# 3D from Skybox video

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# First experience with 3D from spaceborne video

Preliminary results

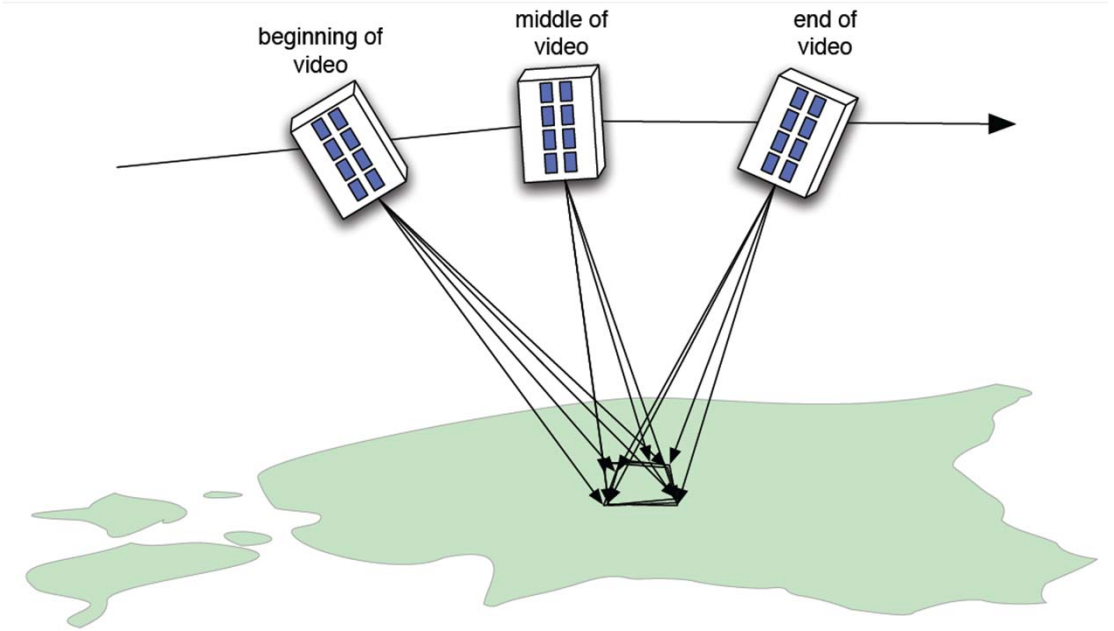


Image © Skybox Imaging

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# Skybox camera model

- Frame camera with 3 CCDs
  - One CCD used for video products
    - gray scale image
  - All three CCDs used for strip products
    - Multispectral image

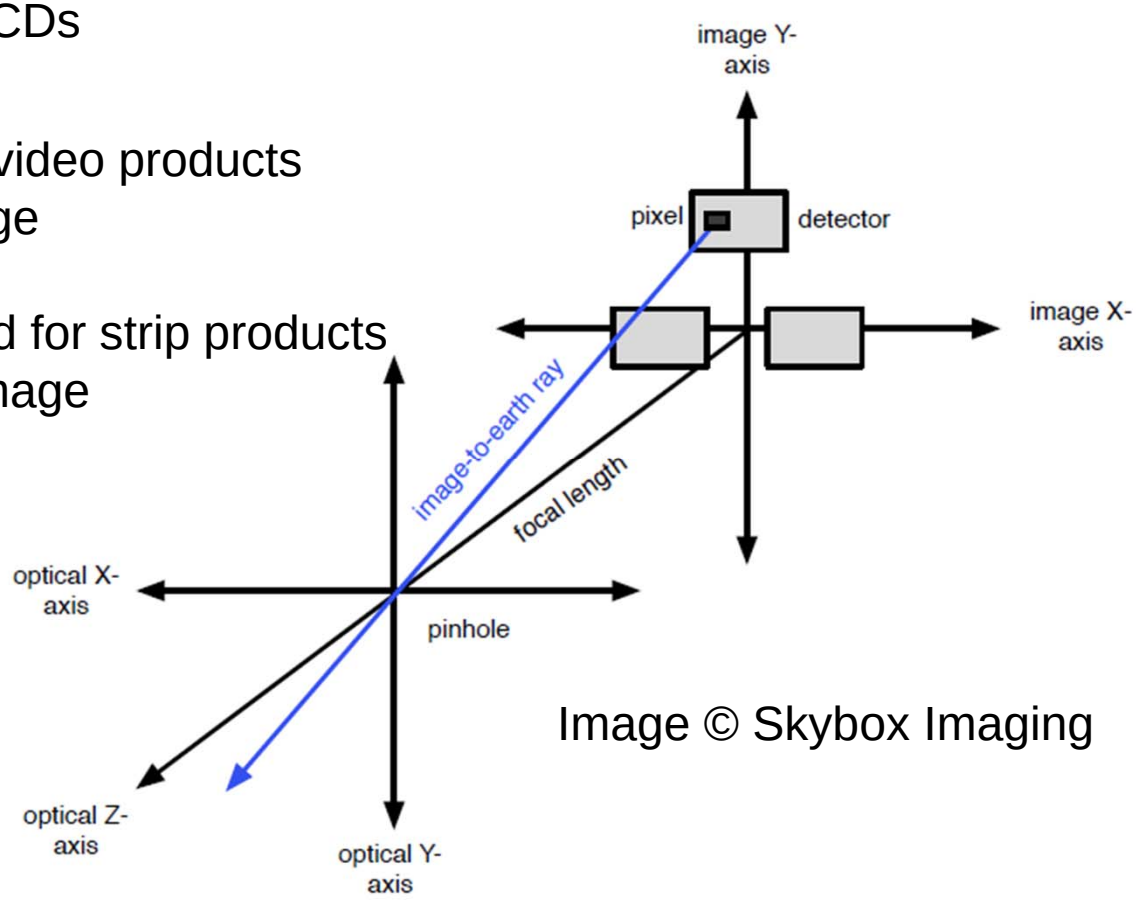


Image © Skybox Imaging

# General Workflow
# Digital Surface Model generation

Input

Images | Metadata

Processing

Orientation

Matching

DSM Generation

Orthorectification

Output

DSM | Ortho

- At least two images, captured on same day.
- Optional: References like Ground control points (GCP), Reference images and DSM.

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# K2
# WorldView-2 Triple Stereo

- Very steep terrain
- Very detailed surface model
- Movie: http://www.dlr.de/dlr/desktopdefault.aspx/tabid-10212/332_read-921/


15°

0°

-15°

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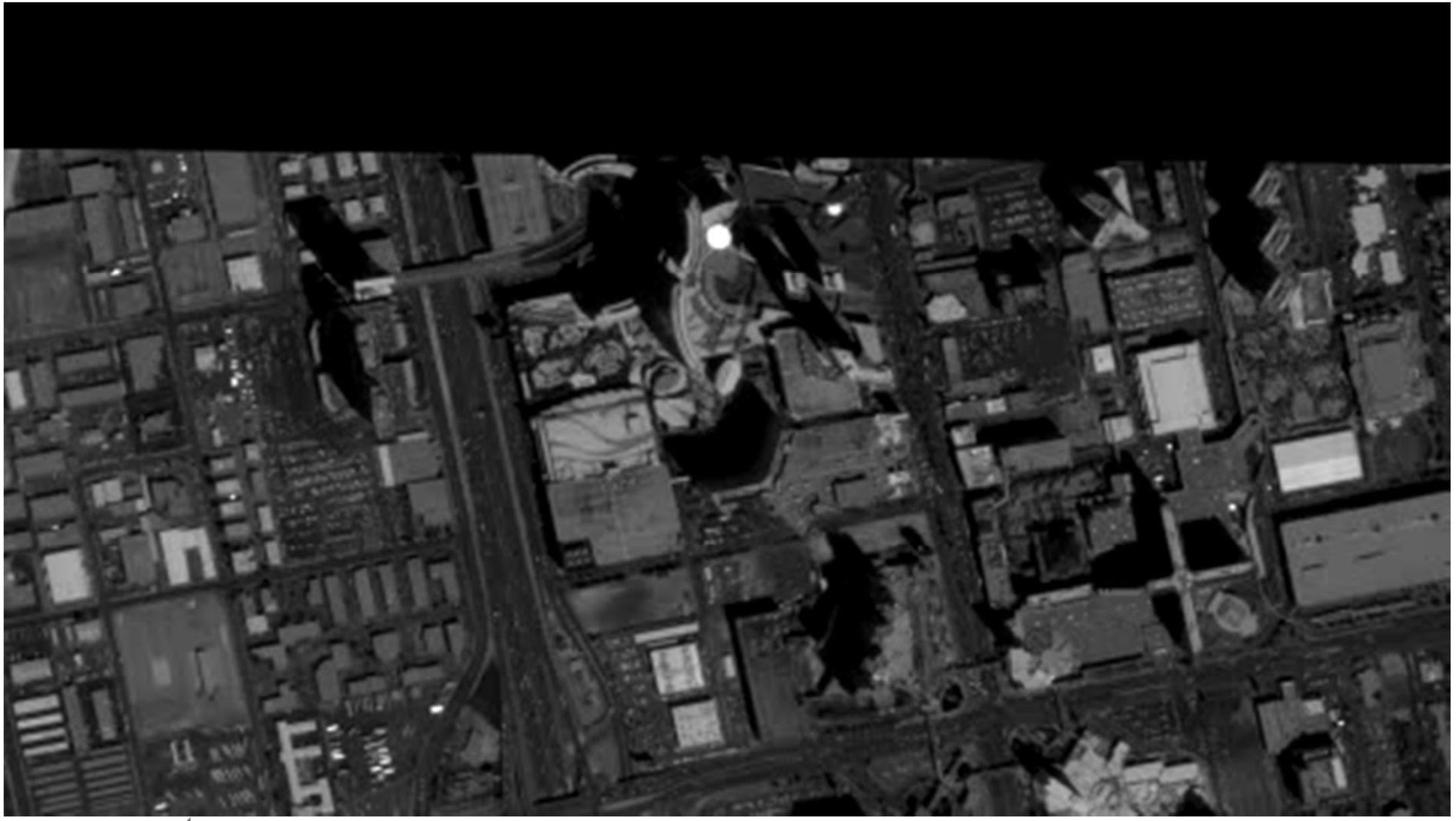
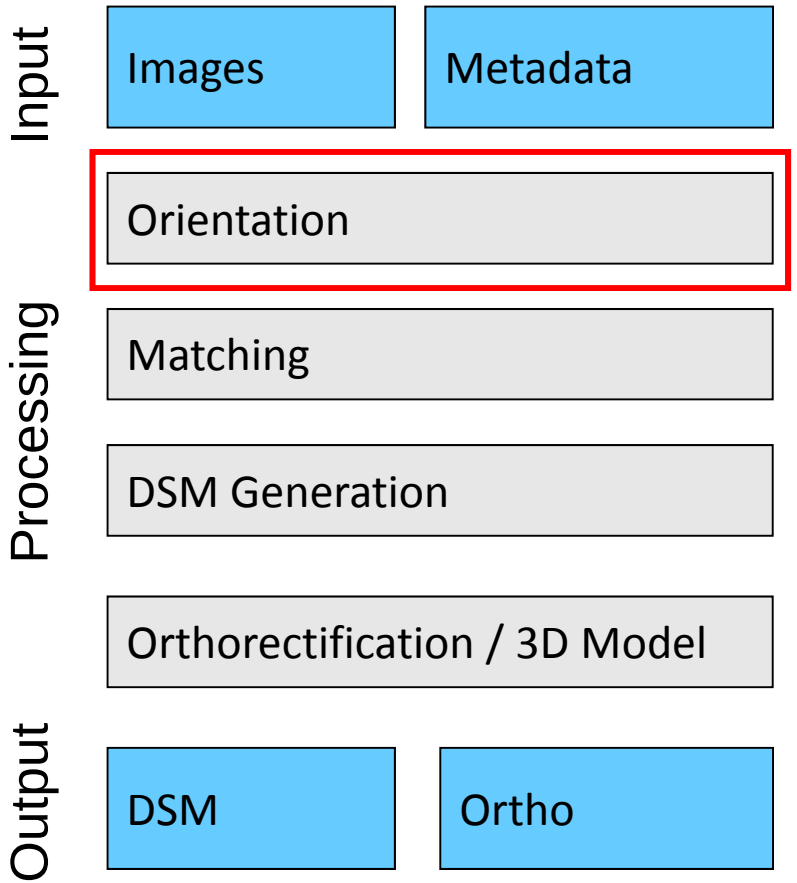
Gerlinde Kaltenbrunner
National Geographic/Maxut Zhumayev
National Geographic/Ralf Dujmovits

# Skybox Las Vegas sequence



# Workflow Orientation




- Good relative orientation required, error < 0.5 pixel
- Automatic GCP/tie point matching (SIFT and local least squares matching).
- Bundle block adjustment estimates improved orientation parameters
- Automatic process, unless GCPs are required

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# Image orientation
# Las Vegas Skybox video

- Subset of 60 images (1 image per second)
  - Little change between each image

- RPC model + relative corrections in image space
  - Magnitude of corrections ~ 100 pixels.
  - Tie point RMSE 0.3 pix (SIFT tie points).

# Workflow
# Dense Matching

Input

Images | Metadata

Processing

Orientation

Matching

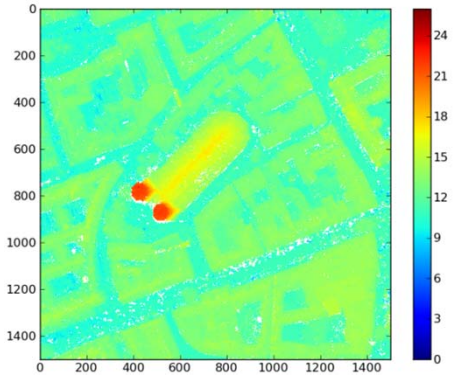
DSM Generation

Orthorectification / 3D Model

Output

DSM | Ortho

- Find correspences for each pixel

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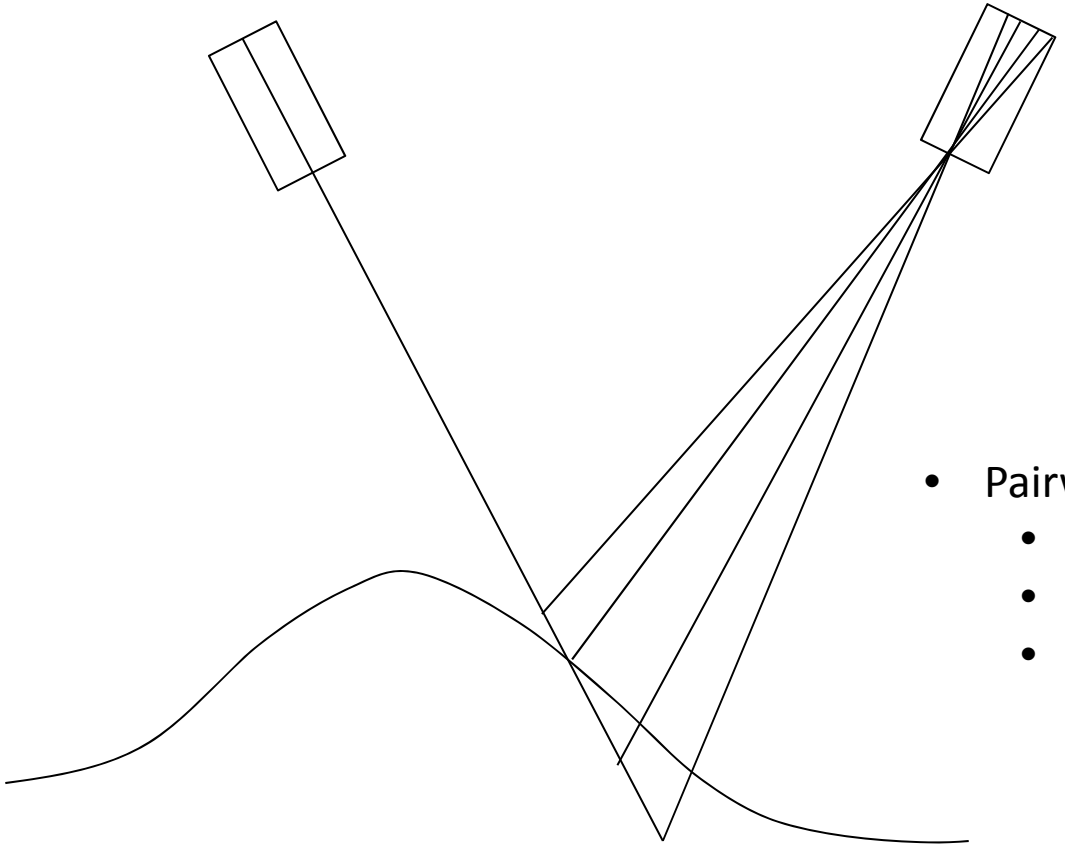
# Pairwise matching



- Pairwise stereo matching + fusion of DSMs
  - merge DSMs with median
  - detect occlusions by left/right check
  - High complexity, early regularisation?

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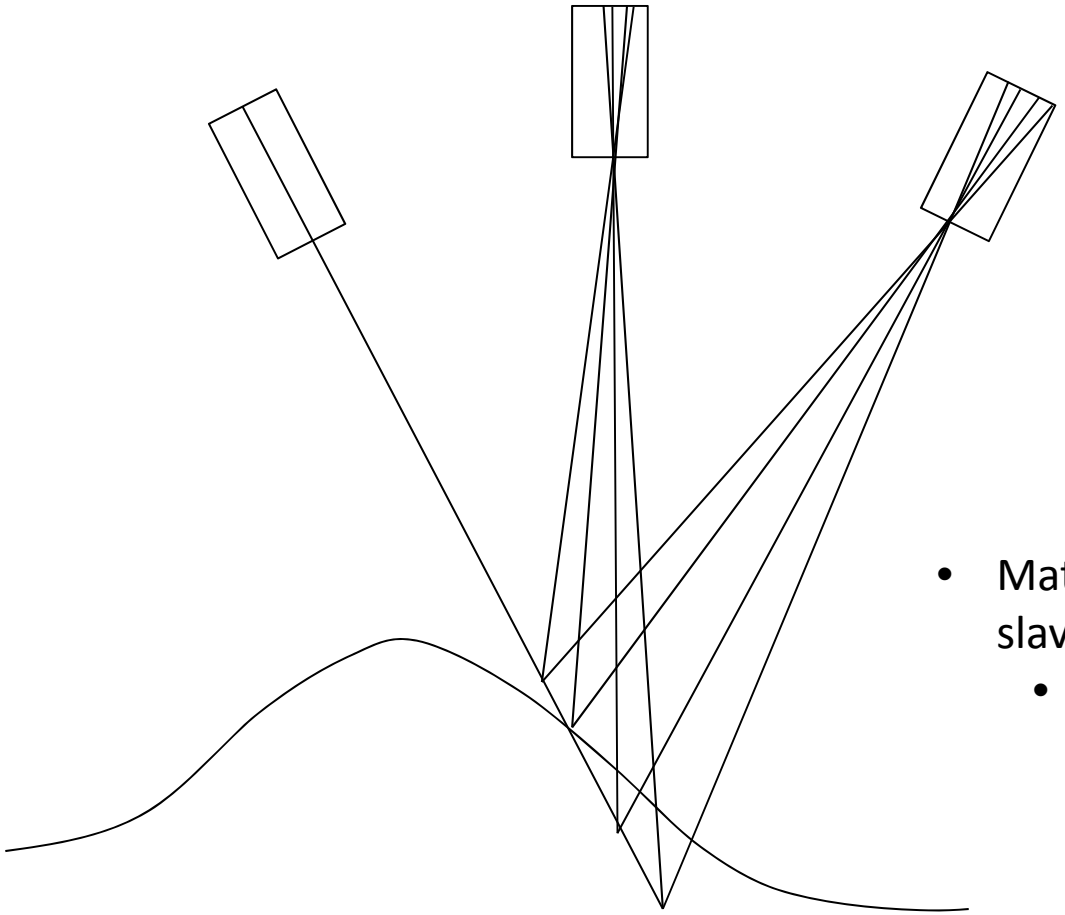
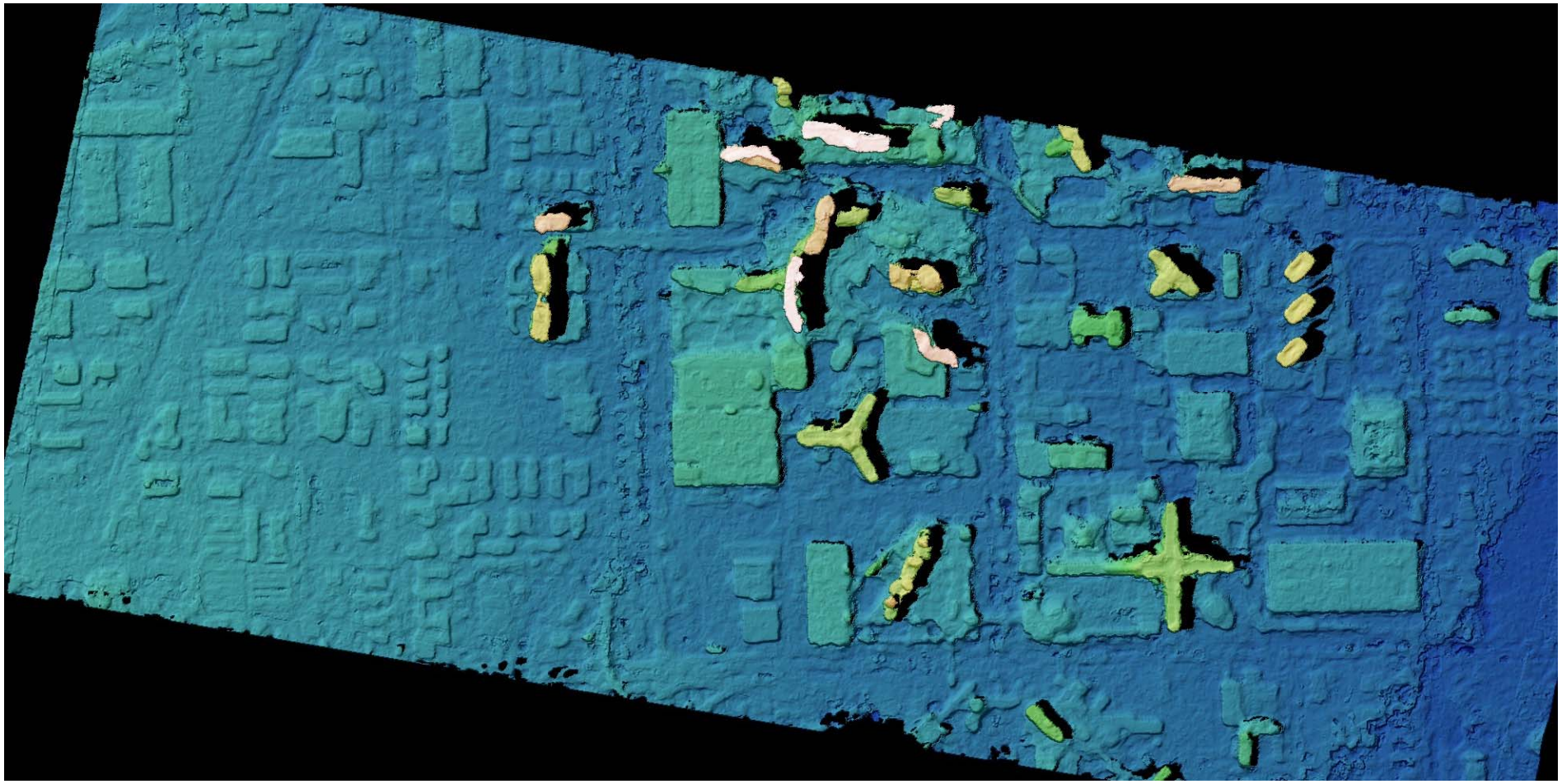
# Multi-image matching



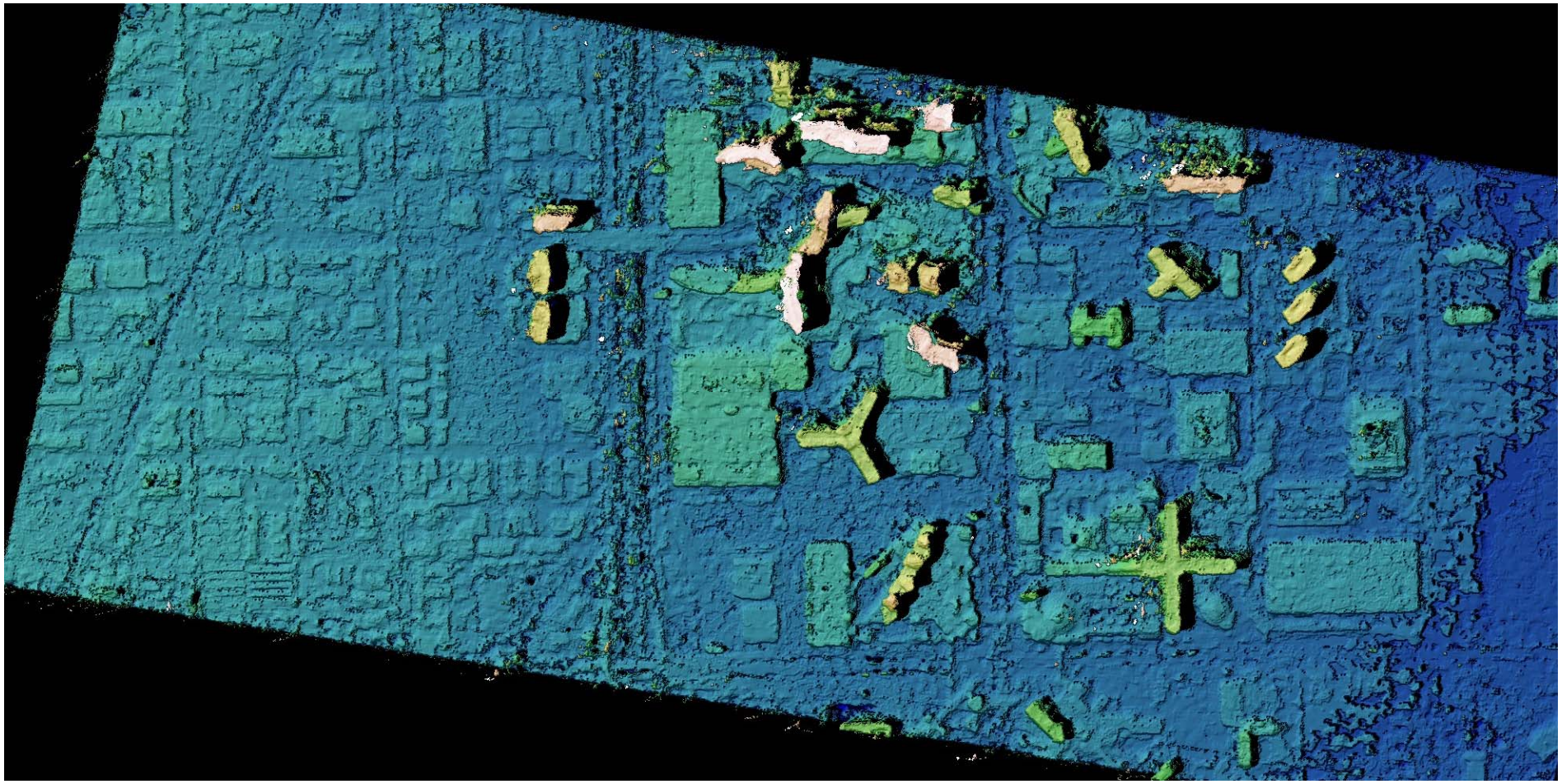
- Matching of master image against multiple slave images.
  - Data cost fusion in image space, before regularization

# Triplet
# Using only 3 images out of 1800



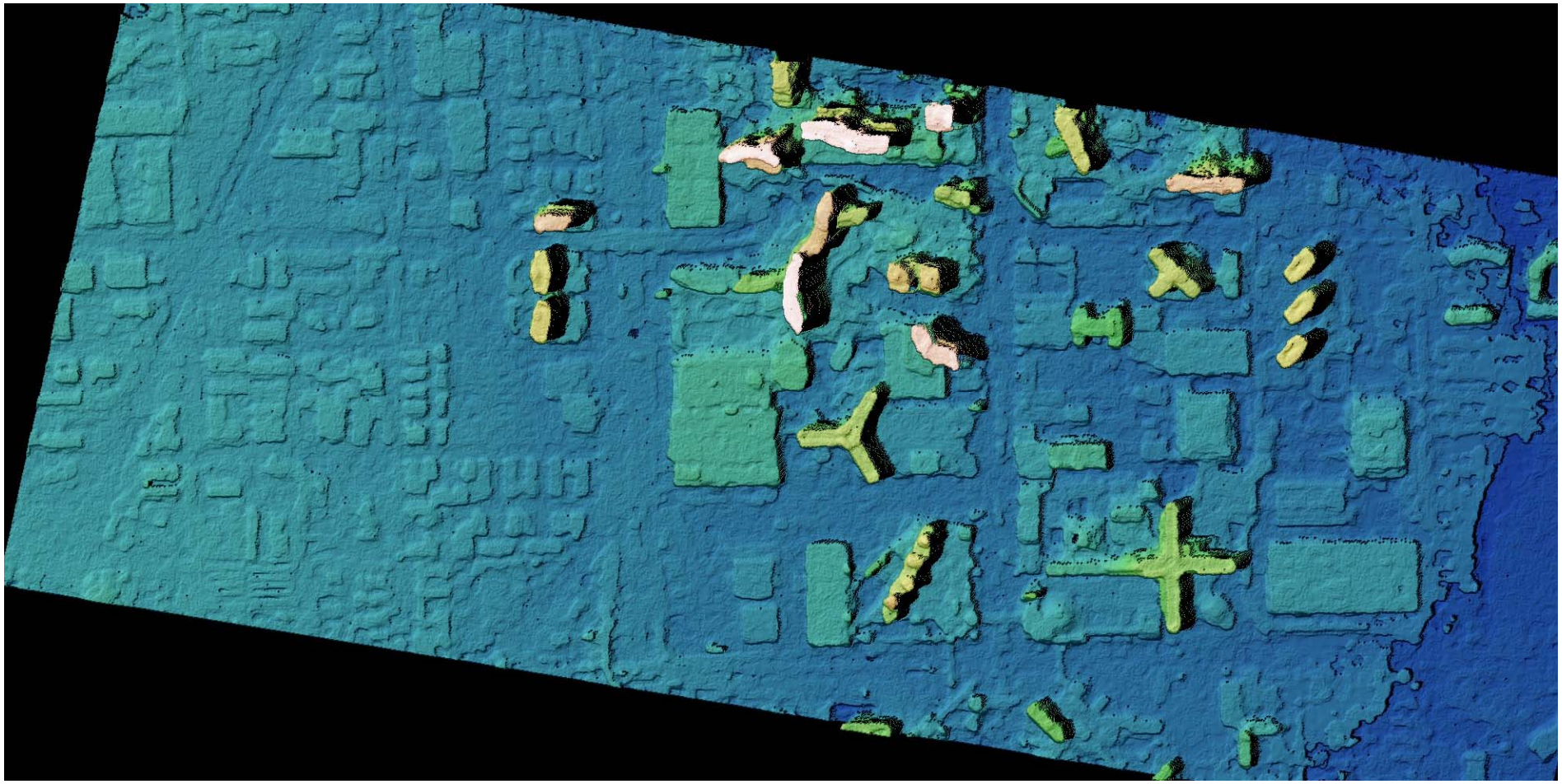
AD+Census, Adaptive Support  + TV regularisation + Median/mean fusion of 3 pairs

# One Master image, 20 Slave images
# No regularization



AD+Census, Small Adaptive Support Regions

# One Master image, 20 Slave images
# Total variation regularization



AD+Census, Small Adaptive Support Regions + Total Variation (Huber) regularization

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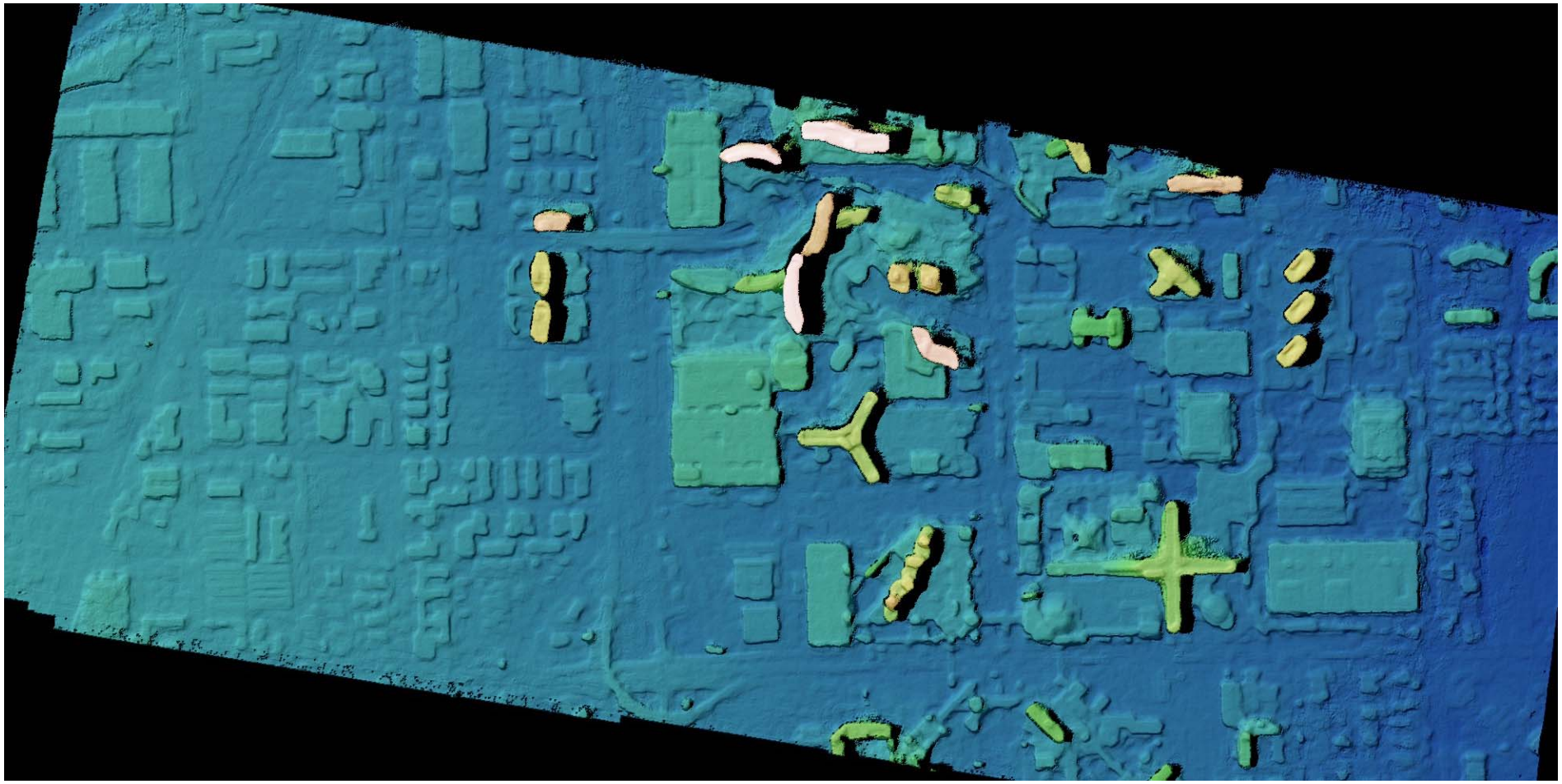
# 15 Master image, 20 Slave images
# Median/Mean fusion



AD+Census, Small Adaptive Support Regions + Total Variation (Huber) regularization

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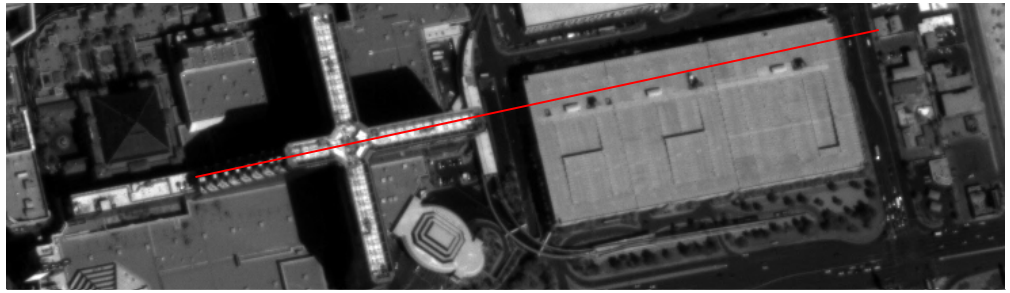
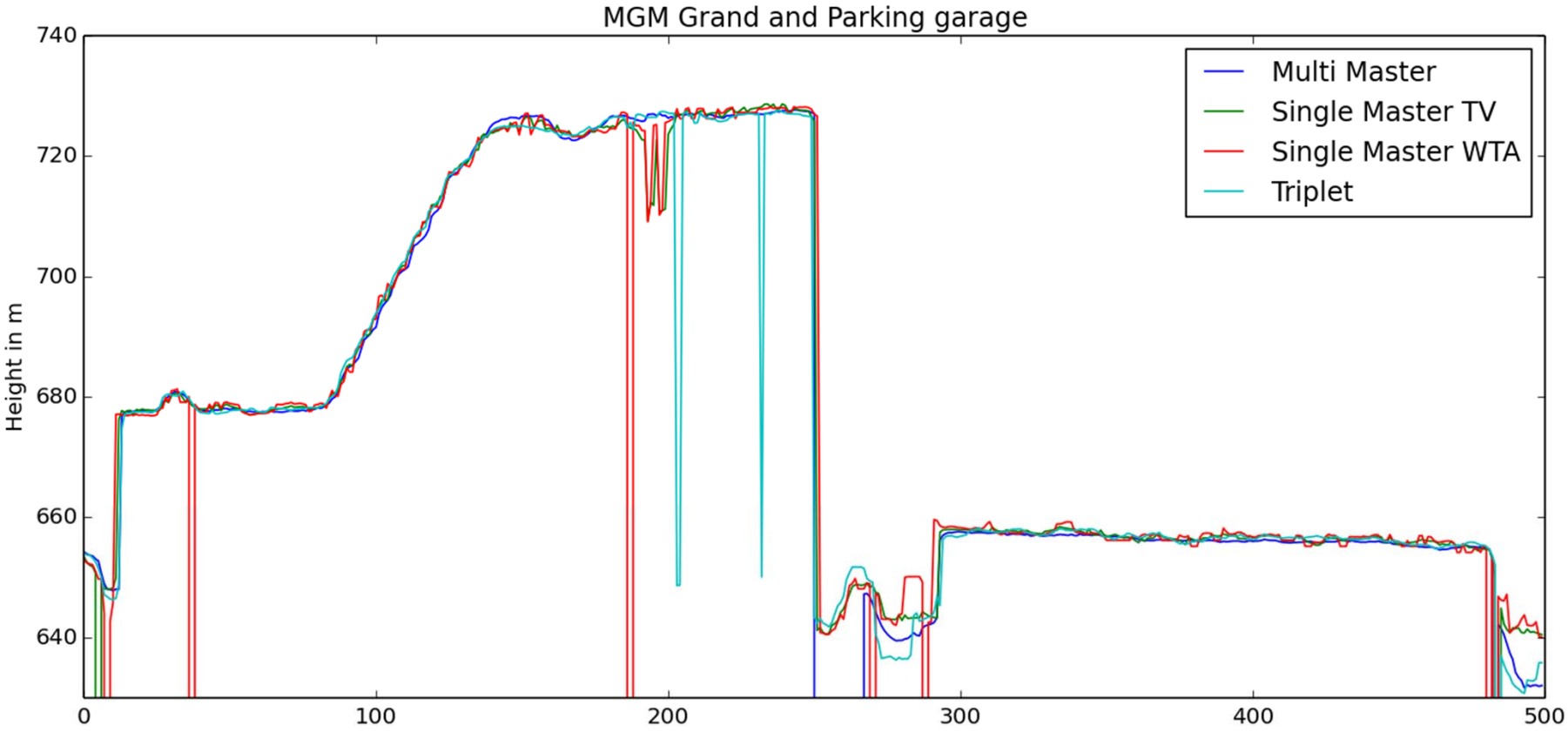
# Profiles



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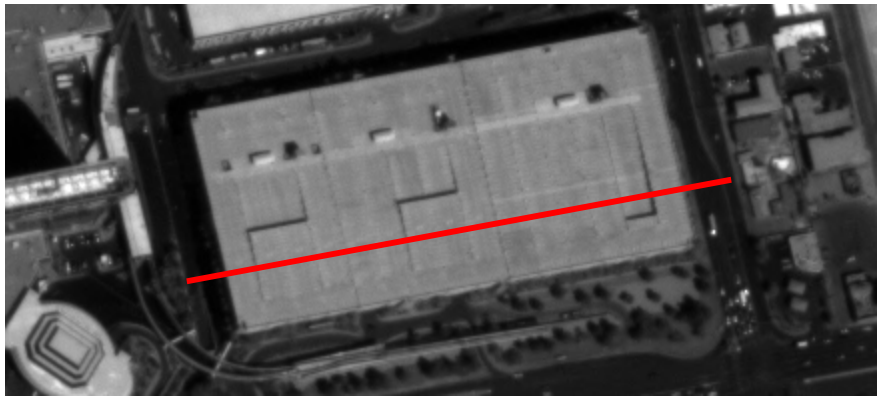

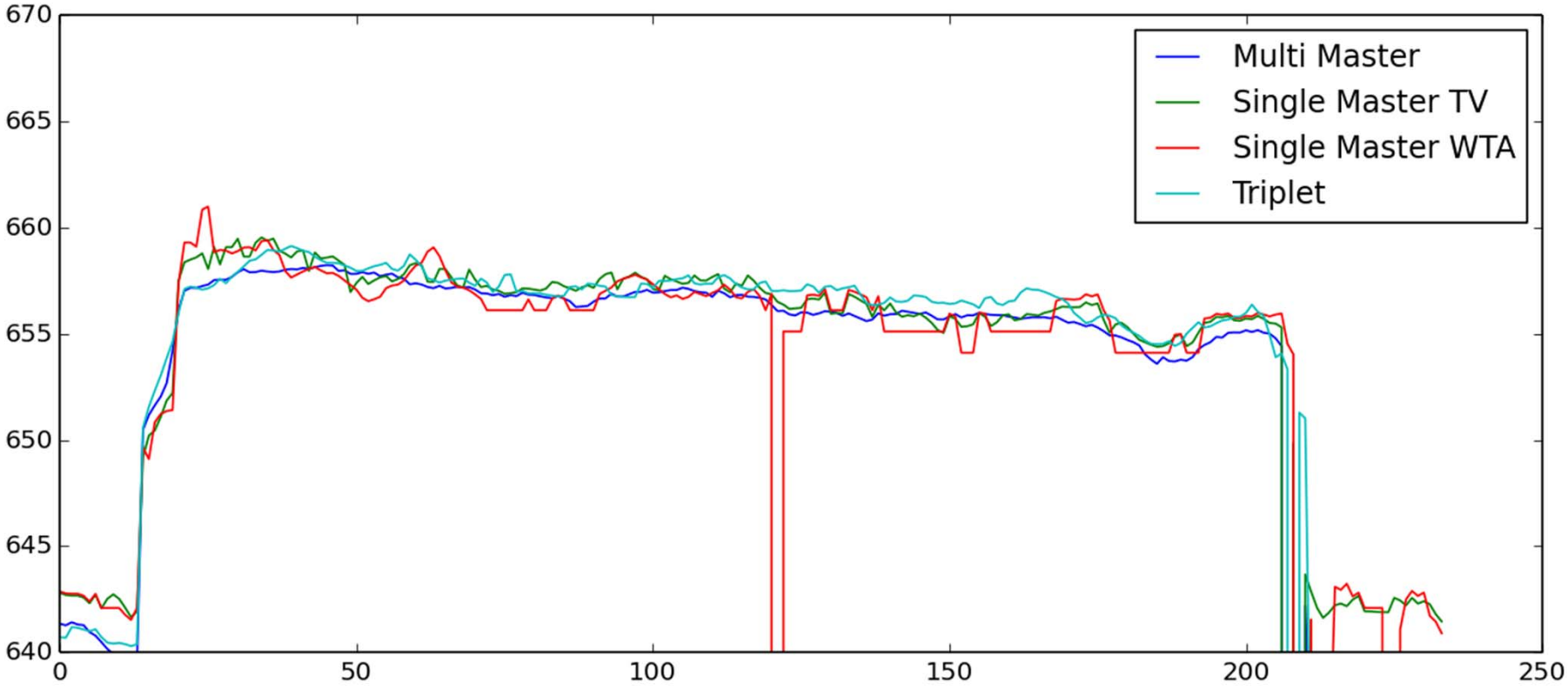
670
665
660
655
650
645
640
0
50
100
150
200
250
Multi Master
Single Master TV
Single Master WTA
Triplet

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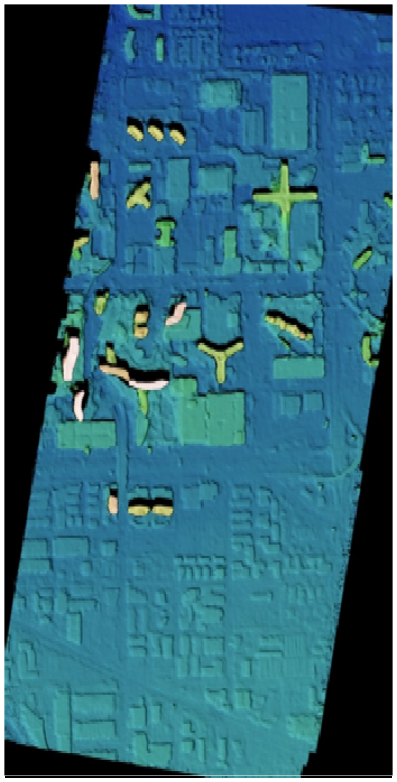
# Conclusions

First results

- Skybox video is well suited for 3D reconstruction
  - DSM generation at sensor GSD possible.
- Open question: How to best exploit the redundancy?
  - Tailored matching strategy
  - SNR improvement(improve matching in shadows)
  - DSM super-resolution?
- Practical applications
  - Good for complex terrain/urban environments.
  - Small area compared to VHR
    (2x1 km vs 16x16 km)



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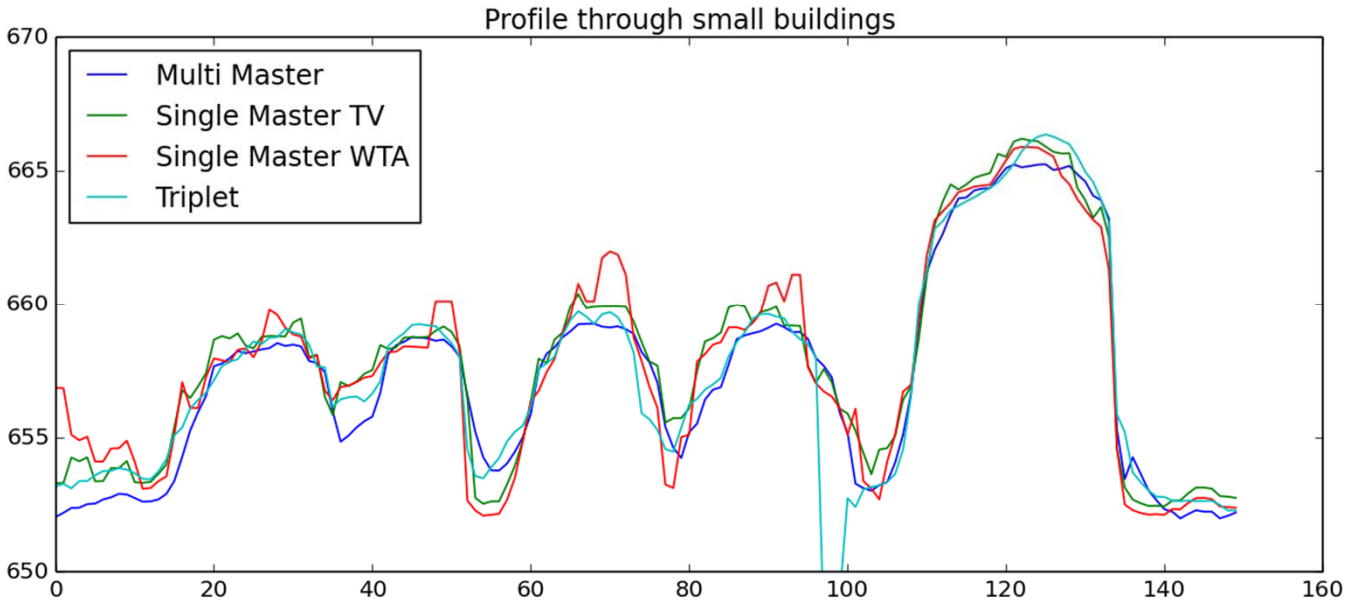
# Profiles


Profile through small buildings
Multi Master
Single Master TV
Single Master WTA
Triplet
670
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120
140
160