VEXCEL IMAGING GmbH

a Microsoft company

UltraCam*X*
Large Format Digital Aerial Camera

Michael Gruber, Ubbo Mansholt

{michgrub, ubboman}@microsoft.com

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UltraCam*X* Digital Aerial Camera System

UltraCamX

Largest Image Format

14430 by 9420 pixel (136 Mpixel)

Novel on board Data Storage

‘unlimited’ storage space

Short frame intervall (1,35 sec)

2,5cm GSD / 60% Endlap / 140 kn

Highly parallel architecture

UltraCam

Background Information

Design Basics

Panchromatic Channel:

Set of four Cones and 9 CCDs

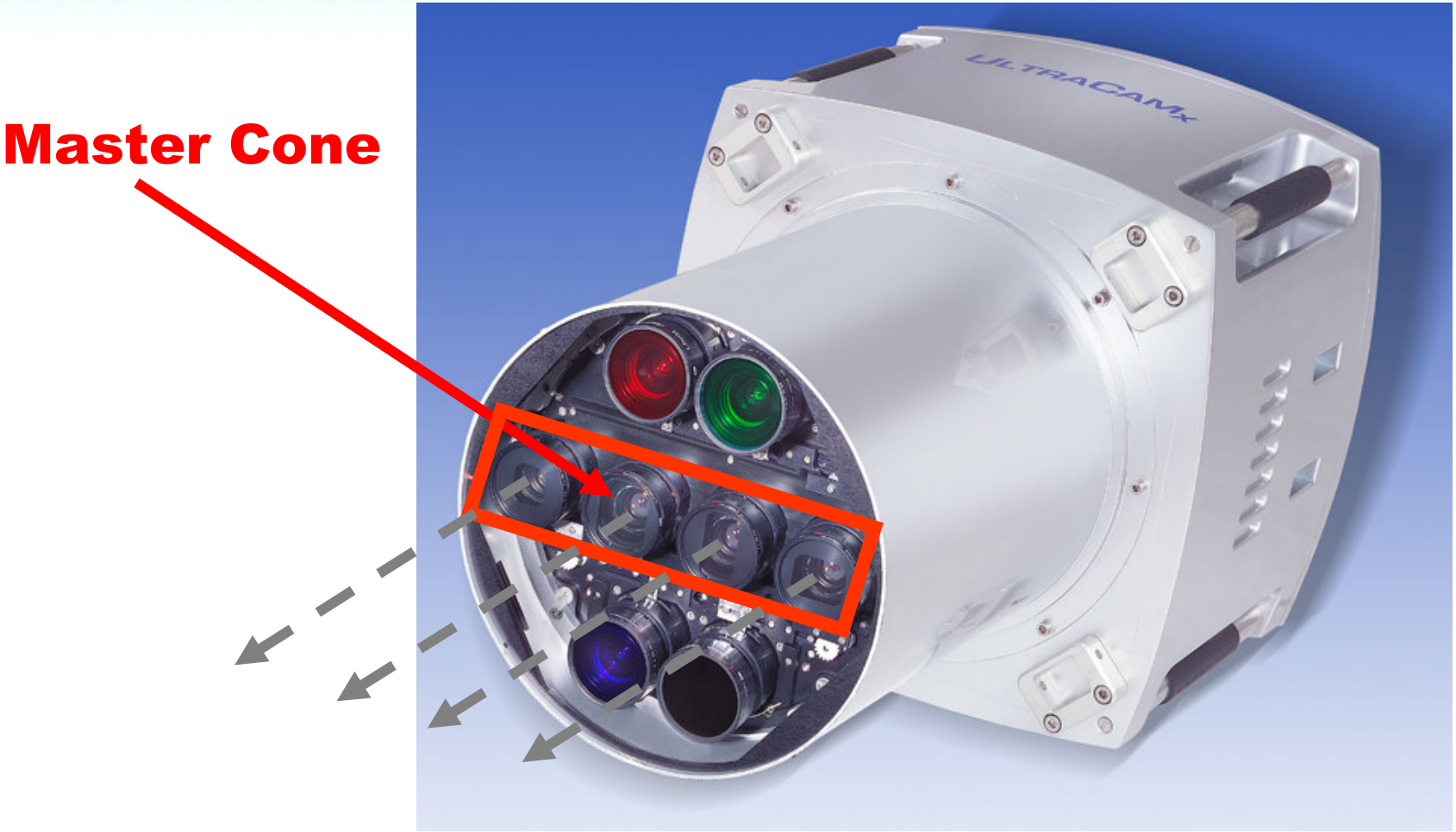
one Master Cone

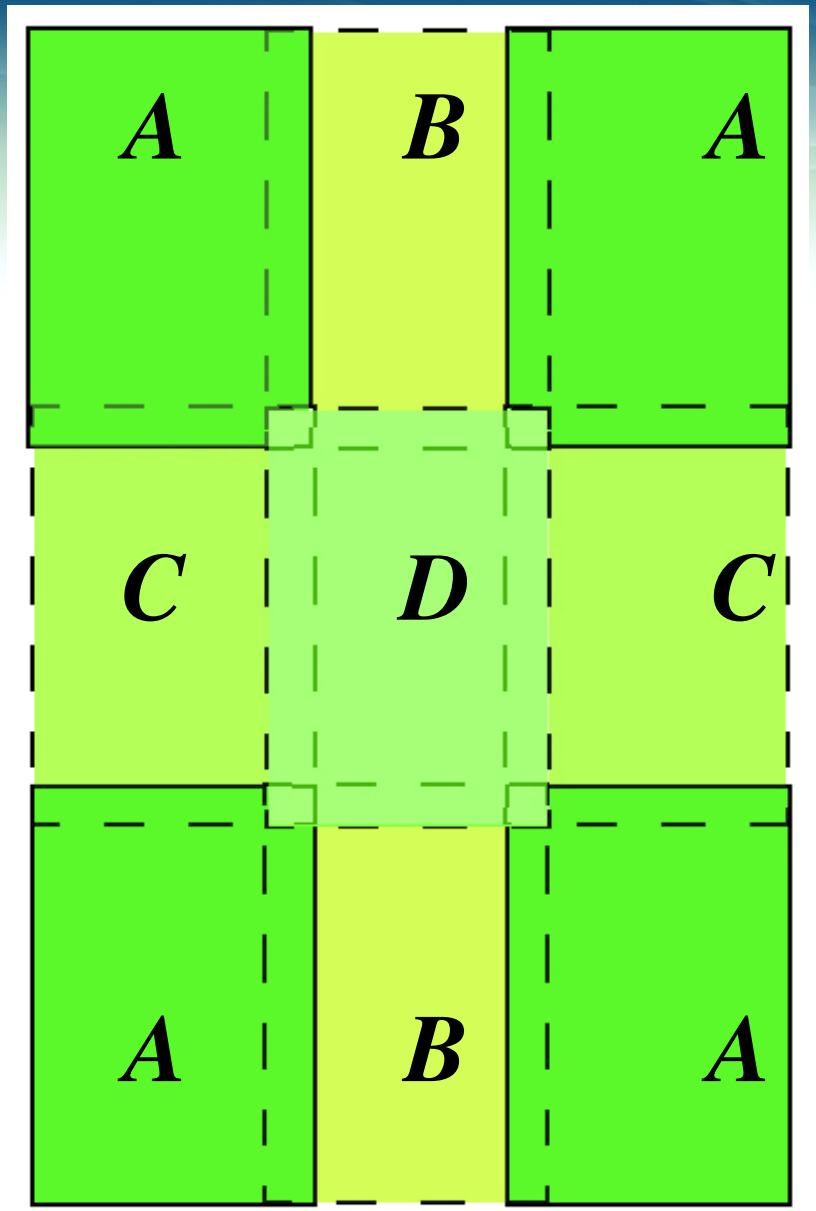
Multispectral Channels:

Set of four Cones

Red-Green-Blue-Nir

UltraCamX – Cone Design

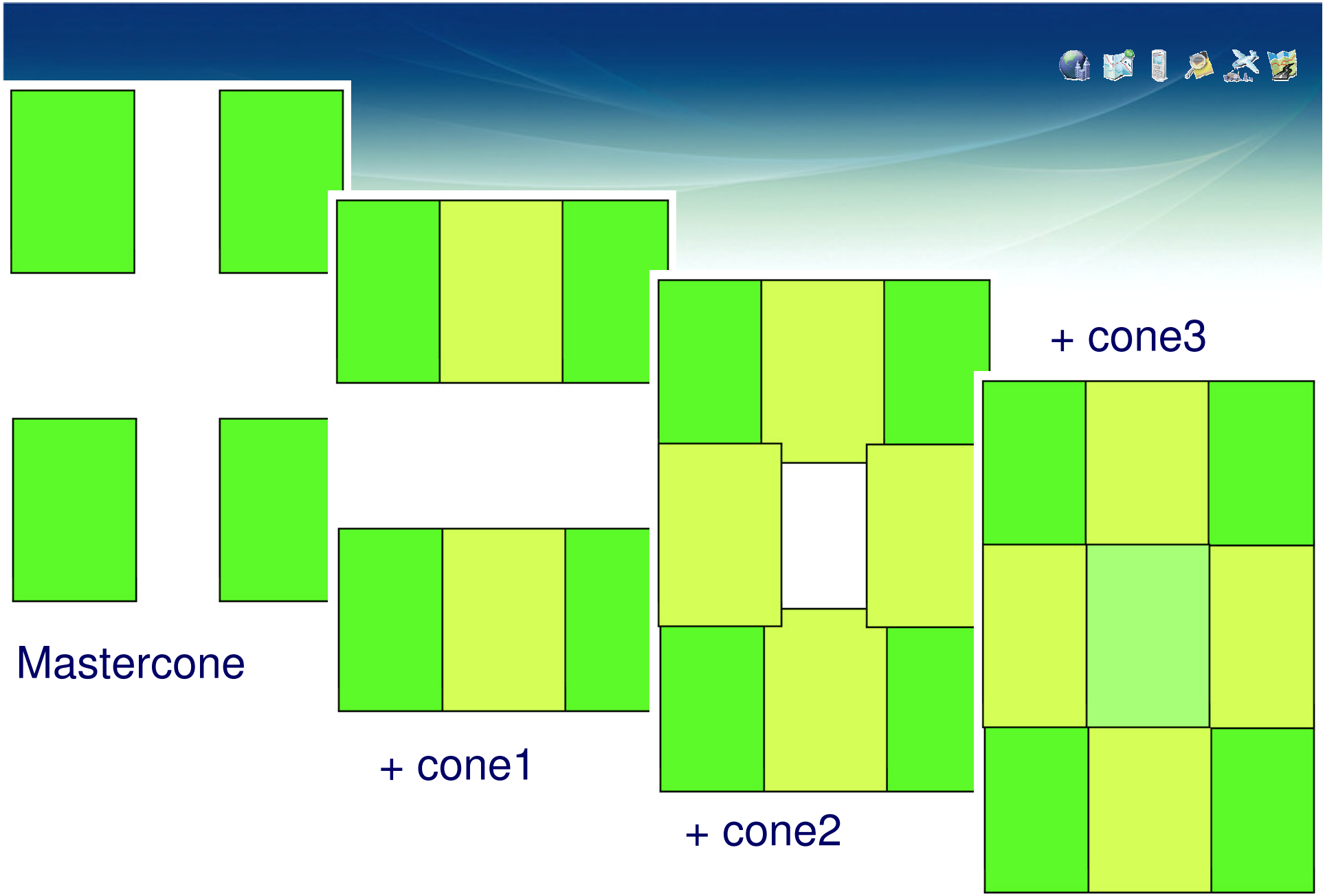

Master Cone
ULTRACAMx

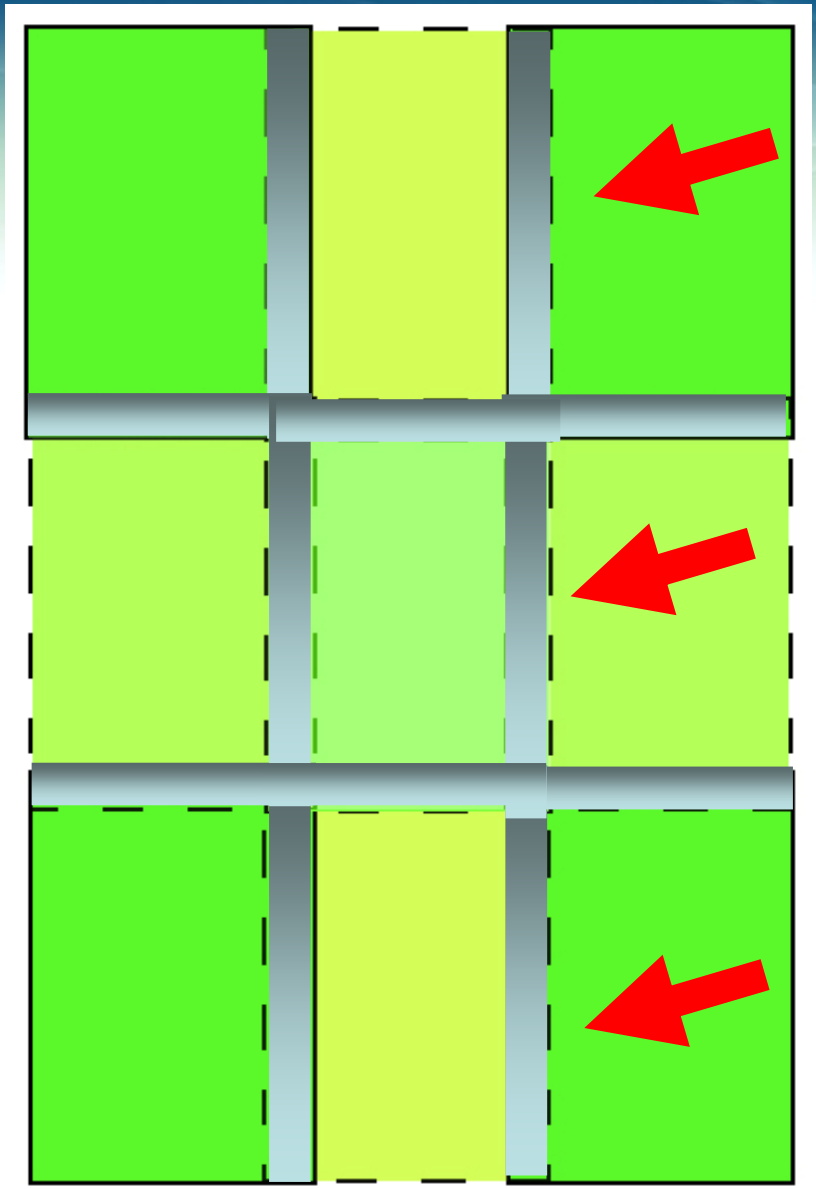


4 Cones
4 Lenses
4 Focal Planes

9 CCD SensorArrays

12 Overlap Areas


Mastercone
+ cone1
+ cone2
+ cone3



4 Cones
4 Lenses
4 Focal Planes

9 CCD SensorArray

12 Overlap Areas

Stitching

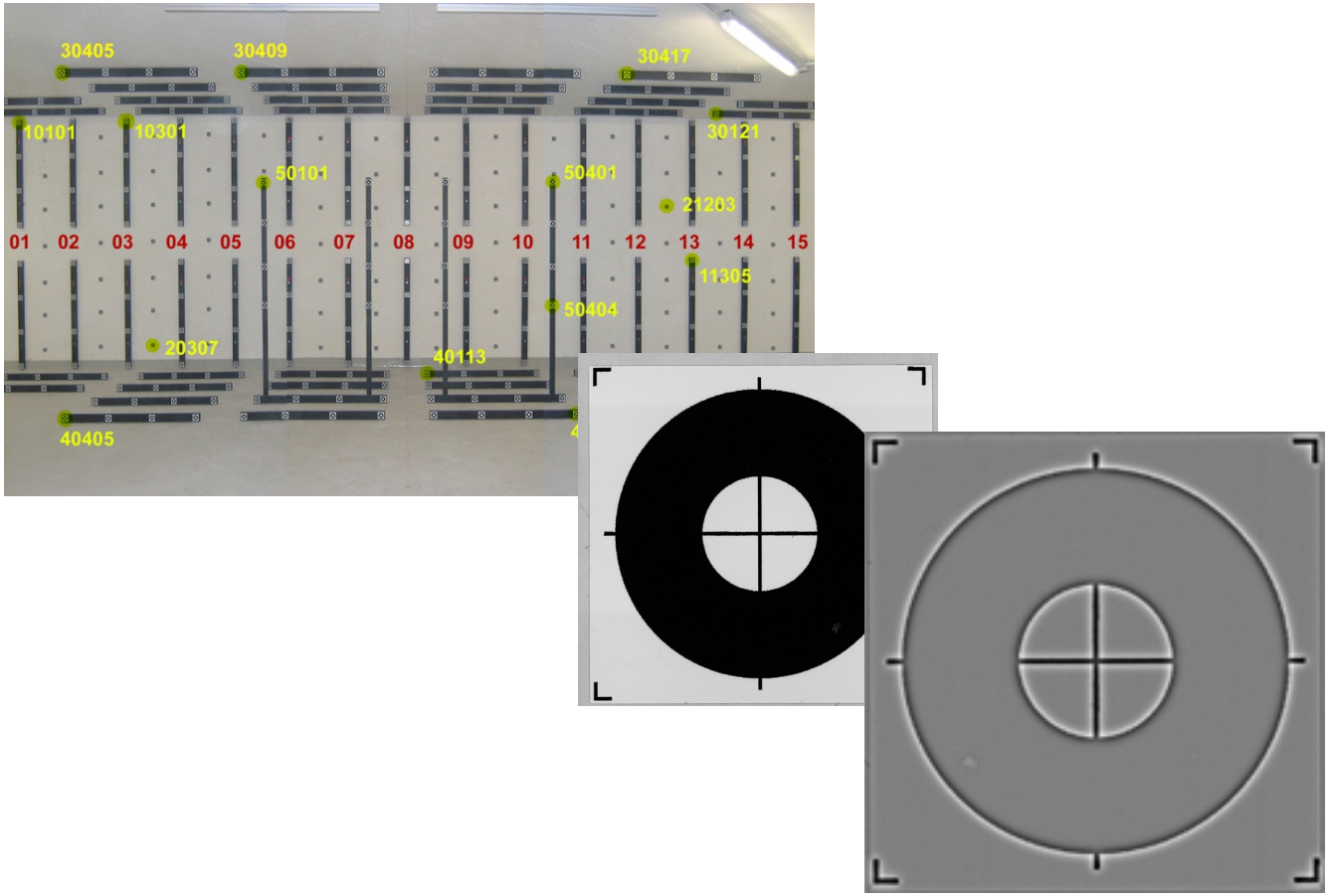
is subpixel accurate (RMSE > 0.1 Pixel)

is documented for each frame (XML)

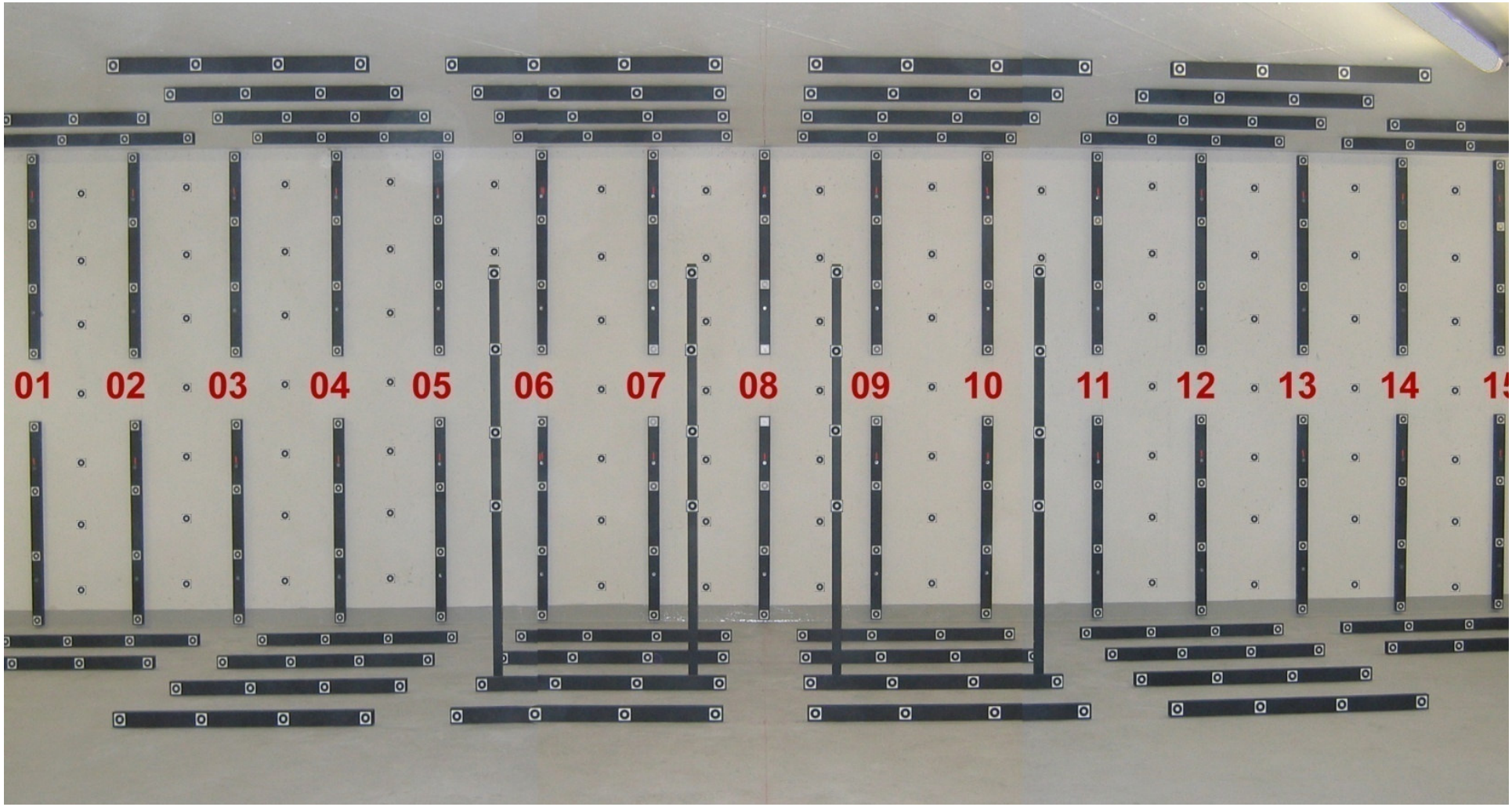
is the basis for geometric QC of each frame

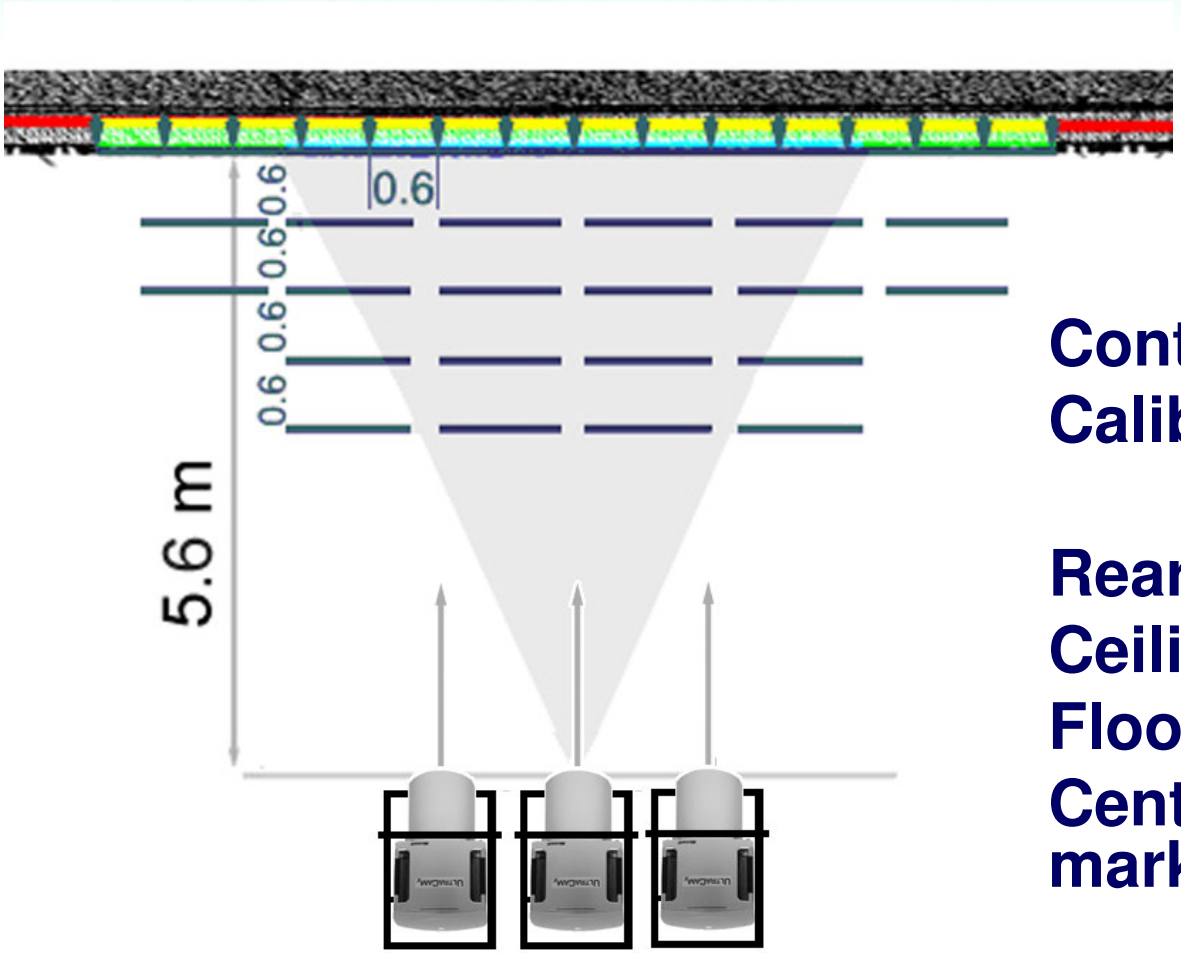
improved by material parameters of the camera body

Laboratory Calibration



Control and Calibration Laboratory

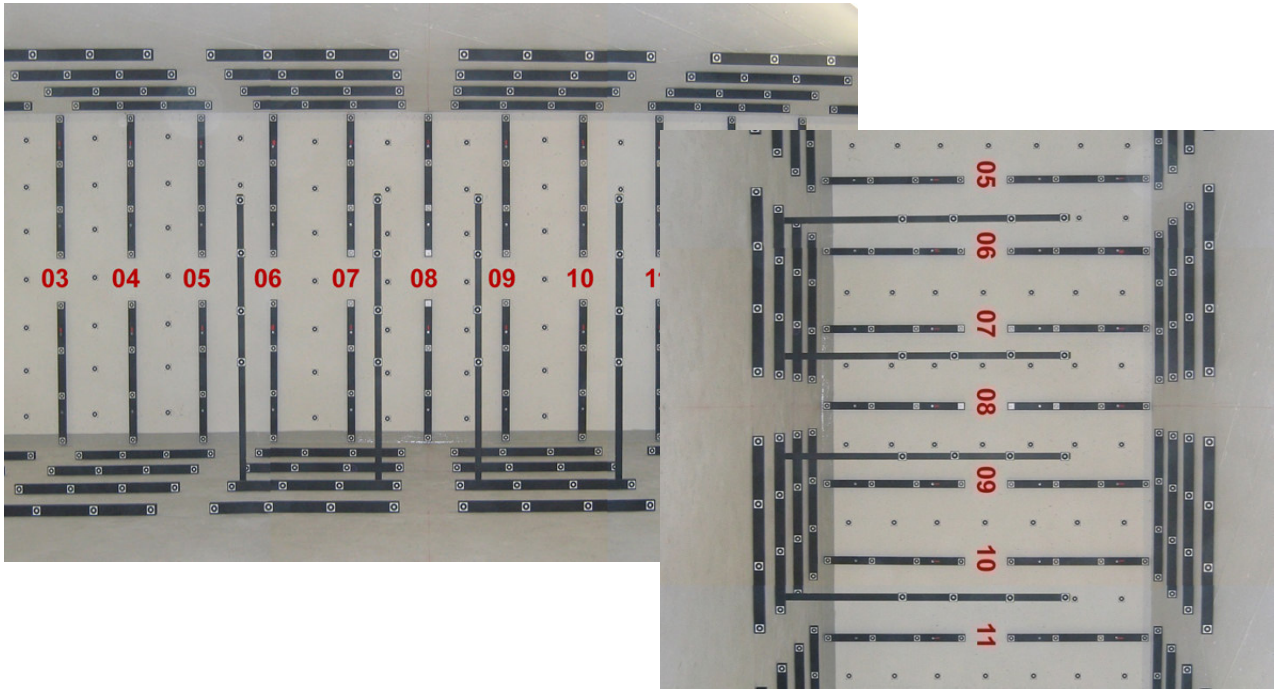




Control and Calibration Laboratory

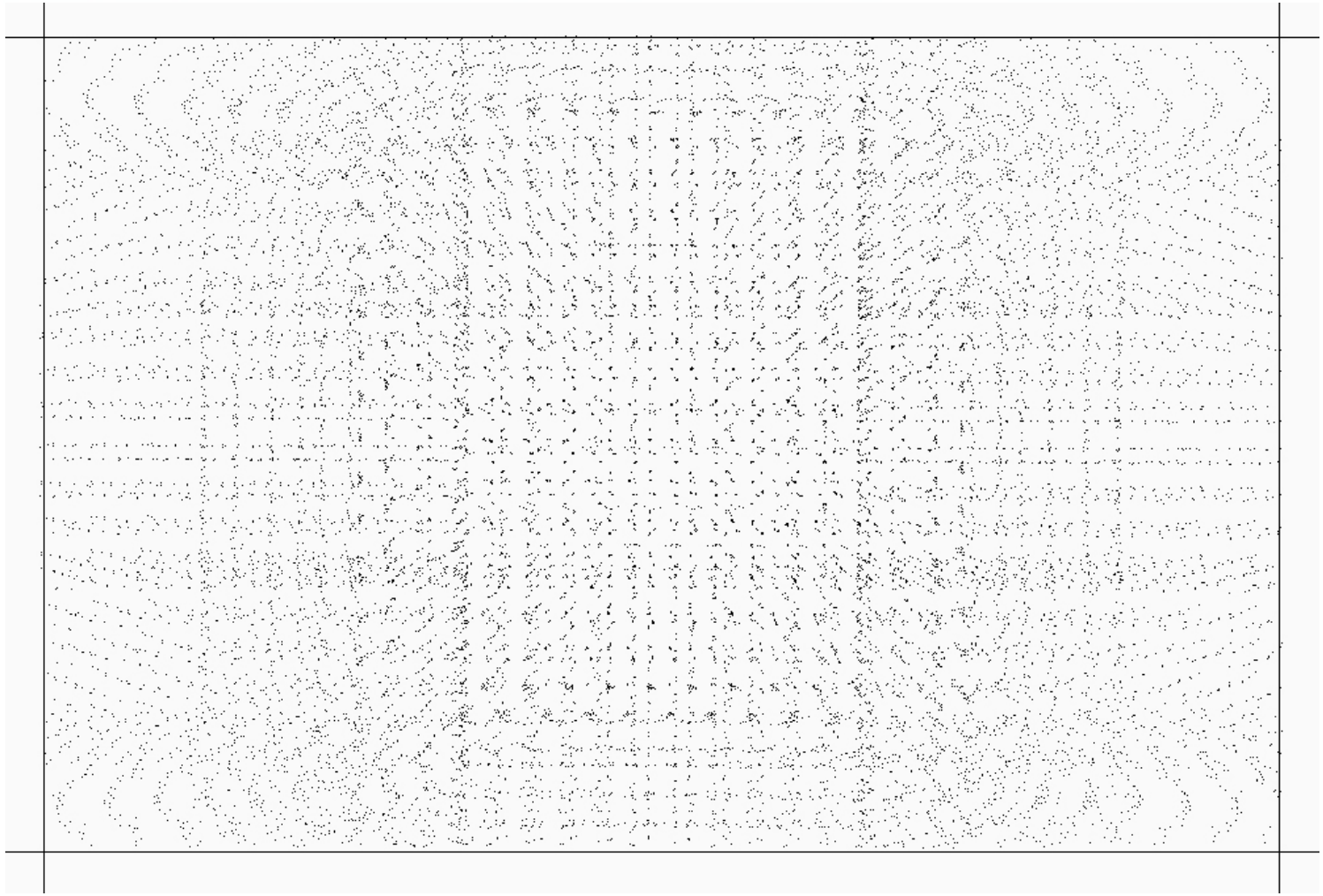
Rear wall	**218 marks**
Ceiling	**80 marks**
Floor	**80 marks**
Center marks	**16**
Total	**394 marks**

Source Data:
Set of 84 images, different rotations



Automatic Point Measurment

~18 000 image positions for each channel



Bundle Adjustment with BINGO

Relevant output for each cone:

- Focal Lenght (* Shift Parameter)
- Principal Point (* Scale Parameter)
- Distortion

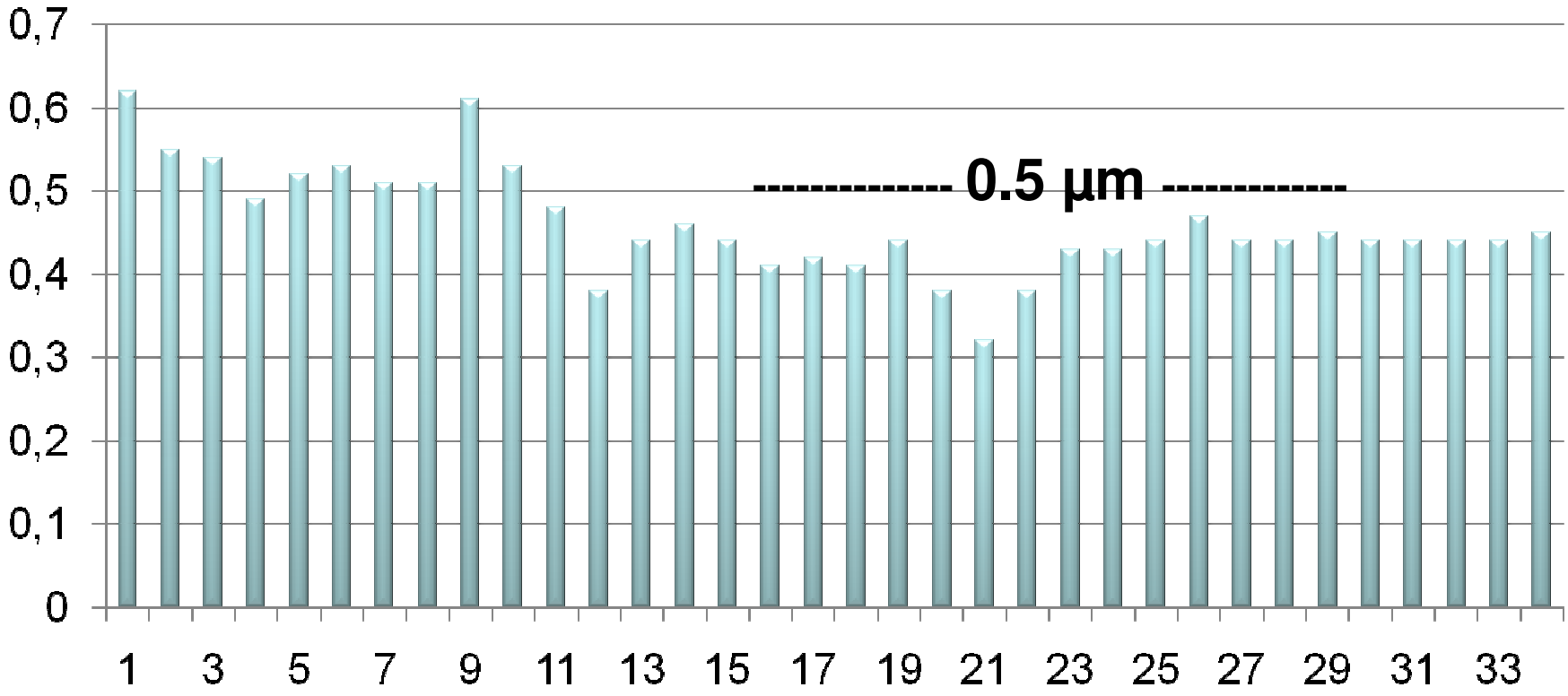
Bundle Adjustment with BINGO

Special Parameters for each CCD

- Shift
- Rotation
- Scale
- Shear
- Perspective Distortion

UltraCam X

Lab Calibration @ 0.5 µm level



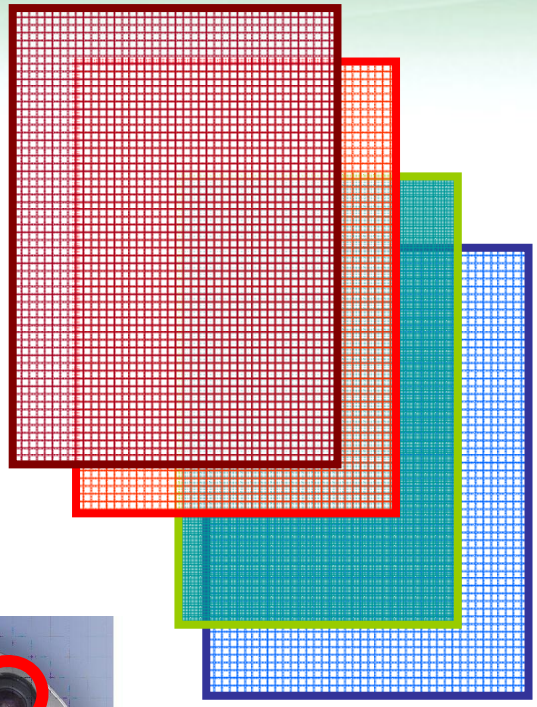
Radiometric Calibration

- Sensor calibration for each CCD
- Shutter calibration for each shutter
- Vignetting calibration for each f-stop

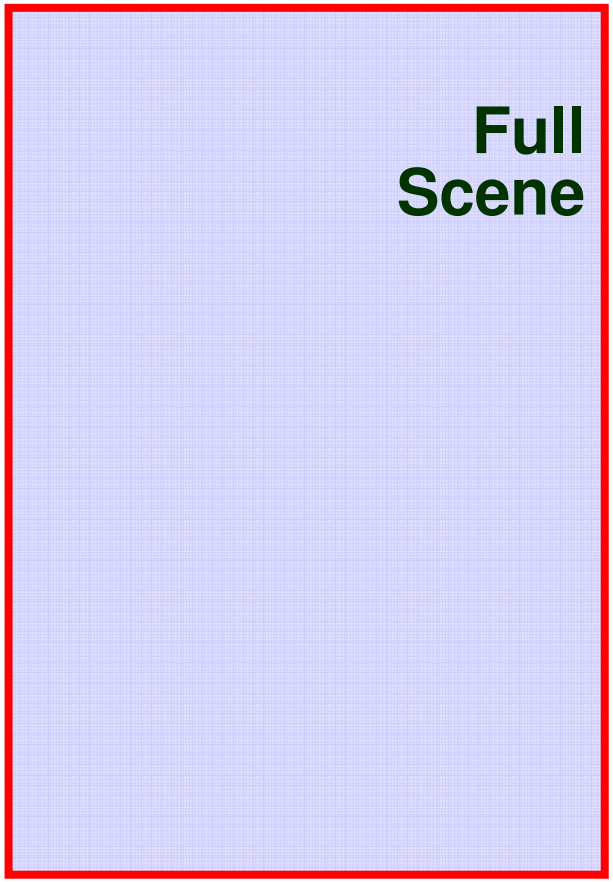
Multispectral (RGB+NIR) Image

RGB and NIR

Cone # 5,6,7,8, each 1 Sensor Elements



RGB/IR bands merged with pan scene

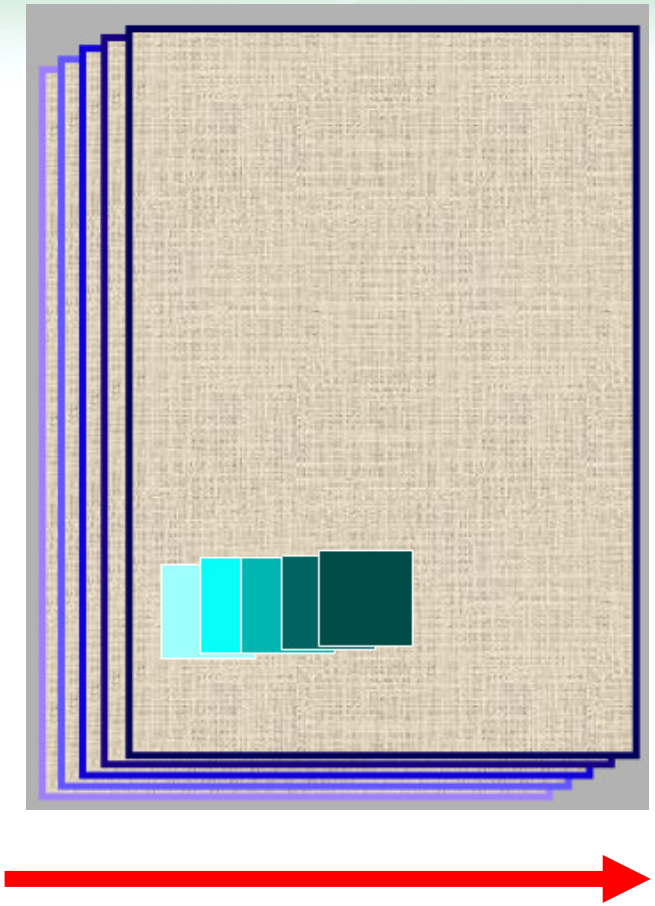


UltraCam*X*,

Forward Motion Compensation (FMC)

Implemented by

- TDI
- (Time Delayed Integration)
- Up to 50 pixel



BUS

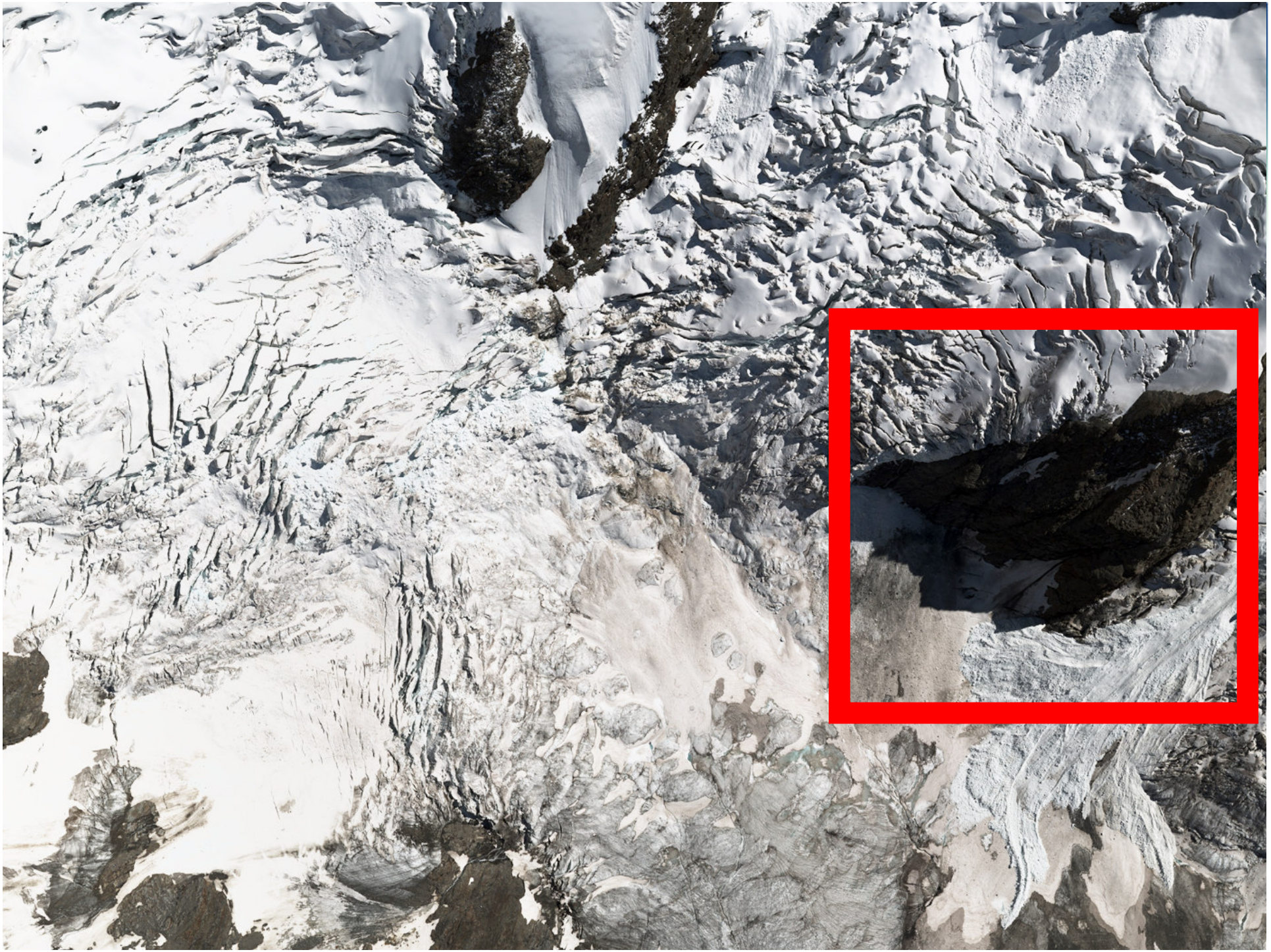
Large Scale Capability

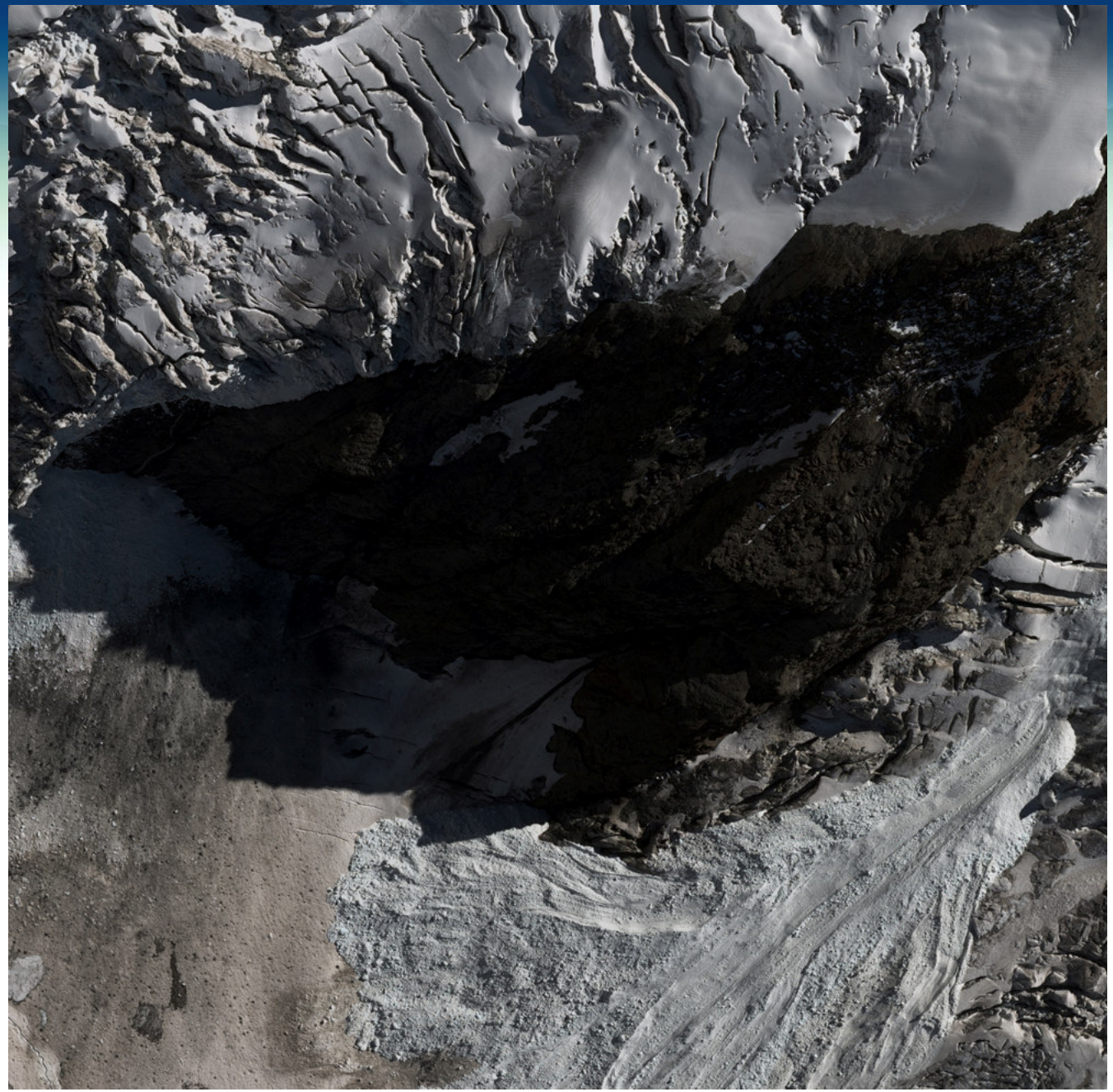
Graz, Airport Thalerhof

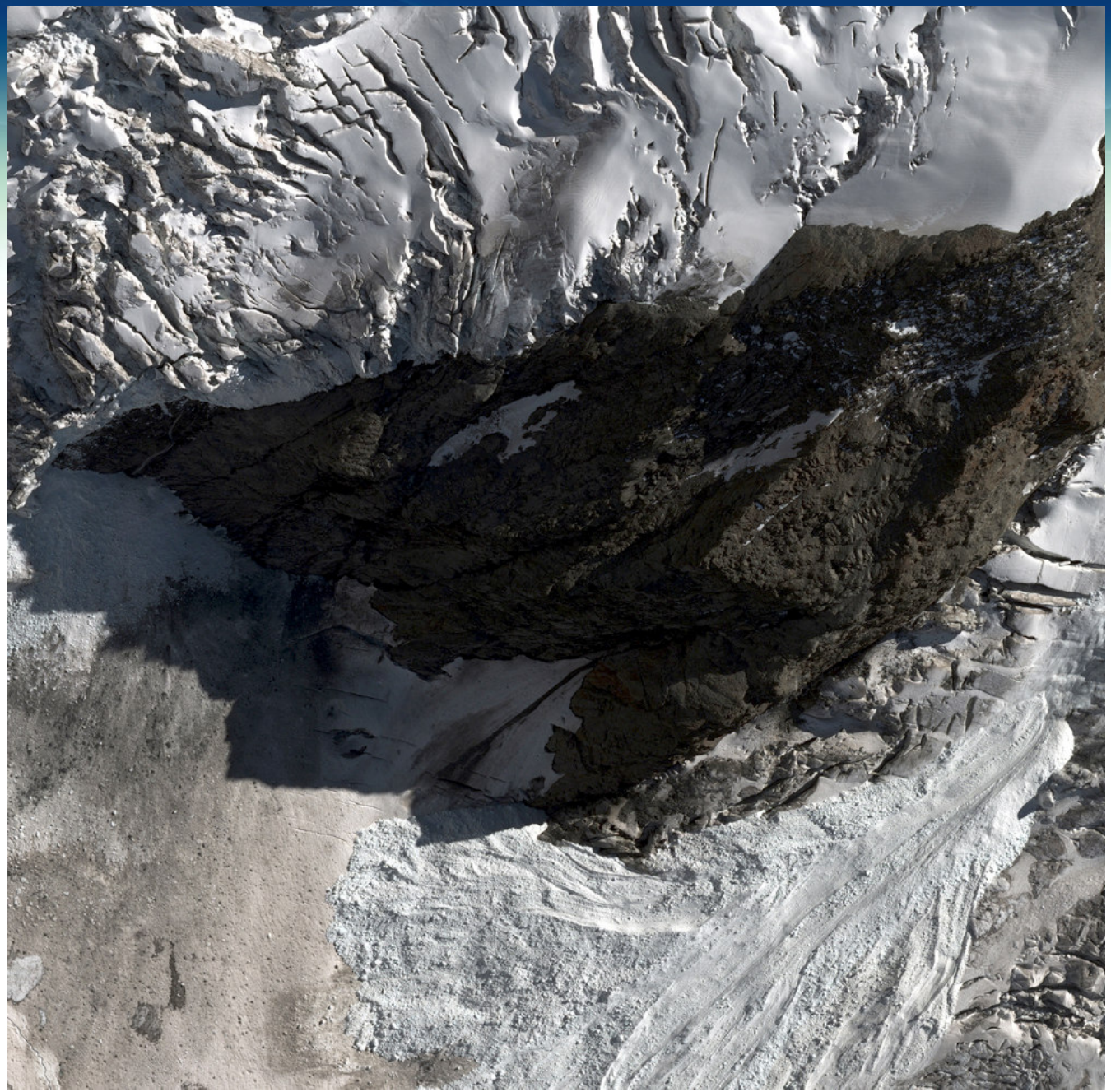
GSD: 8 cm

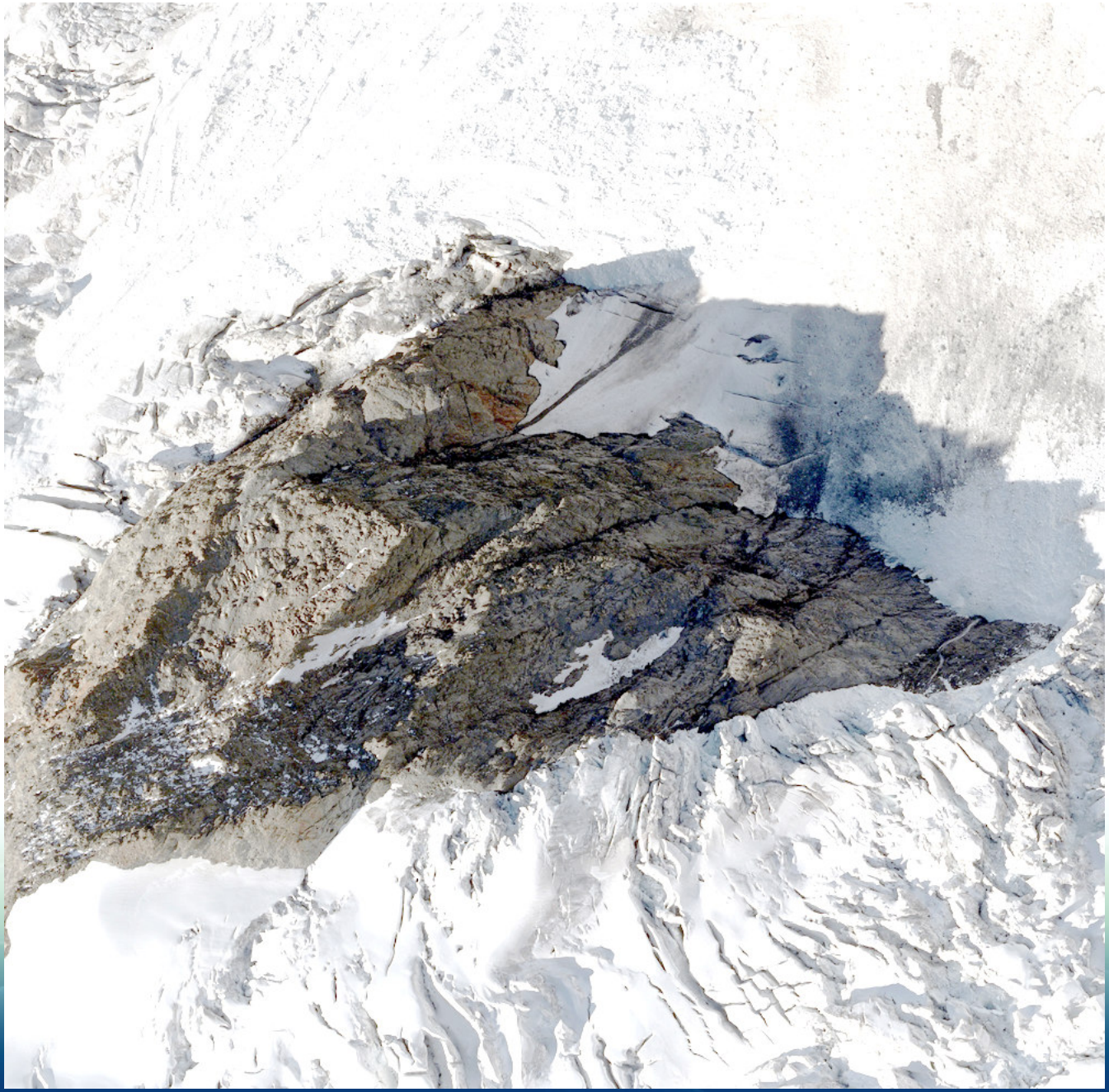
UltraCam

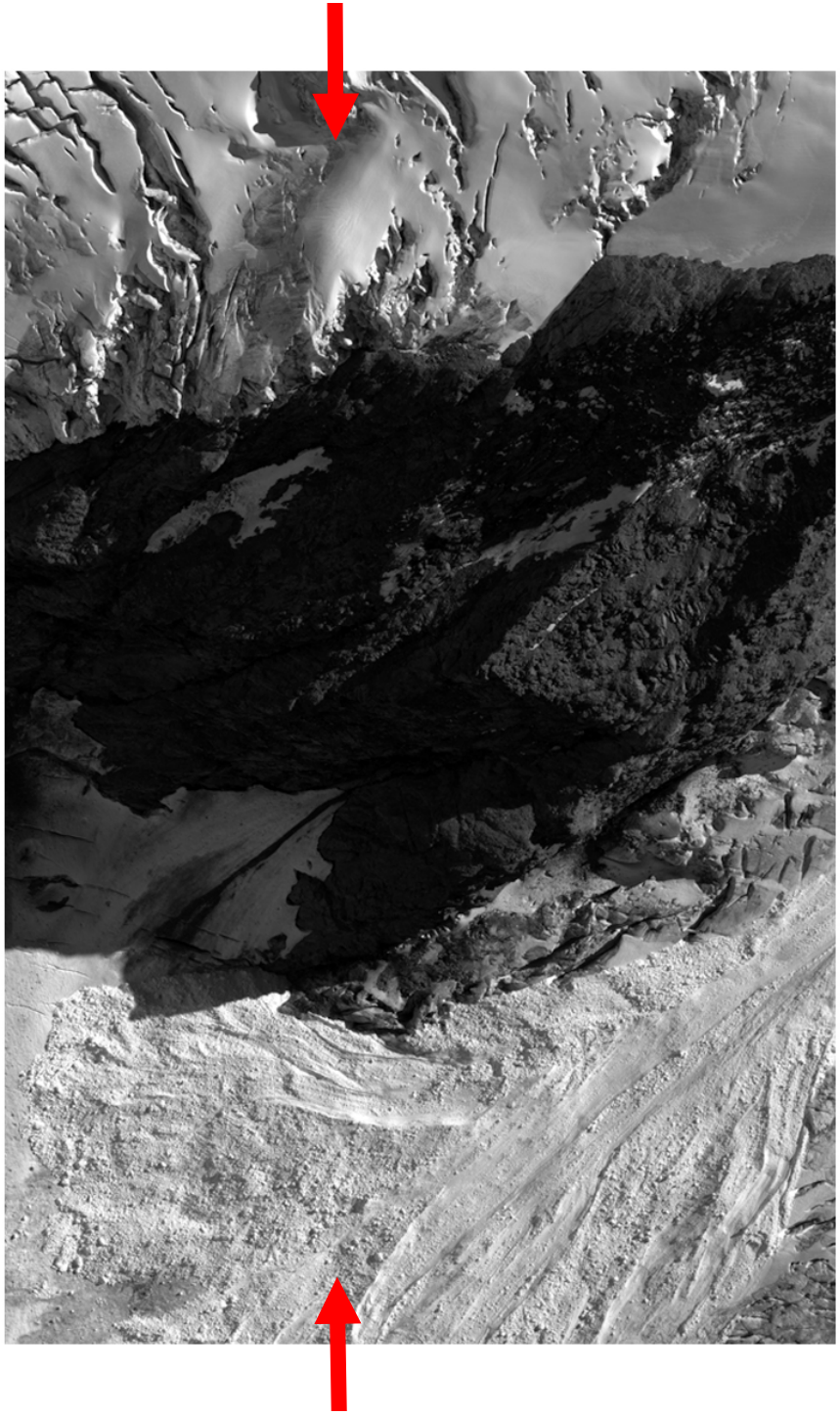
Image Quality by Radiometry

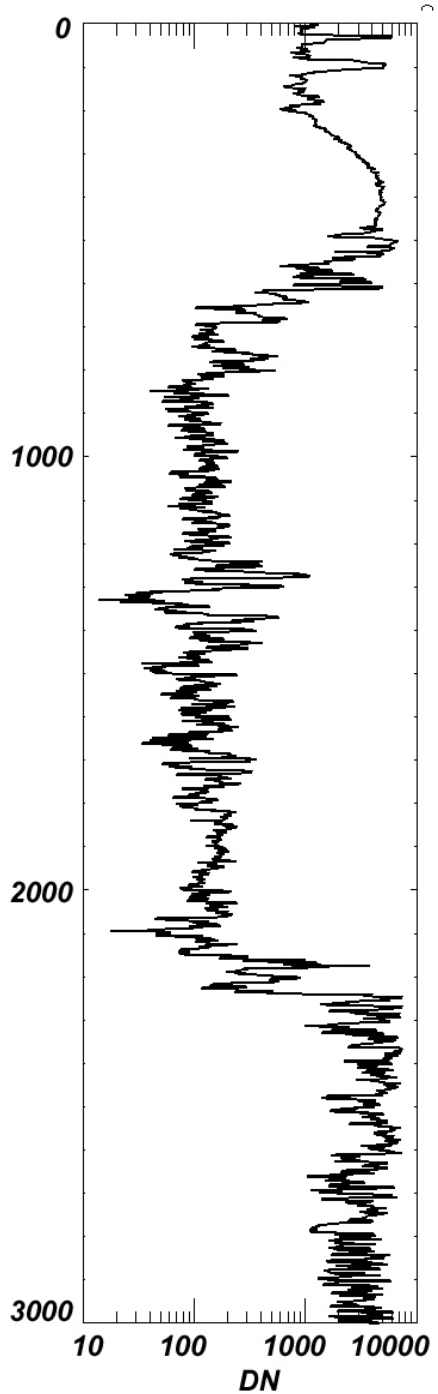












Area:

Min 474
Max 7896

12.9 bit
(12.2 bit S/N)

Profil:

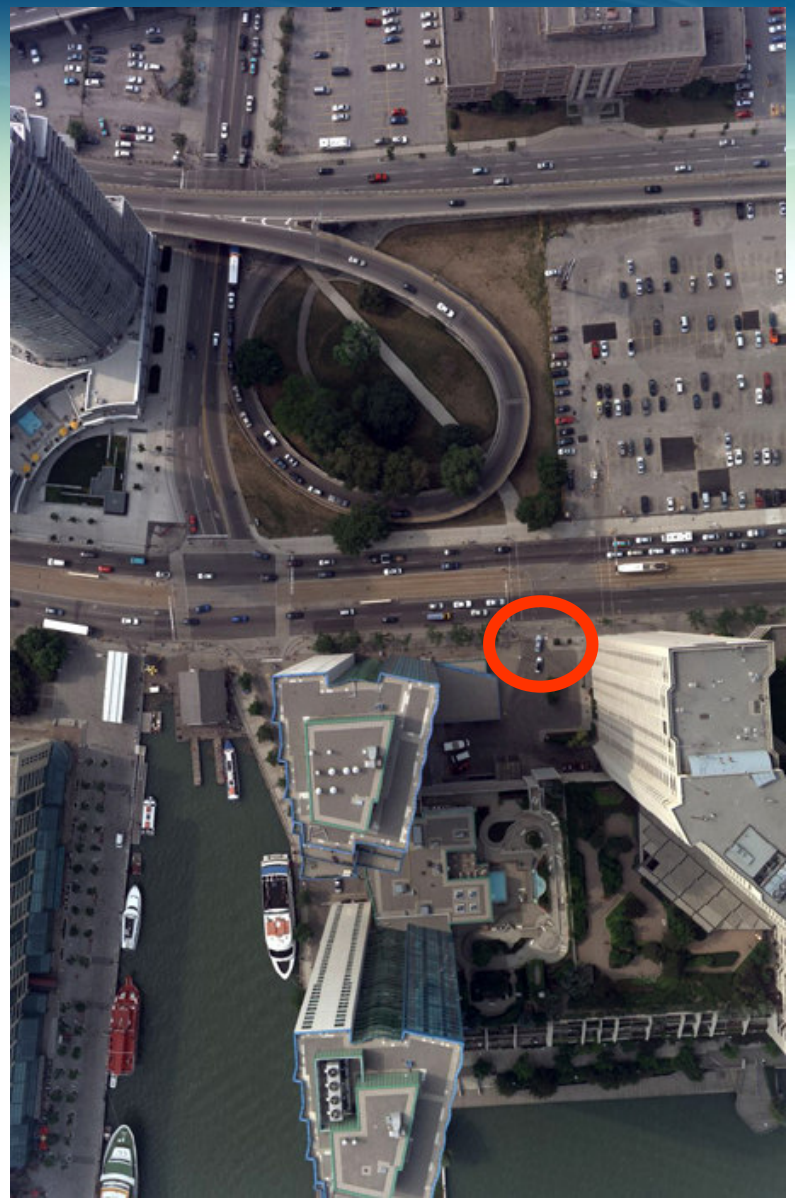
Min 488
Max 7804

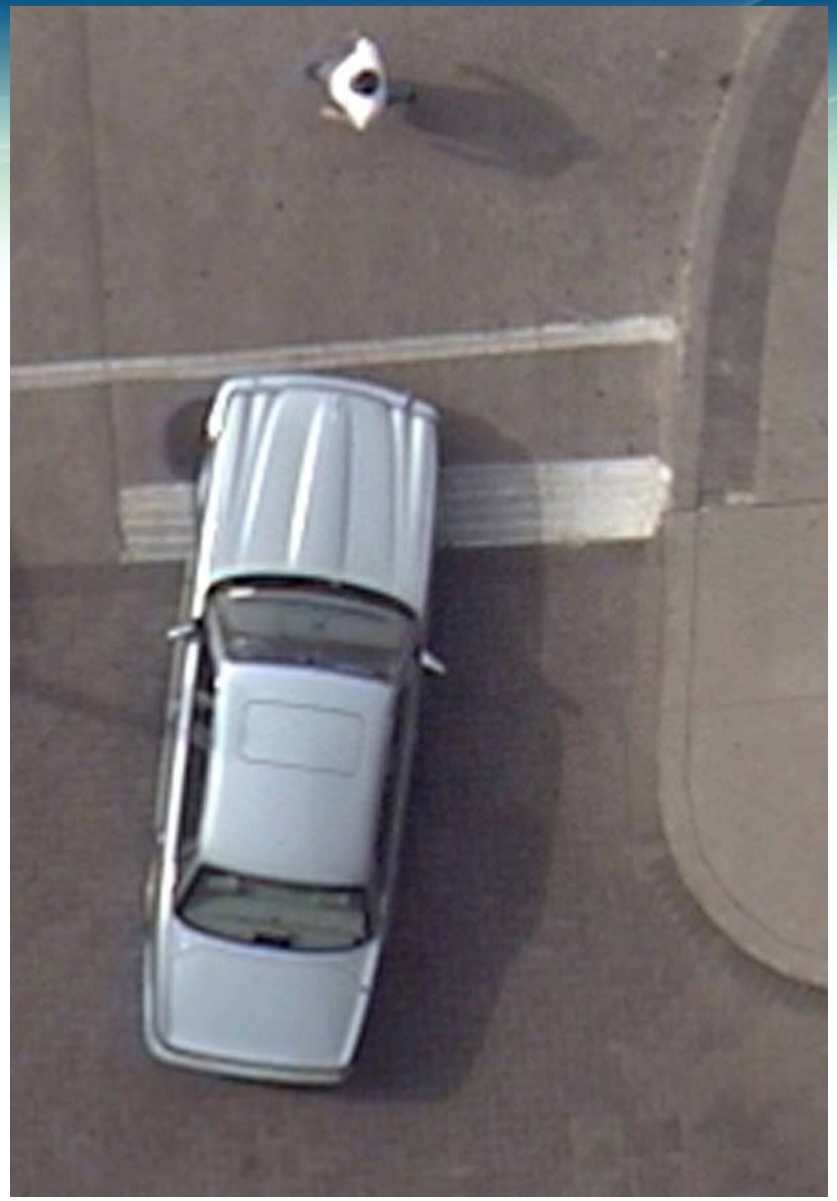
12+ bit CCD Sensor	(~6000 DN)
14 bit ADC	(16384 DN)
16 bit postprocessing	(65536 DN)

Large Scale Mapping

managing large
differences in height

Urban Areas





Street Level

GSD 3 cm

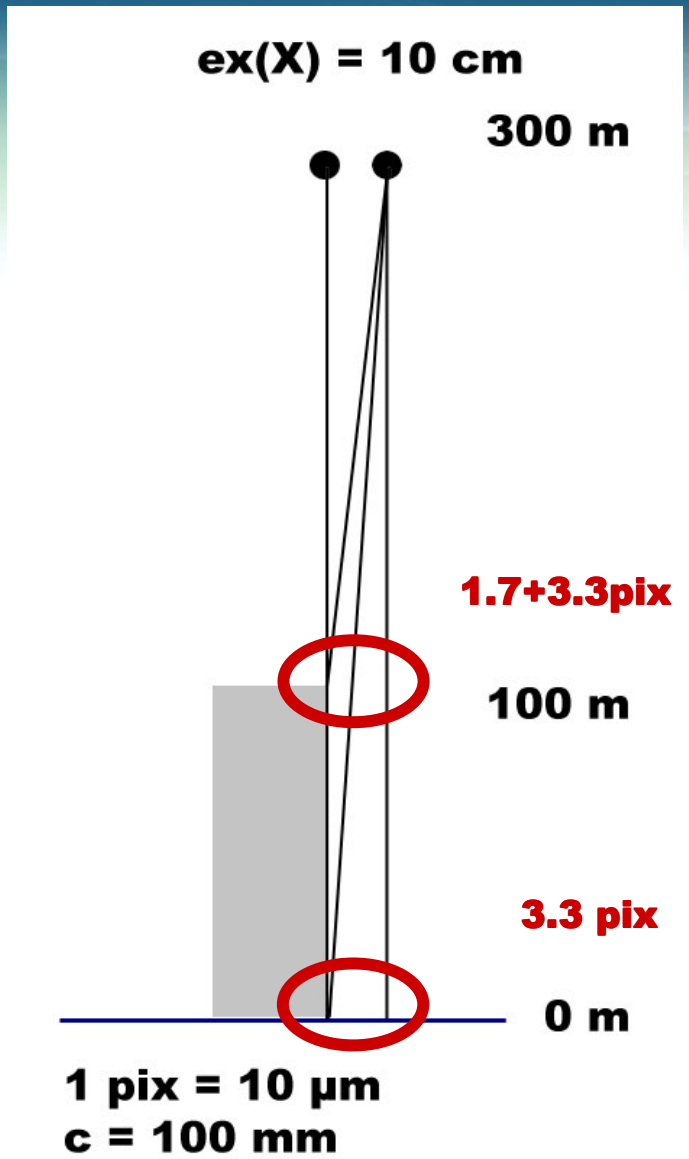
AGL 330 m

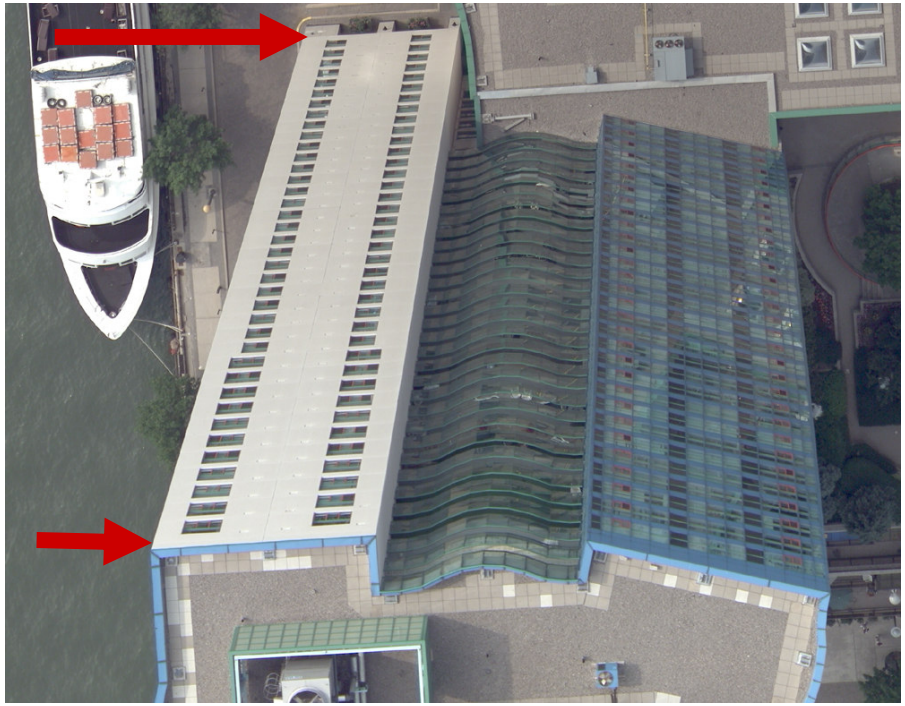
Top Level

GSD 2 cm

AGL 220 m

38 Floors
appr. 120 m

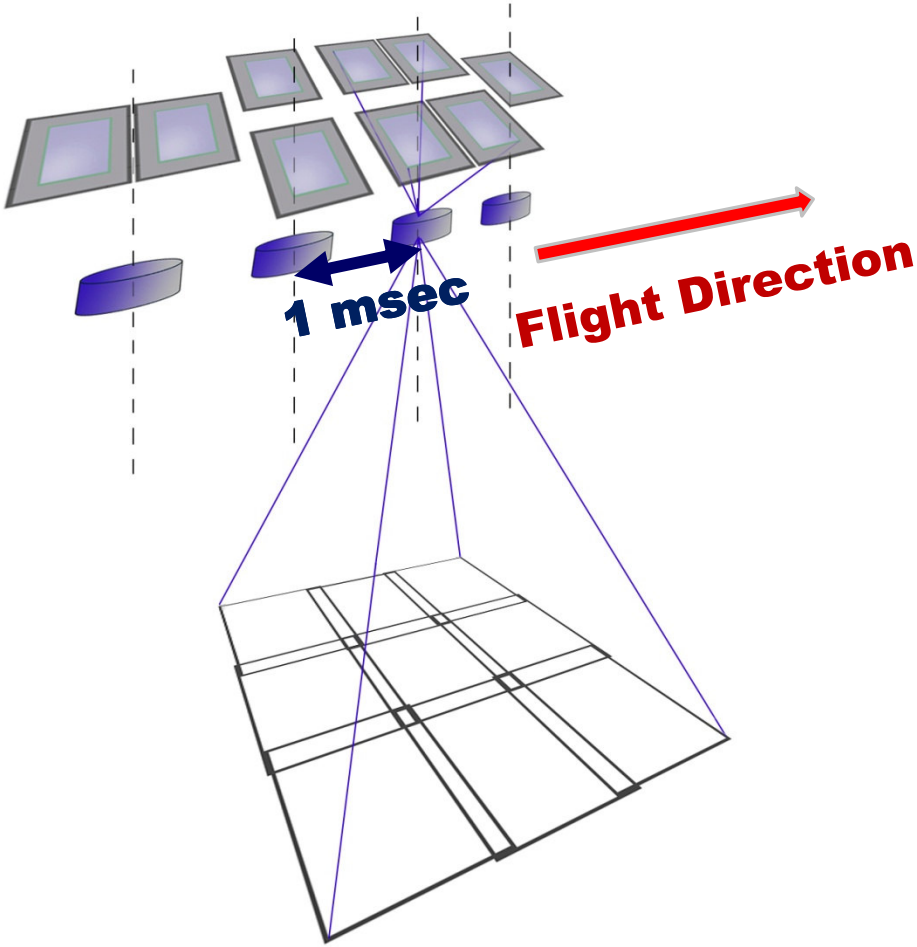




Syntopic Exposure

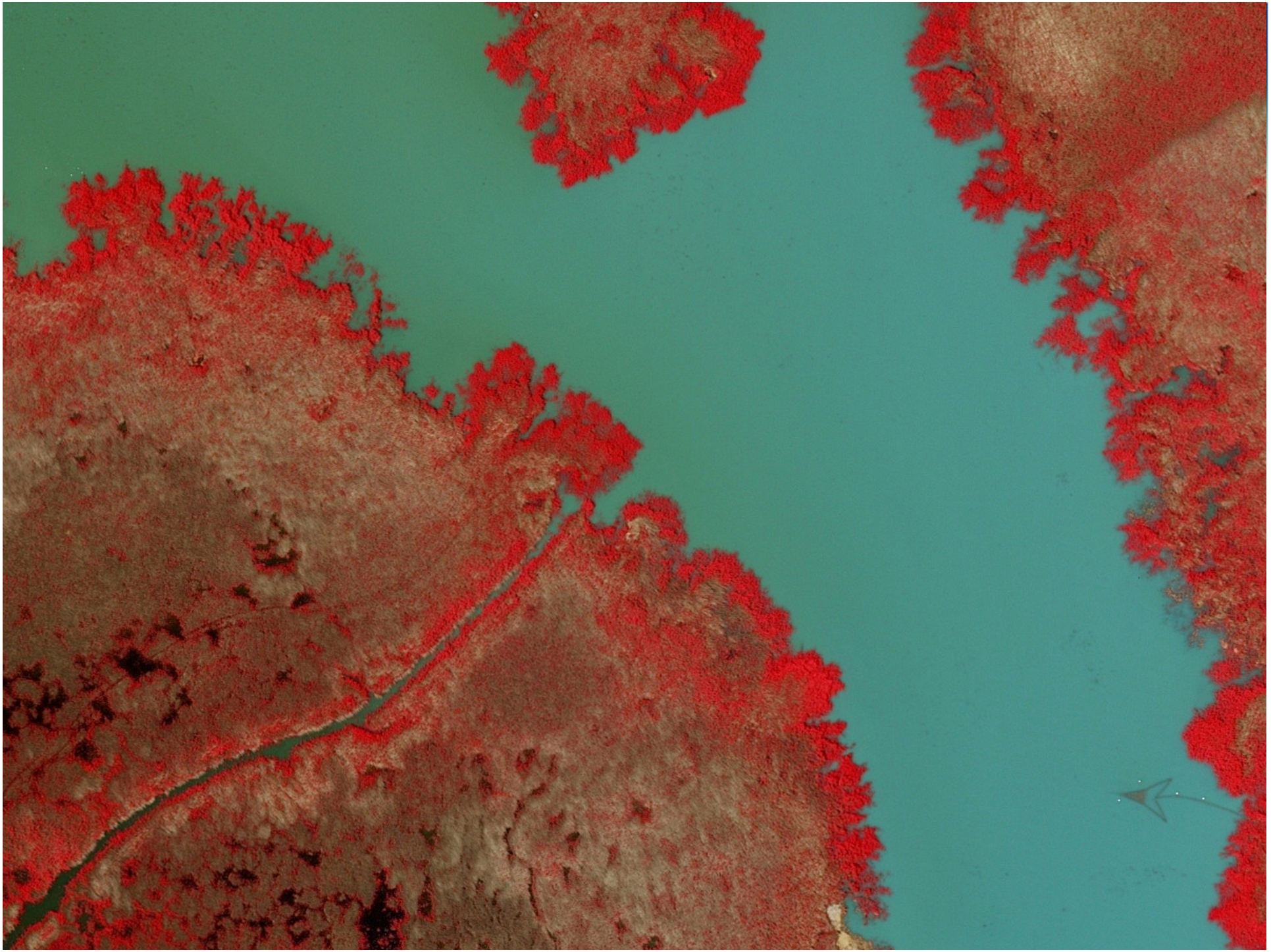
Synchronous
vs
Syntopic

Option:
Position of the four
camera cones
at identical positions
(“Syntopic” exposure)

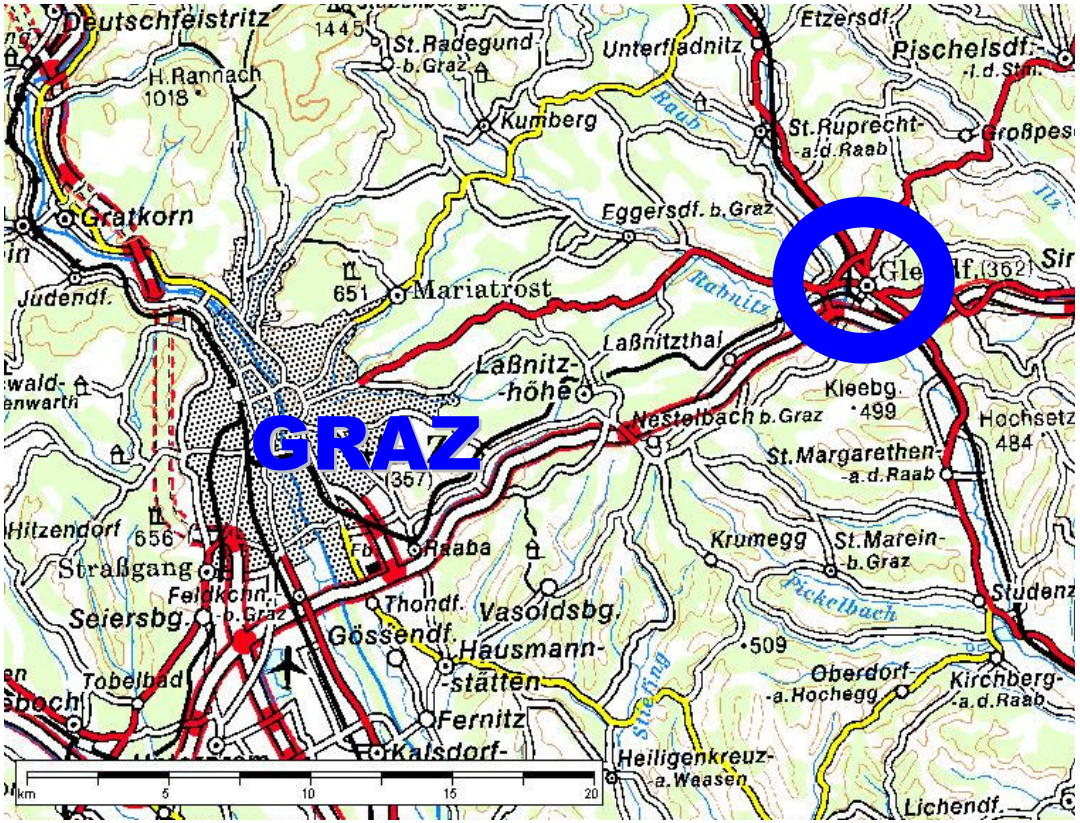


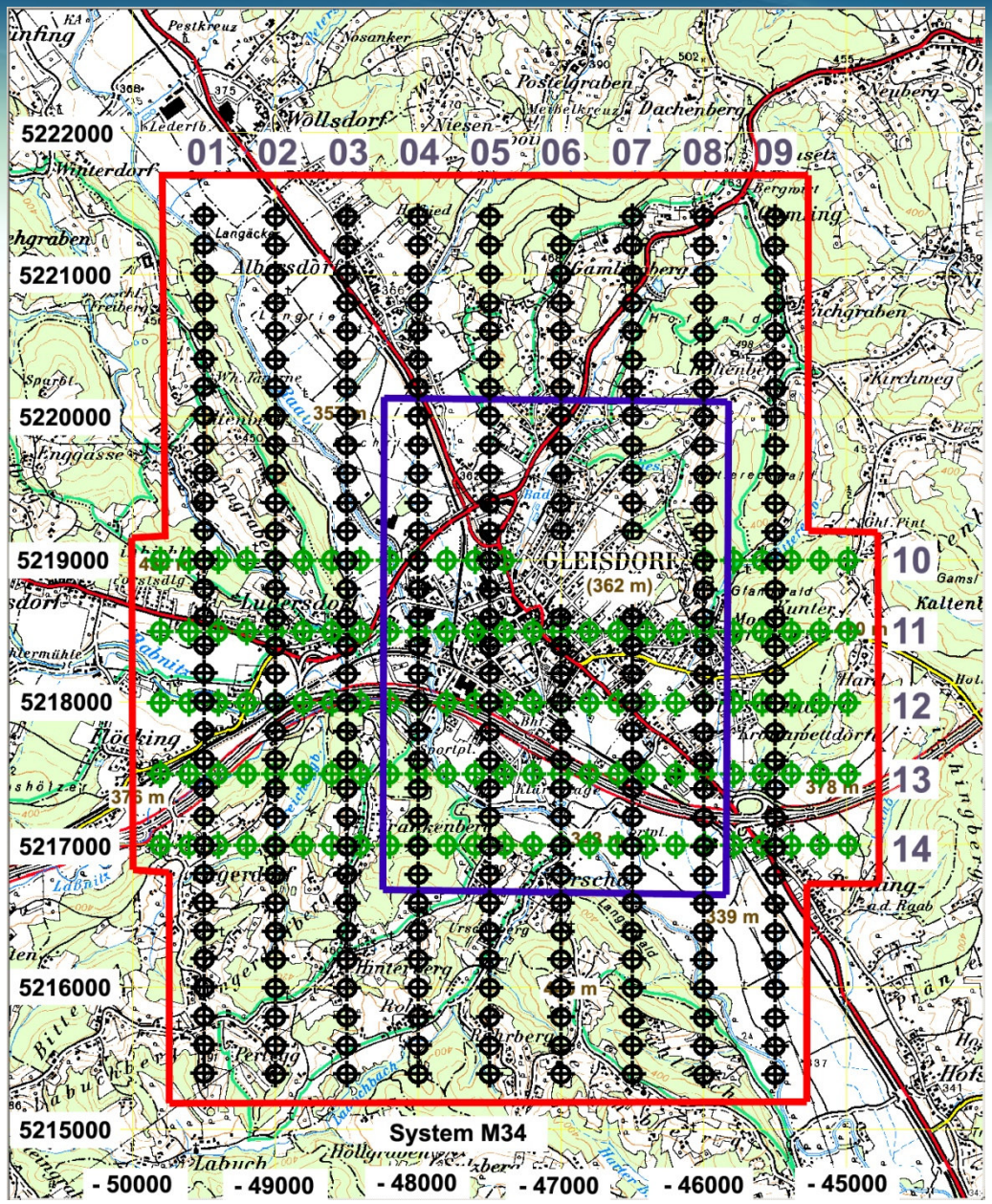
Small Scale Mapping

NIR Application



Geometric Performance
Test Area Gleisdorf





Flight Mission at two Altitudes

GSD 10 cm (1400m AGL)

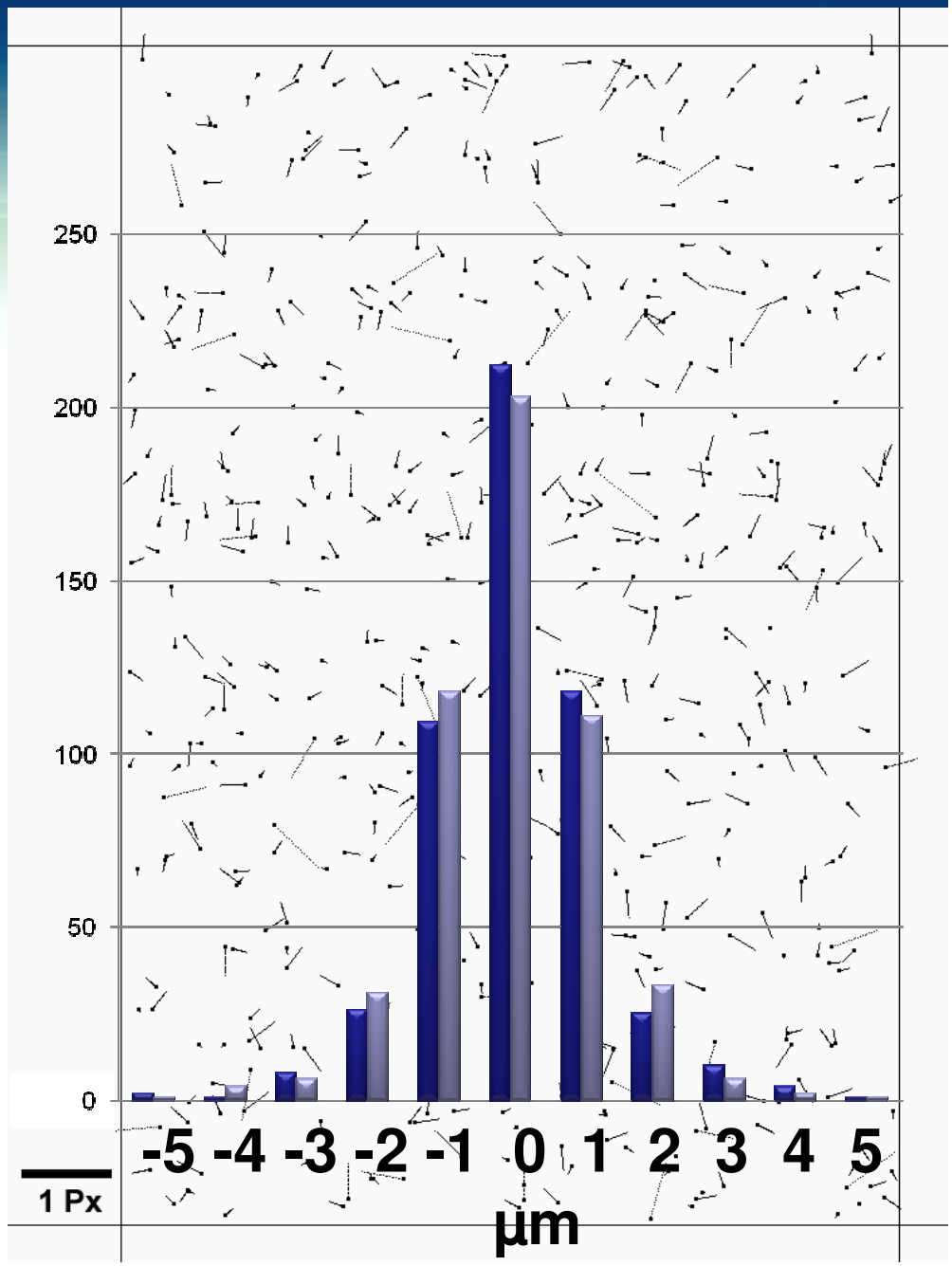
GSD 25 cm (3500m AGL)

Cross Strips
Ground Truth (GCPs)
GPS/IMU

UltraCam X
GCP results

#of GCP positions 516

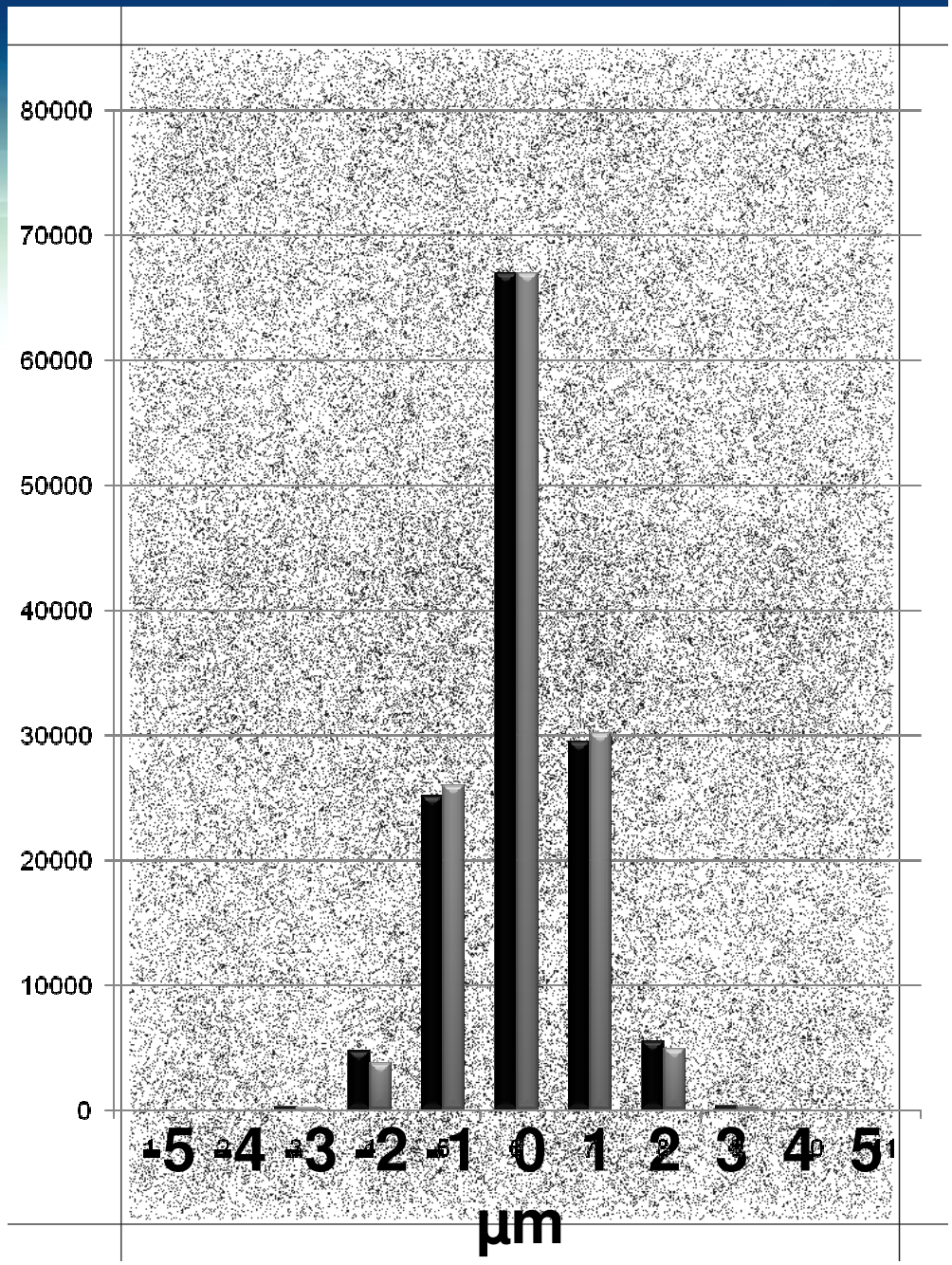
> 85% GCPS < 1.5 µm



UltraCam X
TPT results

#of TPT positions 132125

>91% TPTS < 1.5 µm
>50% TPTS < 0.5 µm

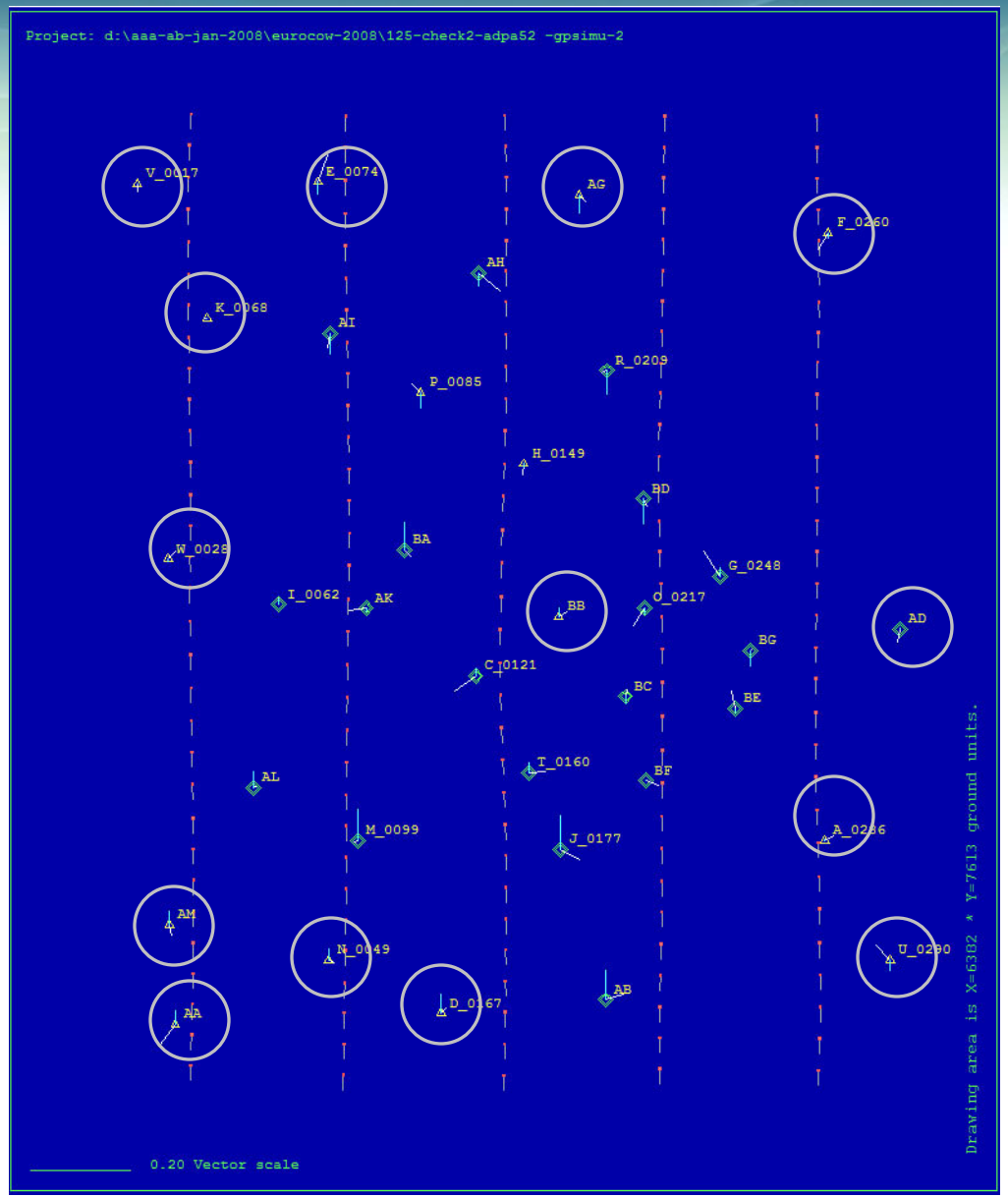


UltraCam X
BA-Result
GSD = 10 cm
Sig_o = 0.67 µm

CheckPts RMSE

24.	22.	36.	mm
22.	22.	24.	mm
22.	23.	37.	mm

With GPS/IMU and AP
Without GPS/IMU, incl. AP
Without GPS/IMU, without AP



UltraCam X BA-Result GSD = 10 cm

Image Residuals
< 0.66 µm (<1/10 Pixel)

with self calibration parameters

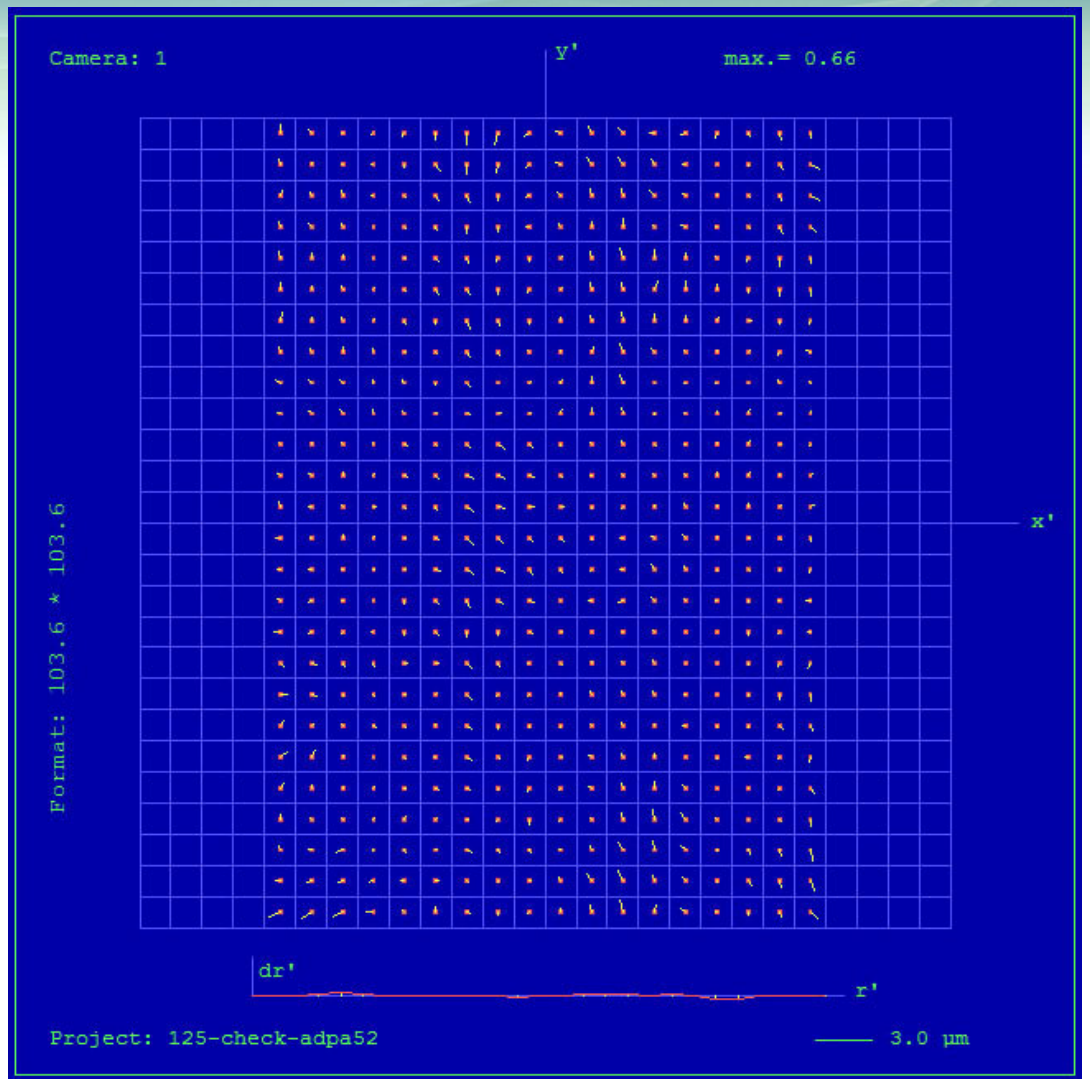
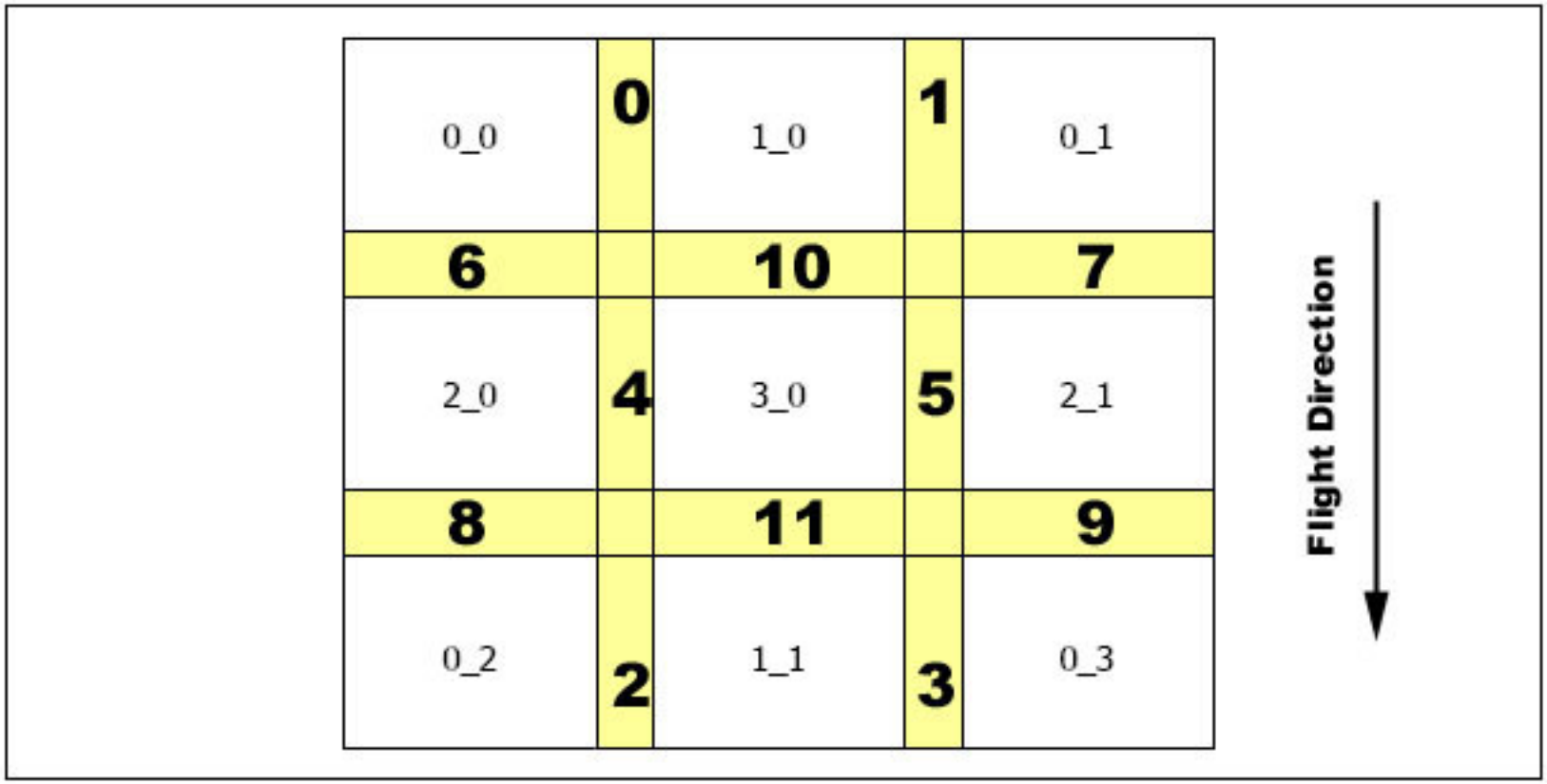


Image Postprocessing
The Stitching Approach

Sensors and Overlaps of the PAN



Numbering and Organization of Cone_Sensor and overlaps of pan. image

Step 1
Transformation of Overlap Areas (Tie Point Matching from similar images)

- Reliability: Number of Points used
- Accuracy: RMSE after Transformation

Tie Point Matching

Points found:

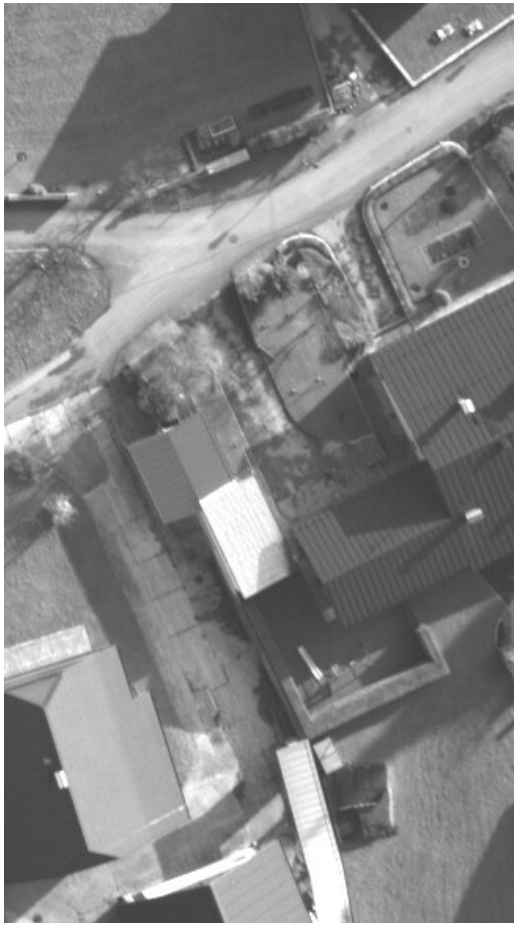
>> 75%

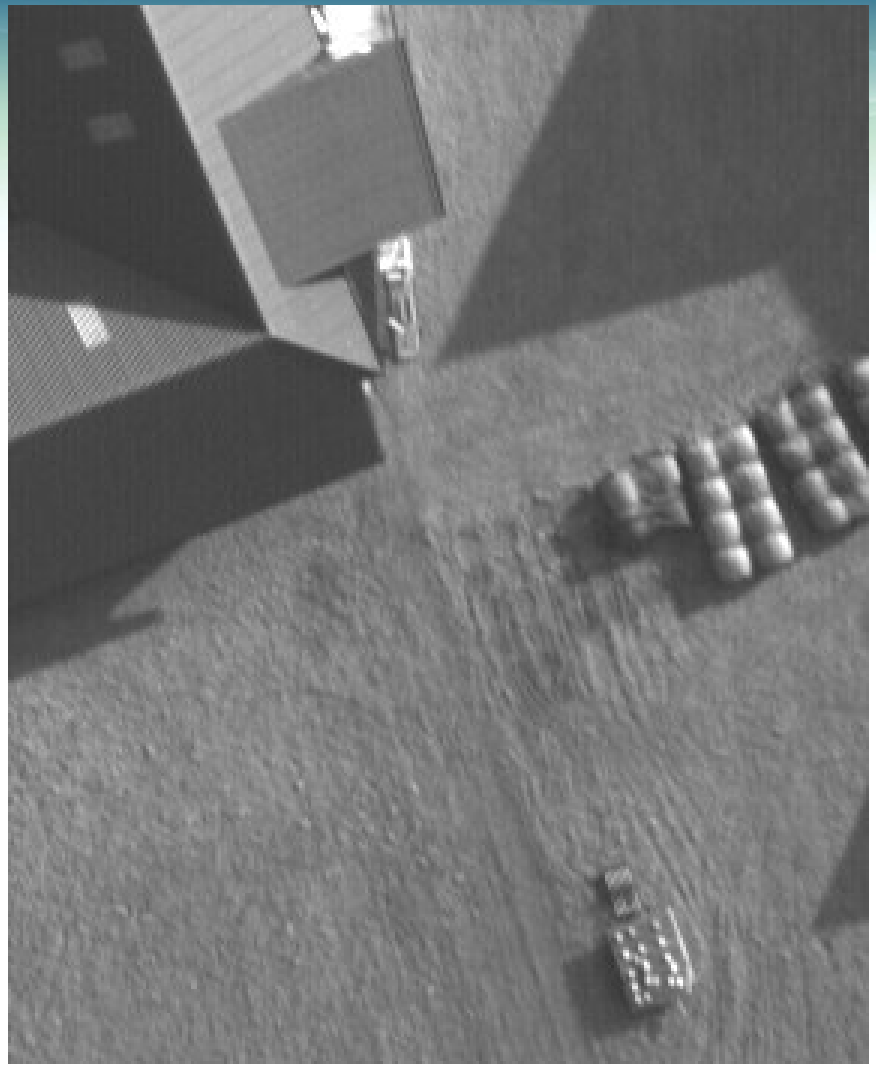
RMSE:

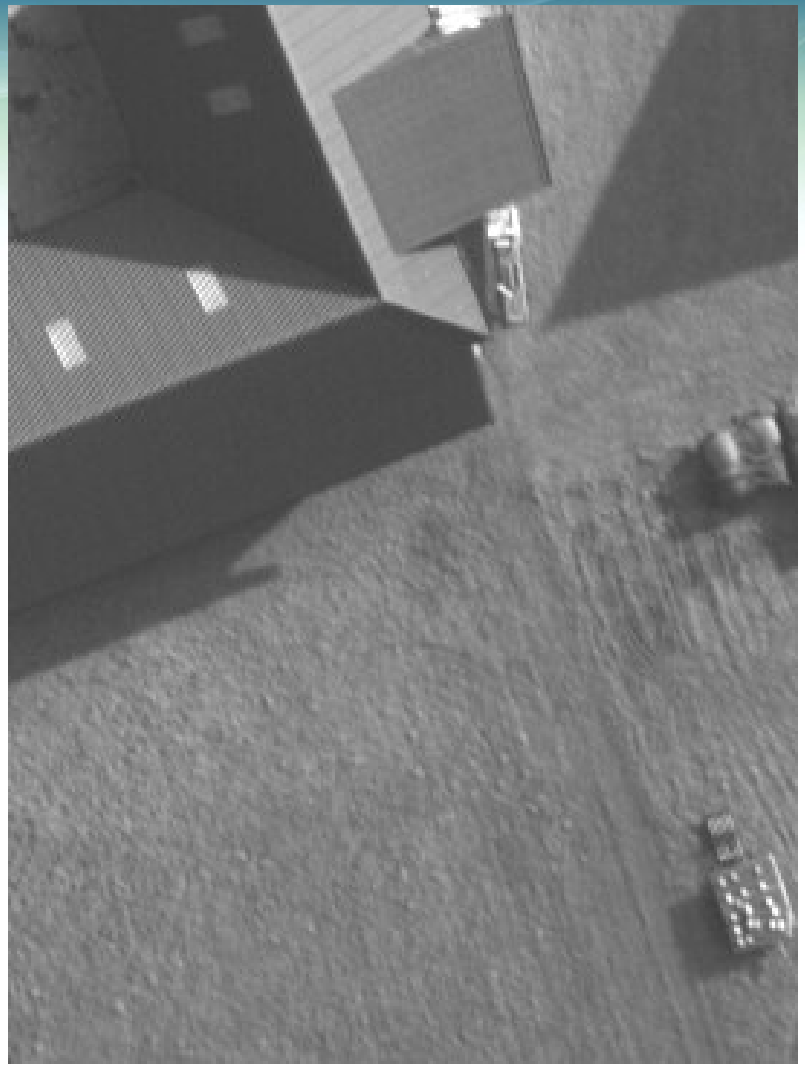
<< 0.1 pixel

Documentation:

Lvl02 xml-file



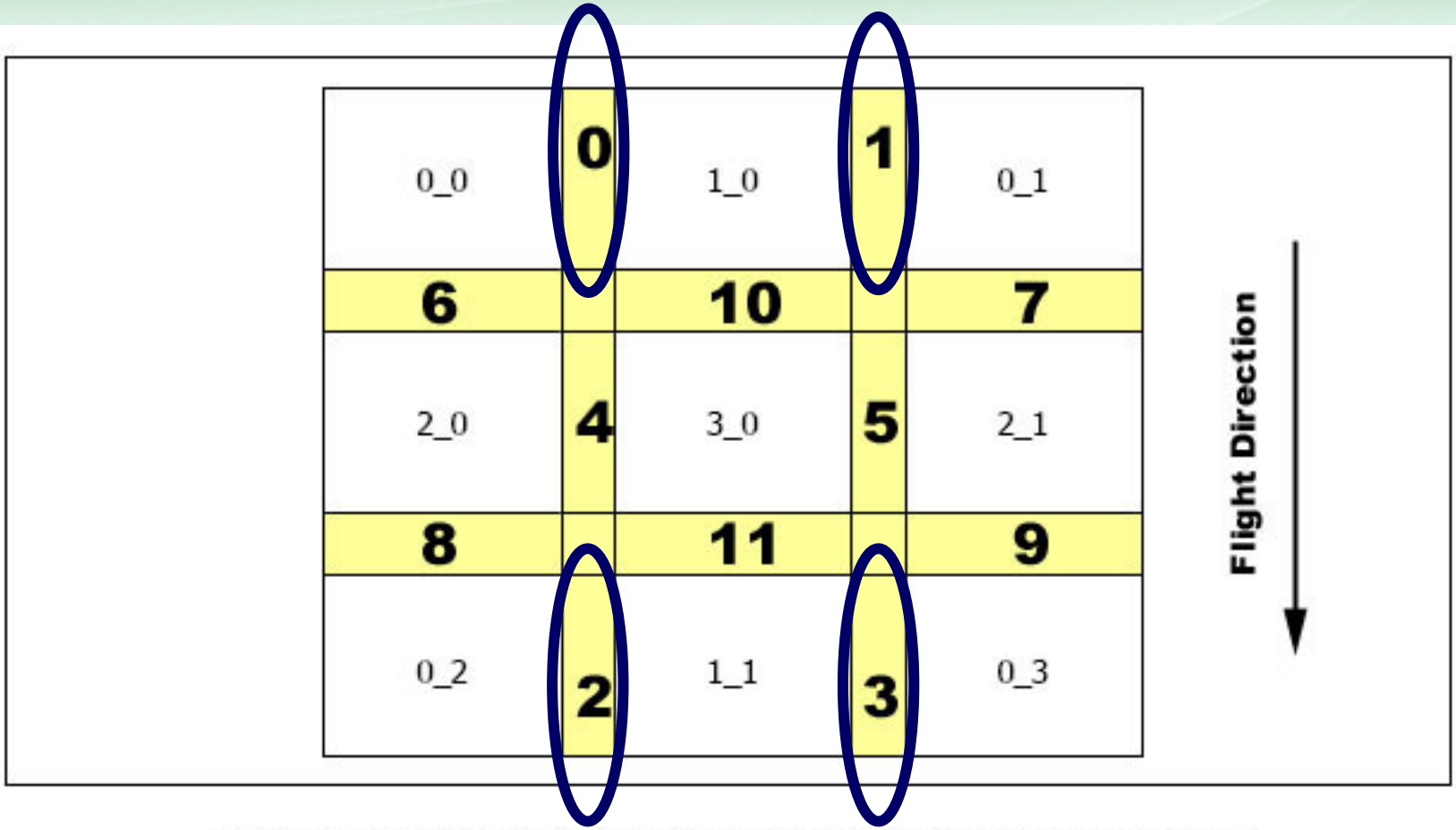




Step 2
Transformation of Layers (Image Plane of Cone 1,2 and 3 to Image Plane of Cone 0)

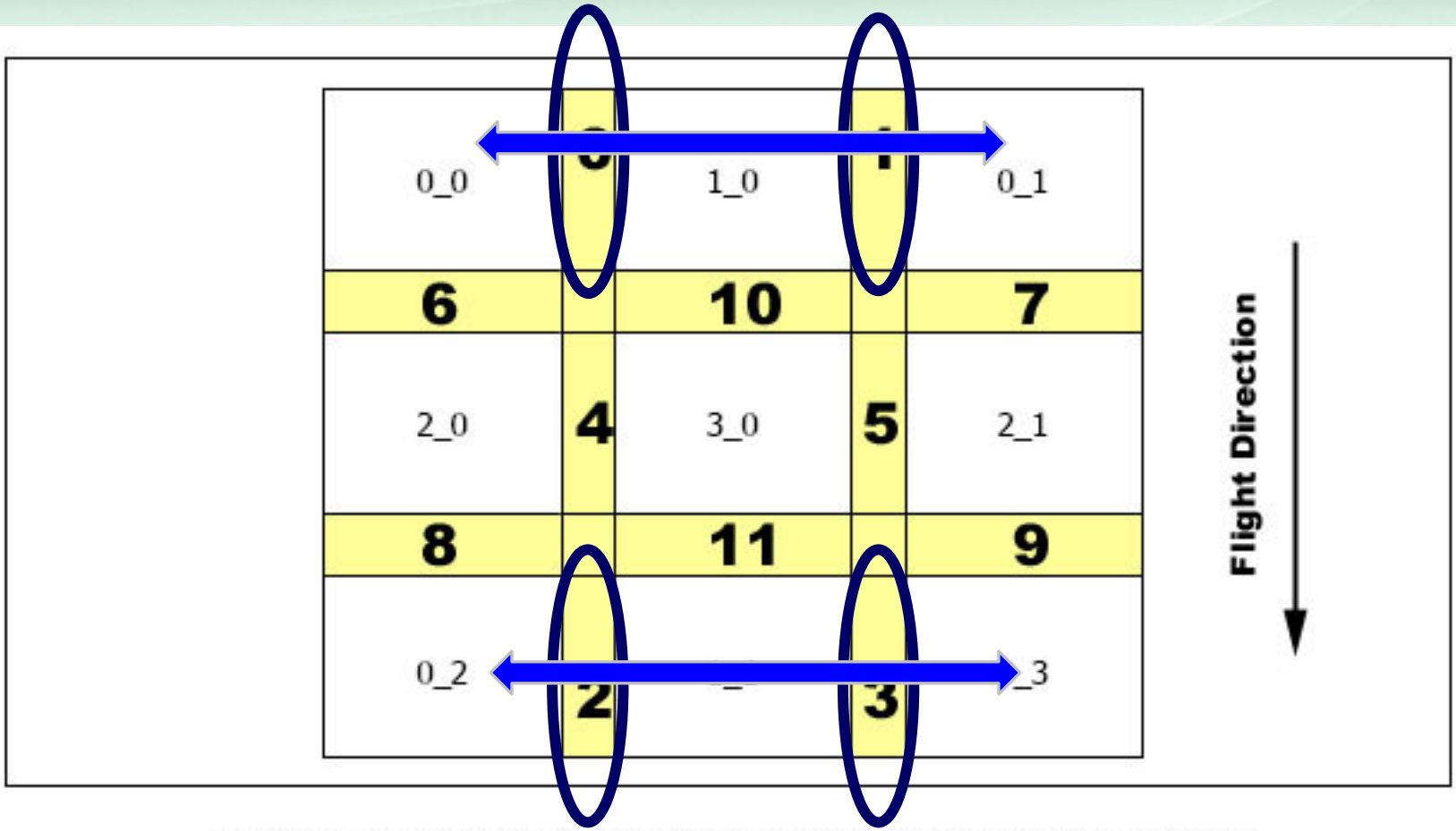
- **Accuracy: RMSE after Transformation**

e.g. Layer 1 to Layer 0



Numbering and Organization of Cone_Sensor and overlaps of pan. image

e.g. Layer 1 to Layer 0, + Scale



Numbering and Organization of Cone_Sensor and overlaps of pan. image

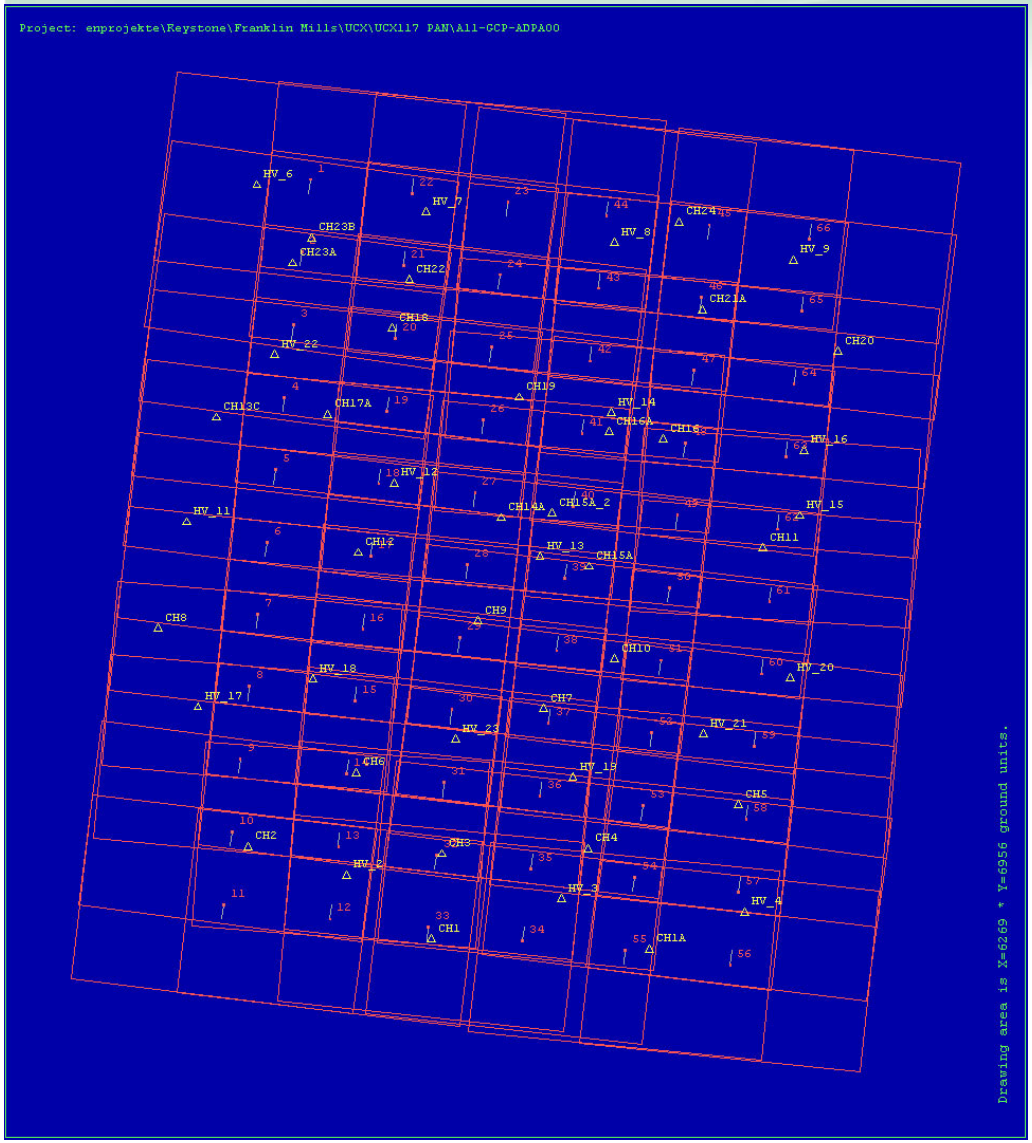
Workflow Issues

Laboratory Calibration
Field Calibration
- standard parameters
- specific camera parameters

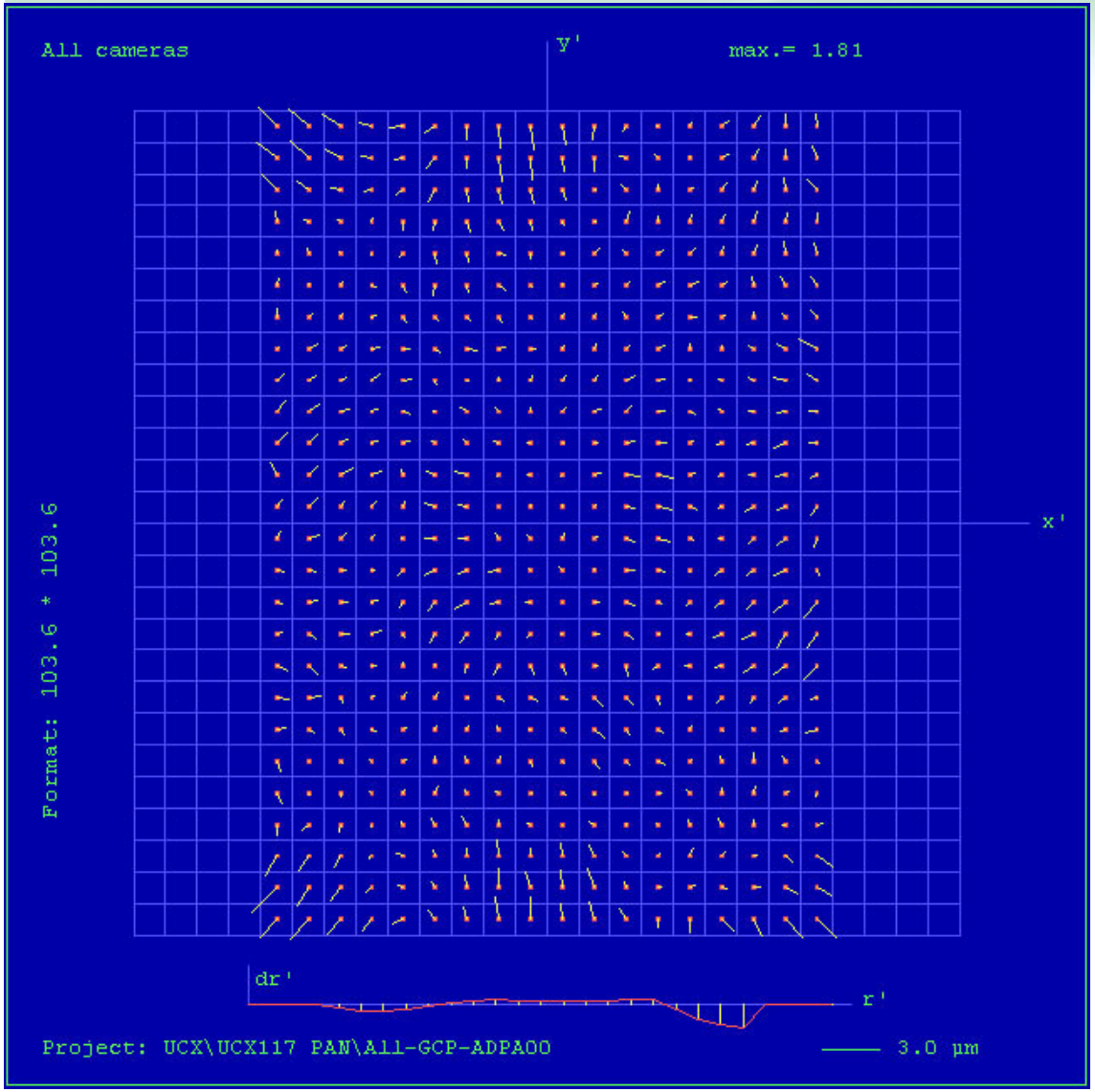
Self Calibration

Workflow Issues

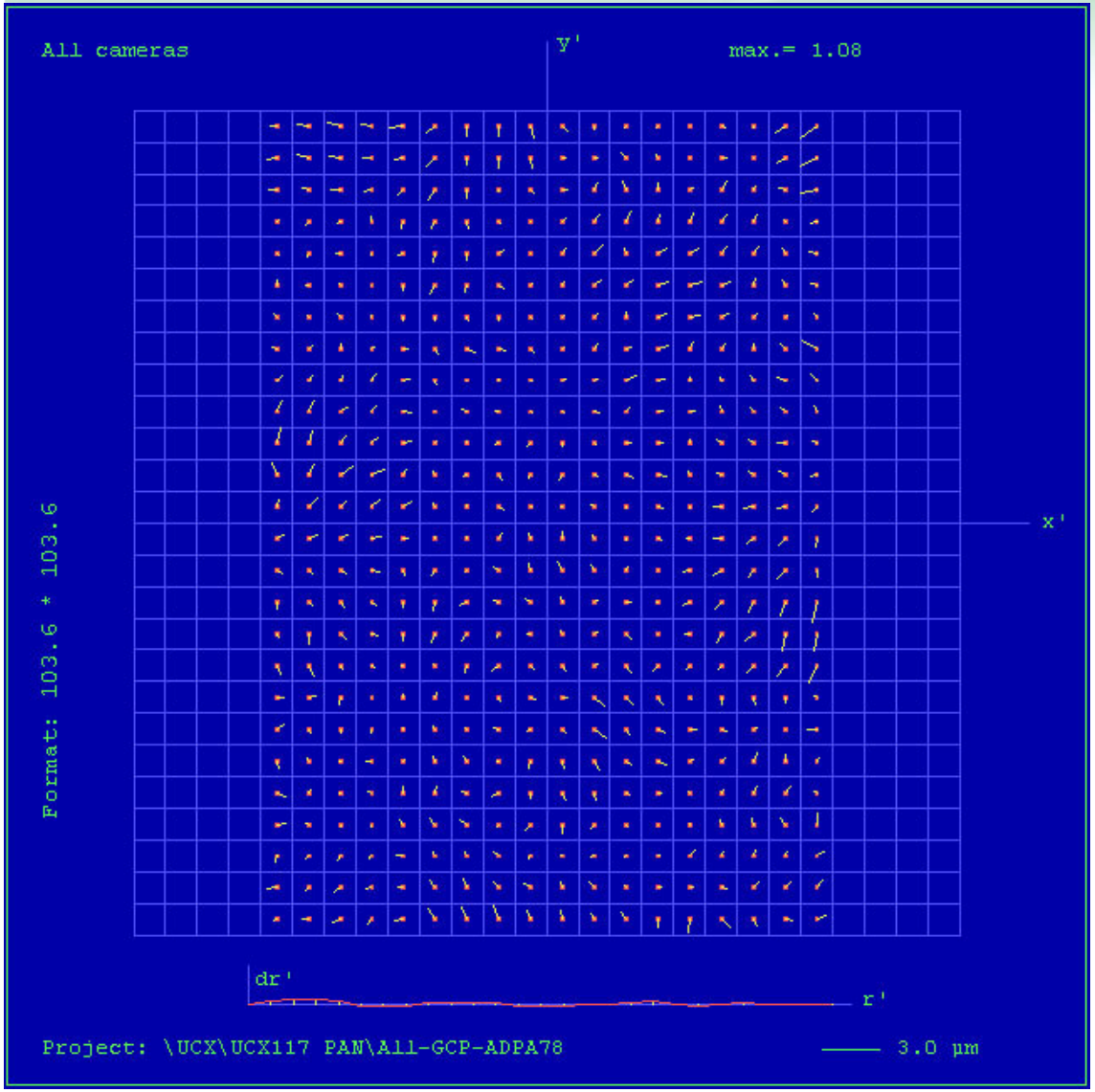
1)Flight Mission (Customer Project)
2)Post-processing (incl. Stitching)
3)BA and estimation of AP
4)Prepare Correction Table and post-process images



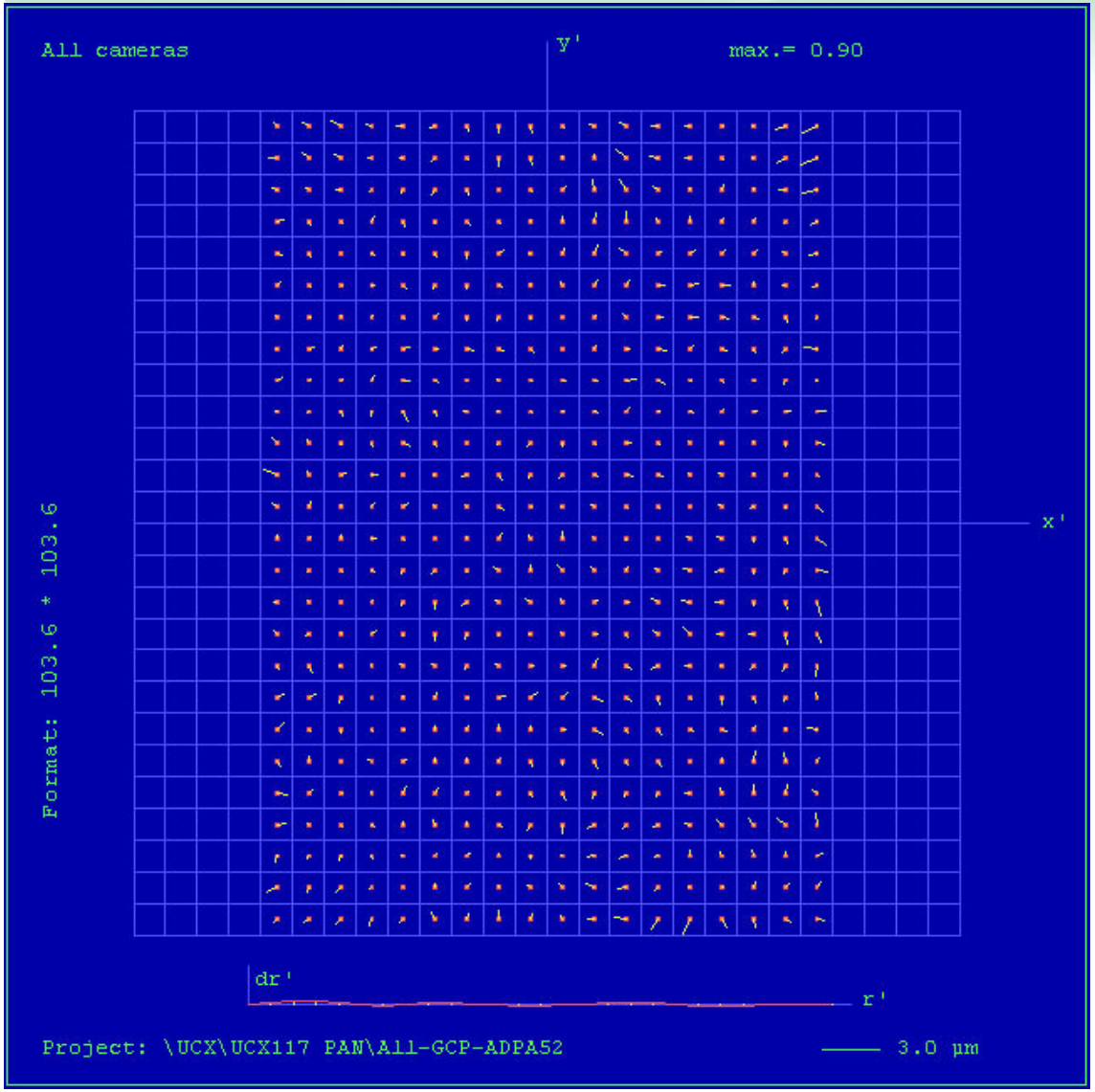
66 images
GSD 37mm
60%/60% OL



w/o Parameters
Max residual
1.81 µm



Standard Parameters Max residual 1.08 µm



Self Calibration Parameters Max residual 0.90 µm

UltraCamX, 66 images,
GSD = 37 mm HAGL = 520 m

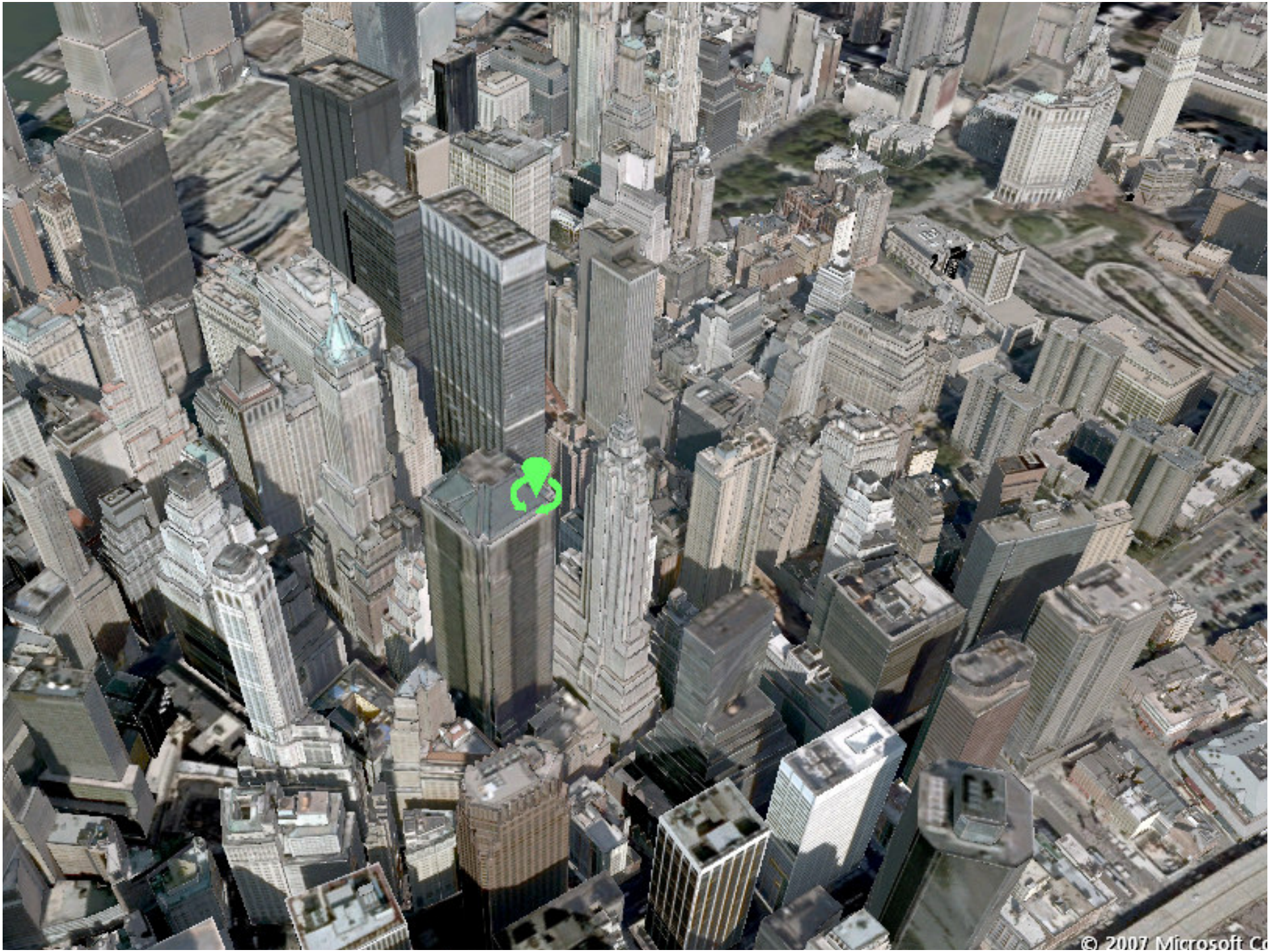
Parameters	Sigma_o	rmse z	
No params	1.01 µm	31.0 mm	
Radial P.	0.91 µm	27.0 mm	
Special P.	0.88 µm	13.5 mm	(0.025 o/oo)

The new Challenge

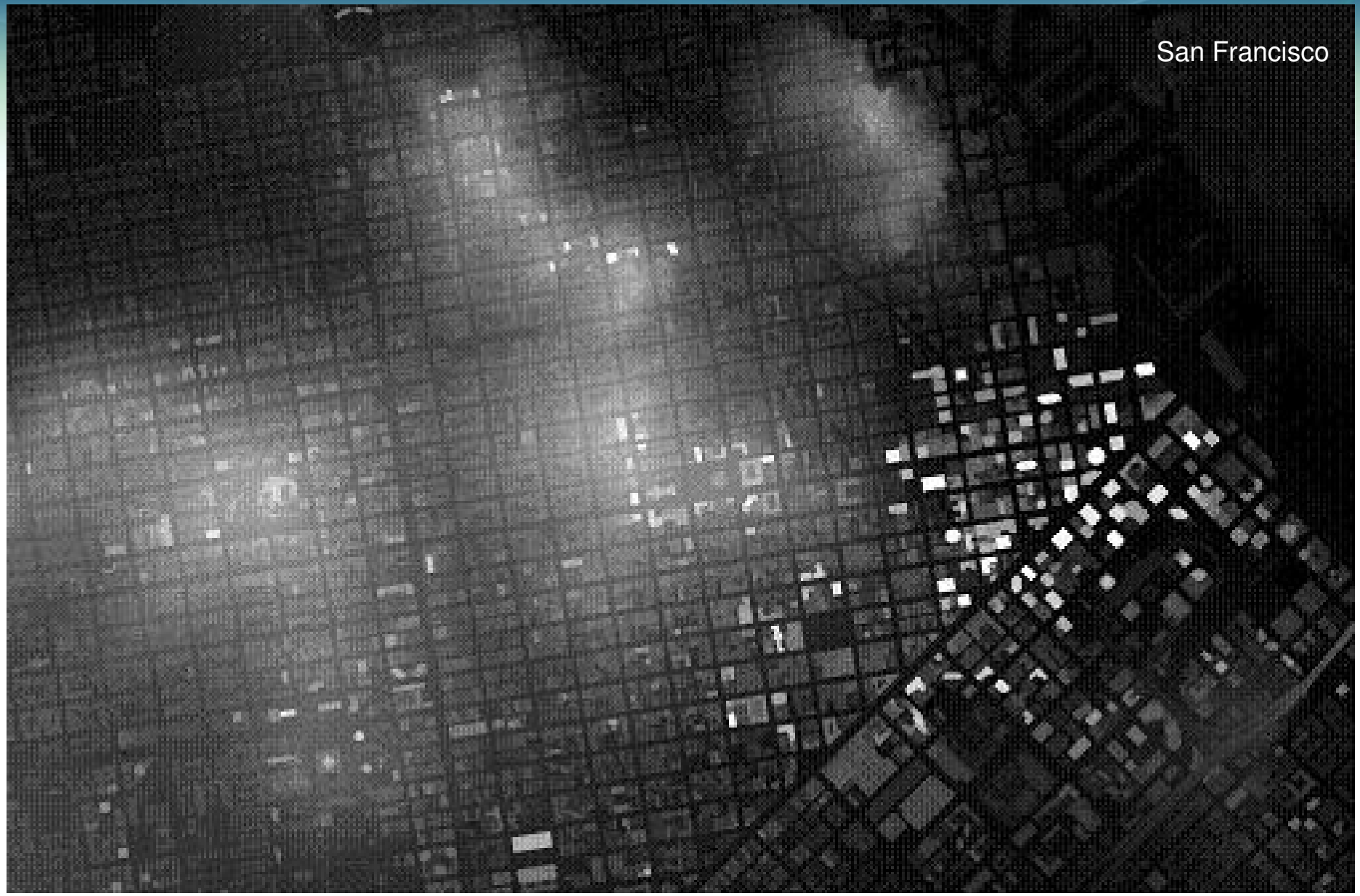
Contributing to the Microsoft Virtual Earth Program

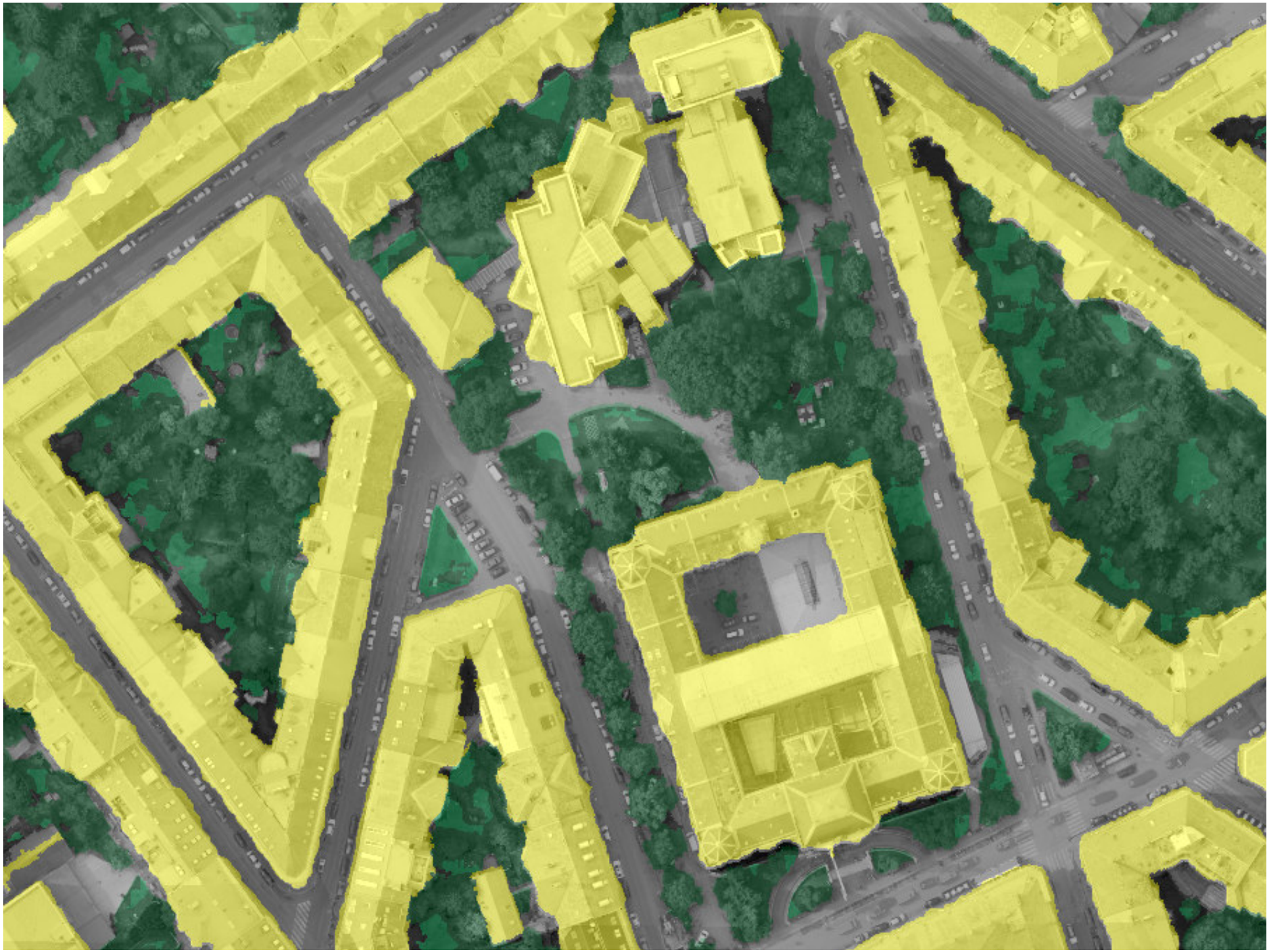
Creating a Virtual 3D World

3D
Road
Aerial
Hybrid
Bird's eye
Traffic
tual Earth™
© 2007 Microsoft Corporation
© 2007 Pictometry International


© 2007 Microsoft Co

Dense Matching





Automated Building Extraction

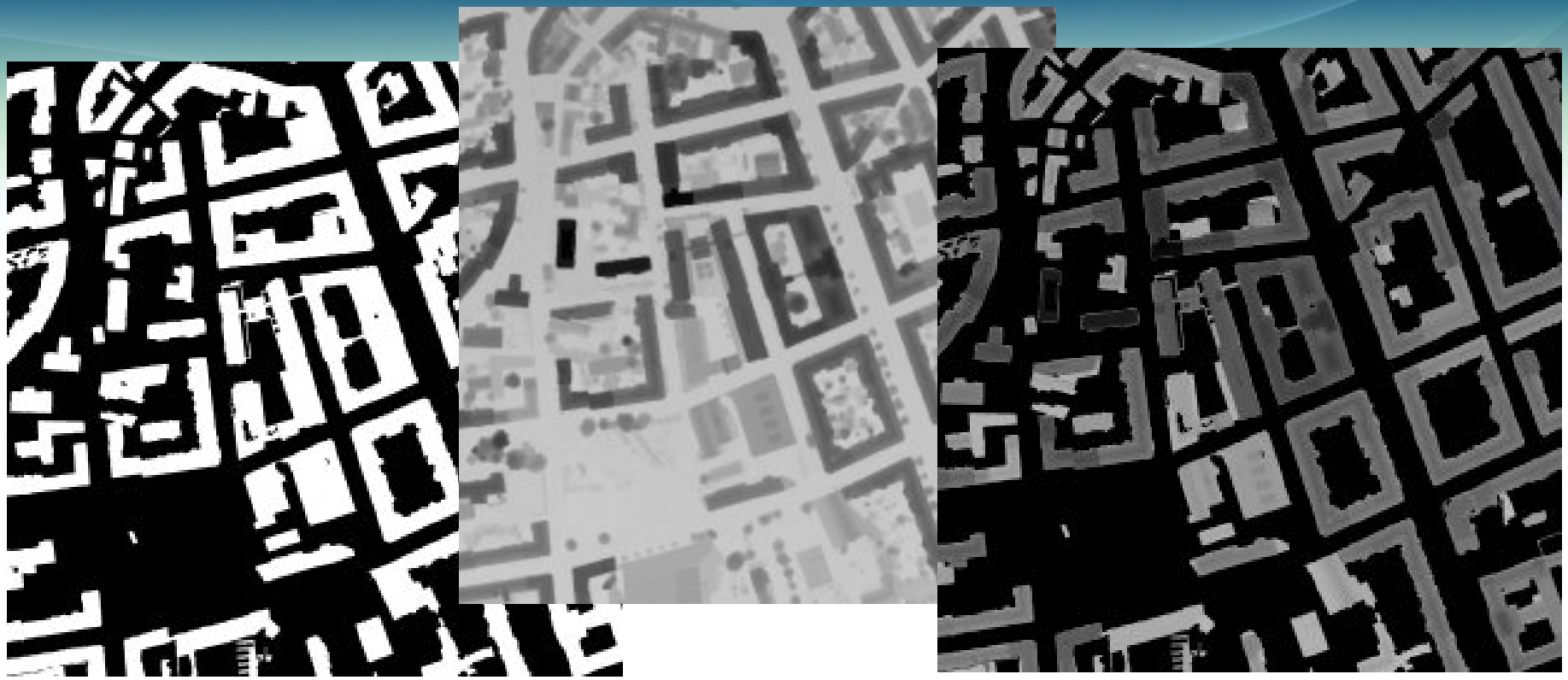


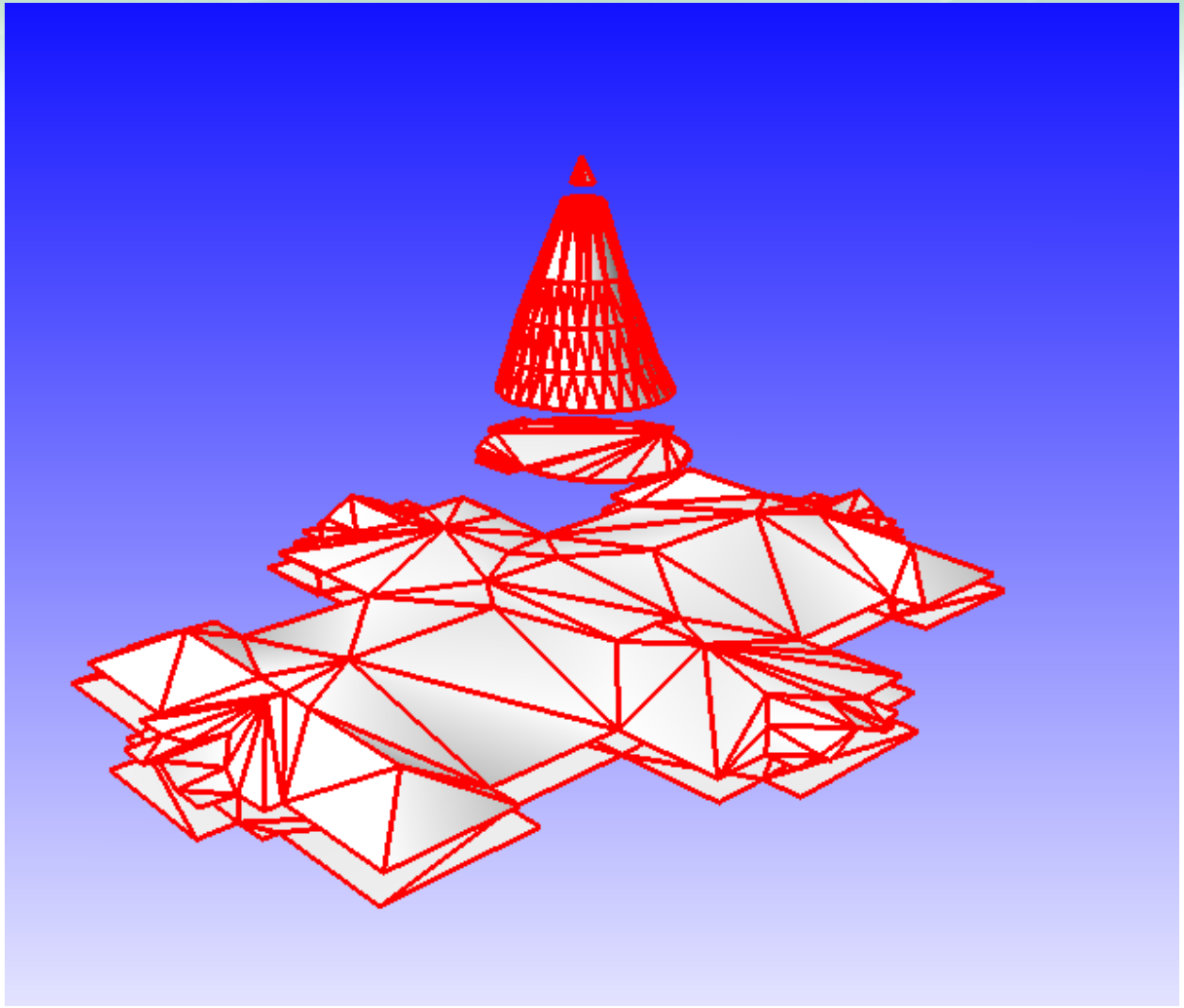
Image classification in combination with dense surface model IDs building (complex) to be extracted

Automated Building Reconstruction

Extrude / intersect roof polygons to each other

Extrude completed roof geometry to the DTM (ie 2.5D)

Phototexture from UltraCam images



Automated Building Reconstruction

Extrude / intersect roof polygons to each other

Extrude completed roof geometry to the DTM (ie 2.5D)

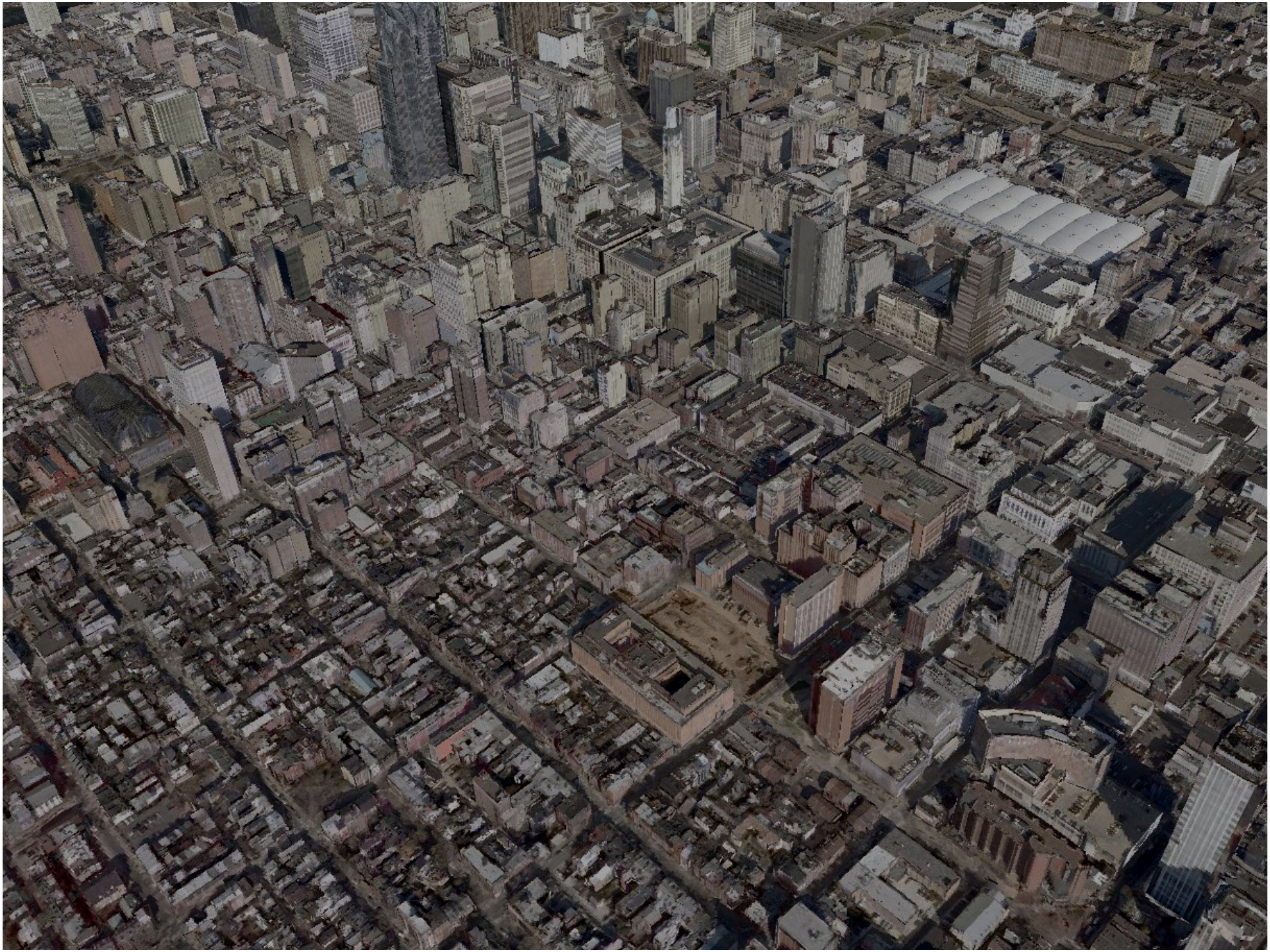
Phototexture from UltraCam images

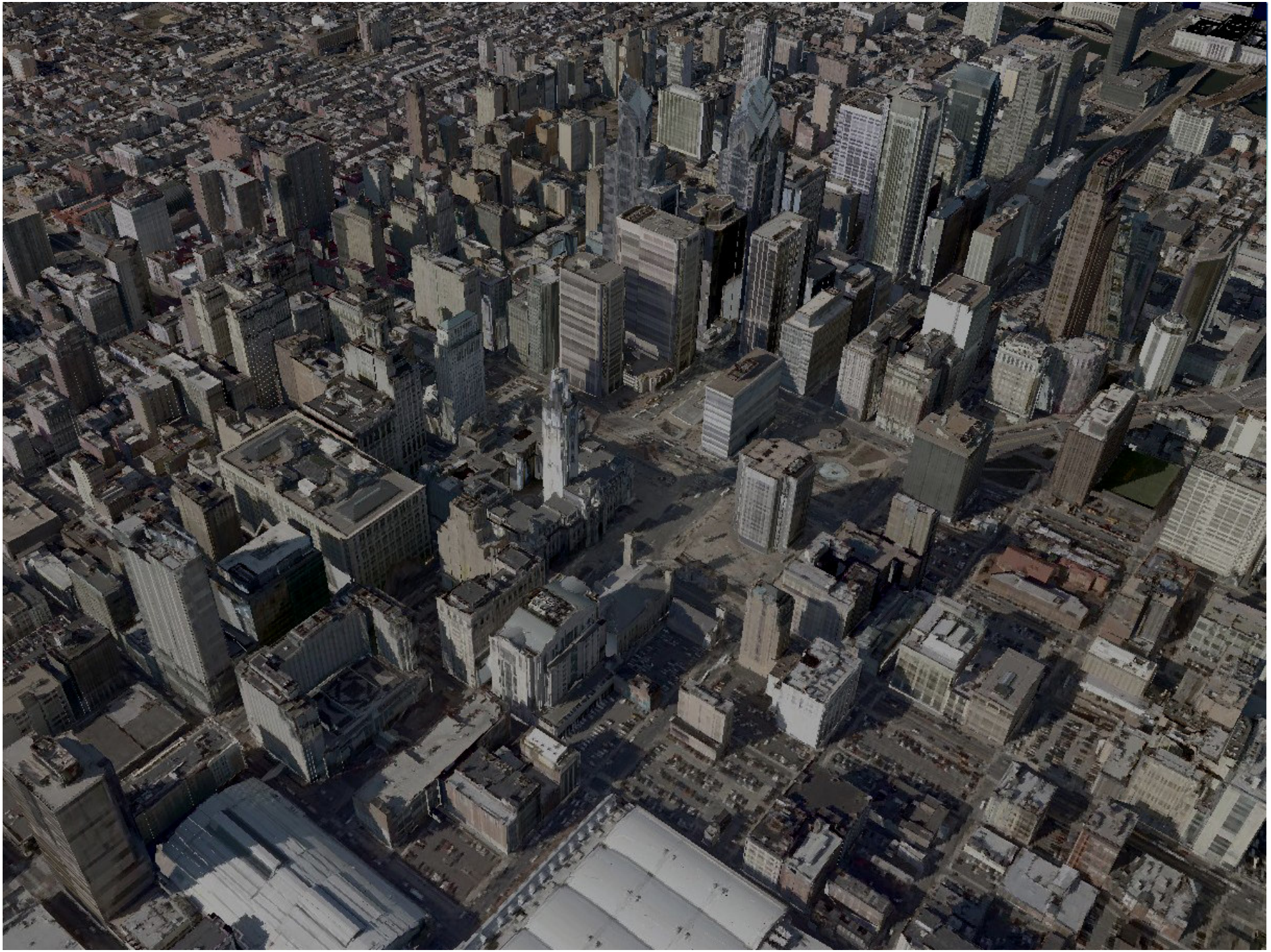
Automated Building Extraction

Combined with DEM and Ortho in Virtual Earth

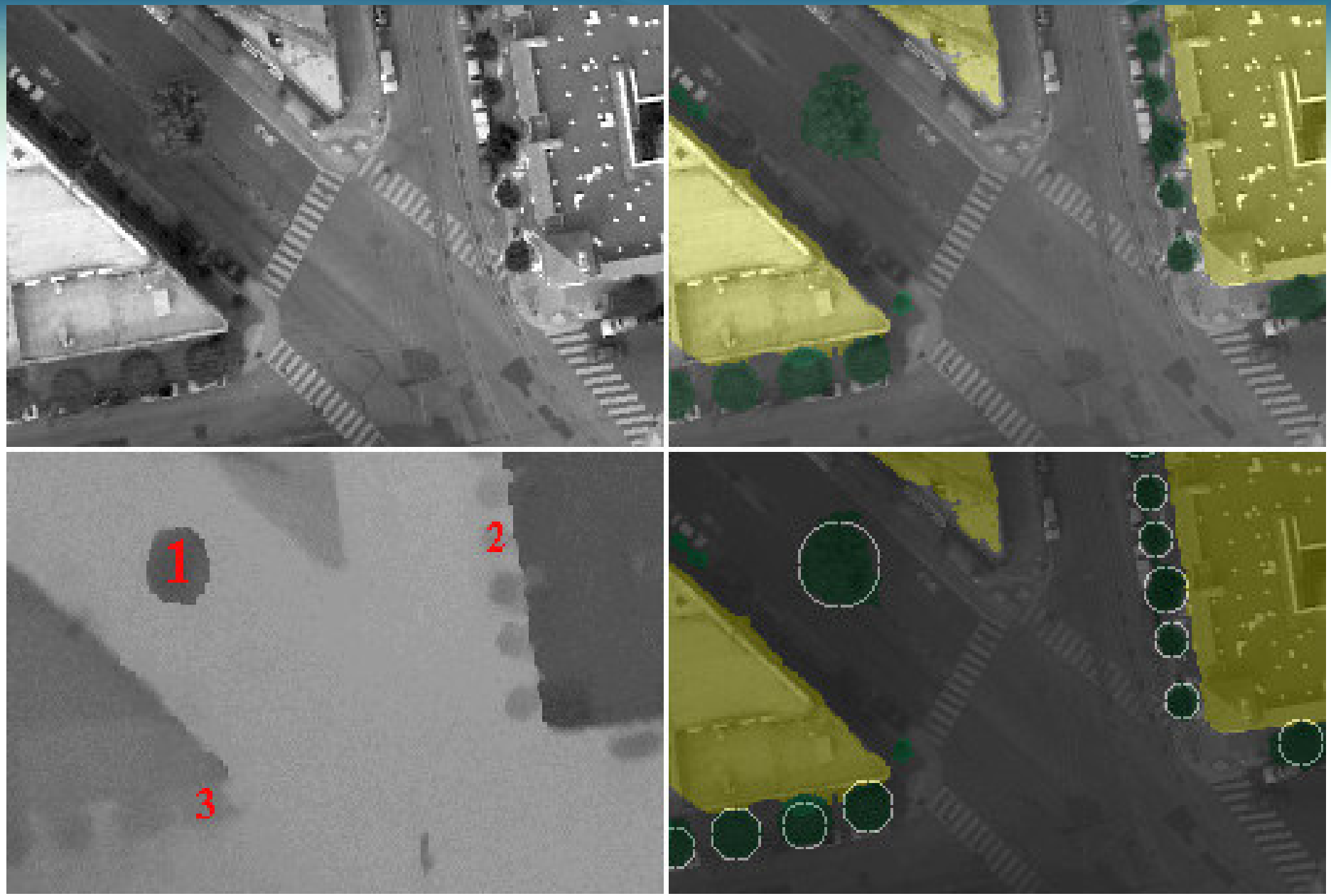
Automated City Model

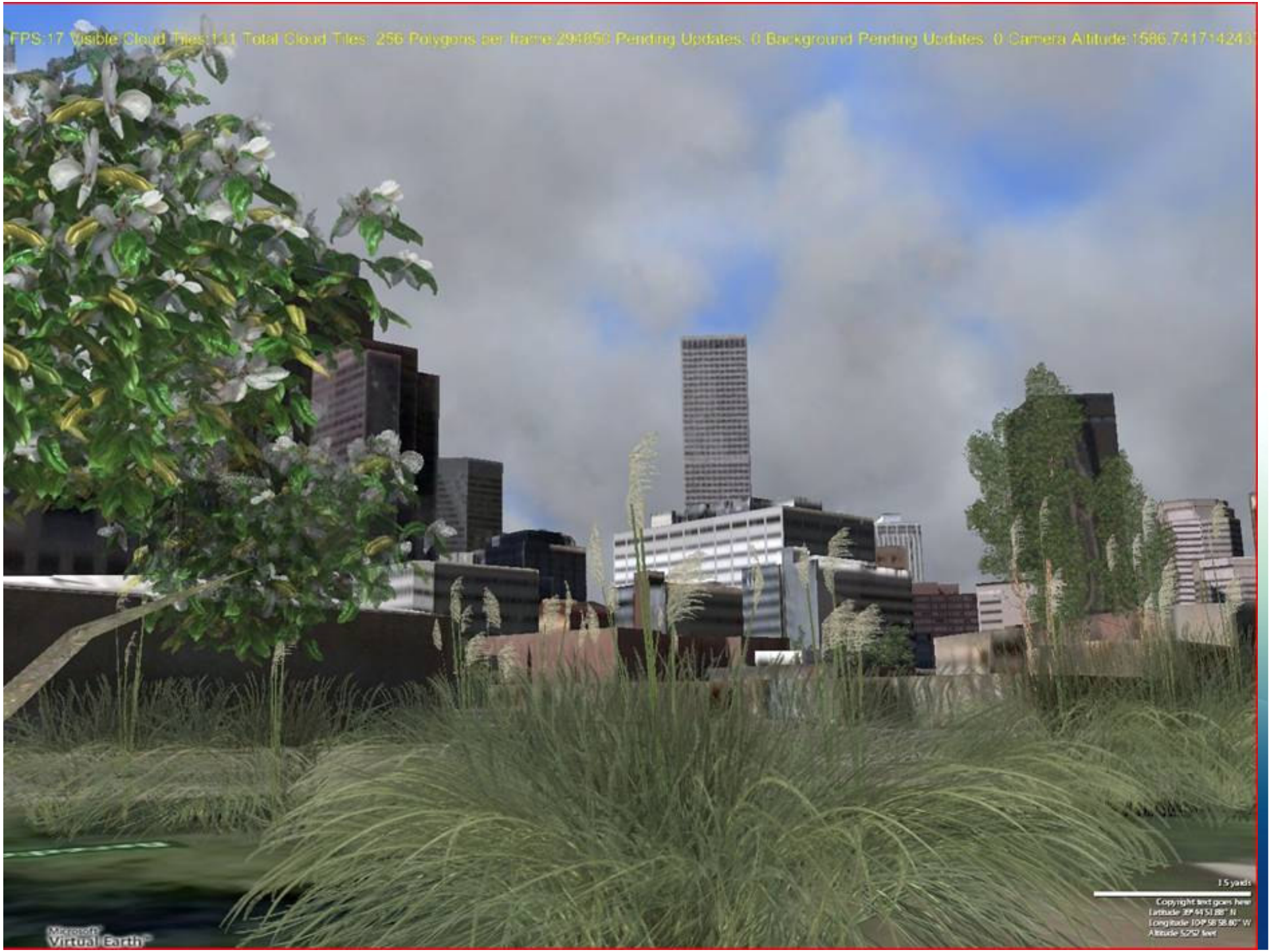
Philadelphia created fully automated using UltraCAM D imagery collected by commercial flyer

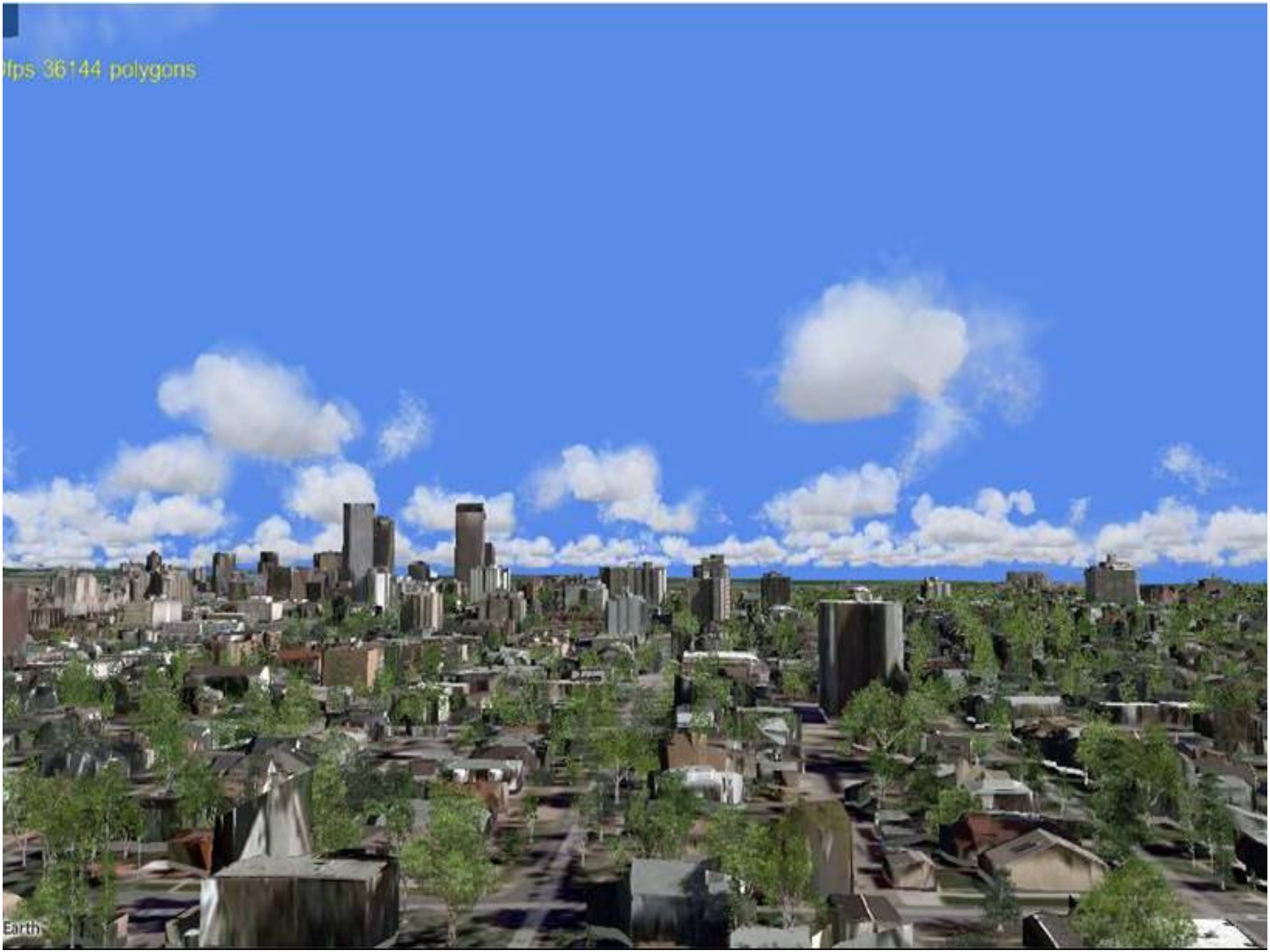




Tree Detection




FPS:17 Visible Cloud Tiles:131 Total Cloud Tiles: 256 Polygons per frame:294850 Pending Updates: 0 Background Pending Updates: 0 Camera Altitude:1586.741714243
15 yards
Copyright text goes here
Latitude 39°44'51.88" N
Longitude 104°58'58.80" W
Altitude 5292 feet
Microsoft
Virtual Earth


fps 36144 polygons
Earth

Finding the way to the JACIE2008

Live Search Maps - Windows Internet Explorer

http://maps.live.com/?q=fairfax&FORM=MSNH&mkt=en-US#JnJ0cD1wb3MucWdya2JrOGpjM3J3X1dhc2hpbmd0b24rRHVsbGVzK0ludGVybmF0aW9uYWwrQWlycG9ydC

File Edit View Favorites Tools Help

Live Search Maps

Live Search Maps — Home Hotmail Spaces OneCare MSN — Sign in

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Businesses | People | Collections | Locations

Welcome | Directions | Collections | Share

Driving directions from Washington Dulles International Airport (airport), United States to Fairfax, Virginia, United States

Show: Start details | Map all | Send to...

Start: **Washington Dulles International Airport (airport), United States**
Save this location · Edit

Trip: **15.1 mi, 25 min**

1	Depart **Propeller Ct**	
2	Turn **right** onto **Cargo Dr**	0.4 mi
3	Road name changes to **Aviation Dr**	0.5 mi
4	Take ramp **left** for **Dulles Airport Access Rd**	
5	Take **Dulles Airport Access Rd** and **SR-28 South / Sully Rd** to **Fairfax, Virginia, United States**	14.0 mi
6	Arrive at **Fairfax, Virginia, United States** *The last intersection is SR-123 / Chain Bridge Rd* *If you reach University Dr, you've gone too far*	

End: **Fairfax, Virginia, United States**
Save this location · Edit

Route options — Reverse

- (•) Shortest time
- ( ) Shortest distance
- [ ] Choose route based on traffic

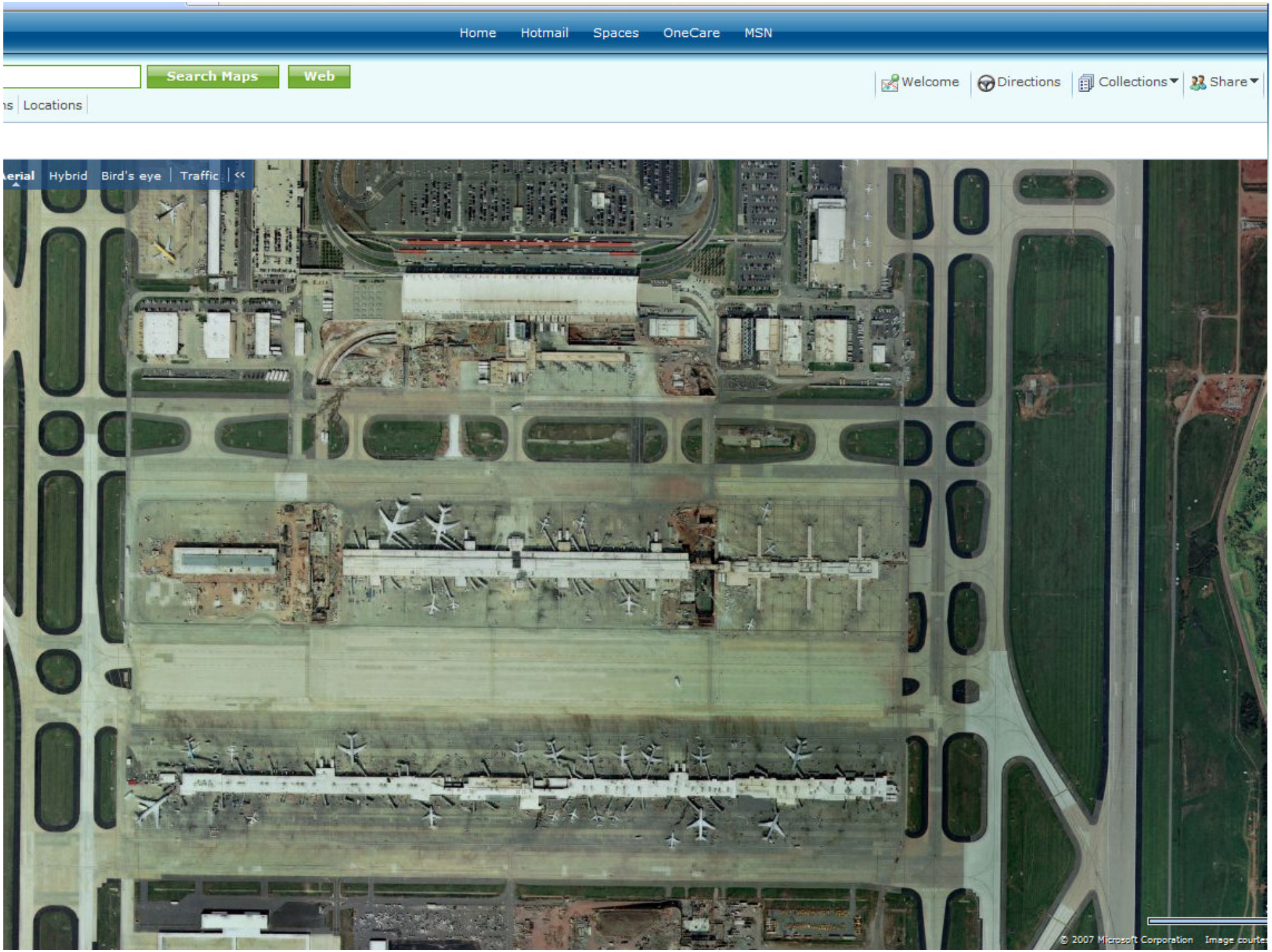
Recalculate directions

These directions are subject to the Windows Live Terms of Use and for informational purposes only. No guarantee is made regarding their completeness or accuracy. Construction projects

2D 3D | Road | Aerial | Hybrid | Bird's eye | Traffic

Washington-Dulles International Airport
Dulles Airport Access Rd
Herndon
Reston
Chantilly
Oakton
Fairfax
Centreville
Fairfax City
Lake Fairfax County Park
Cub Run Stream Valley Park
Great Falls Park
Chesapeake & Ohio Canal National Historical Park
2.5 miles

Microsoft Virtual Earth


Home
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Spaces
OneCare
MSN
Search Maps
Web
Welcome
Directions
Collections
Share
Locations
Hybrid
Bird's eye
Traffic
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Intern

70 yd
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