Flight planning for city acquisition at high resolution

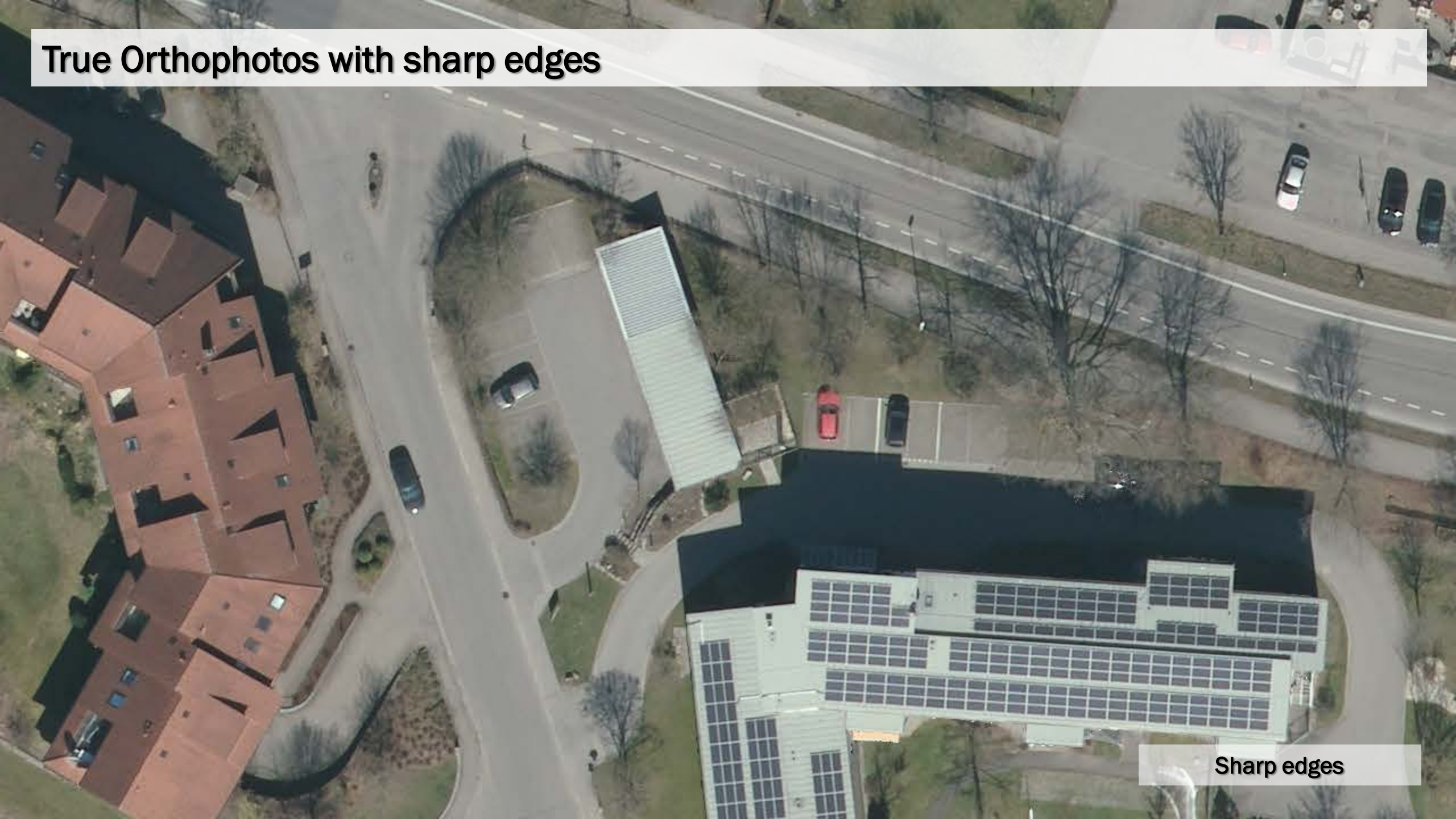
EuroSDR Workshop
Oblique Cameras & Dense Image Matching

Southampton, 19th of October 2015

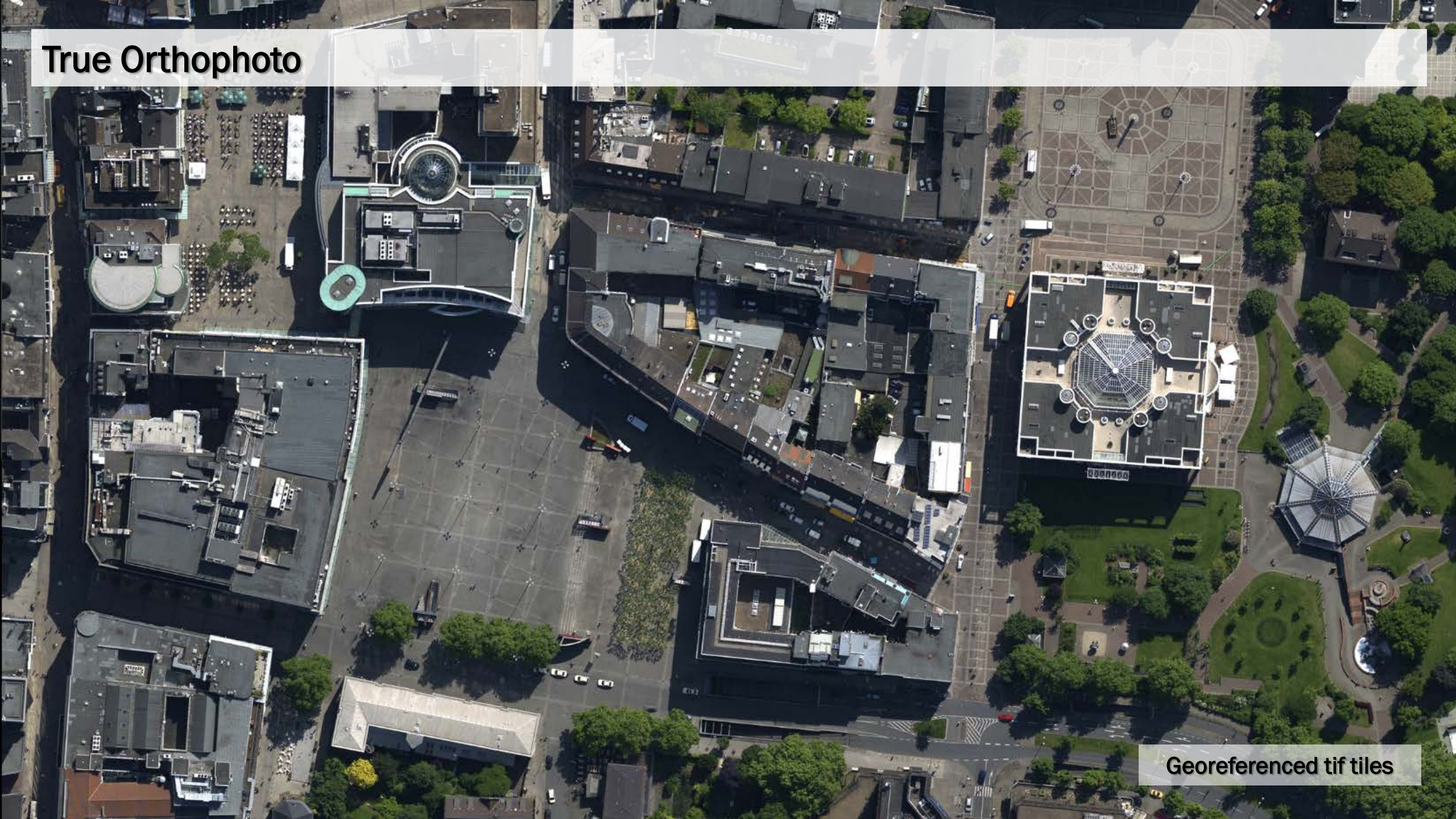
Konrad Wenzel - nFrames

DSM & automatic True Orthophoto

True Orthophotos with sharp edges

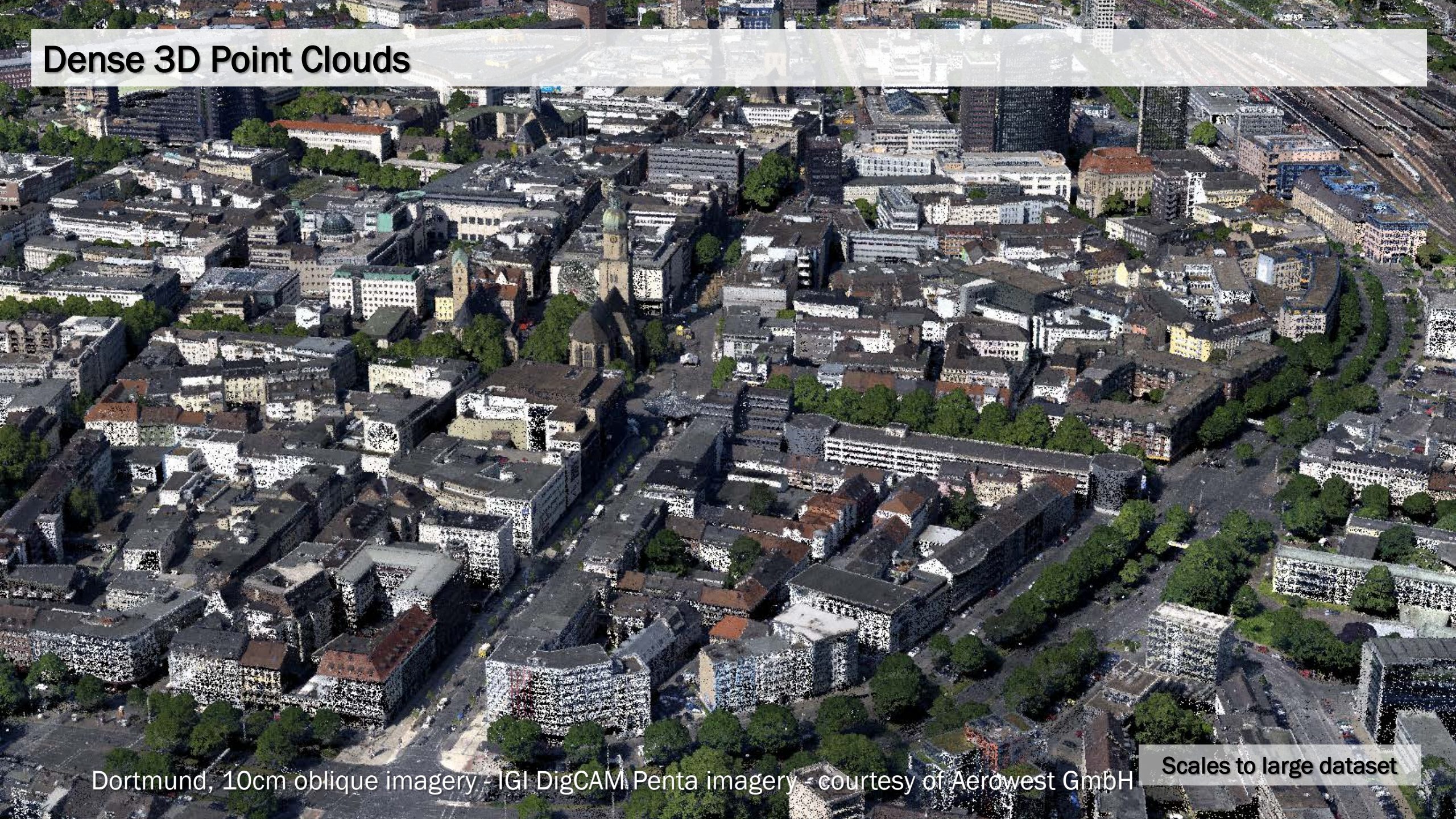


True Orthophoto



Georeferenced tif tiles

Dense 3D Point Clouds

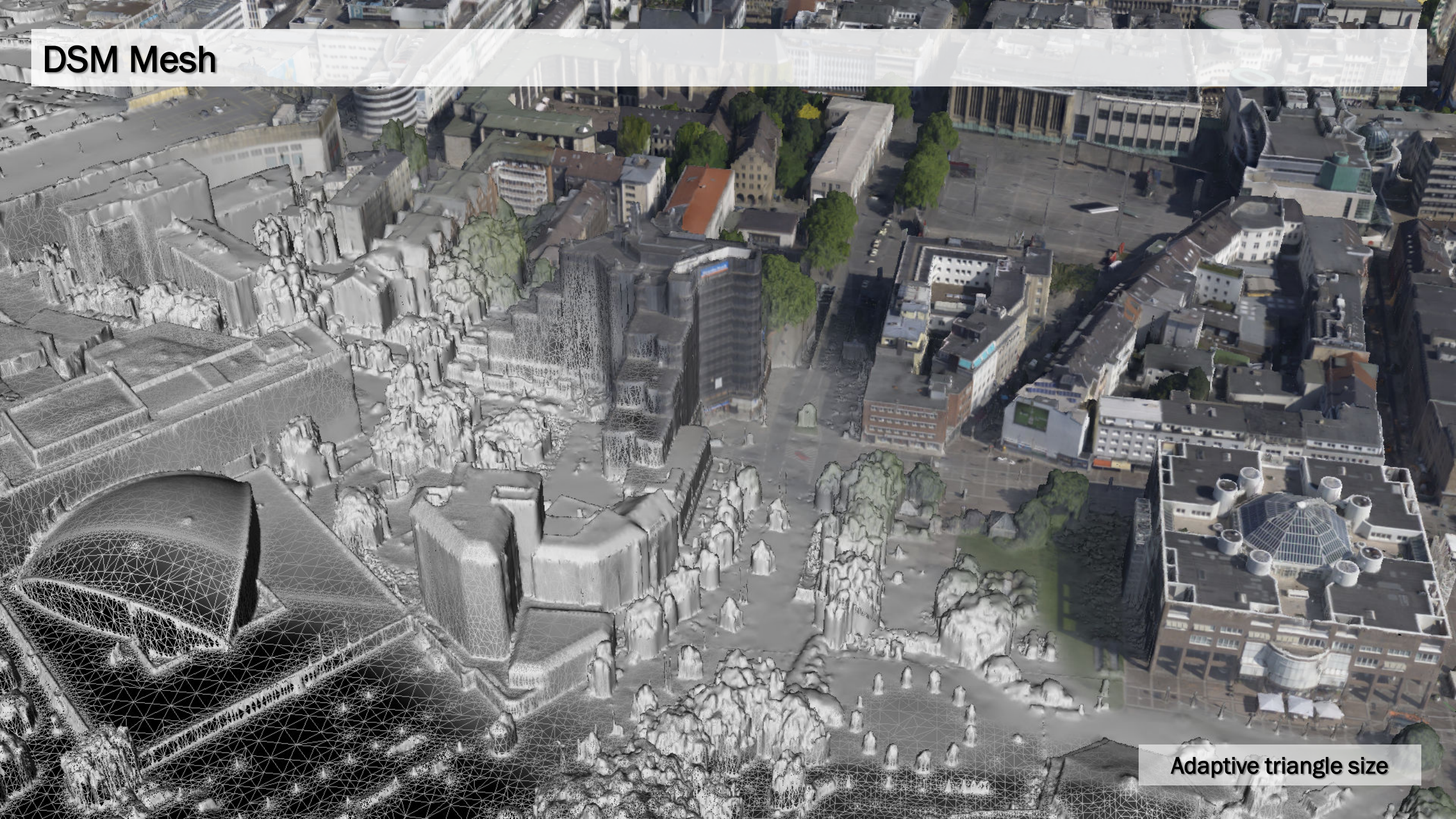


Dortmund, 10cm oblique imagery - IGI DigCAM Penta imagery - courtesy of Aerowest GmbH

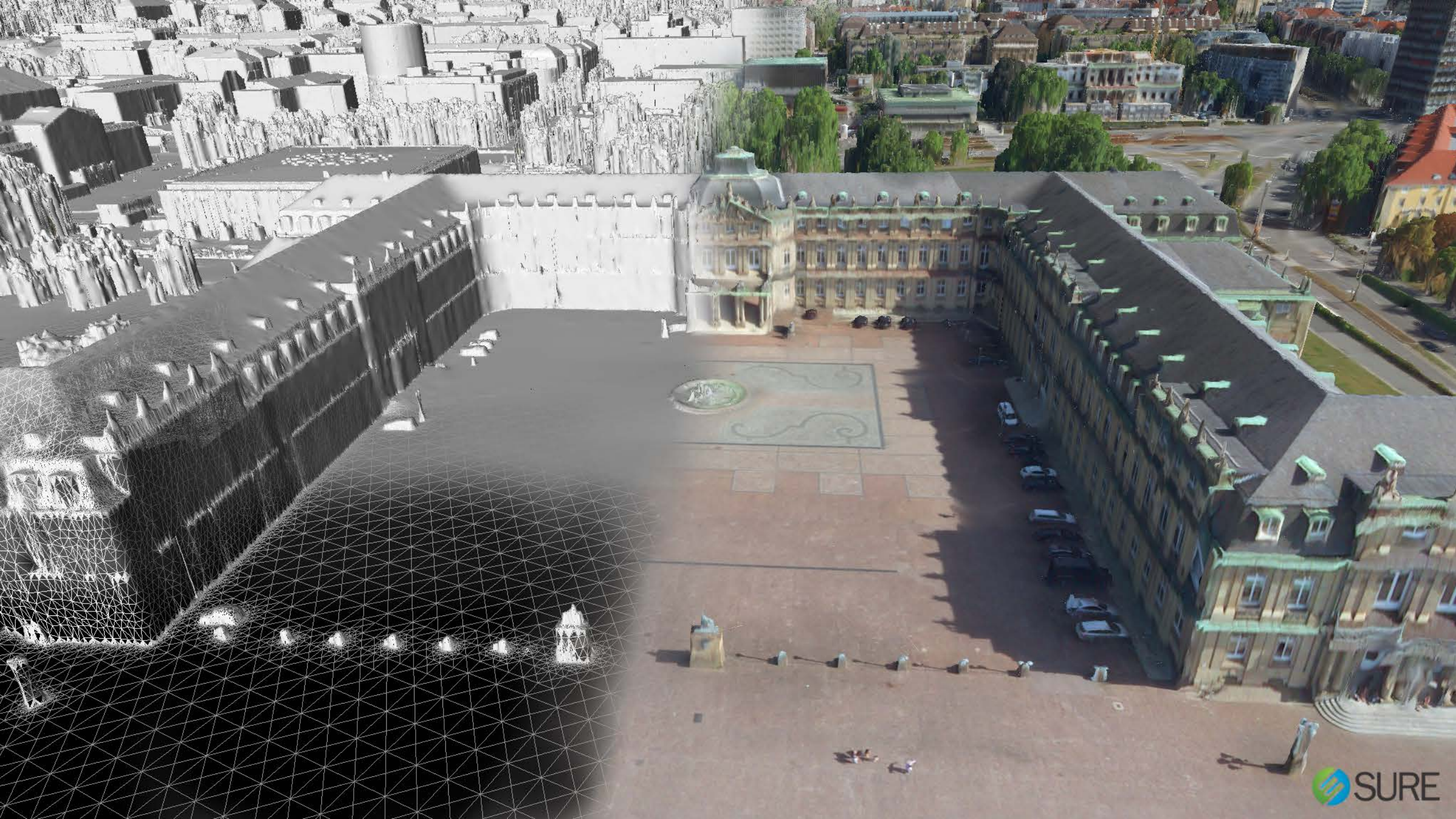
Scales to large dataset

Dense 3D Point Clouds

DSM Mesh




DSM Mesh


SURE

Flight planning for city acquisition at high resolution

Best practice?

SURE

Flight planning - objective

Quality

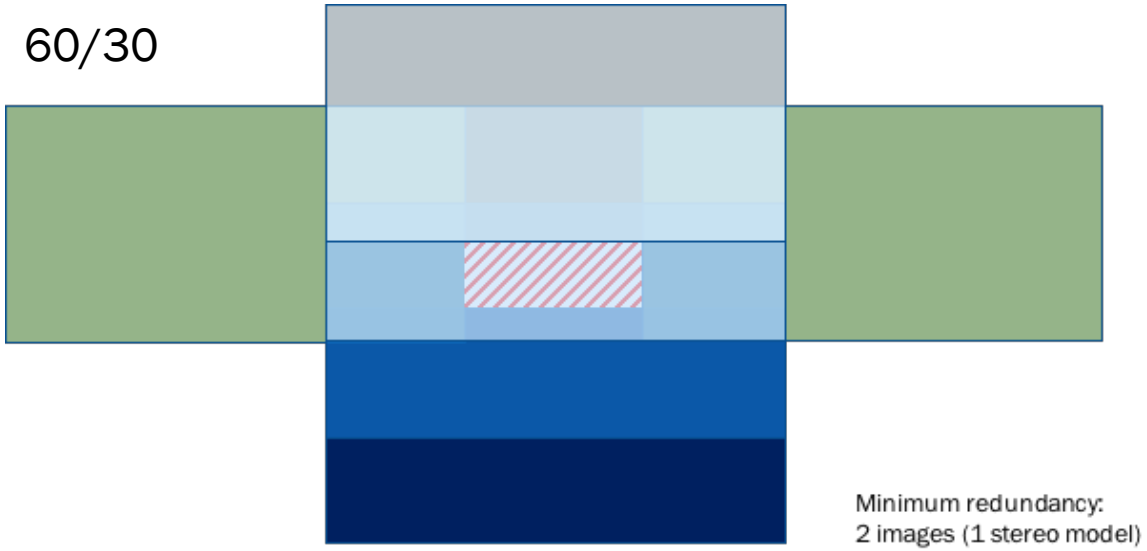
- Precise results
  - Sharp geometry and texture

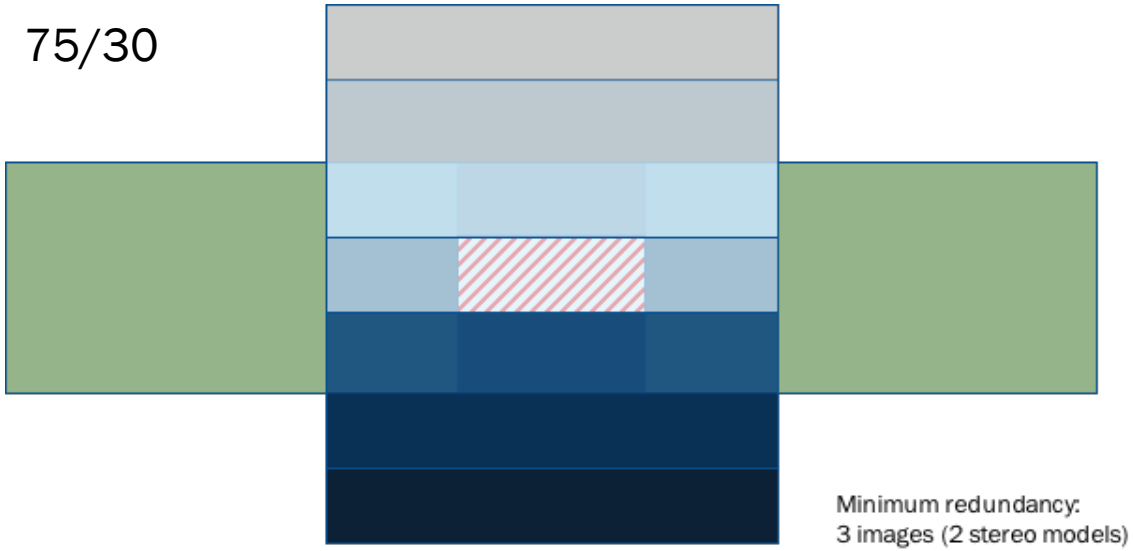
Productivity

- Efficient acquisition
  - Minimal amount of flight lines
- Efficient processing
  - As less manual editing as possible

Nadir imaging – typical flight planning

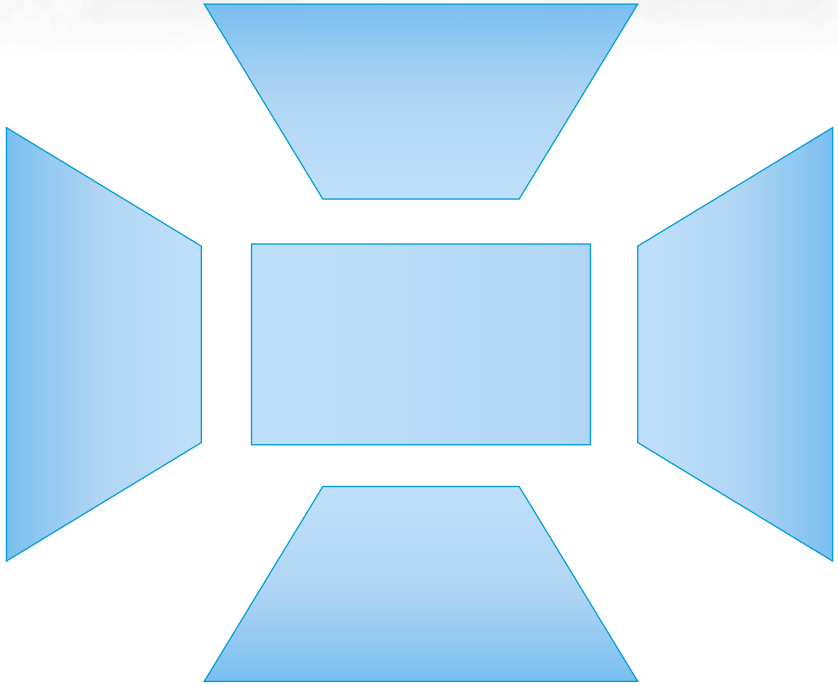
- Based on DTM projections
- Definition of ground sampling distance
- In & across strip overlap
  - Formerly 60/30% – minimum number of images
  - Now typically 80% forward overlap



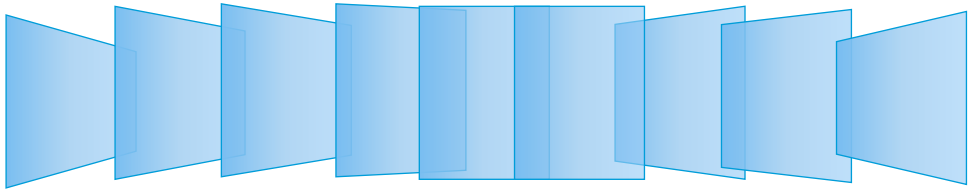


Oblique imaging

» **Medium frame camera systems**
- Typically Maltese Cross configuration
- >= 5 camera heads
- Different camera tilts – 30° vs. 45°
- Current examples:
  - Leica RCD 30
  - IGI PentaCam,
  - Microsoft Osprey
  - Track'Air MIDAS systems ...



» **Small frame camera systems**
- Rigs of large amounts of cameras
- Sweeping systems, such as the VisionMap A3

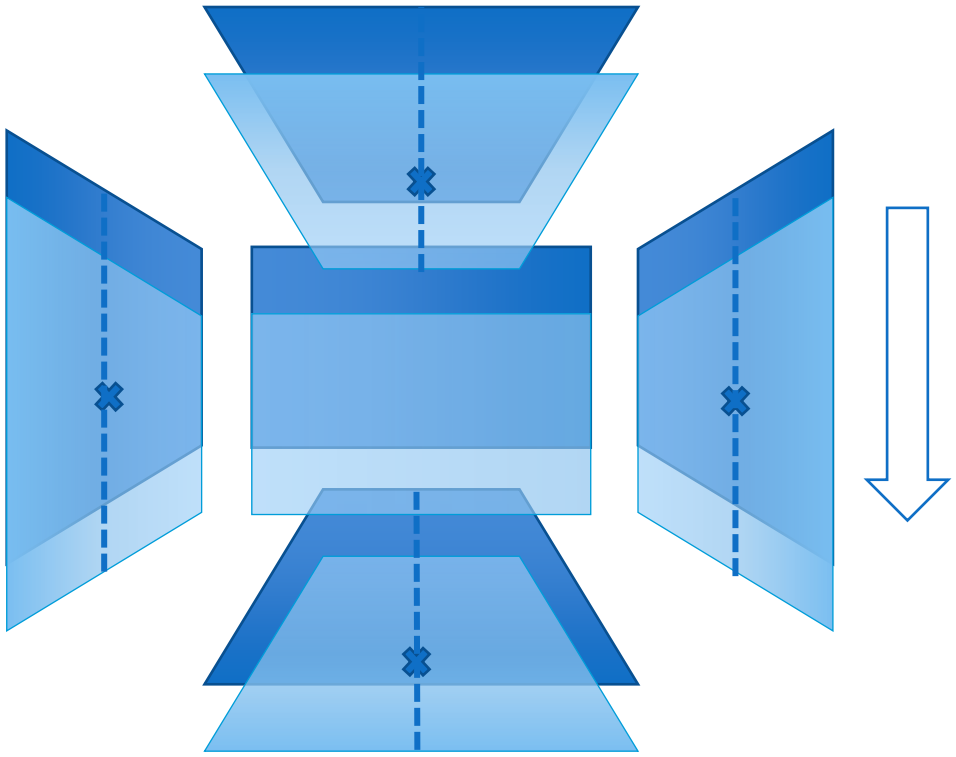


Oblique imaging – typical flight planning

» Lead parameter:
GSD and Overlap in Nadir frame

» Oblique GSD defined in image center

» Oblique overlap defined along center line in flight direction



Oblique imaging – results from the FBK study

Ewelina Rupnik, Francesco Nex, Isabella Toschi, Fabio Remondino, 2015
Aerial multi-camera systems: Accuracy and block triangulation issues.
ISPRS Journal of Photogrammetry and Remote Sensing, Vol. 101, pp. 233–246

» Simulated and real case studies for several oblique setups

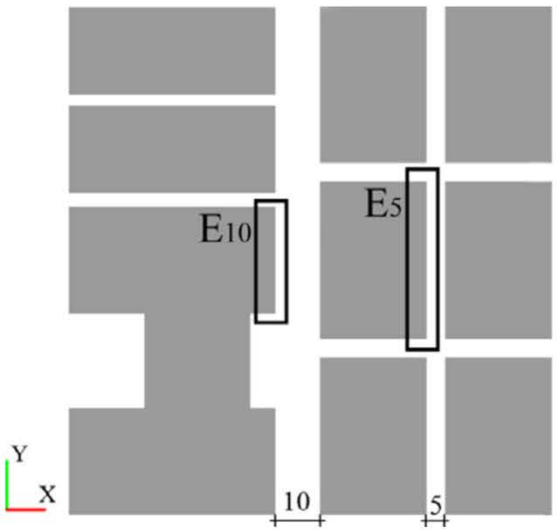
➔ Oblique images
- **increase 3D precision** and accuracy through redundancy
- **increase block stability**

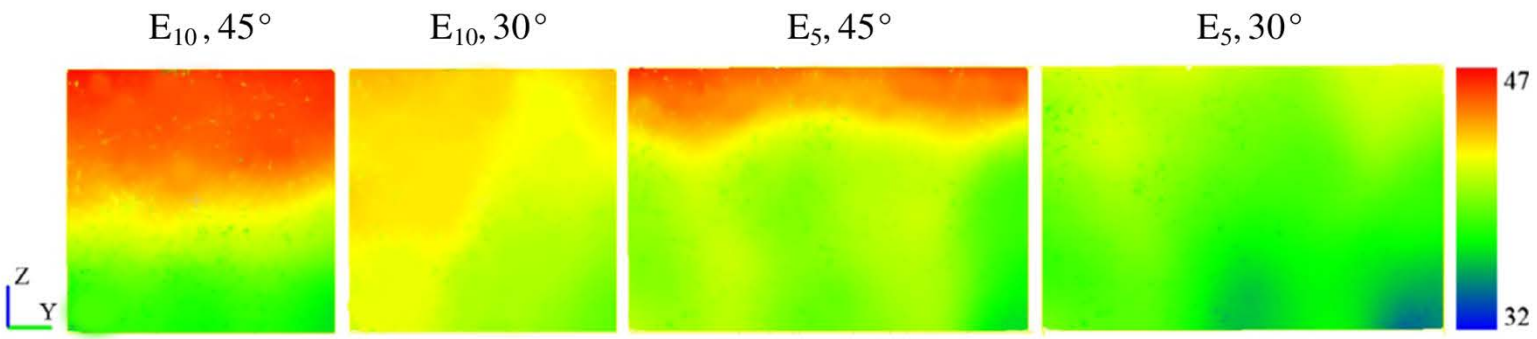
➔ 80/60 can be a compromise between data quality and flight productivity
- More should be considered for urban complex scenes

Oblique imaging – camera tilt

» 45 degrees versus 30 degrees tilt angle

» Intersection geometry & façade visibility versus homogeneous coverage

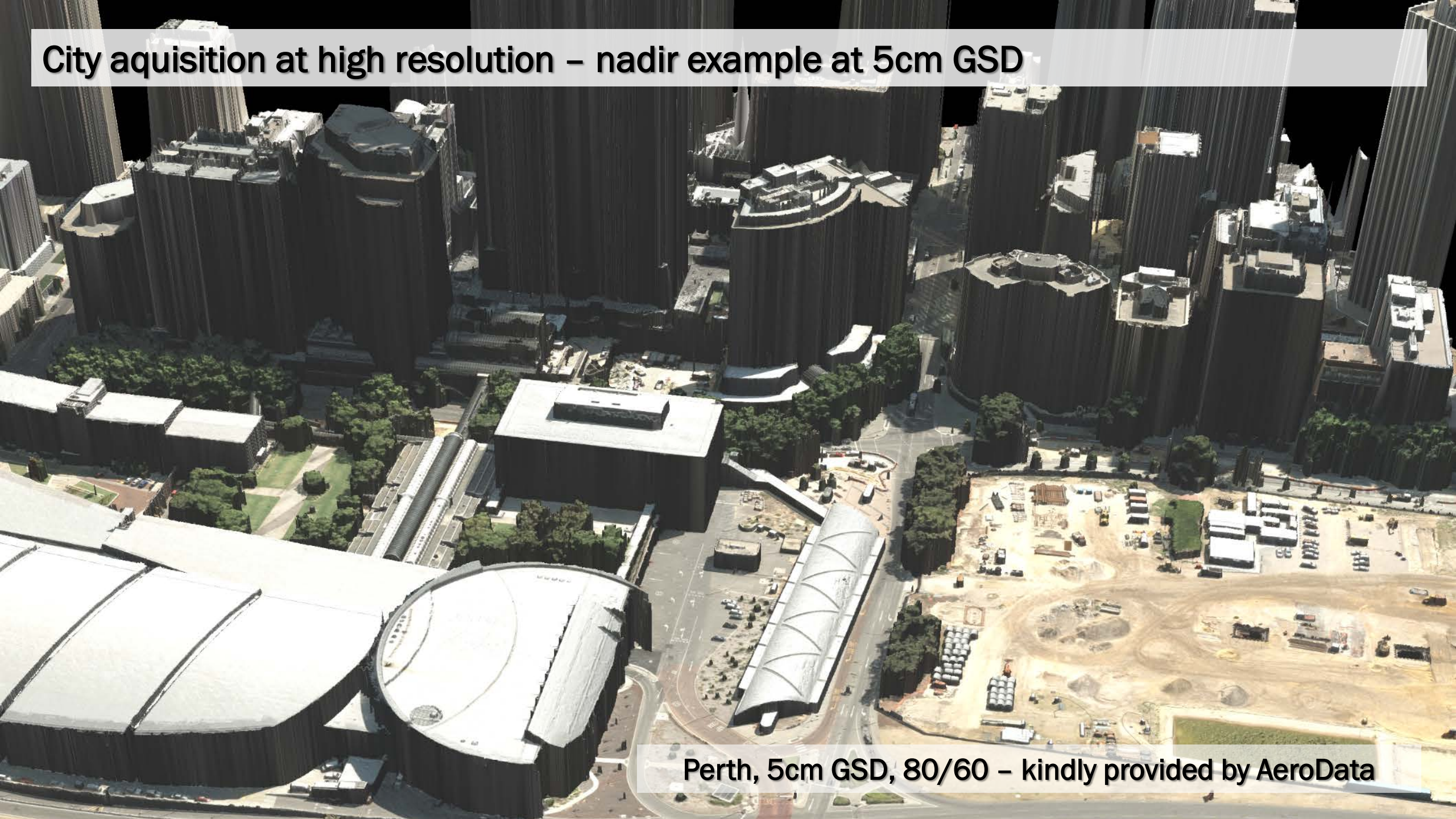




Rupnik et al, 2015

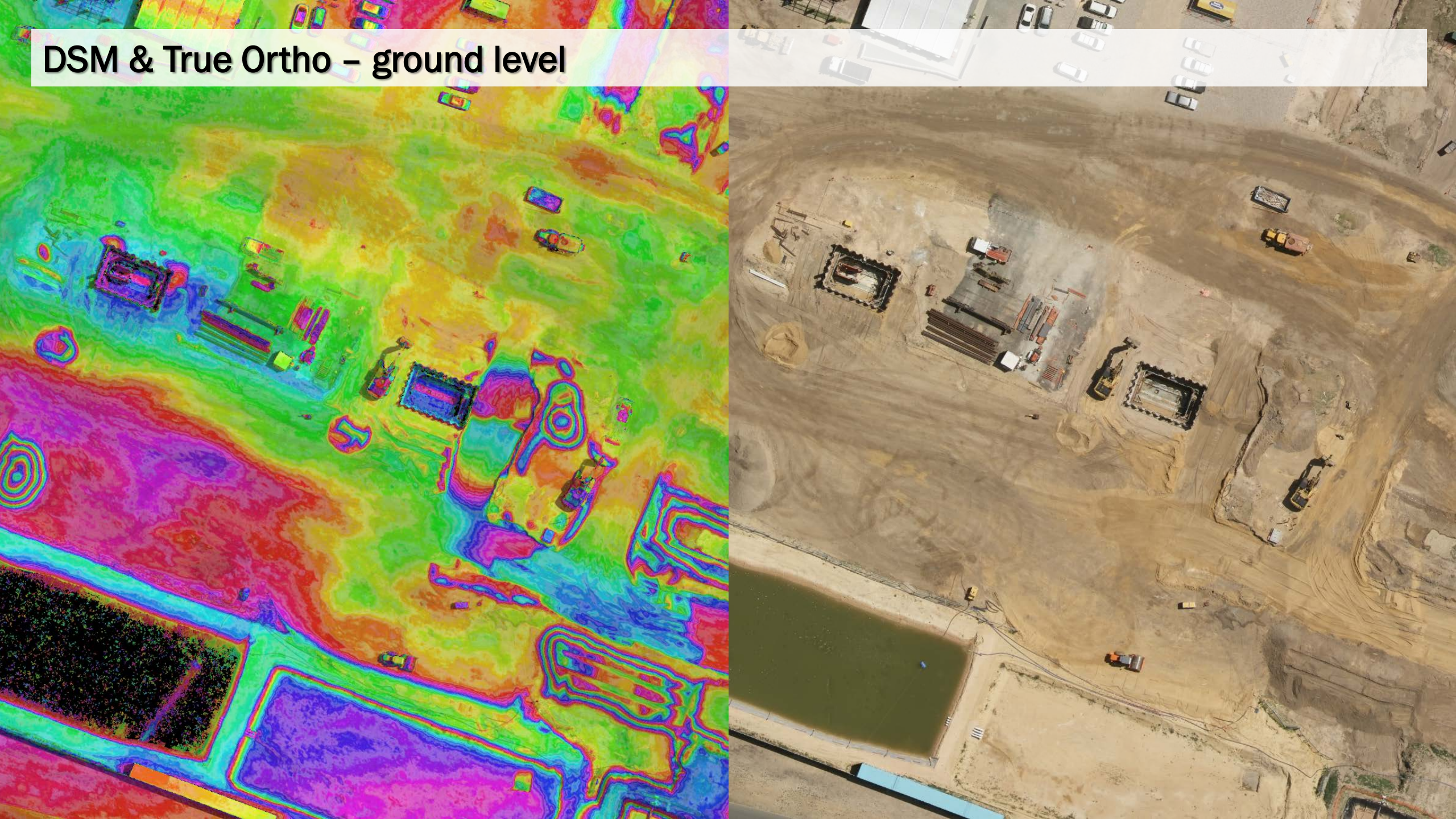
➔ terrain should be taken into account for flight planning

City aquisition at high resolution – nadir example at 5cm GSD



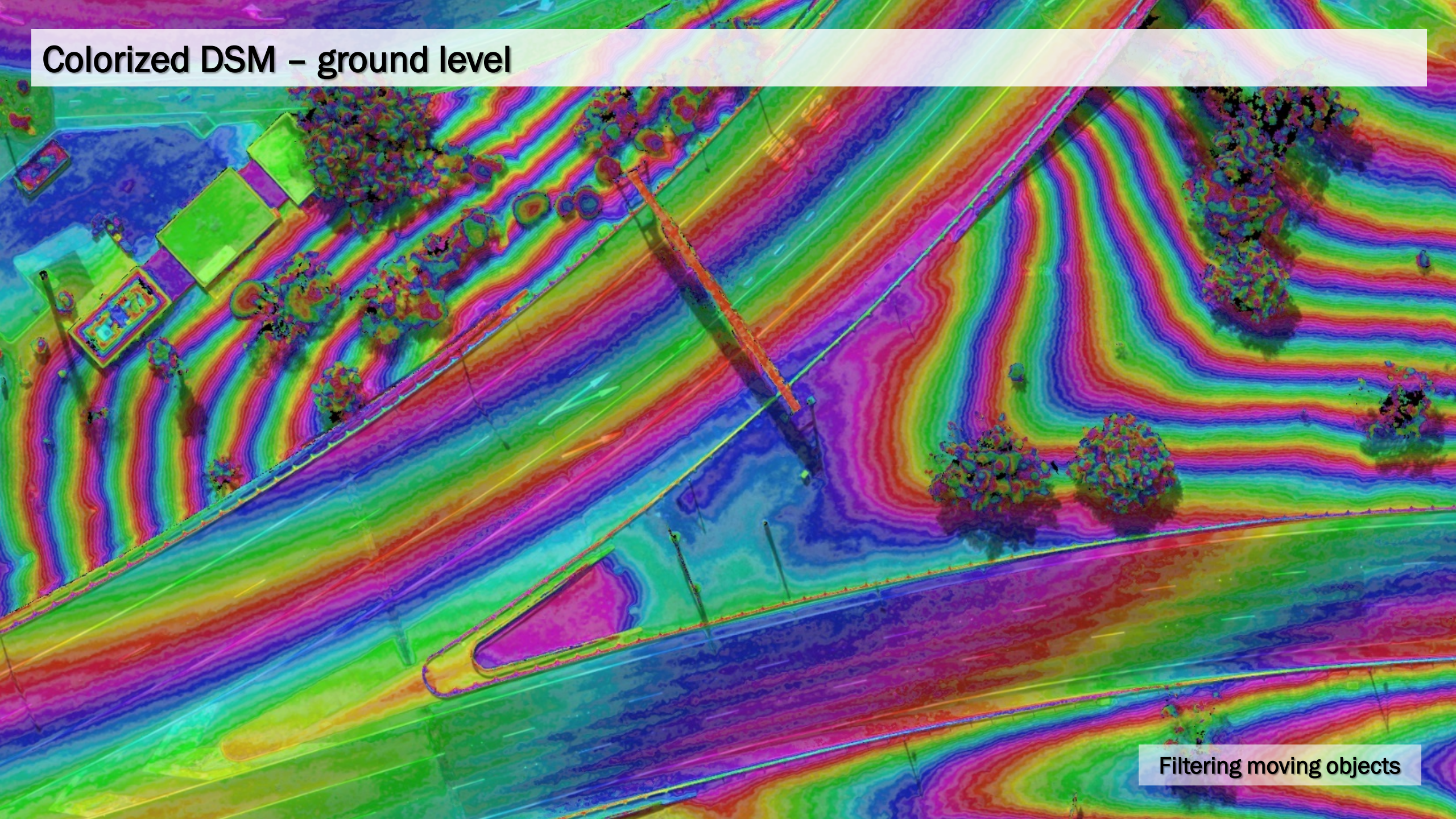
Perth, 5cm GSD, 80/60 – kindly provided by AeroData

DSM & True Ortho – ground level



True Orthophoto – ground level

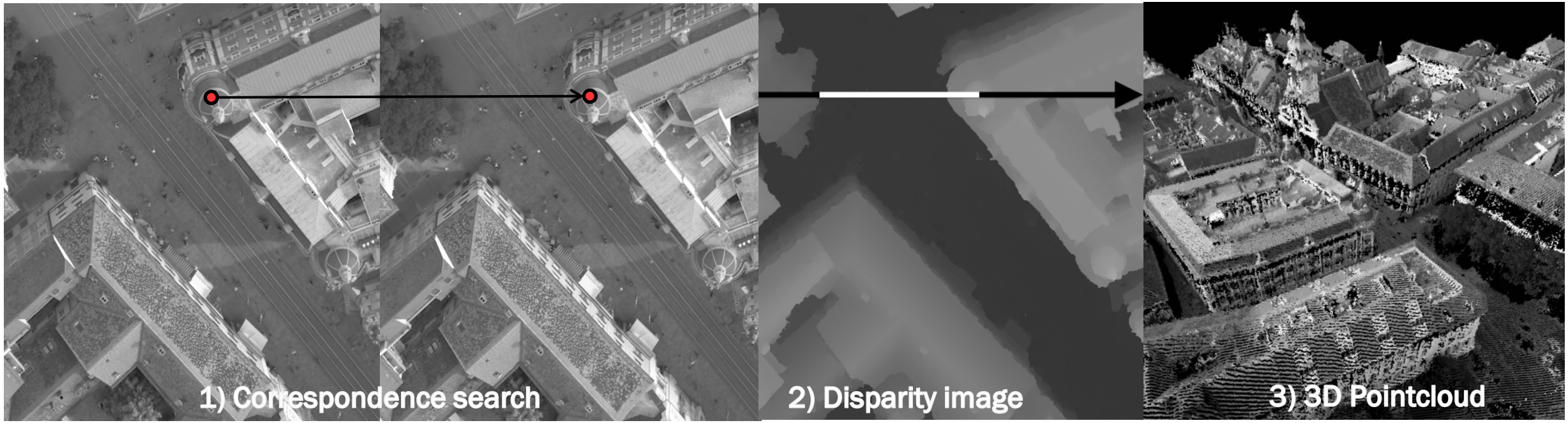
Colorized DSM – ground level



Filtering moving objects

Dense Image Matching

Pixel correspondence search for depth estimation



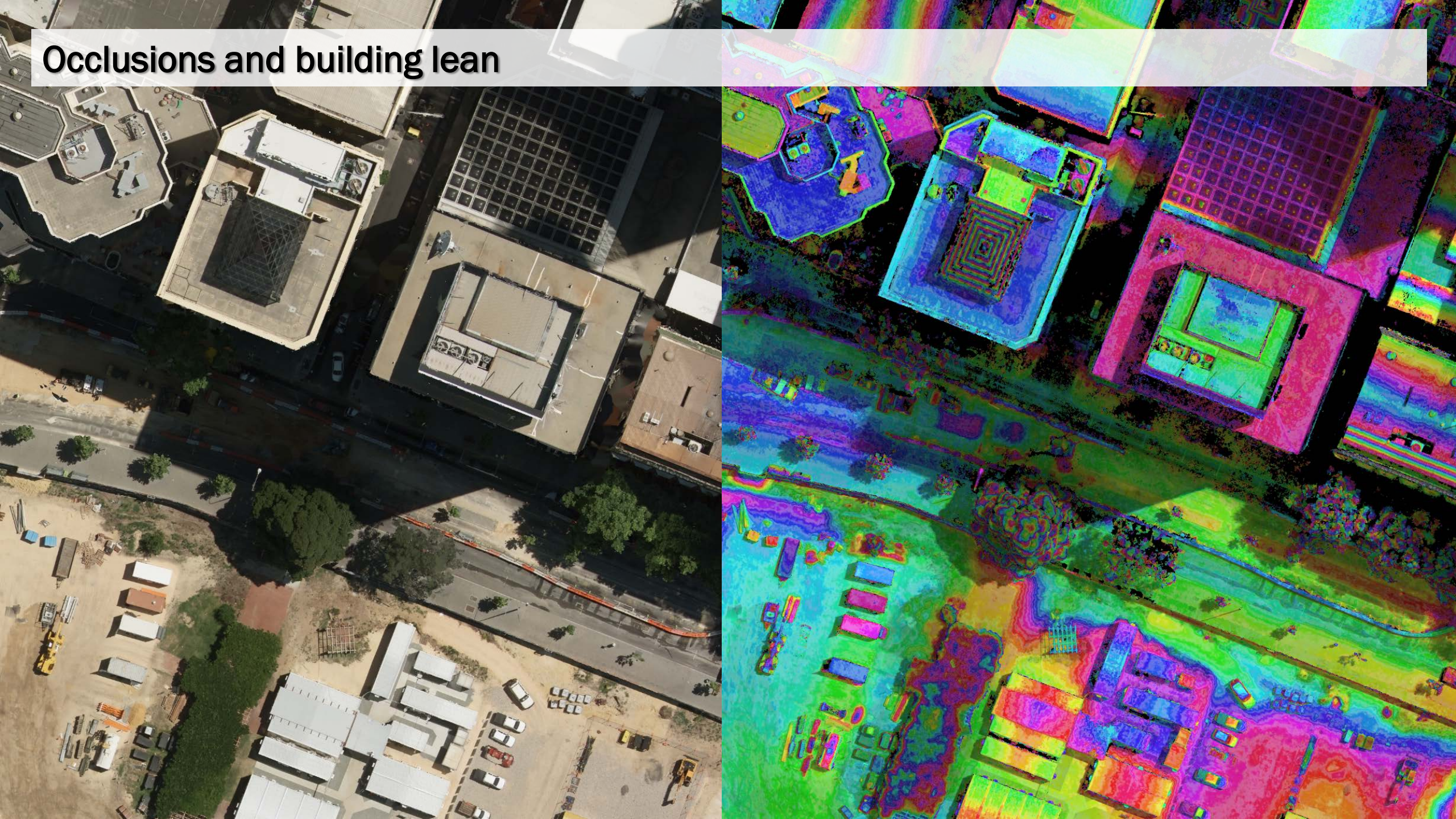
➔ Relies on image similarity

Occlusions and building lean

Brookfield place building - 234m

Occlusions and building lean

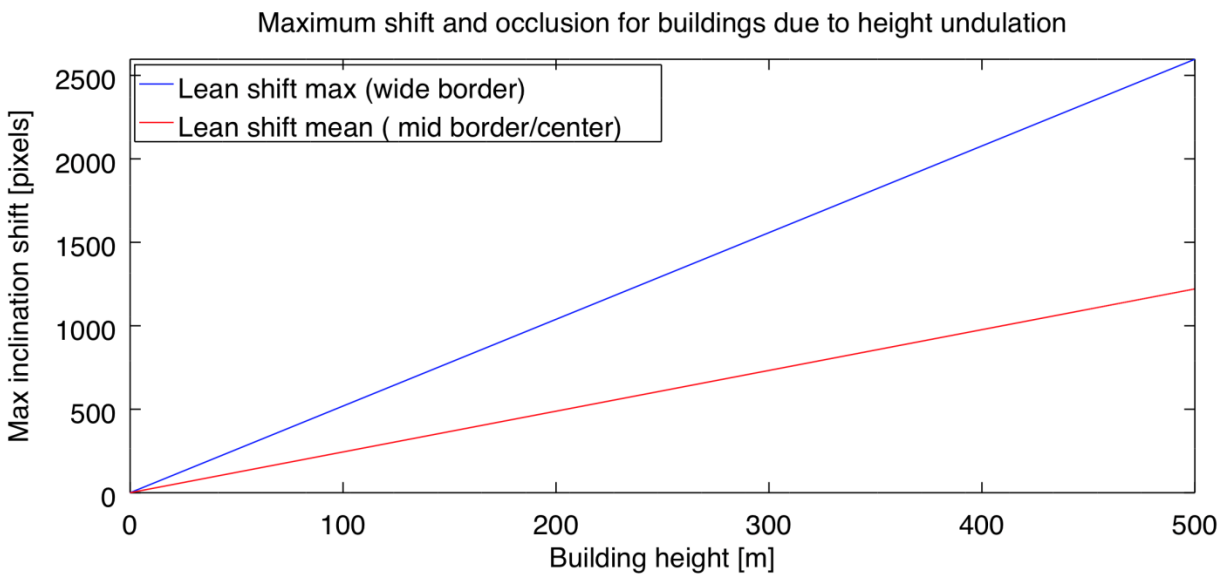
Occlusions and building lean

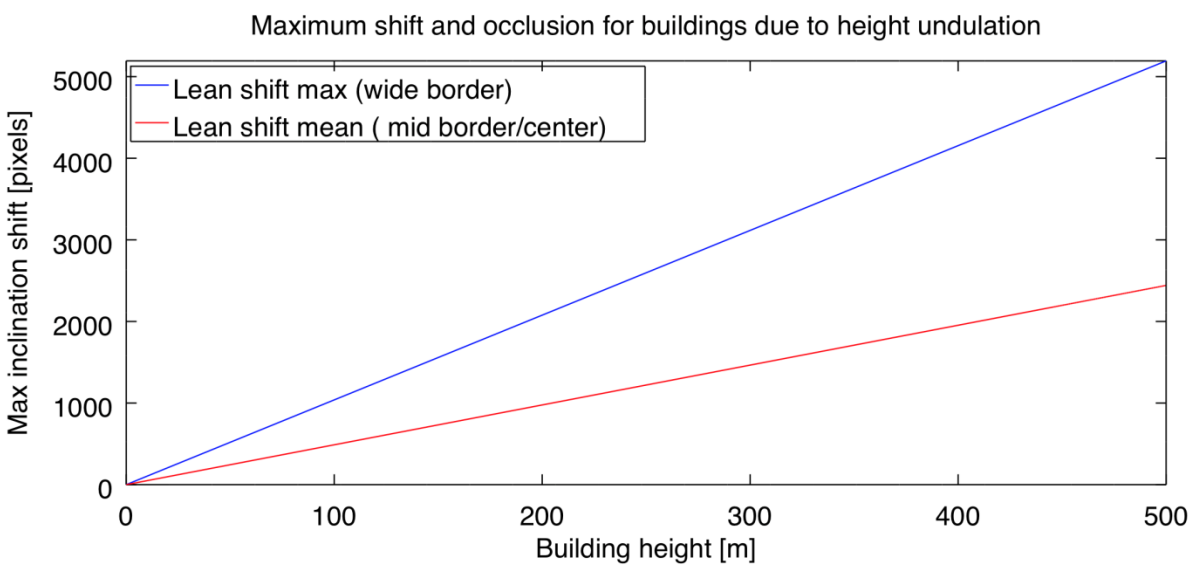


Occlusions and building lean

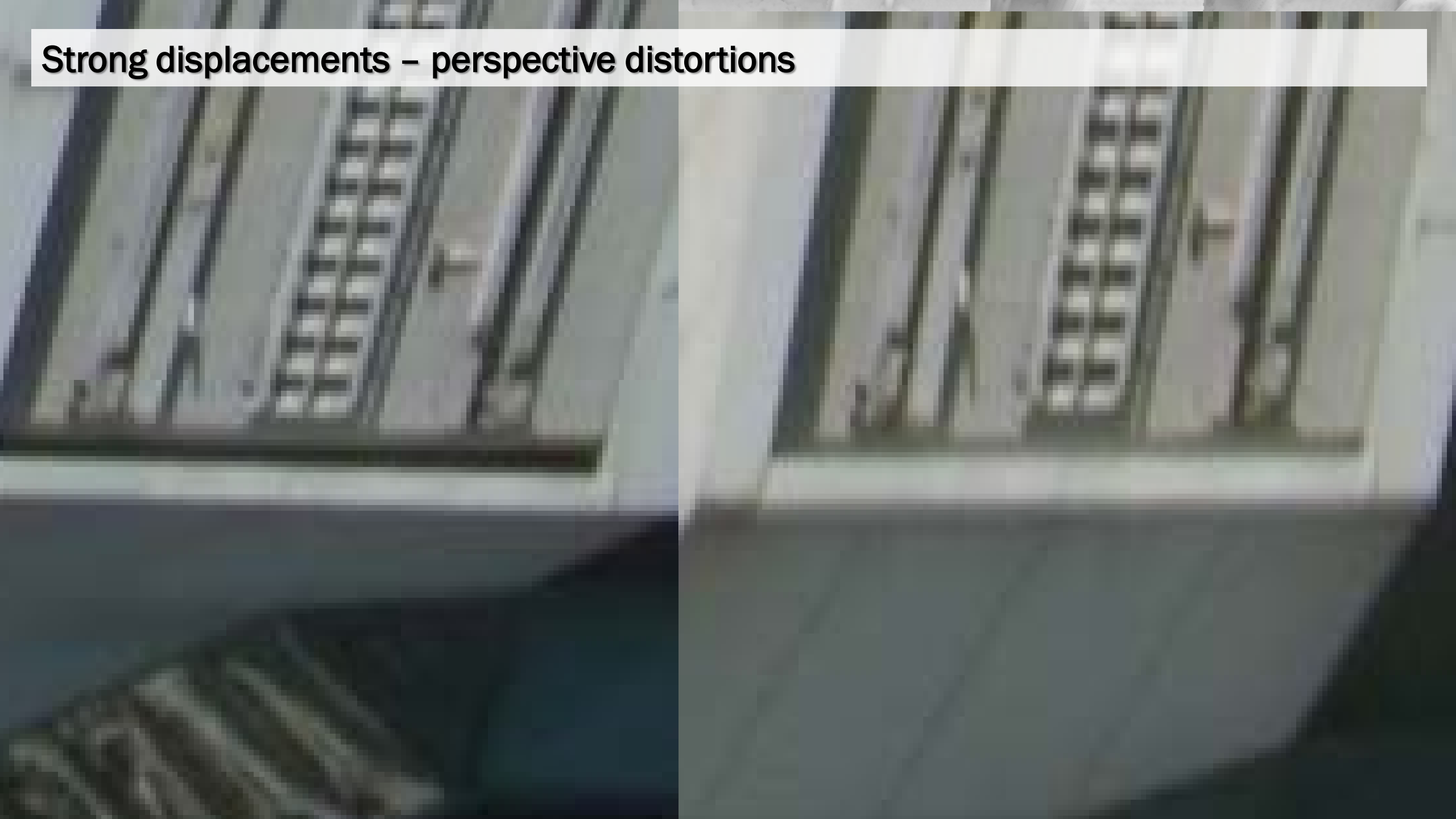
10cm GSD vs. 5cm GSD – lean displacement

» Linear relation



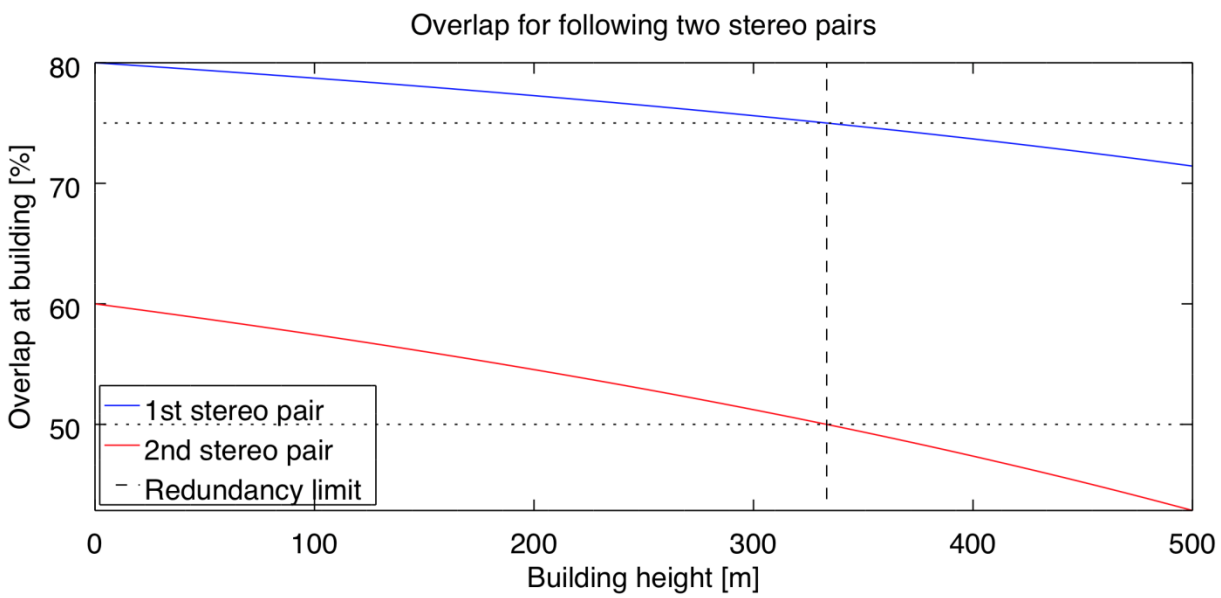


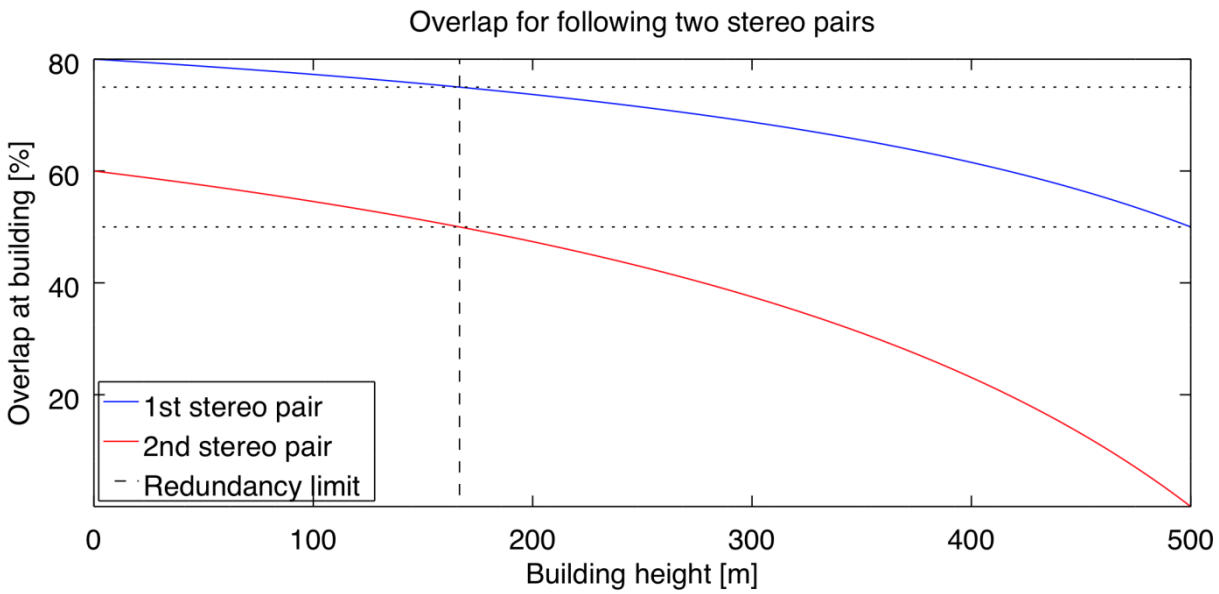
Strong displacements – perspective distortions



10cm GSD vs. 5cm GSD – loss of overlap

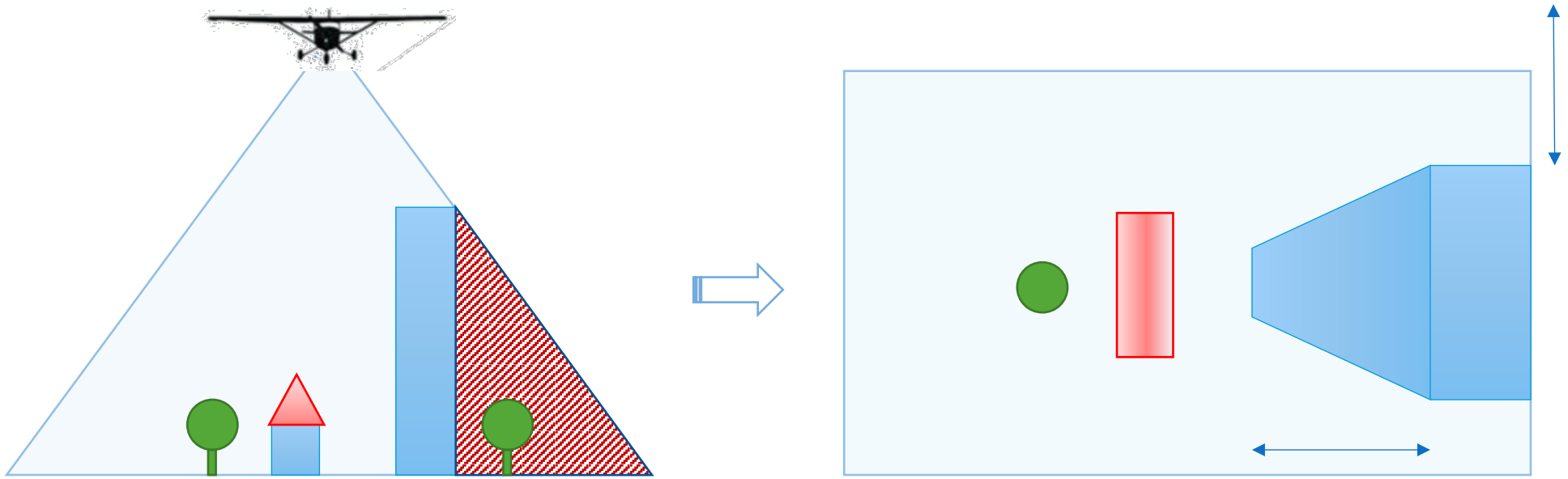
» Corresponds to displacement





Challenges from terrain displacement

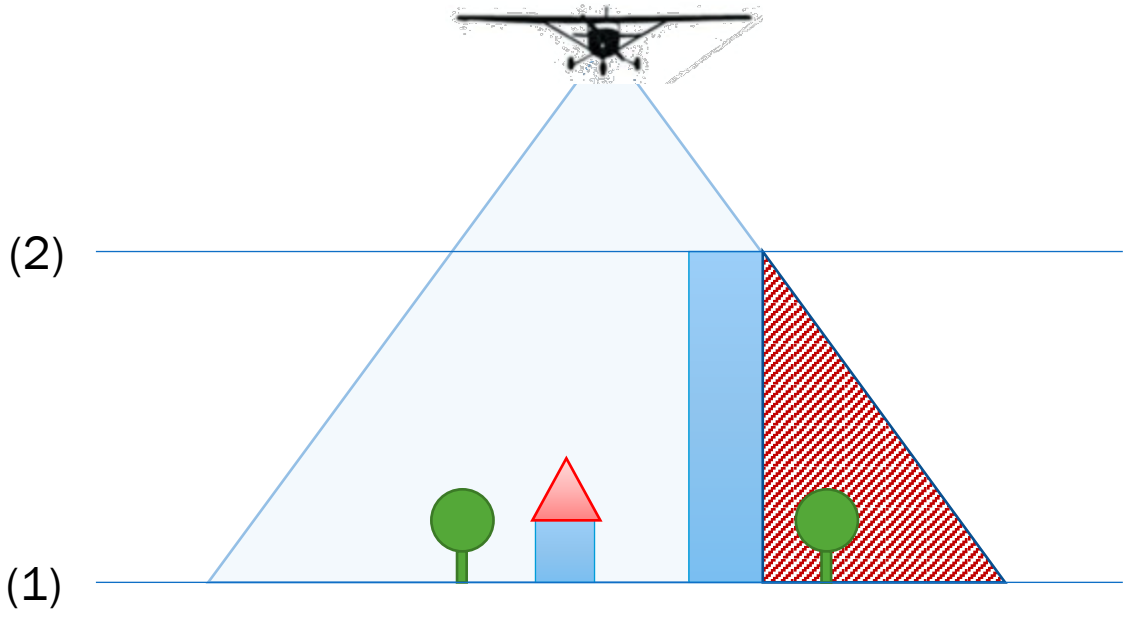
» Pixel shifts untreated in the traditional flight planning
- Occlusions
- Perspective distortions
- Insufficient overlap



Solutions

1) Carry out flight planning at two levels
   - Minimum (1) and maximum (2) ground level
   - Overlap !>= 75%

2) Consider building lean
   - As angle **and** effective pixels



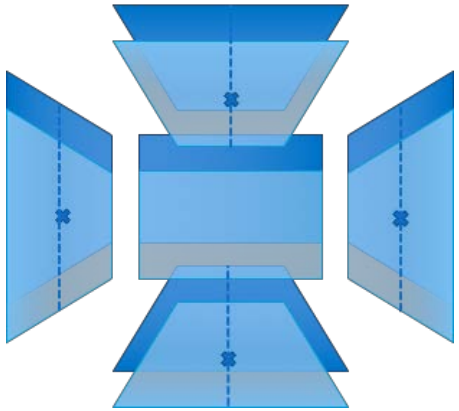
Conclusions and Outlook

» Dense matching products benefit from
- High image similarity
- Low amount of occlusions

➔ **Automatic True Ortho, Point Clouds and Meshes**

» Needs to be considered in Nadir flight planning

» Oblique images
- Help to resolve occlusions – but not image similarity requirement
- Oblique overlap should be > 75%
- Oblique tilt should be chosen according to flight altitude



Conclusions and Outlook

» Flight planning needs **attention on terrain** – in particular for either case

High resolution: <8cm GSD **OR** High ground undulation / narrow streets

» Longer focal lengths should be preferred for city acquisition

» **80/60** in Nadir should be ensured

» 80/80 needed for low flying altitude or large buildings

➔ **Productivity through automatic processing**