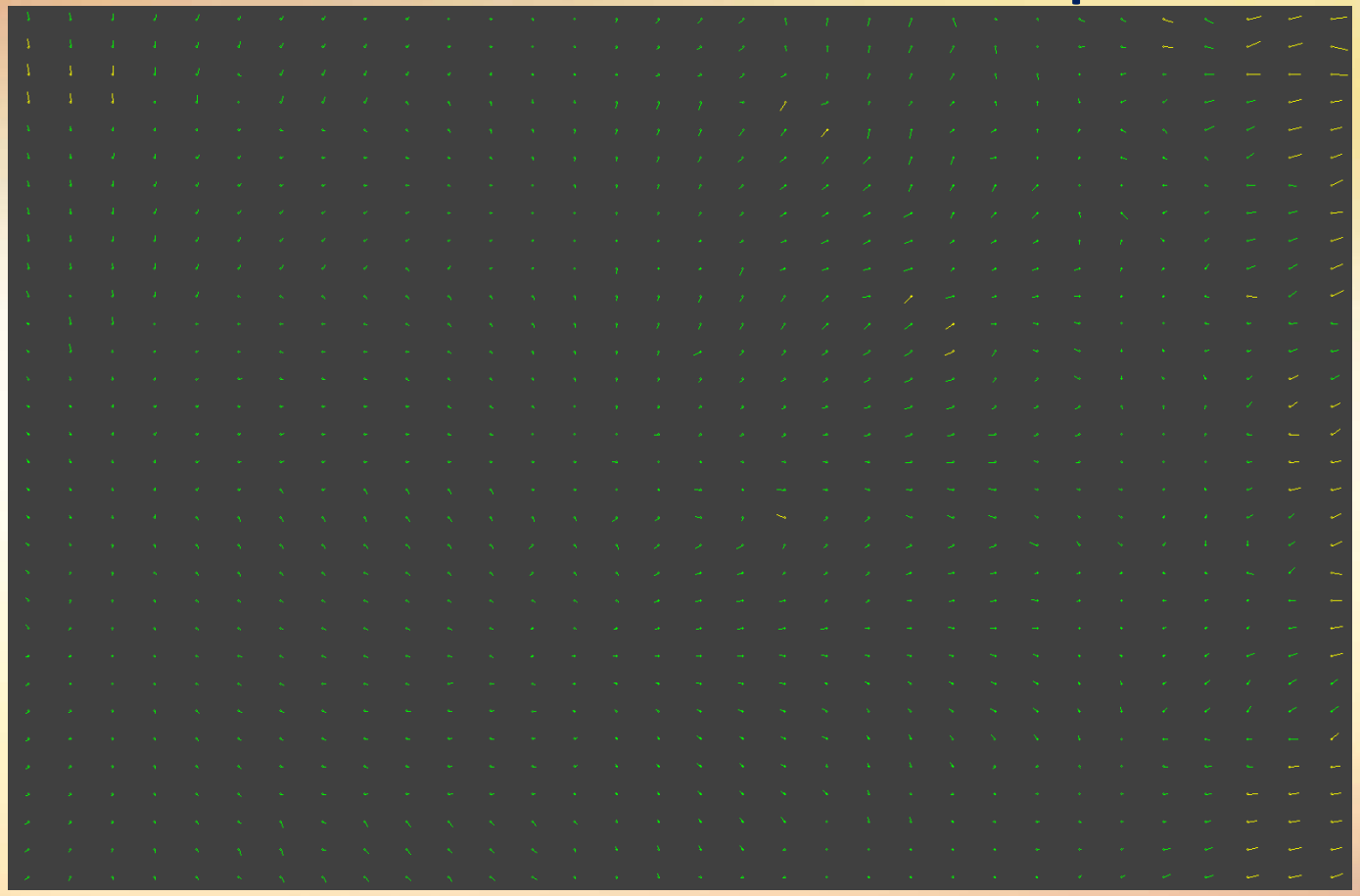
Salzburg UCO cam 17 after update

mean error = 0.48 max error = 1.8 pixel



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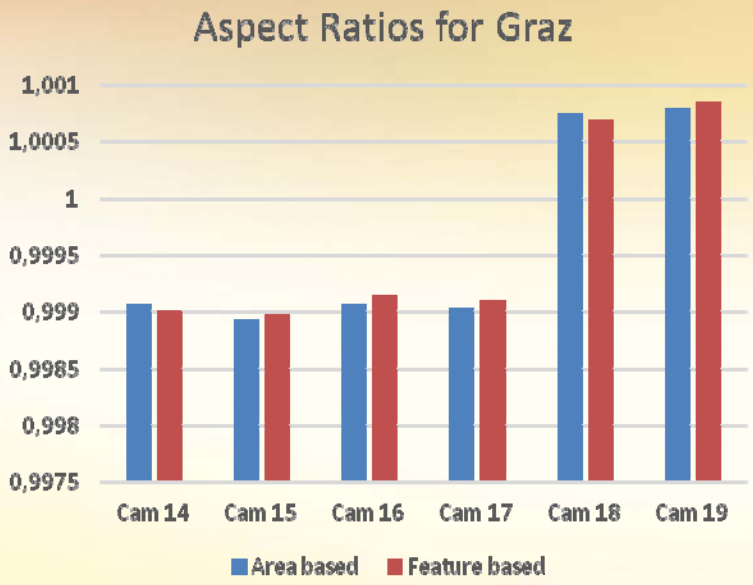
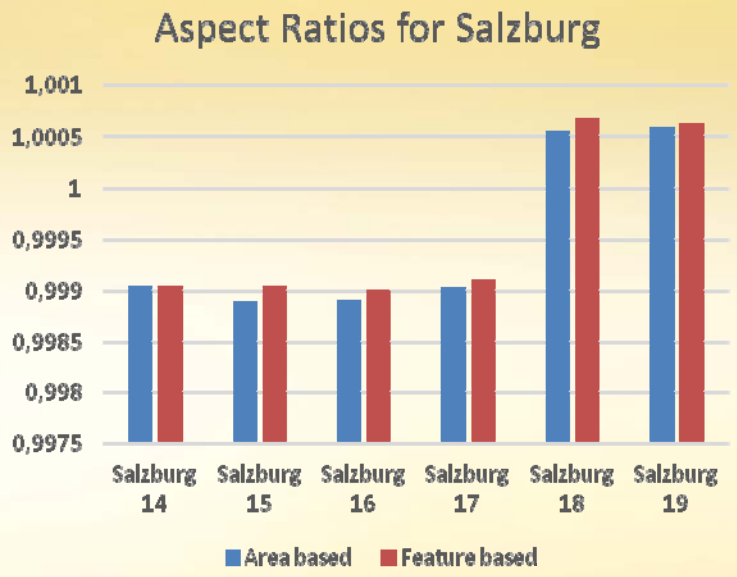
Aspect Ratios for different projects





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What´s causing different Aspect Ratios?

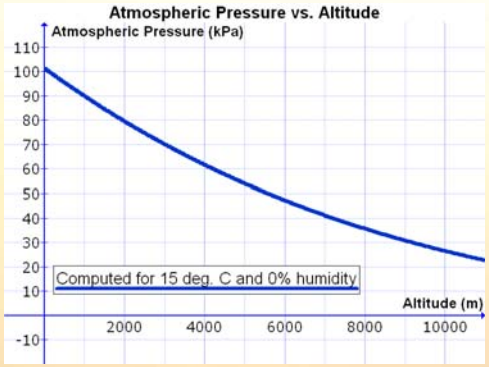
- **Earth Curvature**

  $y = L^2 / (2 * 6371000)$ 7,84 cm bei 1 km

  1,96 m bei 5 km

  7,85 m bei 10 km

- **Atmospheric Refraction**



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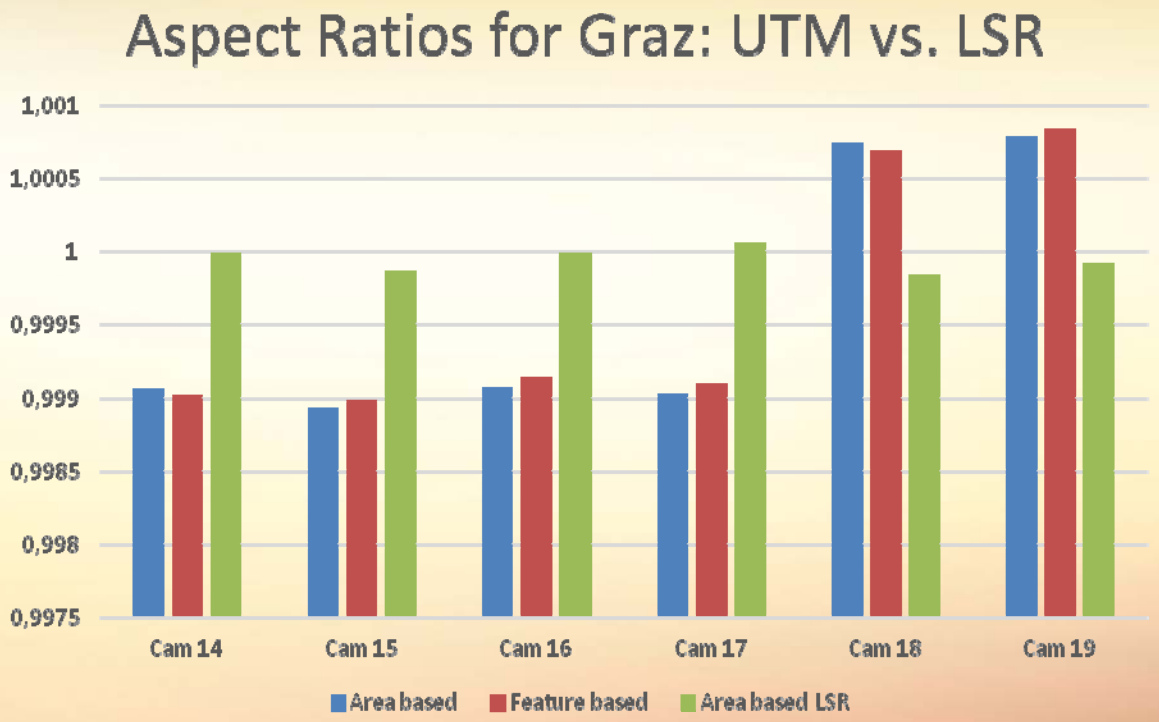
Verification that UTM is causing deviation

1. Processed Lvl02 for Graz without geo bias
2. Calculated new AT in LSR instead of UTM Re-processed area based Nadir-Oblique registration



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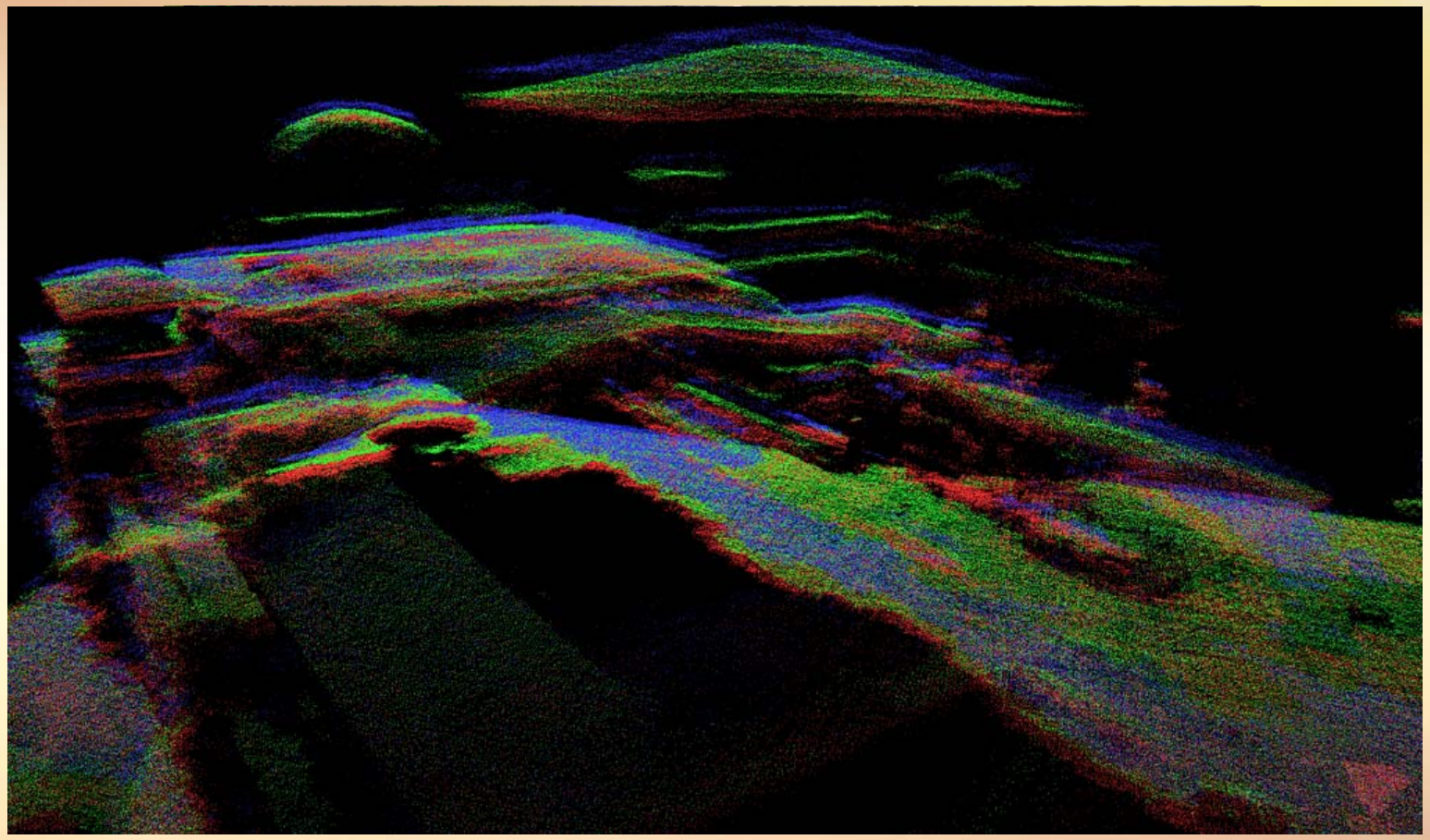
Pointcloud: UCO Graz UTM

nadir forward/backward left/right



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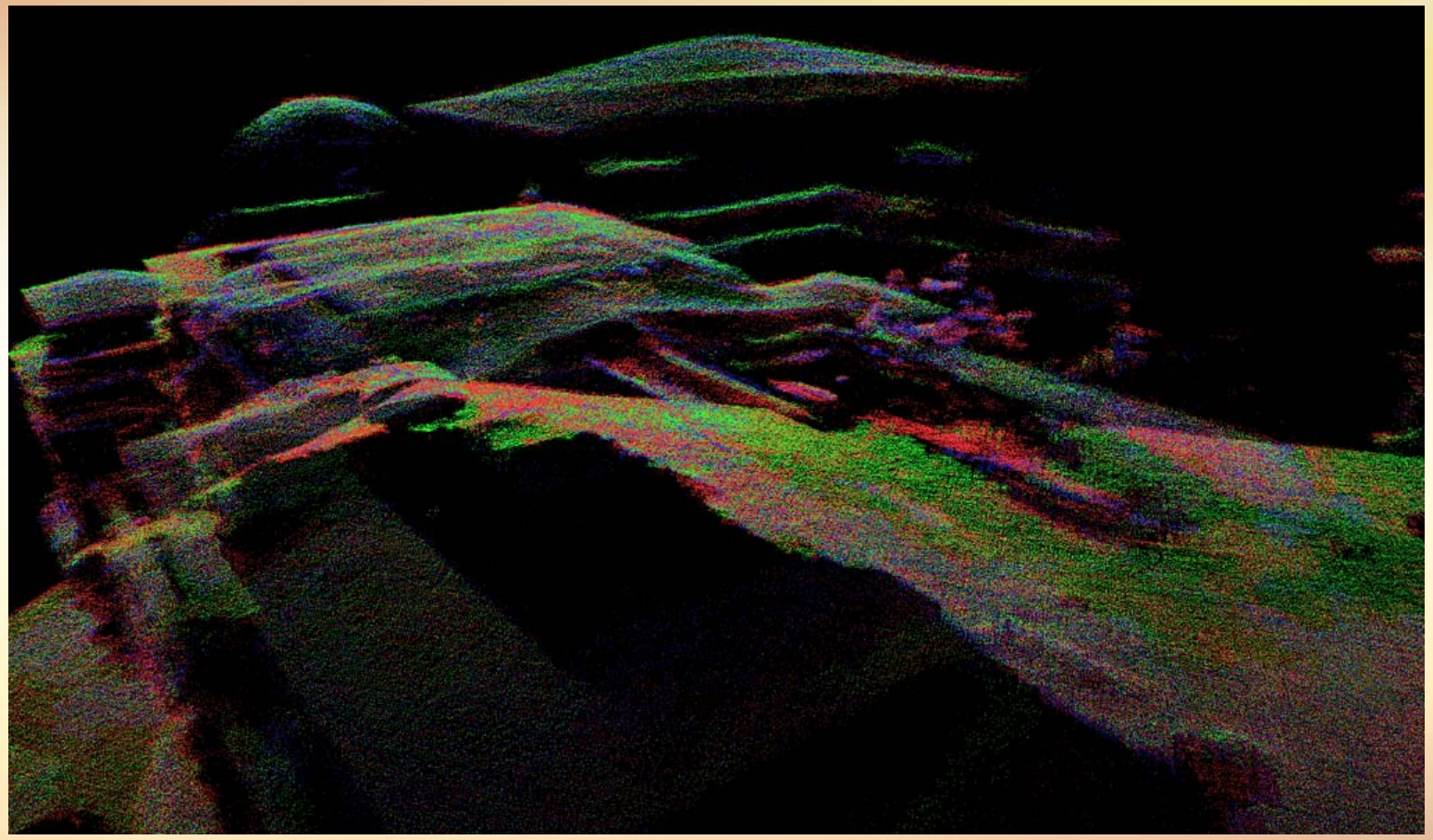
Pointcloud: UCO Graz LSR

nadir forward/backward left/right



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Conclusion

- Nadir serves as the geometry backbone
- Impact of refraction and earth curvature
- AT in UTM is problematic – especially for oblique images
- Geo bias depends on altitude, UTM zone and latitude
- LSR system allows to improve nadir-oblique registration

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UltraCam Osprey Project Results

Flight Mission Salzburg, May 2013
GSD (nadir) 10,5 cm, Height AGL 890 m

Flight Pattern 75% fwd OL, 65 % sdw OL
Base 142 m, line distance 305 m

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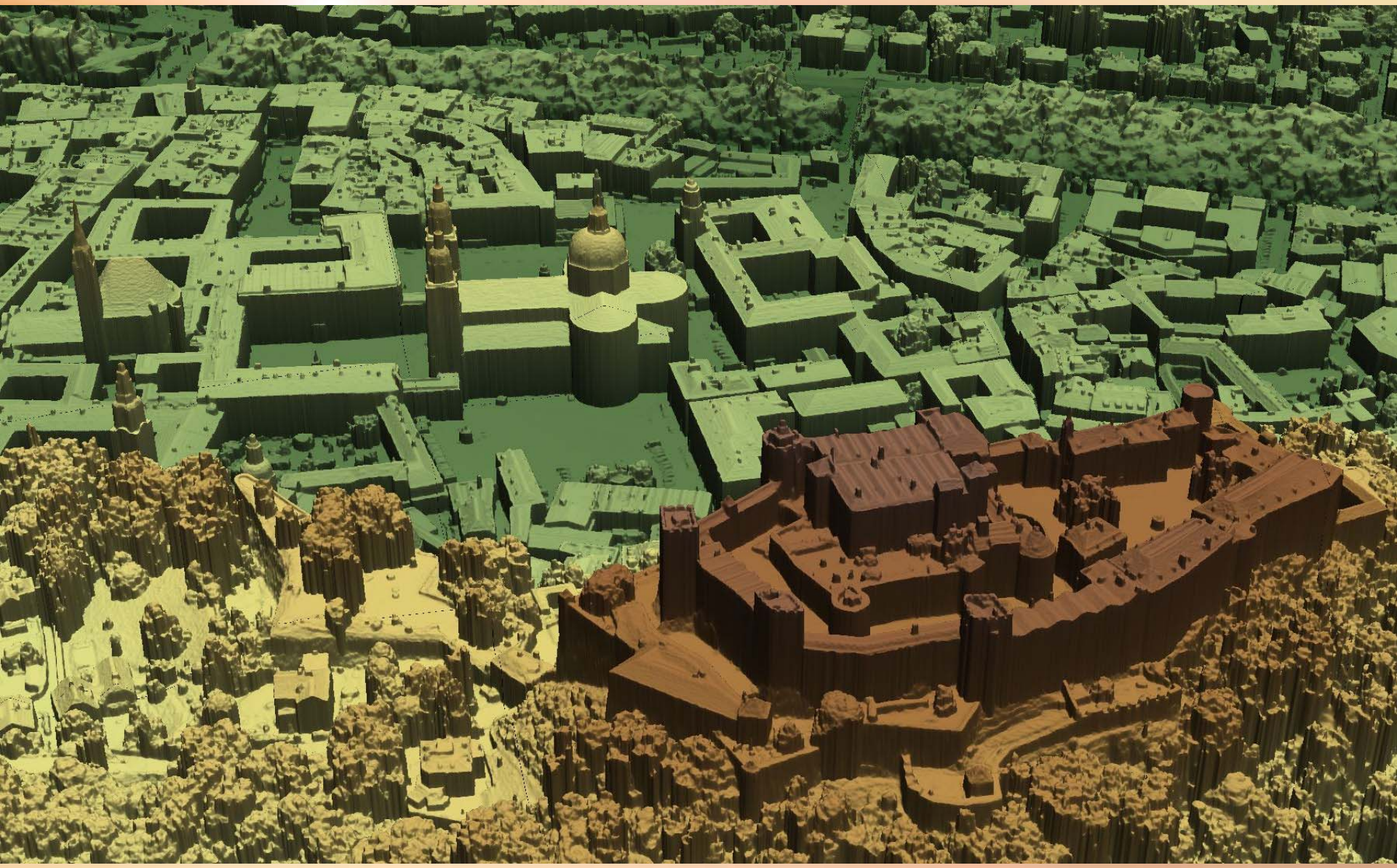

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Thank you very much

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