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EMPOWERING PHOTOGRAMMETRY

Photogrammetry with Oblique Camera Systems

Challenges and Solutions

Dr. Konrad Wenzel
nFrames


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About us

» **Company history**

- Initiated 12/2012 as spin-off from the Institute for Photogrammetry, University of Stuttgart
- Since 10/2014 independent company *nFrames GmbH*
- Currently team of 14 people
- Financed exclusively by revenues
- Close connection to Universities and cutting edge research

» **Products & Services**

- Core product “SURE” + SDKs
- Consulting services


SURE
aerial
SURE
aerial
SURE

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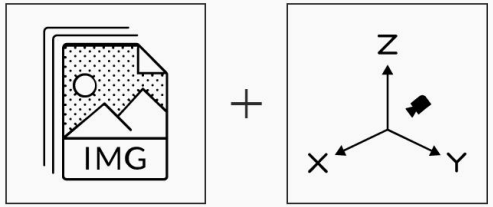
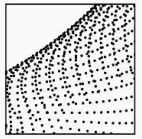


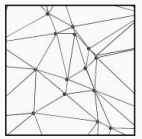
Image Files

+

Orientation Files*



Dense Point Clouds



Textured Triangle Meshes

True Orthophoto & Digital Surface Models

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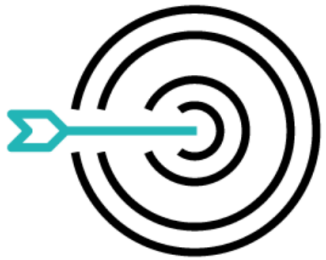
Values

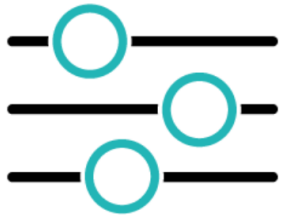


PRECISION

ACCURATE AND SHARP.

PERFORMANCE

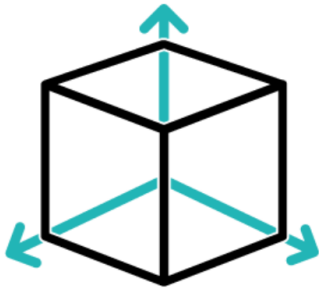
GET YOUR RESULTS FASTER.



USABILITY

AS EASY AS YOU NEED.

Values

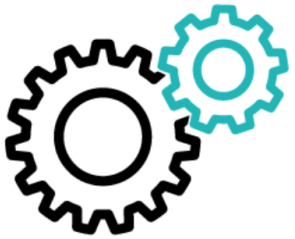


SCALABILITY

NO LIMITS IN DATA SIZE.

INTEGRATION

FITS INTO YOUR VALUE CHAIN.



MODULARITY

ACCESS THE LEVEL YOU NEED.

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Selected Customers & Partners

DLR
COWI
BLOM
IMAGING THE WORLD
ASIA AIR SURVEY
AVT
AEROWEST
Geodata On Demand
GeoFly
focus the world
geoplana
3D RealityMaps
DIGITAL WORLD
MV punktgenau
Amt für Geoinformation, Vermessungs- und Katasterwesen
Bezirksregierung Köln
LGLN
Bayerische Vermessungsverwaltung
IGI
www.igi-systems.com
Danish Geodata Agency
kadaster
LANTMÄTERIET

(...)

DSM

True Orthophoto

Projection on the DSM

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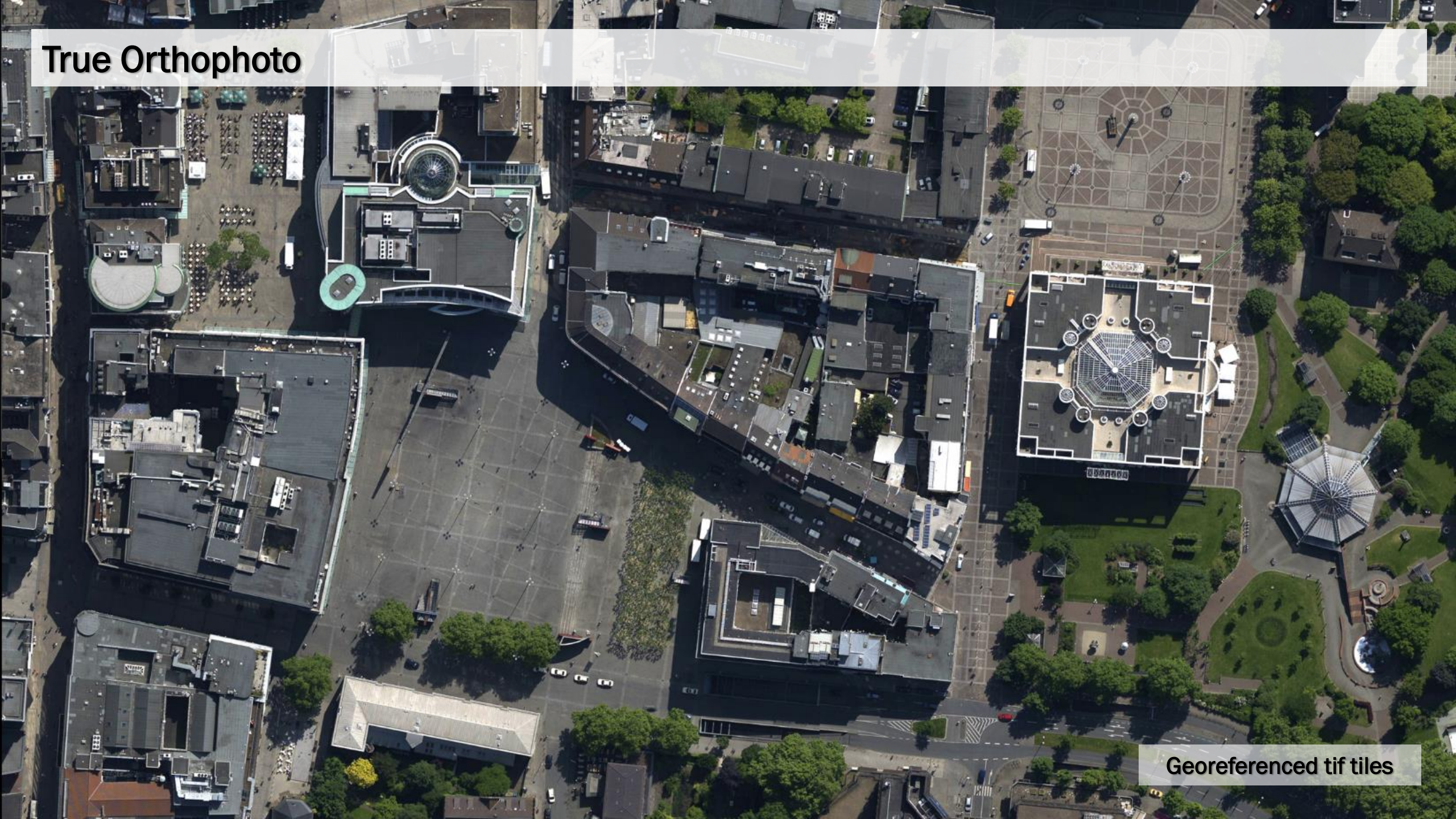
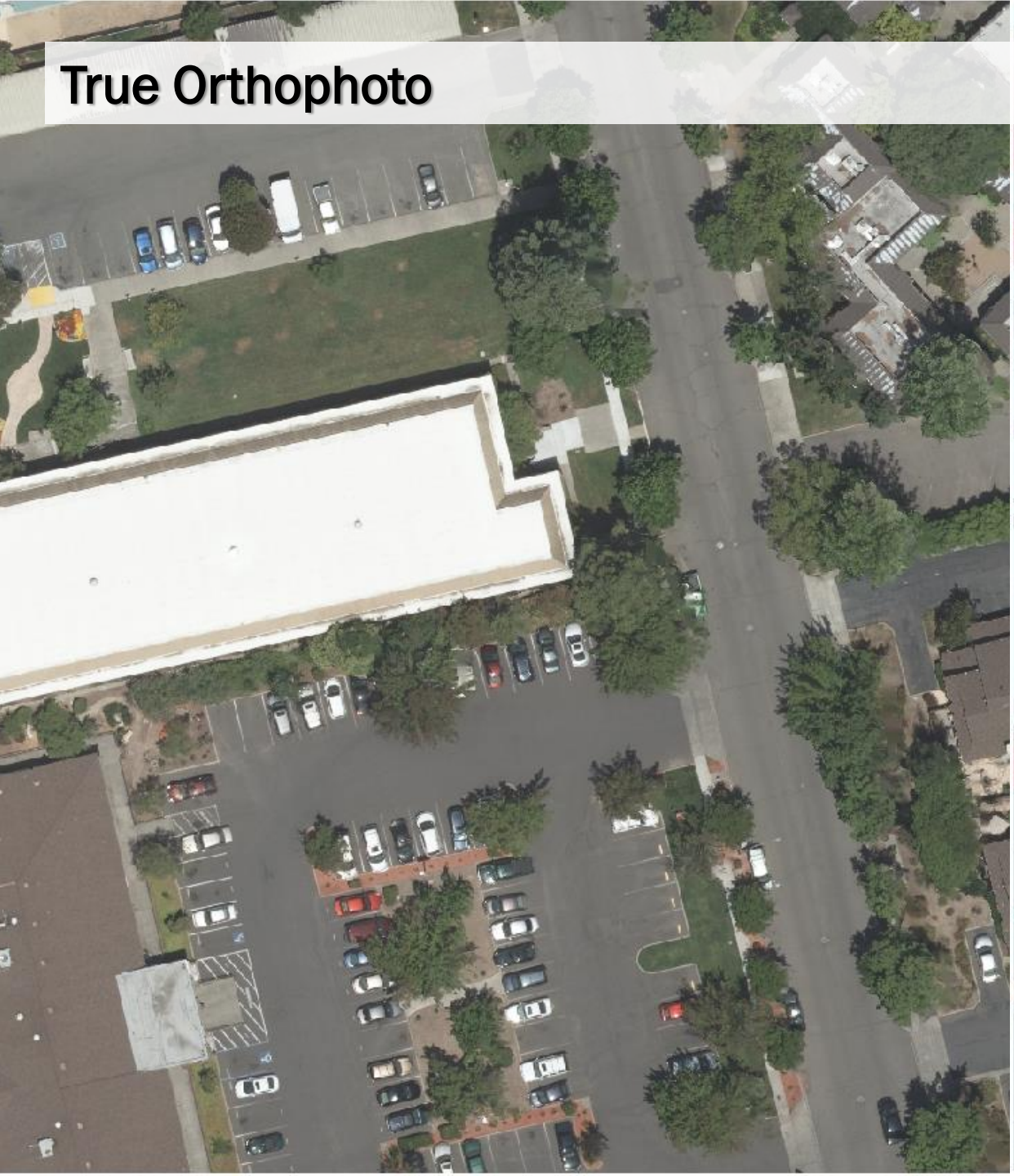
Traditional Orthophoto

SURE True Orthophoto

True Orthophoto

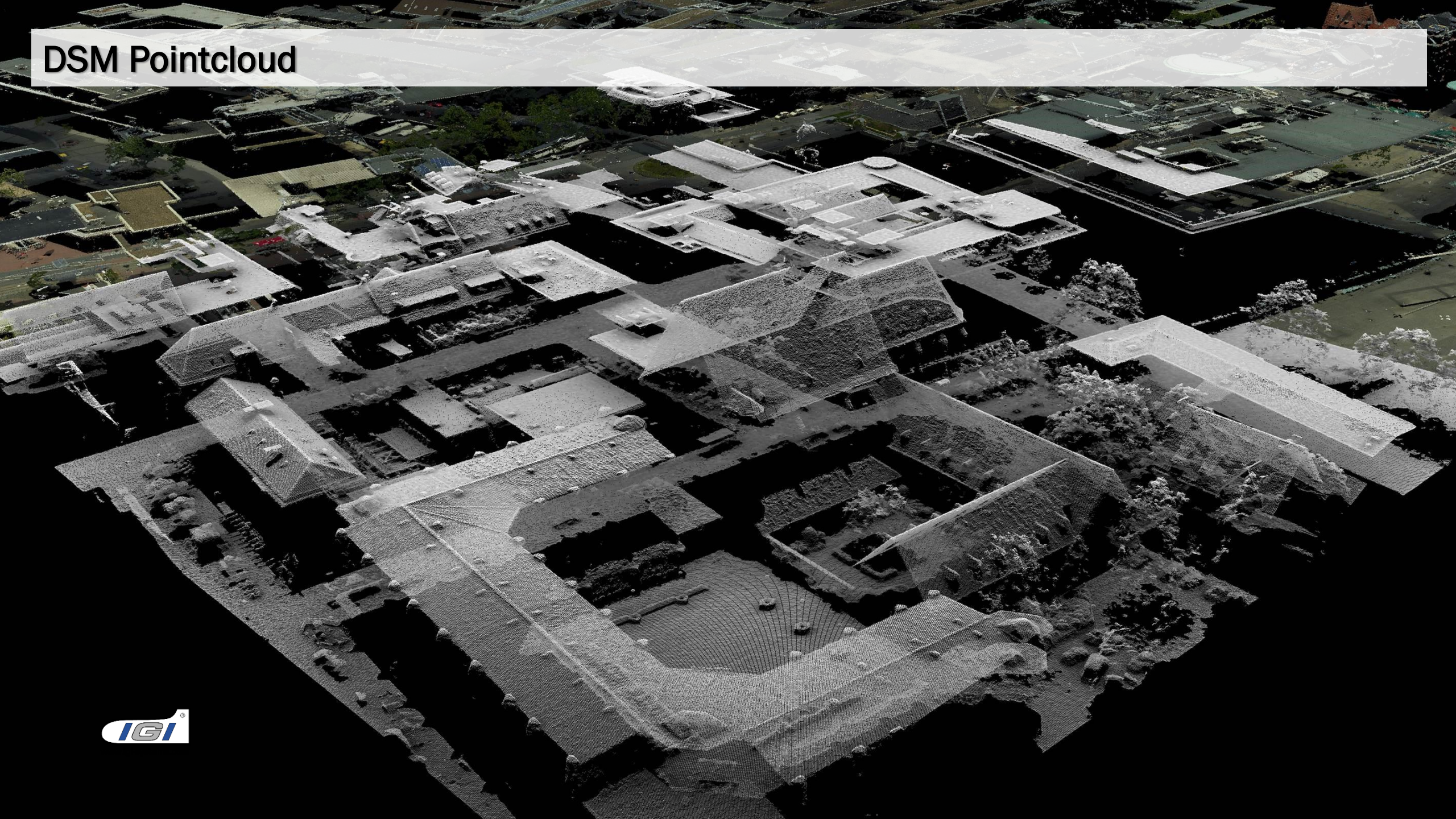


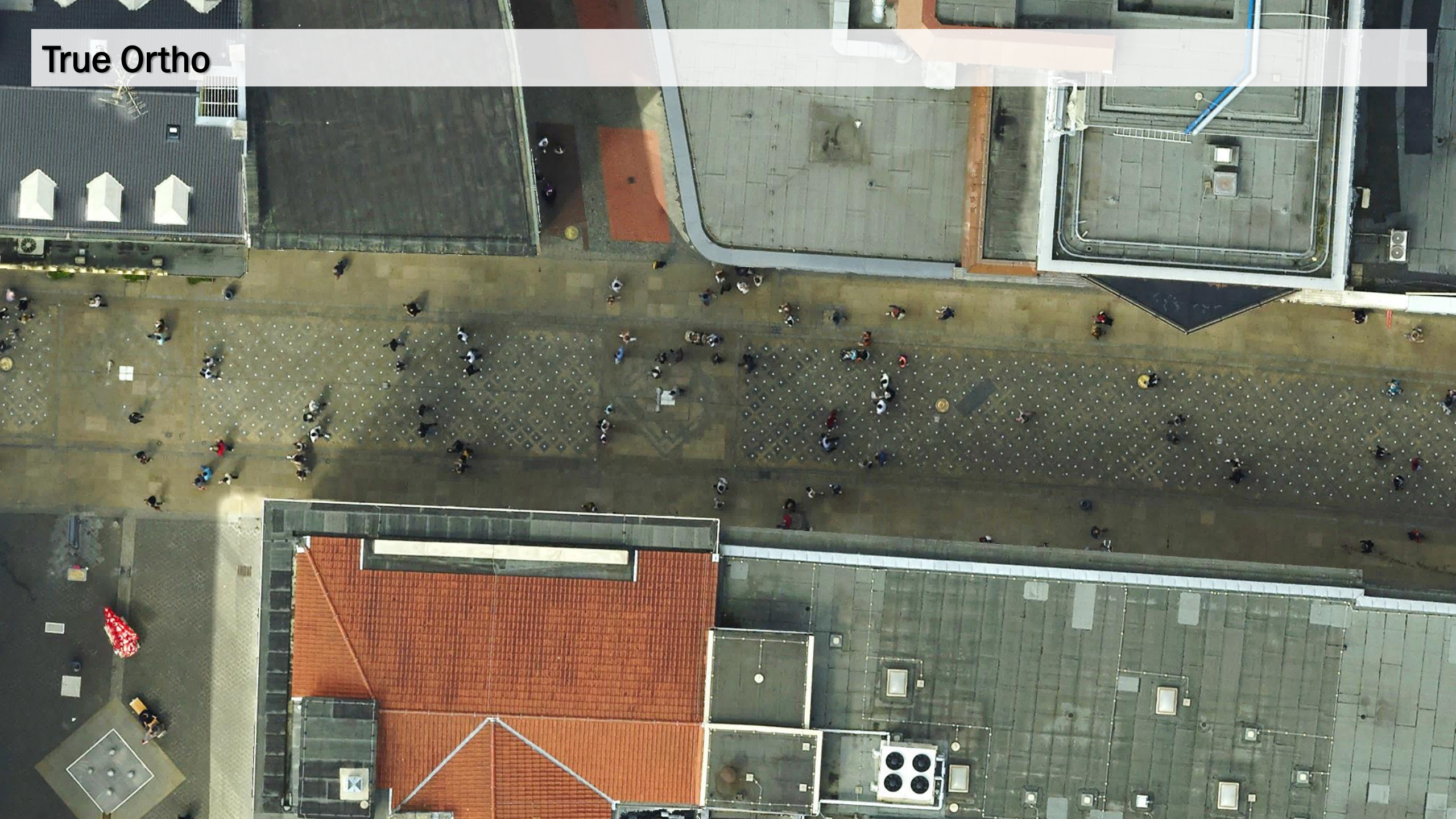
Georeferenced tif tiles


True Orthophoto


16 Bit Multispectral

DSM Pointcloud




True Ortho

True Ortho

Dense 3D Point Clouds

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Challenge: 3D Point Cloud Filtering

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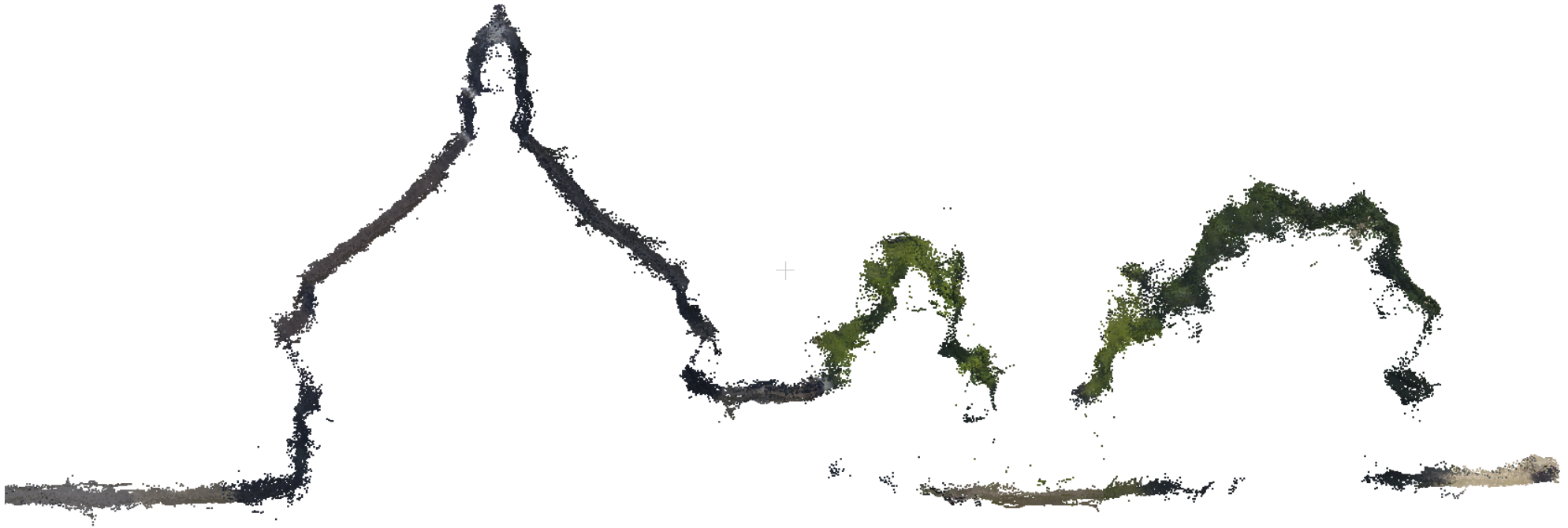

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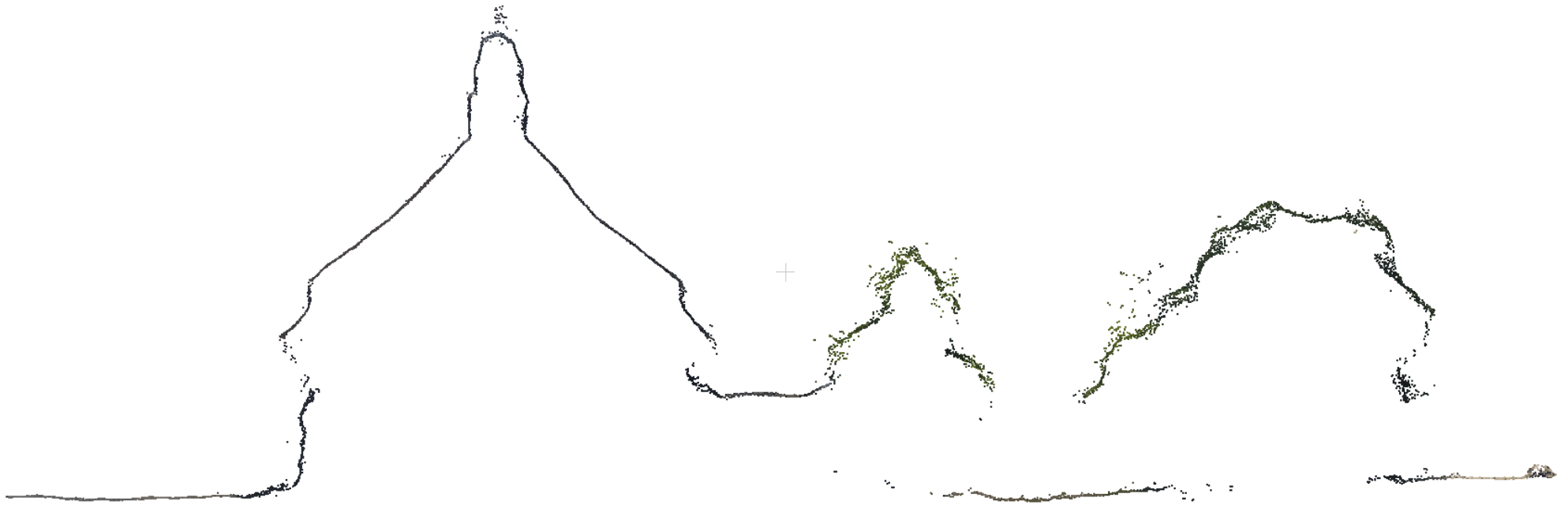
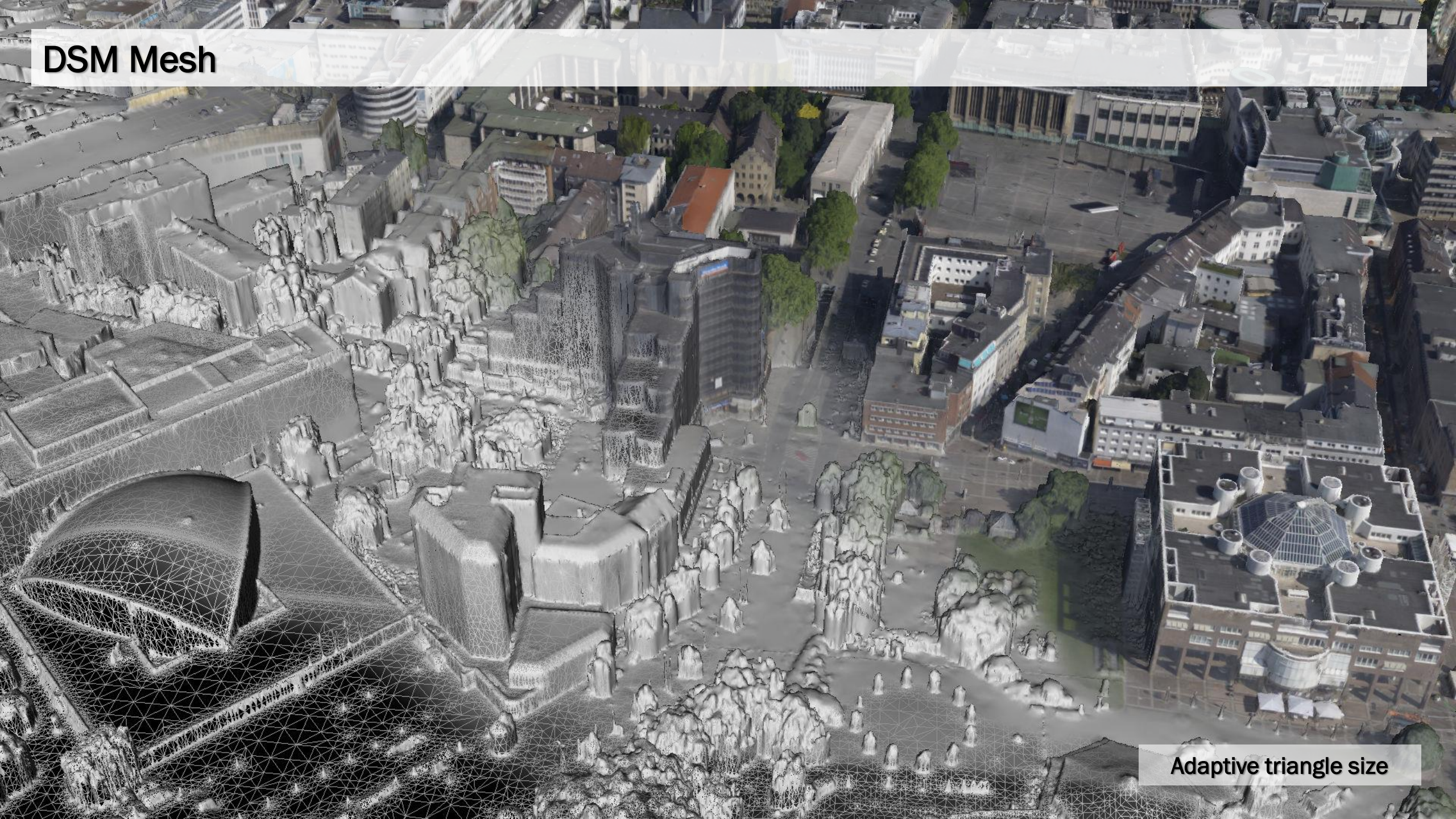


DSM Mesh



Adaptive triangle size

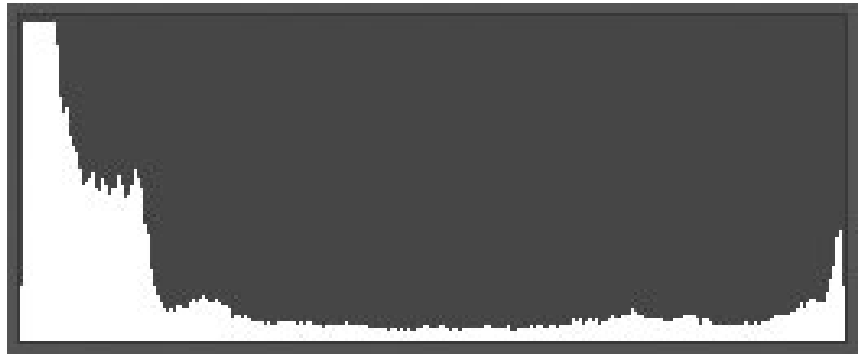

AEROWEST


AEROWEST


Dataset courtesy of FBK

Challenge: Radiometry

- Data acquisition: **Ortho vs. Dense Matching**
  - Visual appearance <> Pixelwise Photogrammetry
  - Signal to Noise ratio in radiometry of every pixel is relevant



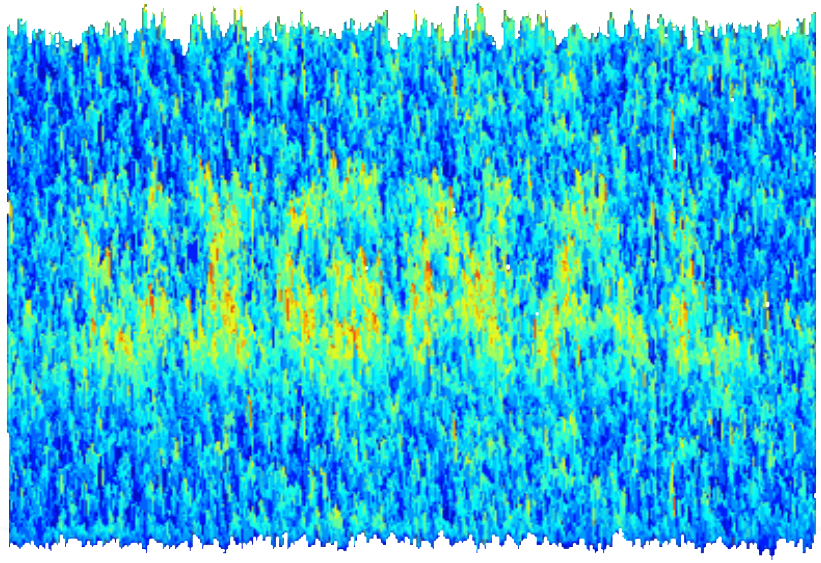
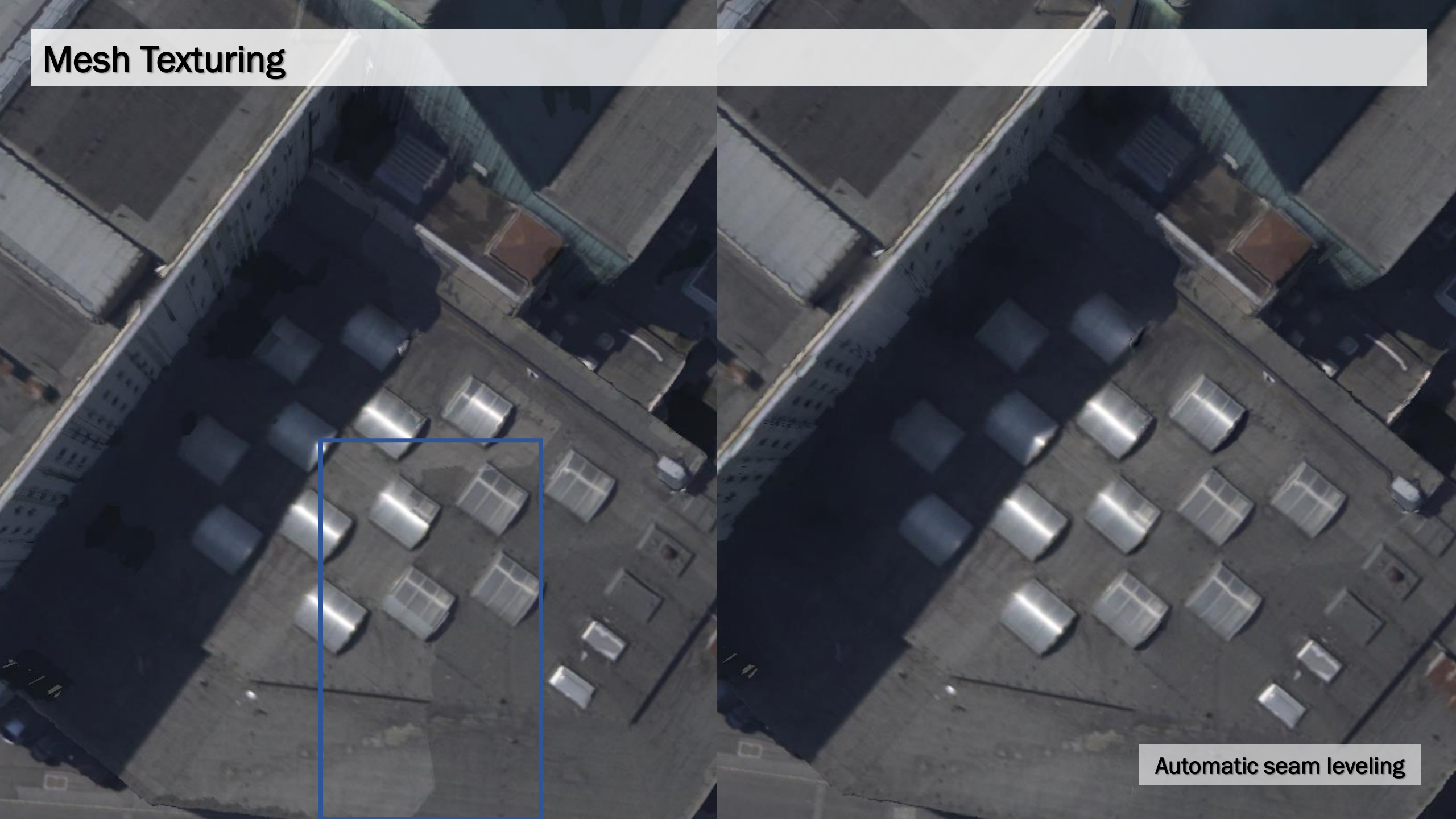


Image Credits: http://www.doctordisruption.com/design/principles-of-design-58-signal-to-noise-ratio/

Weak Signal-to-Noise and De-Bayering effects

Mesh Texturing



Automatic seam leveling

Texturing – Consistency Check

Texture Sharpening

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Challenge: Data delivery

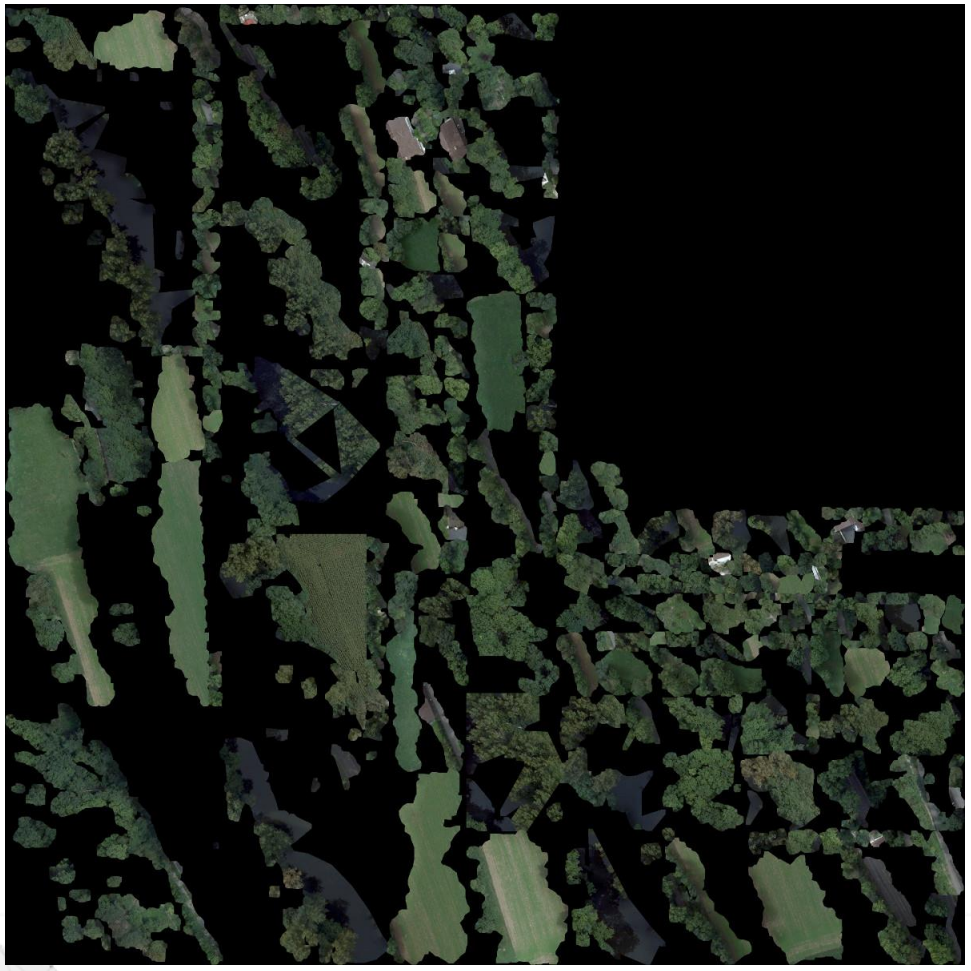
Meshes

Streaming

Web

Native Cesium tileset support

Texture Compression



- New texture image (atlas) packing
- New texture compression

➔ Up to 6 times less storage

Challenge: Editing

Focus: Automatic data extraction

+

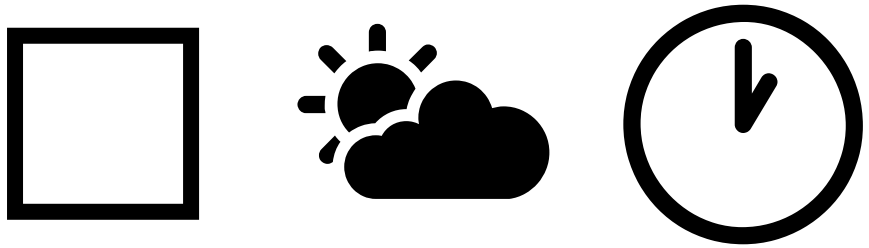
Option for efficient editing if needed

as upselling option or for objects of interest

Challenge: Productivity

↑ quality

↓ flight lines



Flight planning - Objectives

Quality

- Precise results
  - Sharp geometry and texture

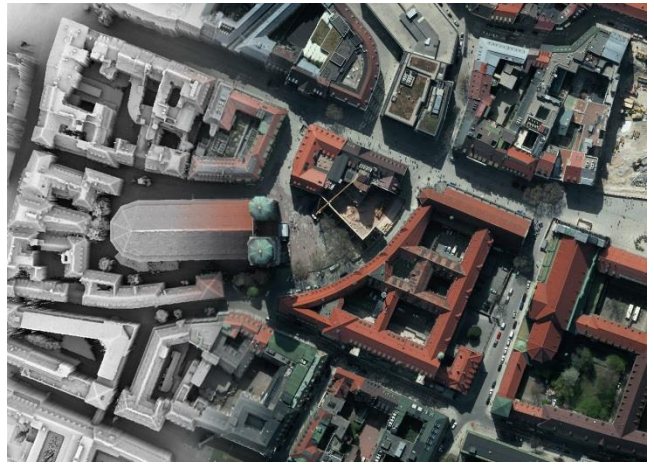
Productivity

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

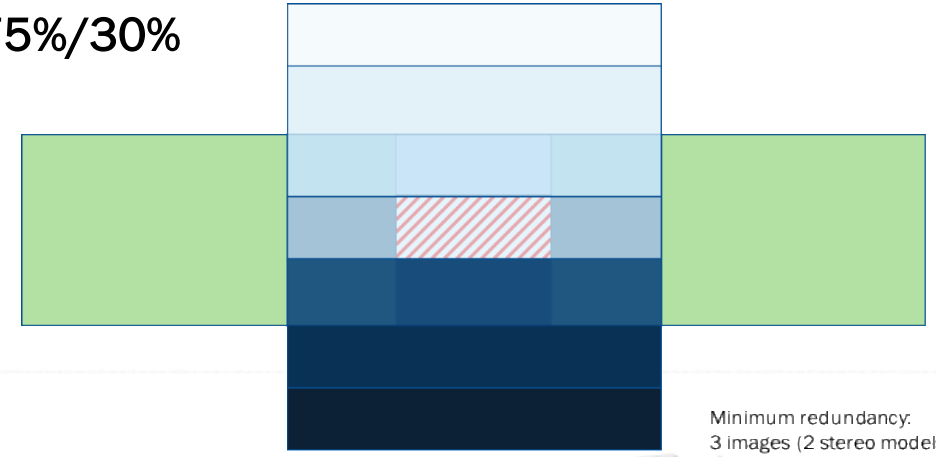
Nadir imaging – countrywide production

» Automatic products
  - DSM
  - True Ortho
  - Textured DSM Mesh

» High production efficiency
  - Flight efforts
  - Image count
  - Processing time *DSM & True Ortho:*
    - 0.4h/km² @ 20cm GSD
    - 0.7h/km² @ 10cm GSD



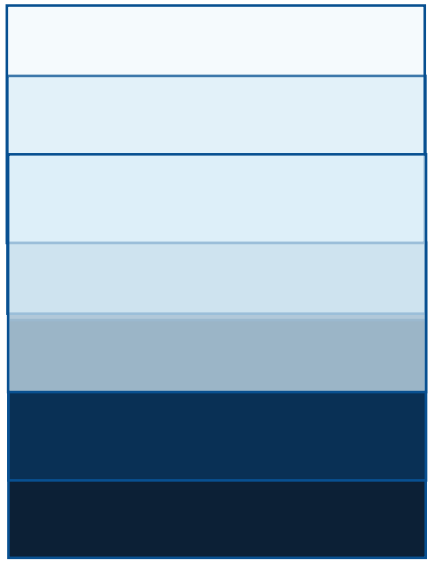
recommended: >= 75%/30%



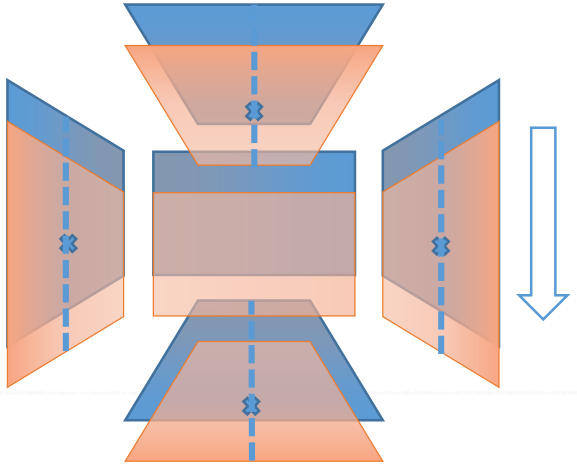
Minimum redundancy:
3 images (2 stereo models)

City capturing

» Nadir
  - 80% Forward overlap
  - Higher sideward overlap recommended
    - 60% common buildings, 80% skyscrapers

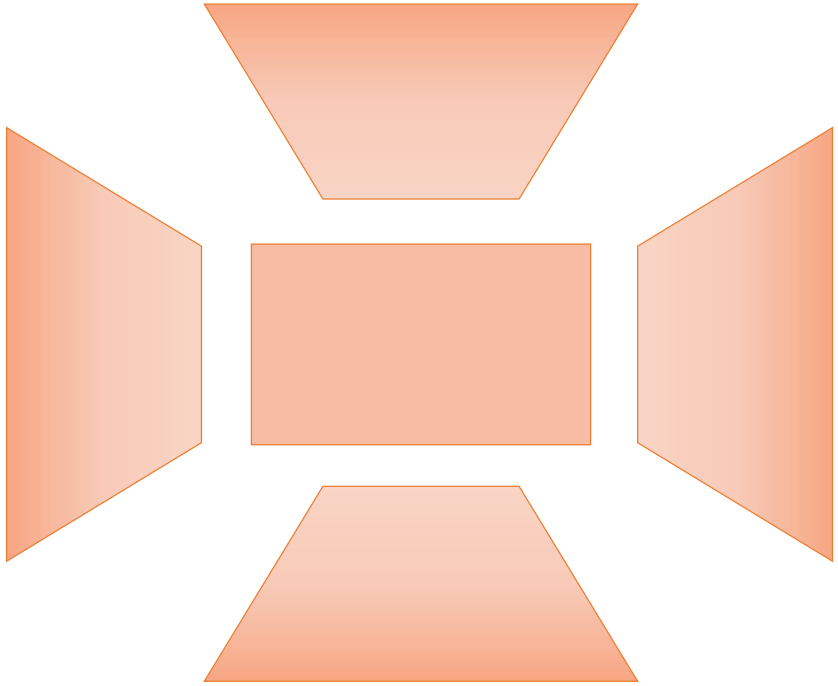


» Oblique
  - Maintain Nadir overlap
    - Resolve street occlusions + enable True Ortho
    - Additional oblique views for façade observation

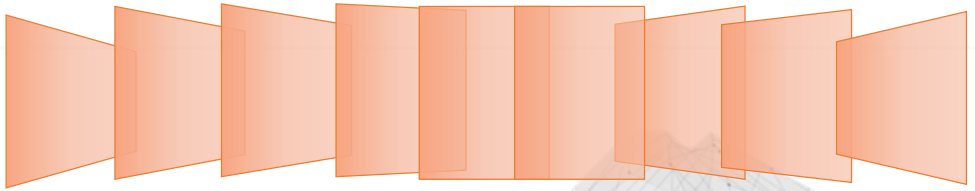


Oblique imaging

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



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

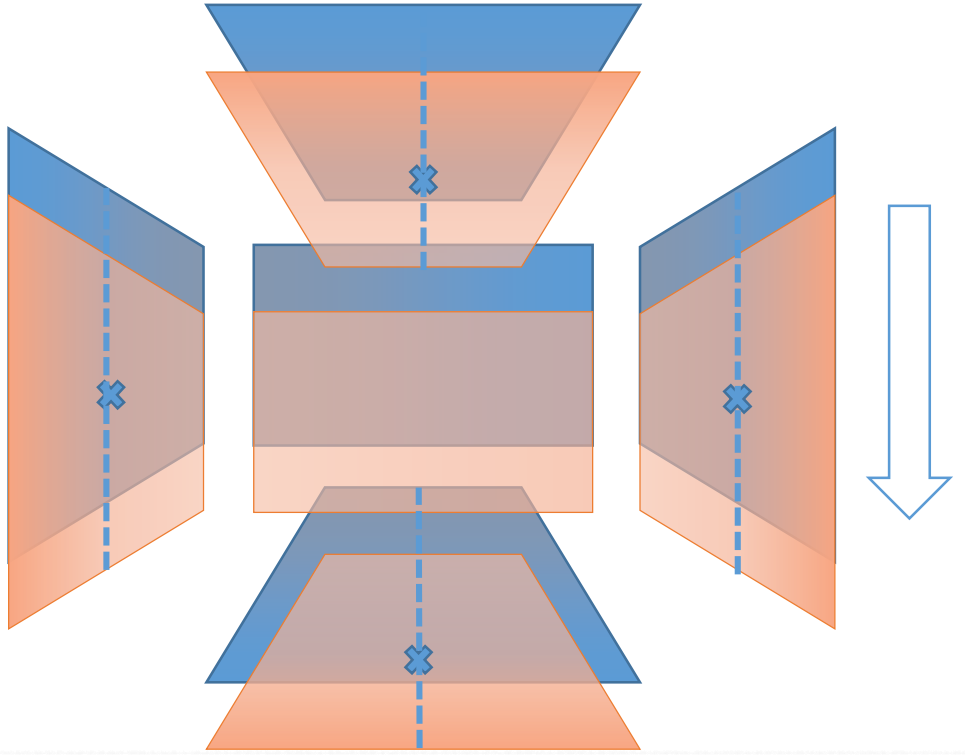


Oblique imaging – typical flight planning

» Lead parameter:
GSD and Overlap in Nadir frame

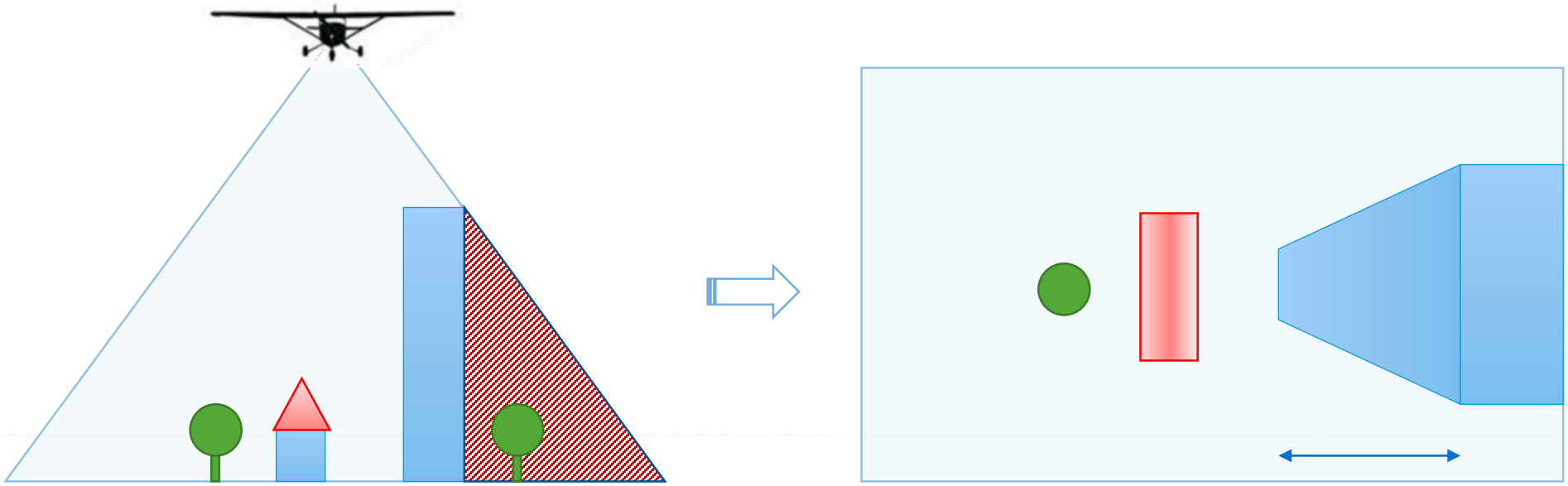
» Oblique GSD defined in image center

» Oblique overlap defined along center line in flight direction



Challenge: Perspectives & Occlusions

- Occlusions
- Perspective distortions
- Insufficient overlap

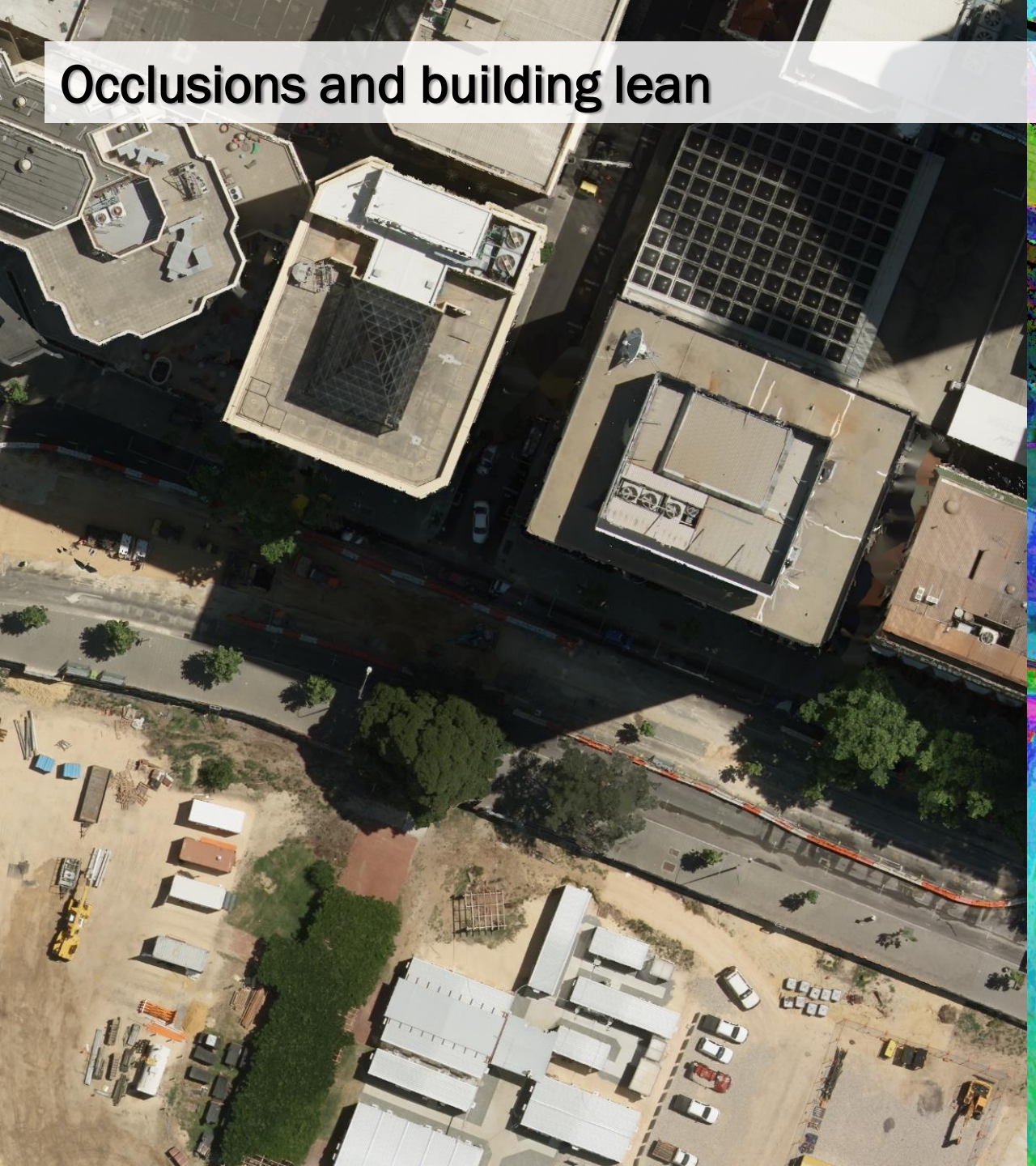


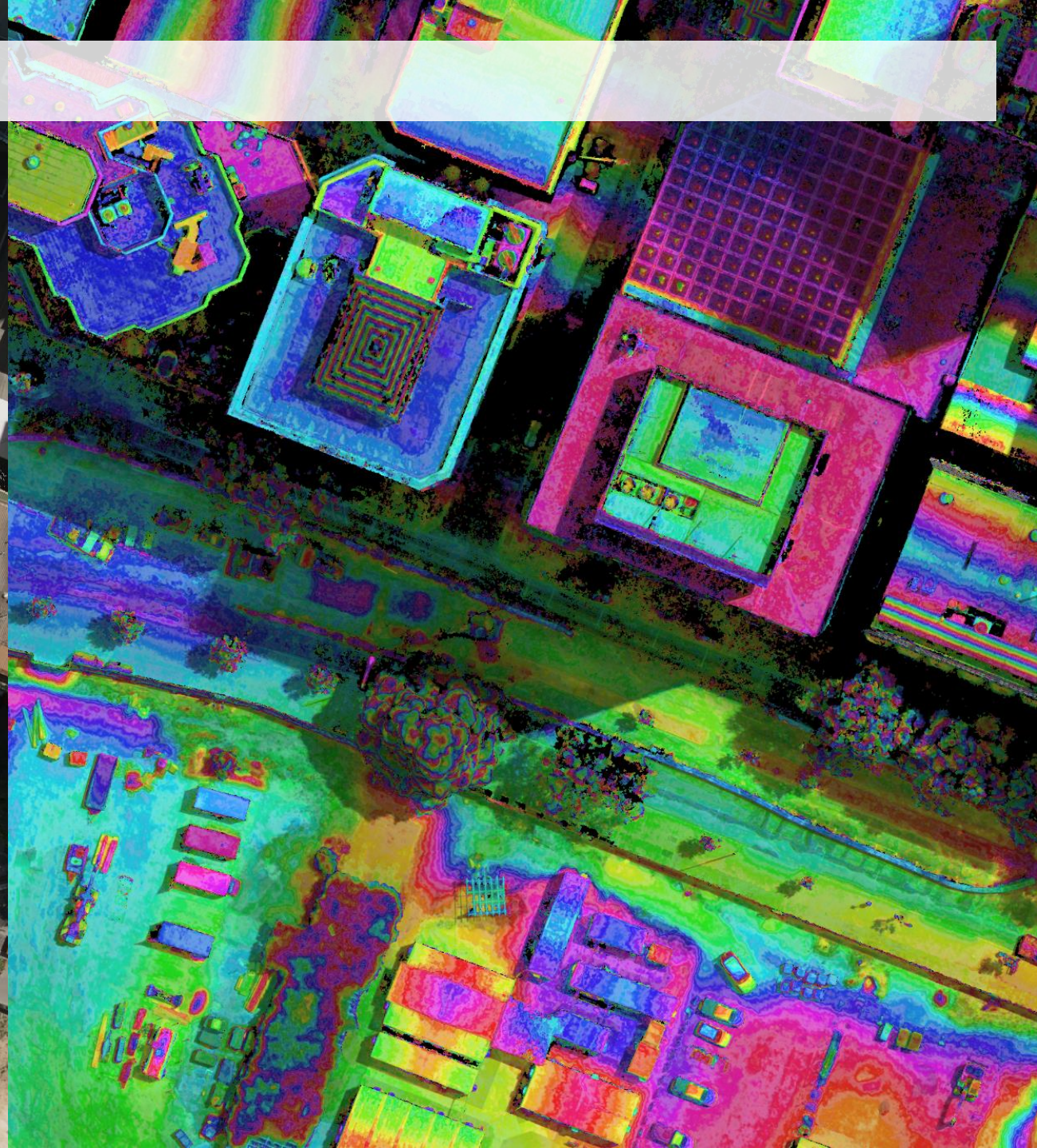
Occlusions and building lean

Brookfield place building - 234m

Occlusions and building lean

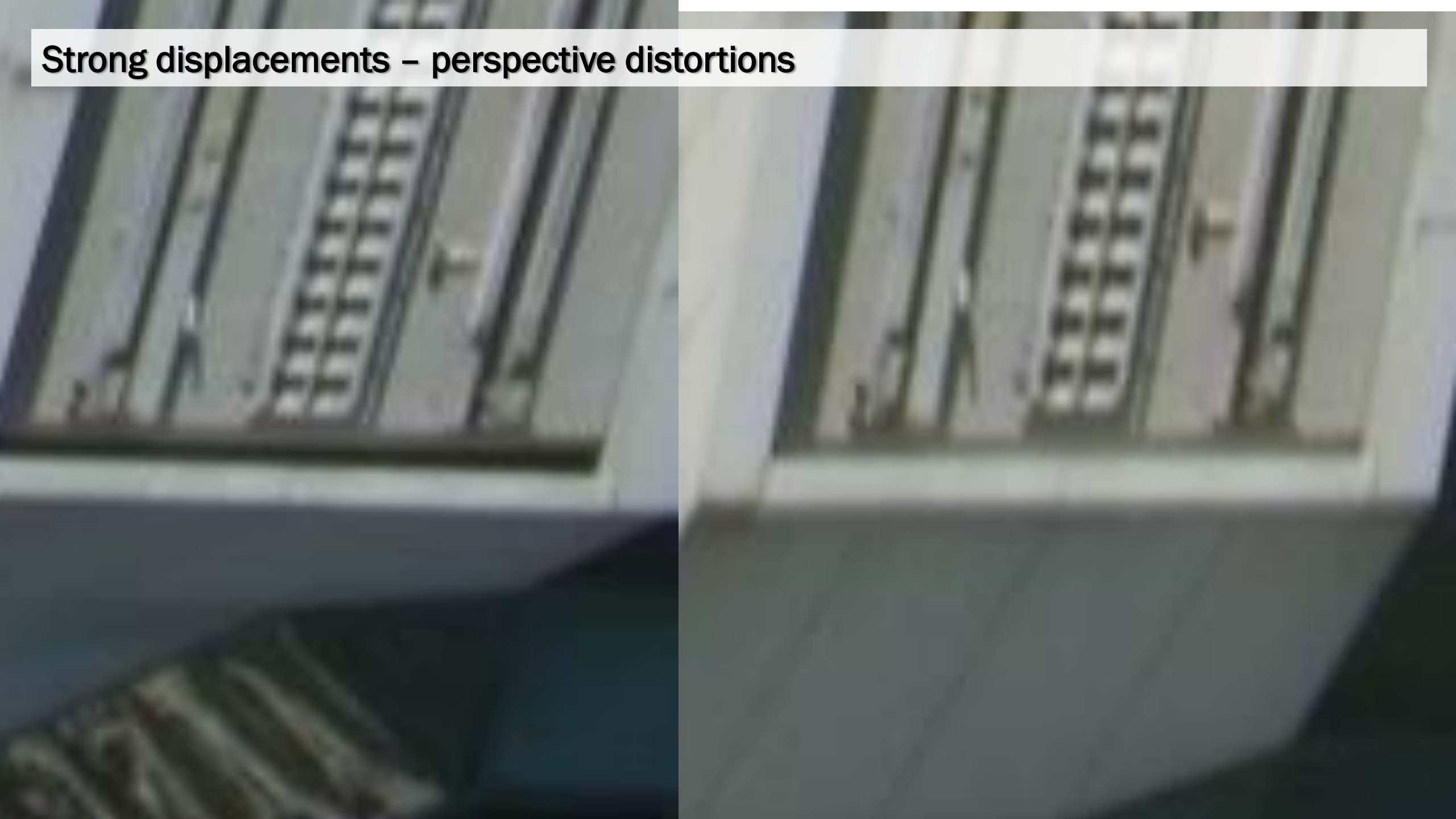
Occlusions and building lean





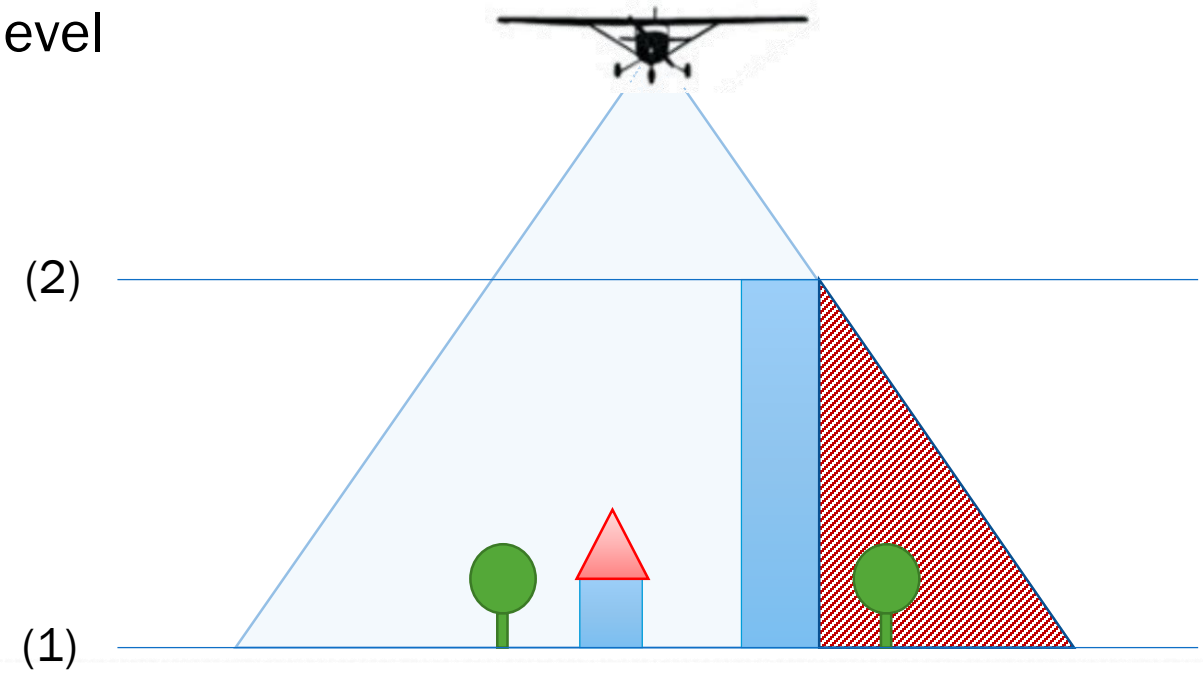
Occlusions and building lean

Strong displacements – perspective distortions



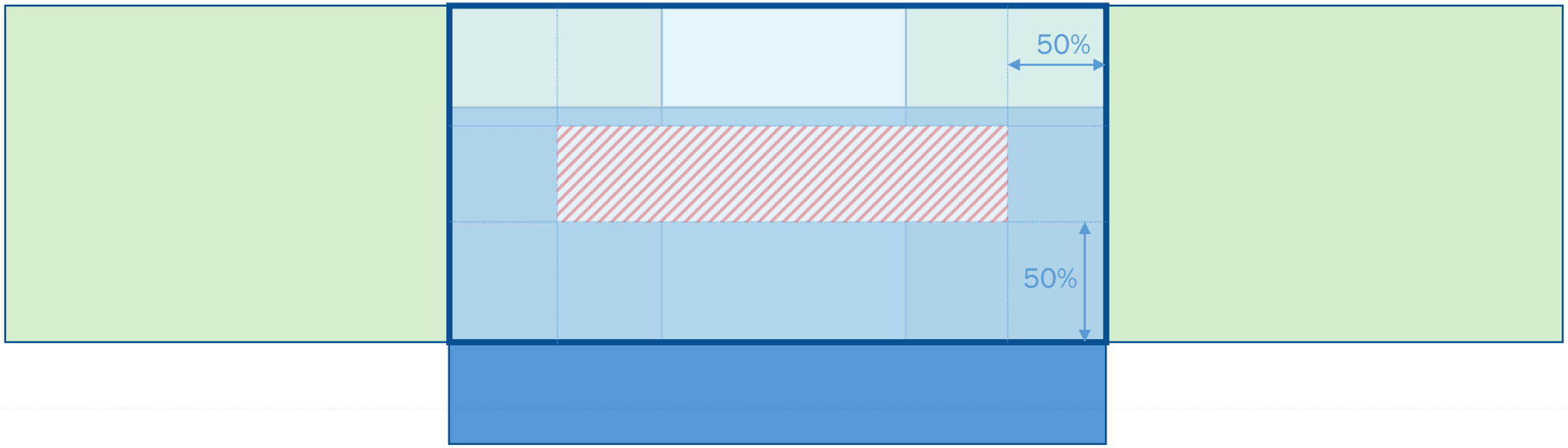
Flight planning - Solutions

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



Flight planning - Solutions

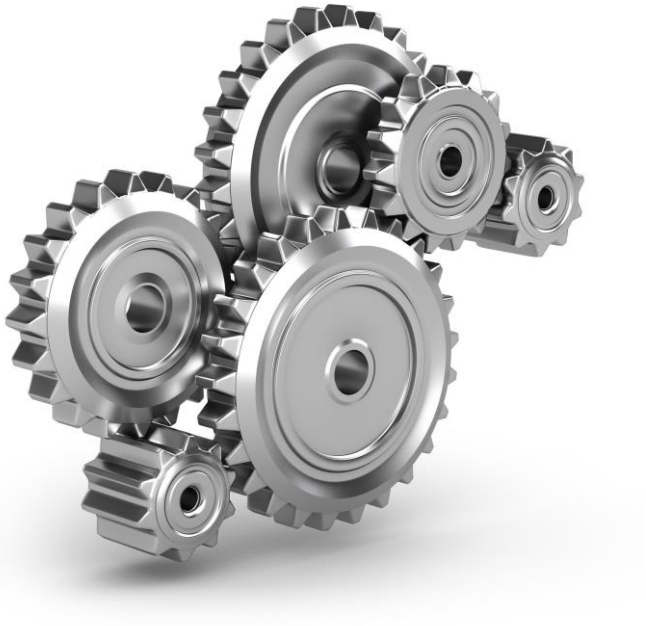
2) Consider **building lean** in *Central Image Contribution Area*
    - considering camera & max. building height
    - the area between overlaps (80%/30% ➔ 20%/70% central area)
- Determine occlusion in **effective pixels** (minimize to <30)



Challenge: Oblique Aerotriangulation

- Much more challenging than for Nadir datasets
  - in particular connection between oblique and nadir strips
- Key challenge: **tie point matching**
  - classic tie point matching requires high quality initial Eos (initial search radius)
  - or robust feature points with descriptors needed
    - Good distribution
    - Robust to change in illumination, rotation, scale and perspective distortion
- Dataset should have good redundancy
  - Overlap, occlusions and perspective changes should be considered

Challenge: Customization



Advanced workflows

Integration with third-party tools

Custom Workflows

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Geoinformation Vermessung
Freie und Hansestadt Hamburg

Geometry correction for better True Orthos by using the 2.5D Tool for any point cloud

here: automatic replacement of water points

Integration of further point cloud sources

Integrate & Combine

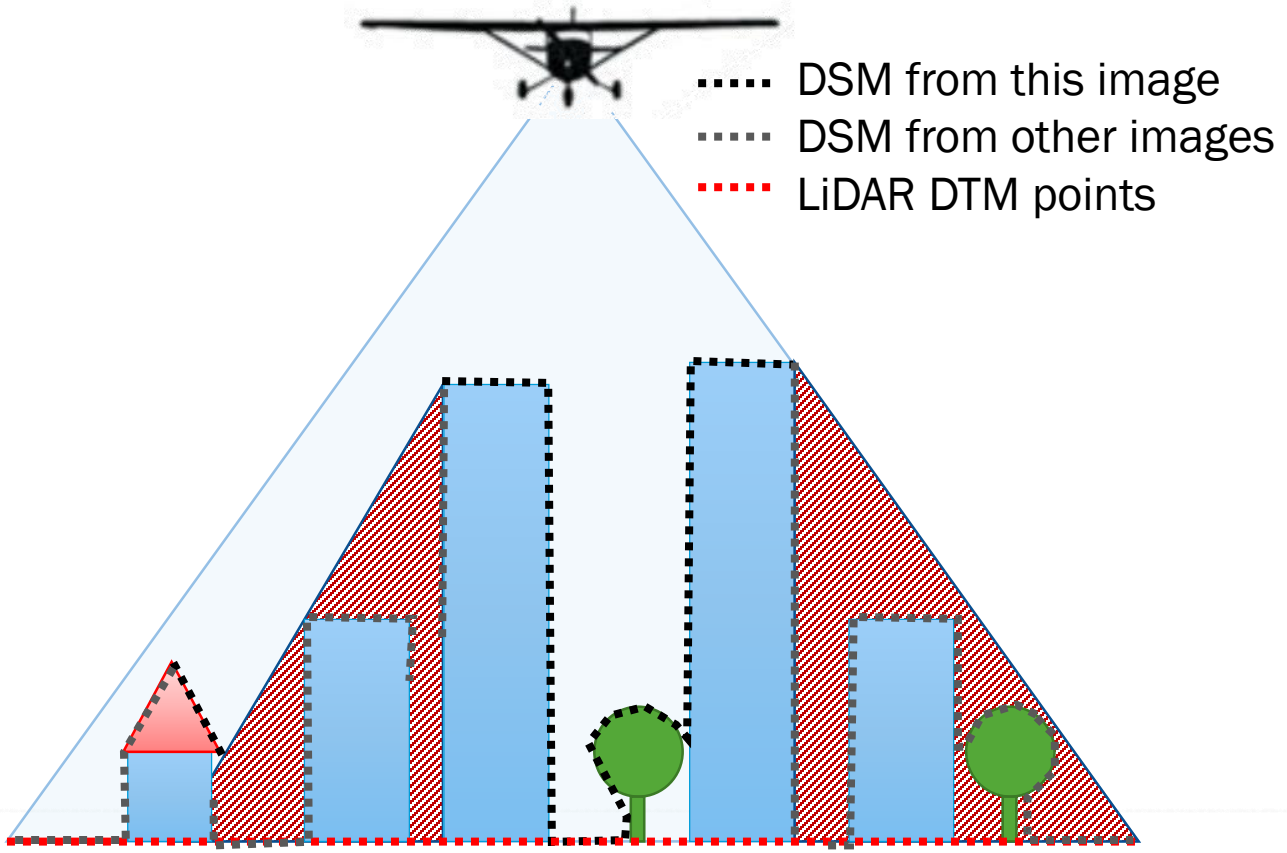
» Edited point clouds

» Point clouds from other sensors
  - E.g. LiDAR

➔Improved completeness

➔Compensation of occlusions

➔Compensation of texture issues



Gottfried Mandlburger, Konrad Wenzel, Andrea Spitzer, Norbert Haala, Philipp Glira and Norbert Pfeifer (2017): IMPROVED TOPOGRAPHIC MODELS VIA CONCURRENT AIRBORNE LIDAR AND DENSE IMAGE MATCHING, PhotoGA 2017

Mandlburger et al, 2017

LiDAR DSM

Mandlburger et al, 2017

LiDAR & Dense Image Matching

Mandlburger et al, 2017

LiDAR & Dense Image Matching interpolated


Mandlburger et al, 2017
LiDAR and Dense Image Matching DSM Mesh

Mandlburger et al., 2017

True Ortho - Dense Image Matching only

Mandlburger et al., 2017

True Ortho - LiDAR and Dense Image Matching

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