

The Power of Multi Ray Photogrammetry

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Frame 0178



Frame 0177



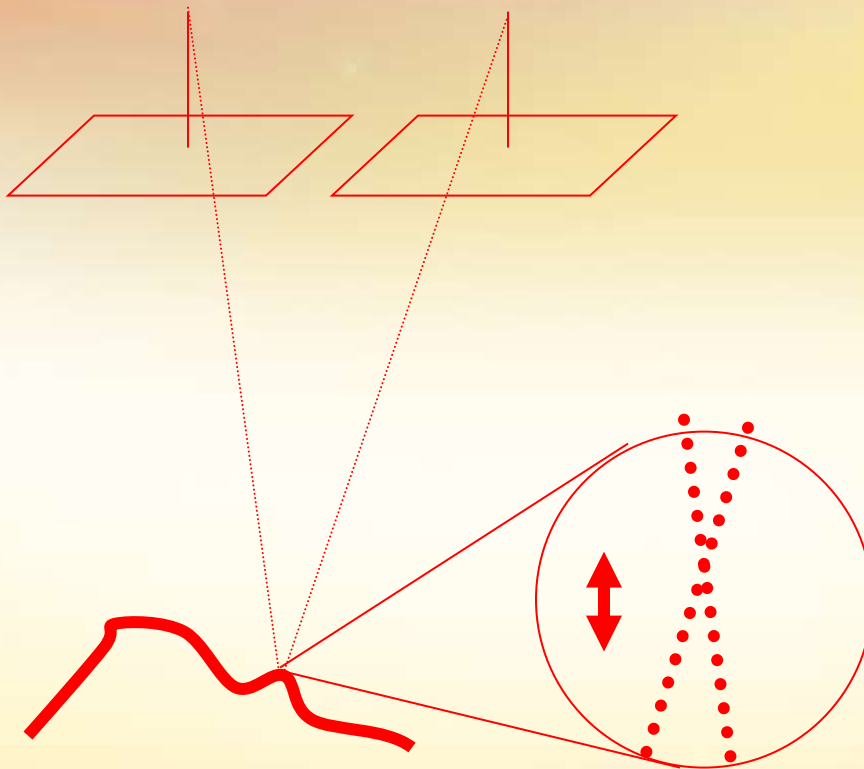
Frame 0219



Frame 0176



Stereo Geometry



**Two Ray
Intersection**

No redundancy

2 Links $\sigma z \sim \pm 16.0$ to ± 33.0 [cm]



Multi Ray Photogrammetry

- 80/60 flight pattern:
up to 12 rays per ground pixel
- Effective occlusion avoidance
- Robust and highly automated





ULTRACAM

Multi Ray Photogrammetry



Frame 175



Frame 176



Frame 177



Frame 178



Frame 179



Frame 218



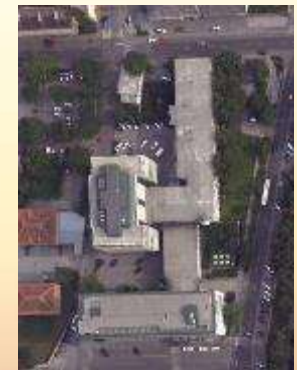
Frame 219



Frame 220

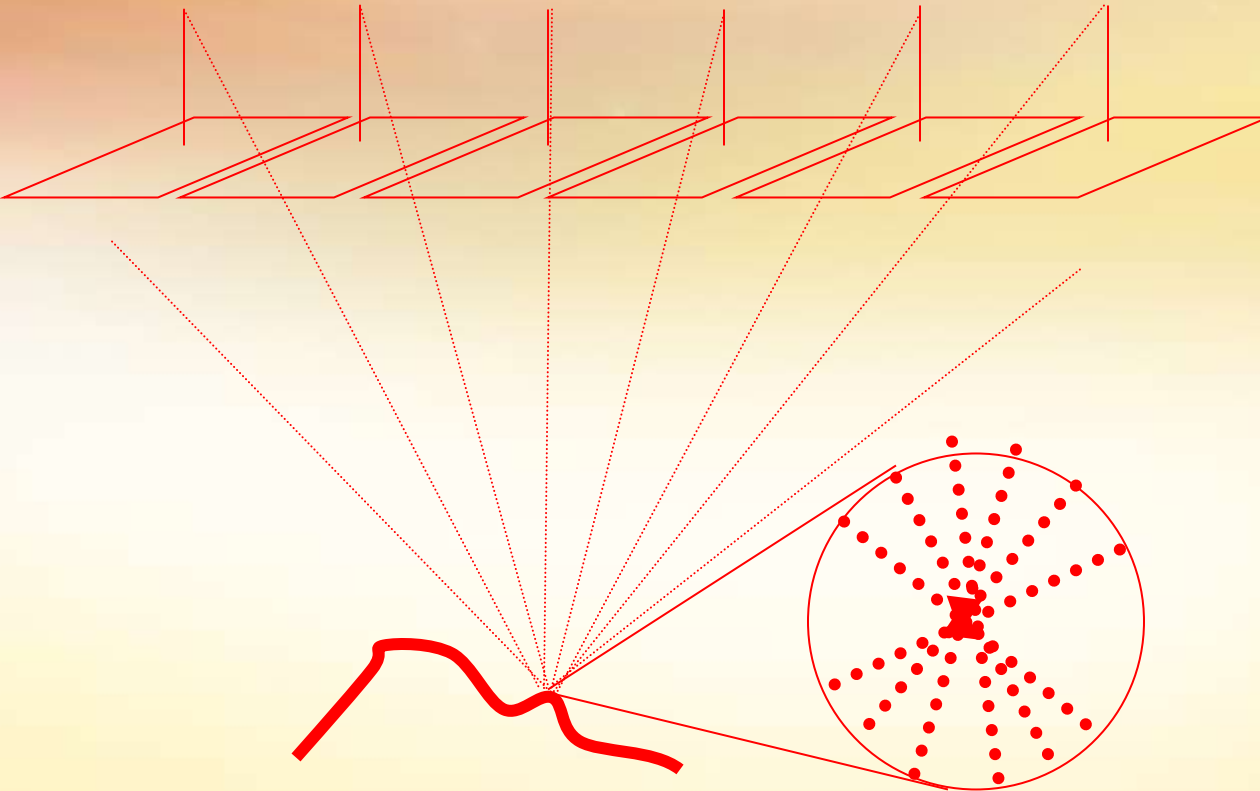


Frame 221



Frame 222

Multi Ray Geometry



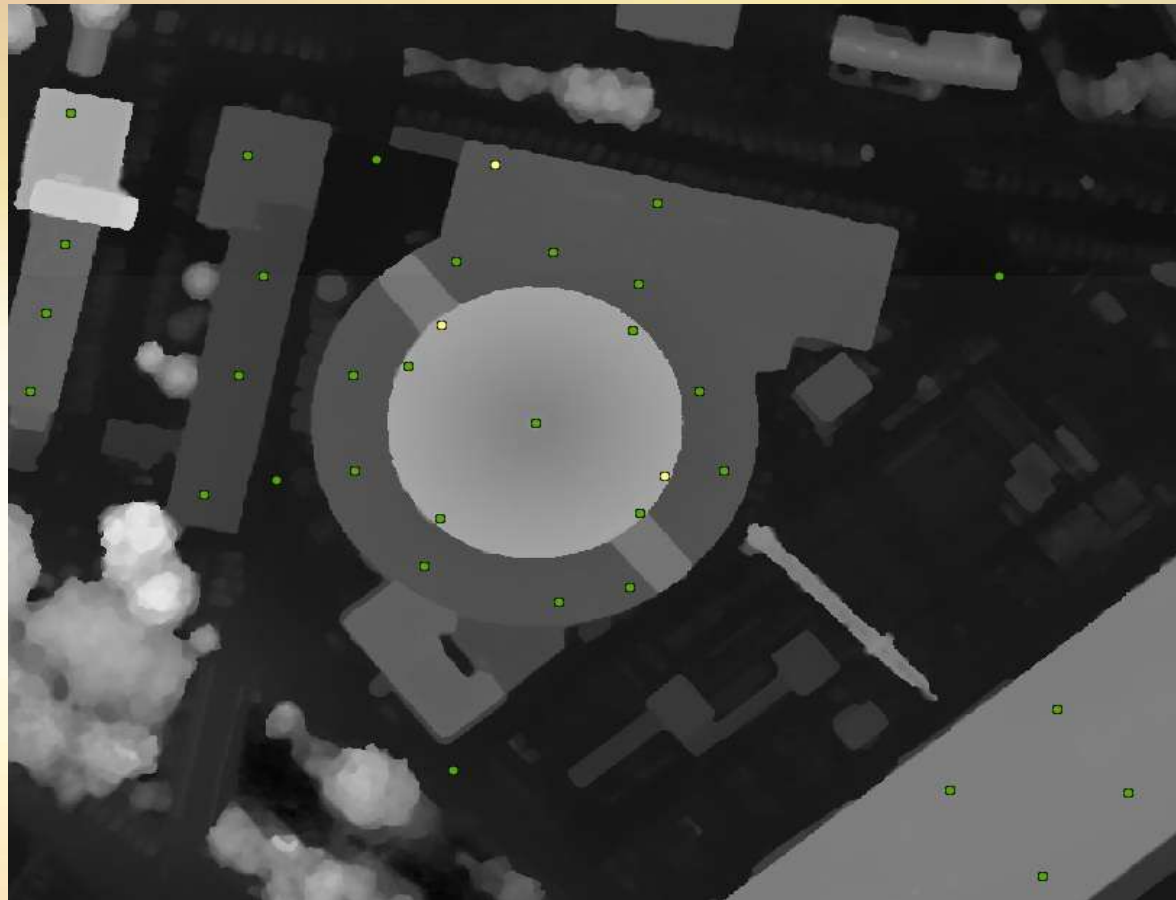
Multi-Intersections

Improve Statistical Optimum

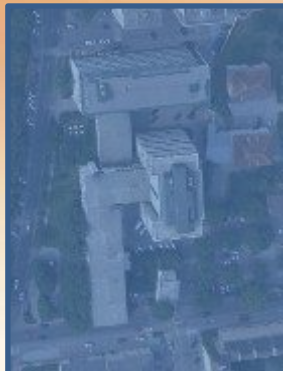
8 Links $\sigma_z \sim \pm 4.3$ to ± 4.6 [cm]

DSM by Multi Ray Photogrammetry

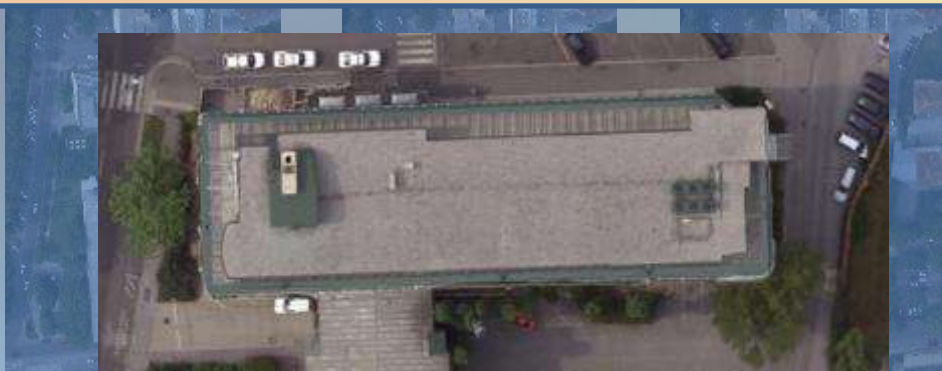
- **Source**
 - Set of high resolution images
 - 80/60 overlap
 - Up to 12 rays per point
- **DSM by an automated dense matching of the pixel**



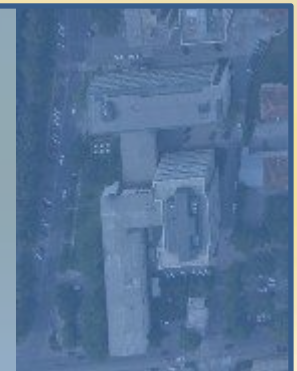
DSMOrtho by Multi Ray Photogrammetry



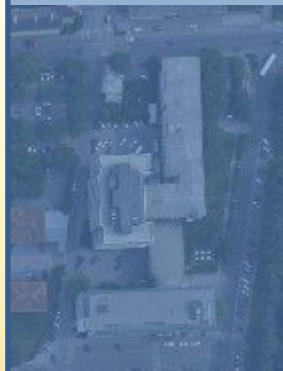
Frame 175



Frame 179



Frame 179



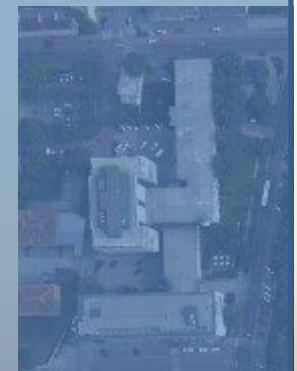
Frame 218



Frame 219

Frame 220

Frame 221



Frame 222

Output: single DSMOrtho

Problems

- Many images to handle
- Too much manual work
 - Too expensive

ULTRAMAP^{3.0}

Workflow Software System

**Towards an “All-In-One-Solution”
using multi-ray photogrammetry**

UltraCam Camera Series



UltraCam Family

>20,000 pixel accross!!



UCLp



UCF



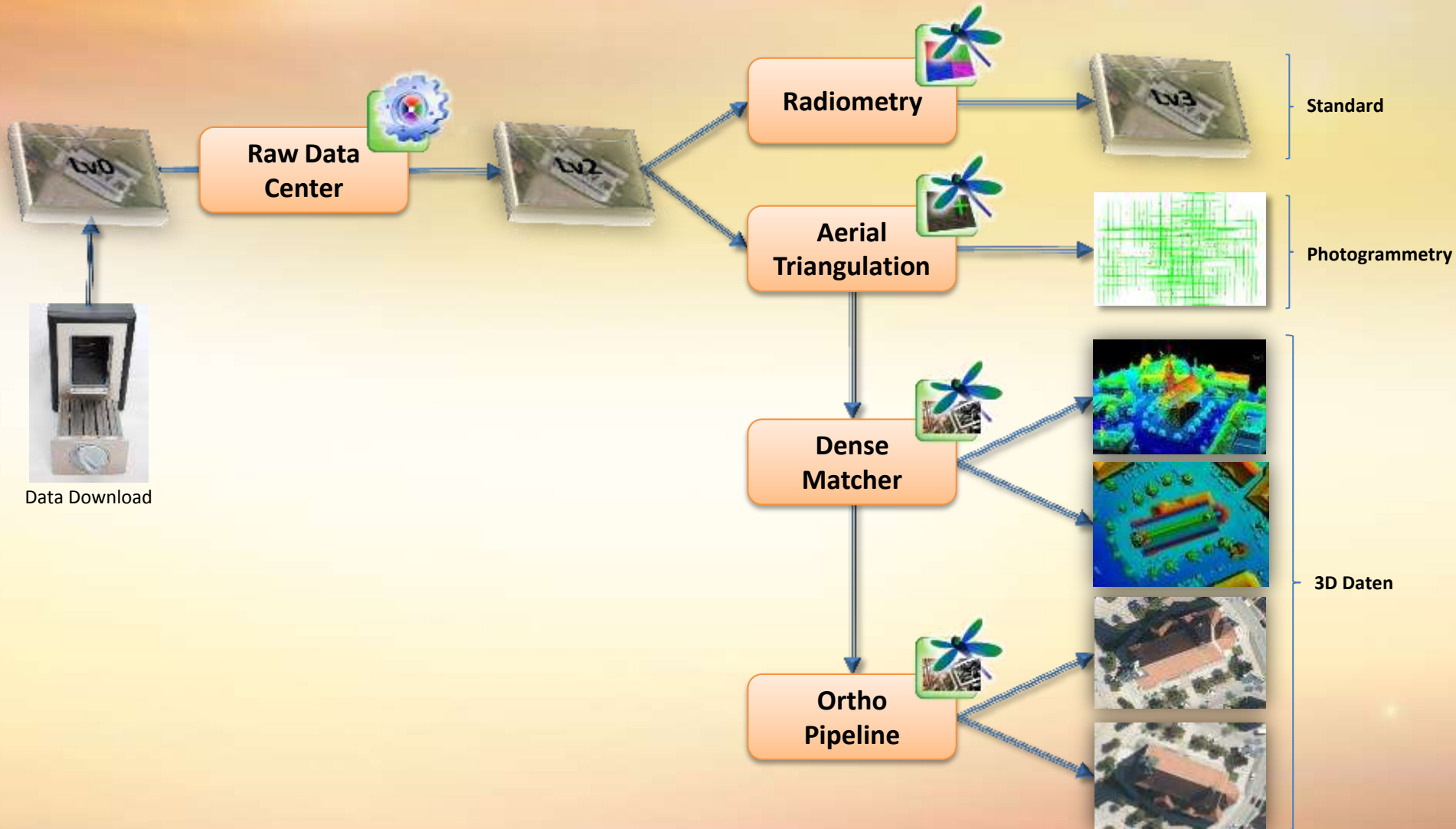
UCFp



UCE

→ Flight Direction

UltraMap3: Workflow



DragonFly Visualization

- Microsoft technology
- Seamless interaction with large amount of data
- DragonFly is core interaction platform for
 - General QC
 - Radiometry
 - Aerial Triangulation



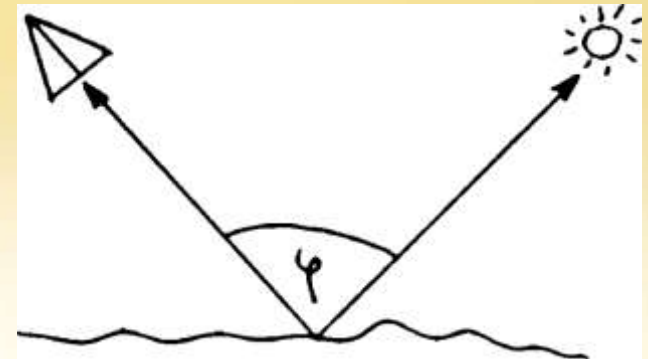
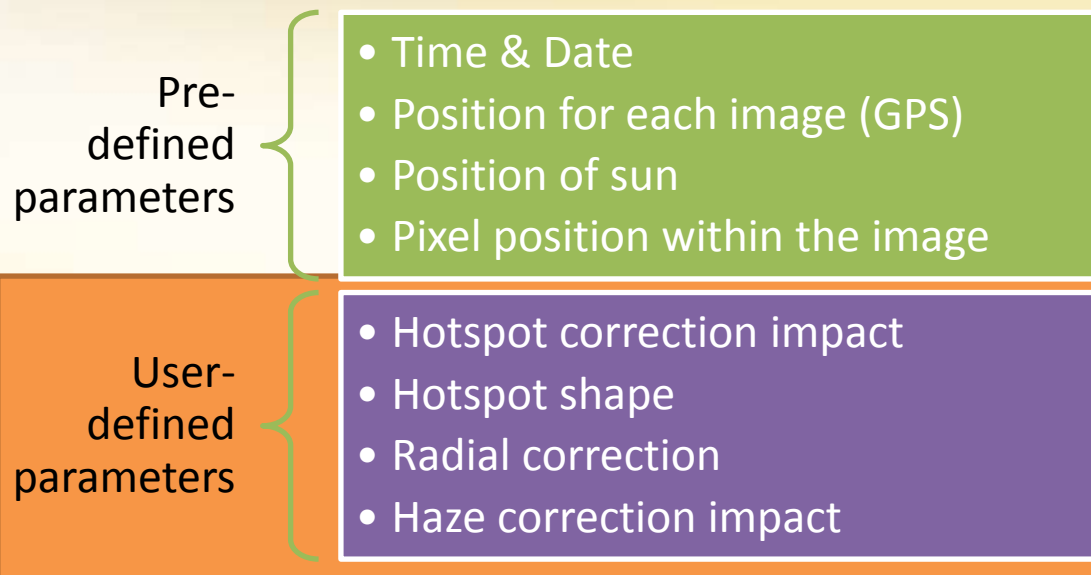
The sky's the limit

External
influences

What can we do?

Consider External Influences

External influences



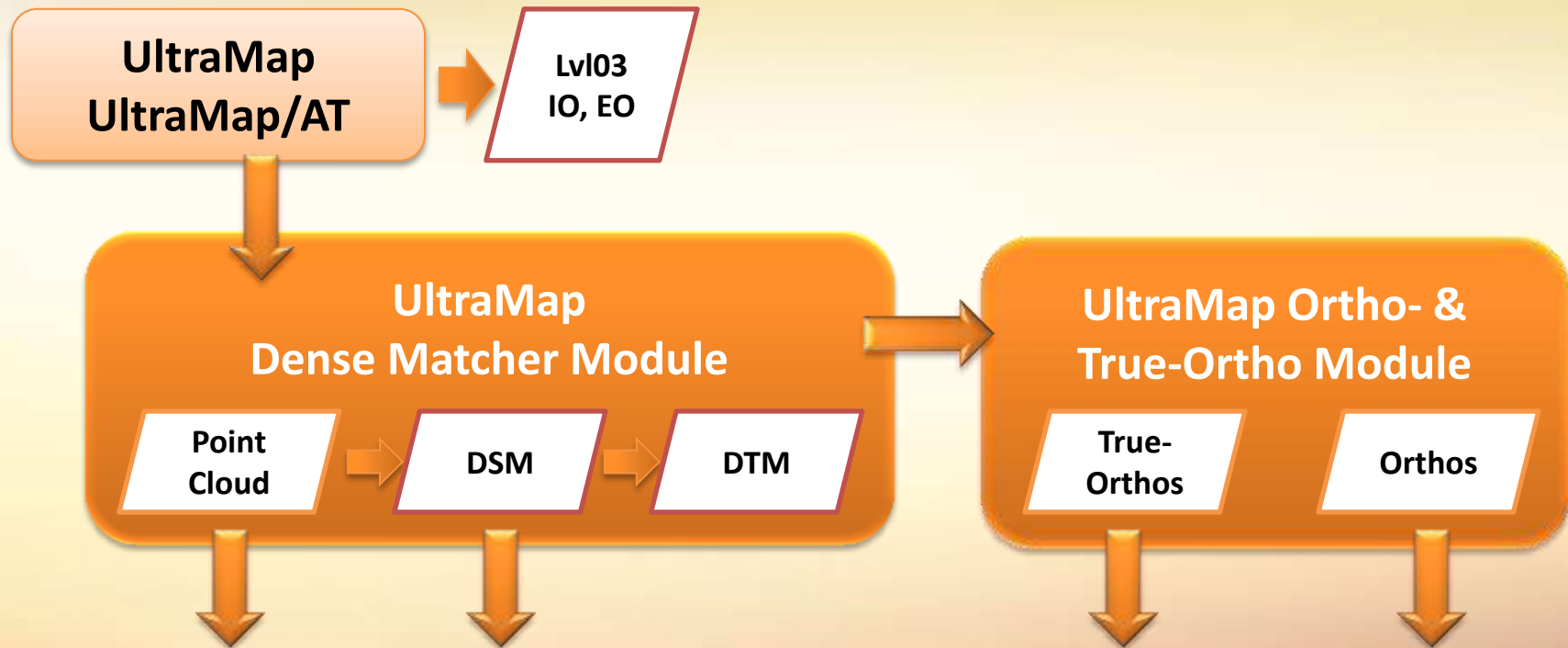


ULTRACAM

Radiometry



UltraMap 3.0 - Workflow





Aerial Triangulation

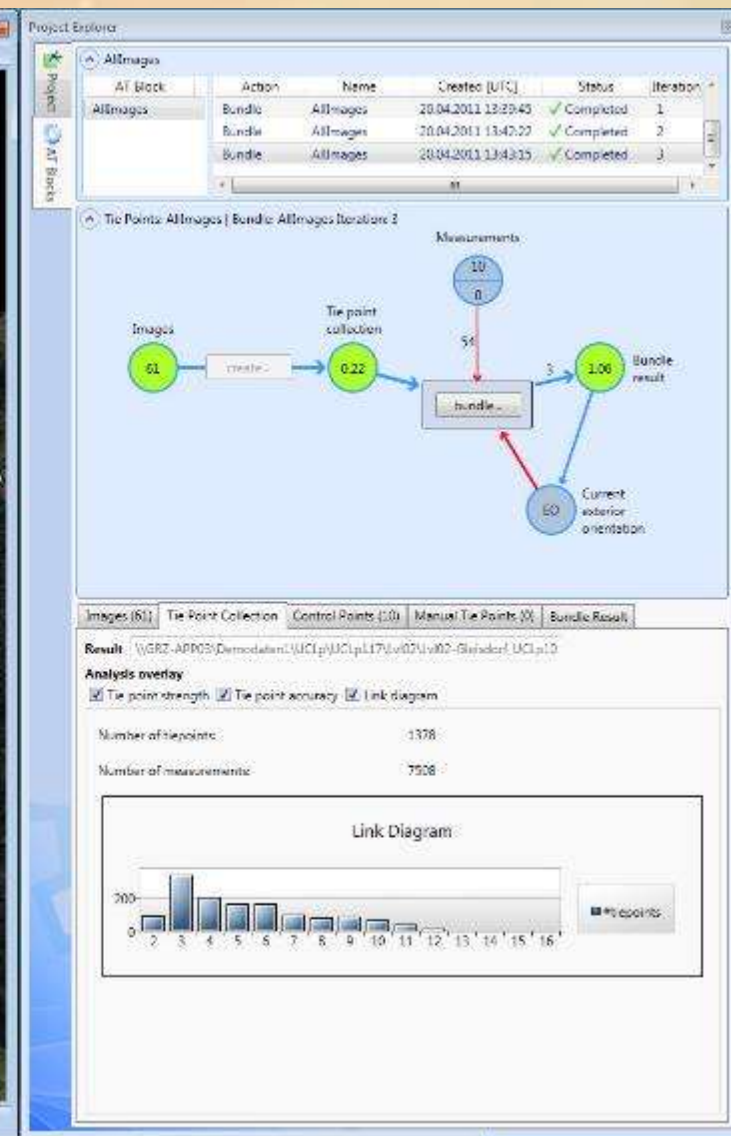
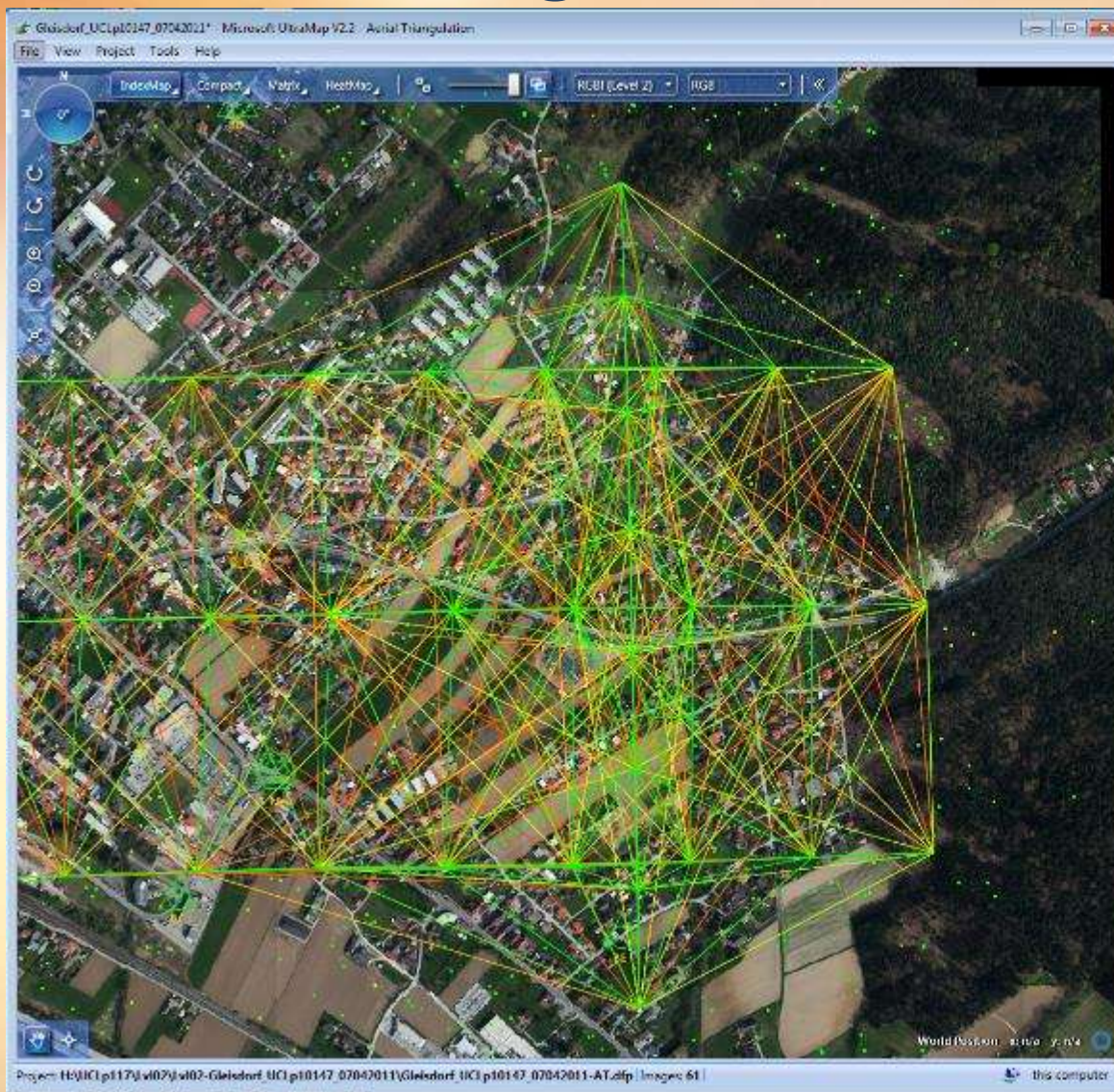
- High redundancy needs less GCP's
- Interactive workflow

=> Exploiting Dragonfly technology for image interaction and visualization of large image blocks



ULTRACAM

Aerial Triangulation



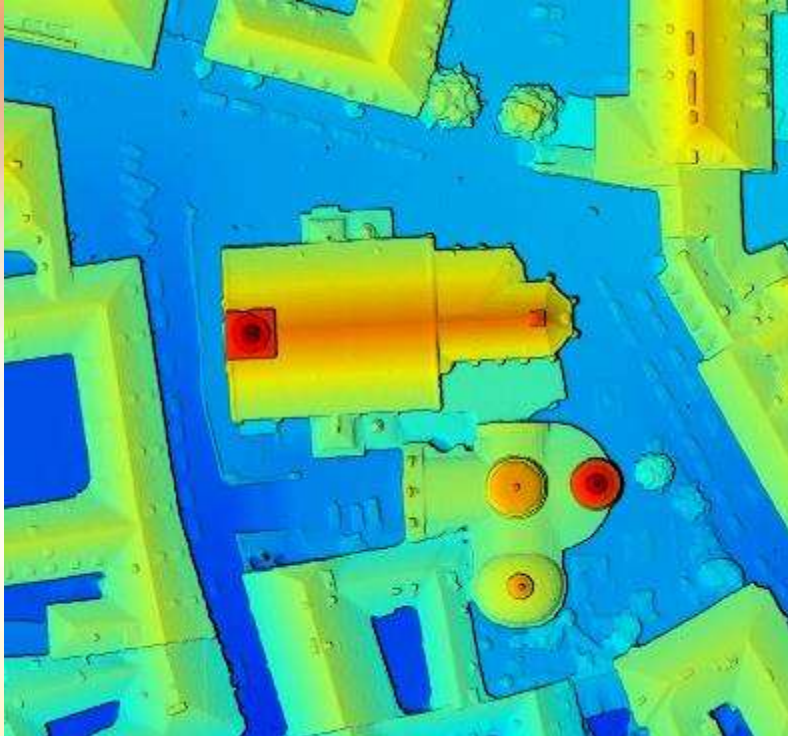


Dense Matching

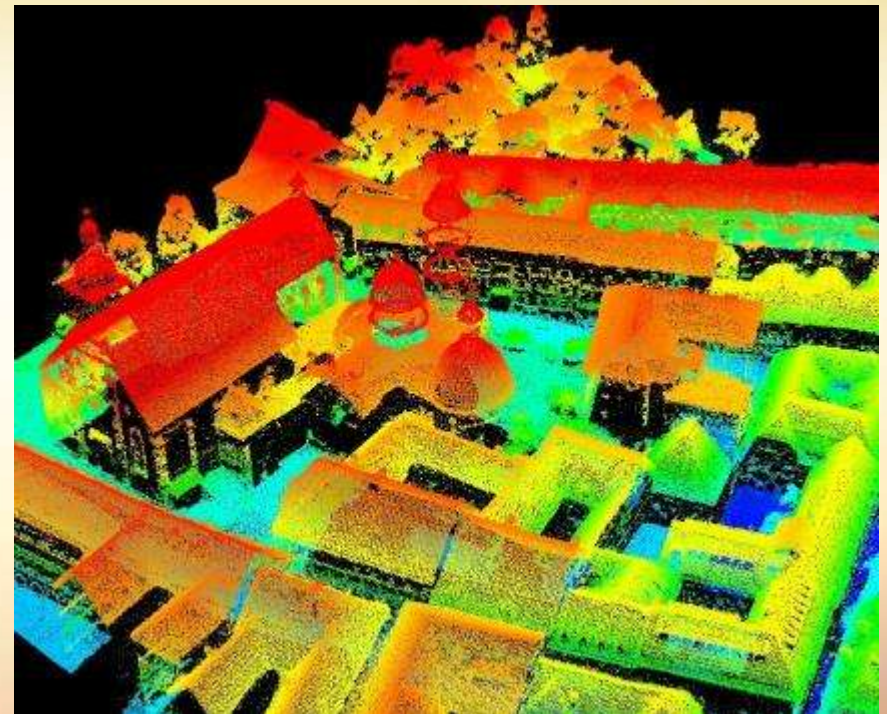
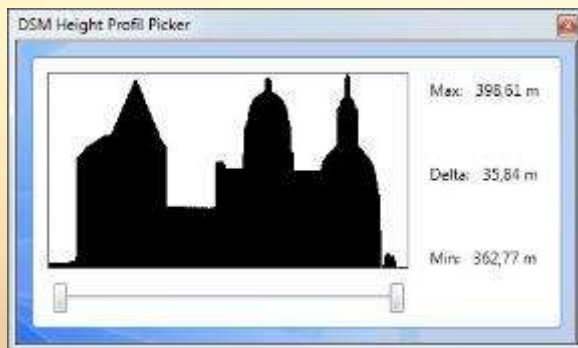
- Highly redundant data set
- Pixel based matching between image pairs
- Result: point cloud
 - Pixel location = x, y value
 - Dense matcher = z values per pixel
 - Point density >>300 points per square meter



Dense Matching

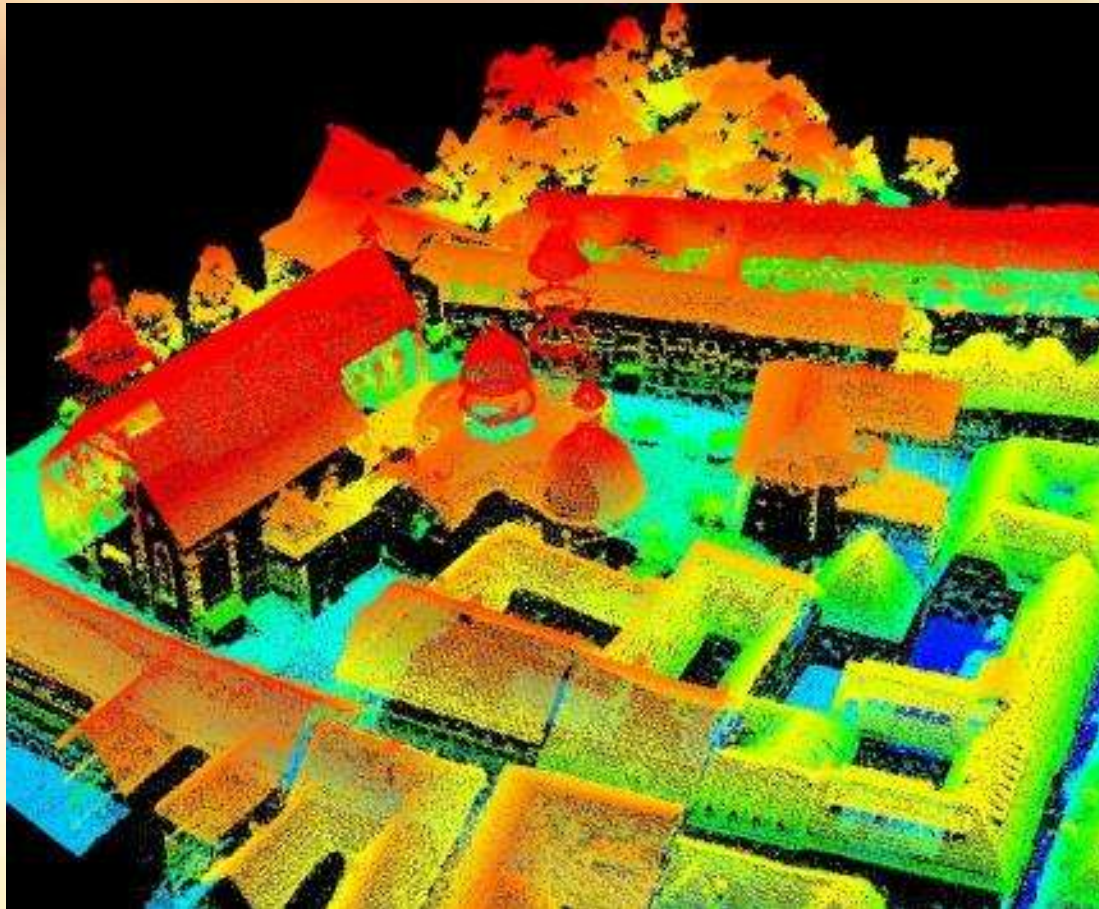


DSM



Point Cloud

Dome of Graz, Austria



14.442.499 points, **~3.5 points per pixel**
about 1400 points/sq meter

Terrain Model



DTM Generation By Winston-Salem Filter





Ortho Pipeline

- Generates the final ortho mosaics from all available inputs such as Level-2 imagery, AT results, Radiometry and DSM/DTM:

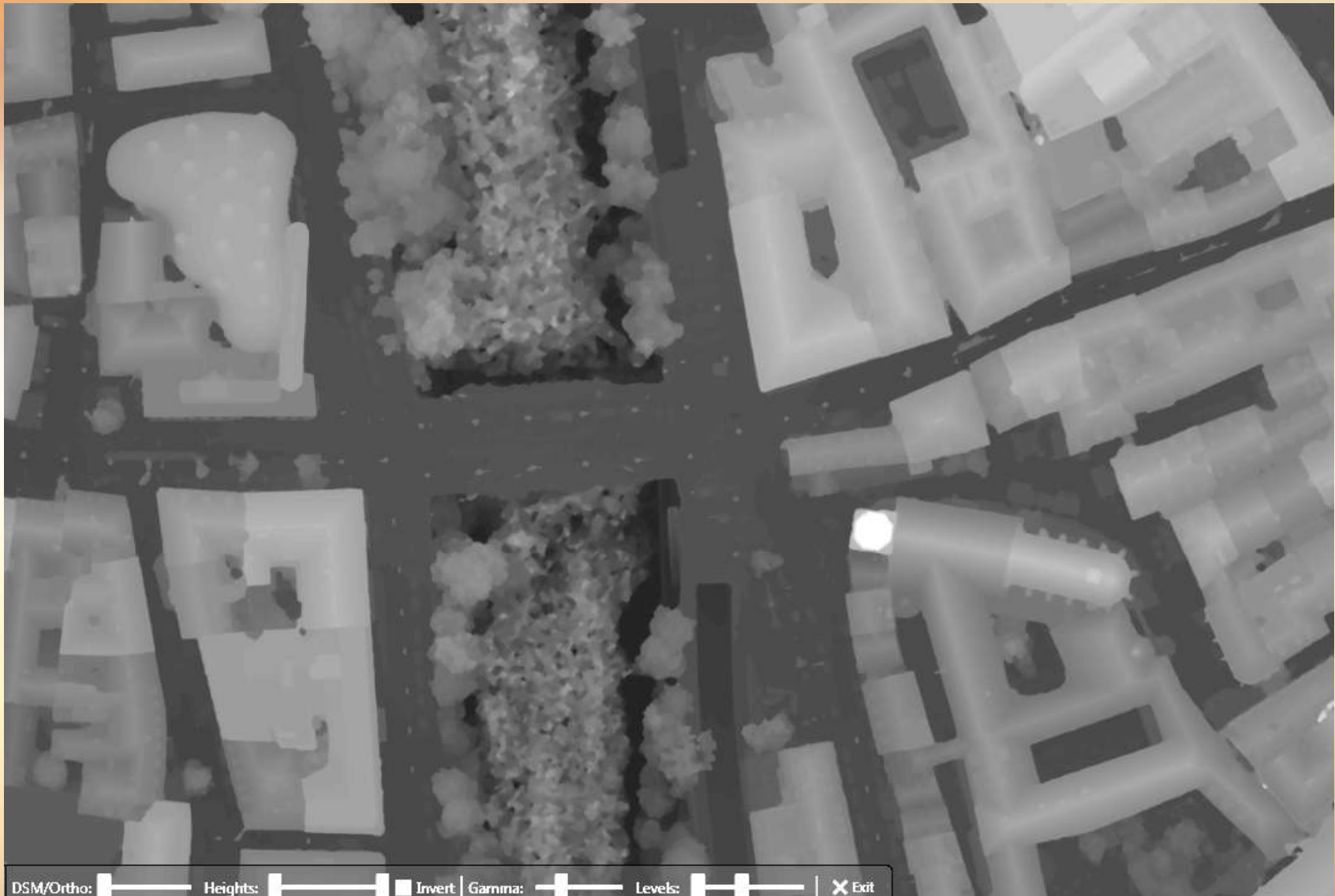


DSMOrtho



DTMOrtho

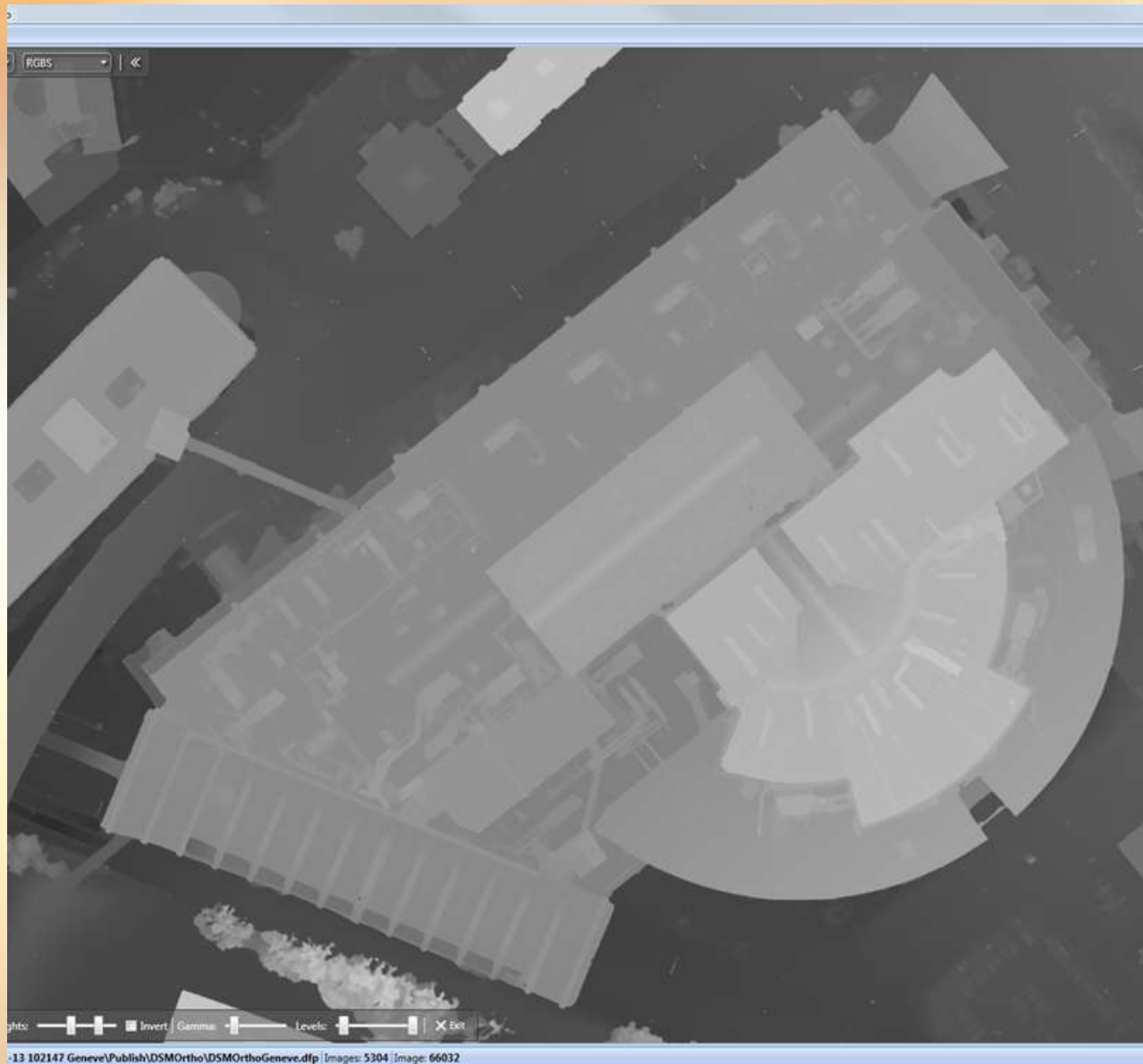
DSM, Graz, 10cm GSD



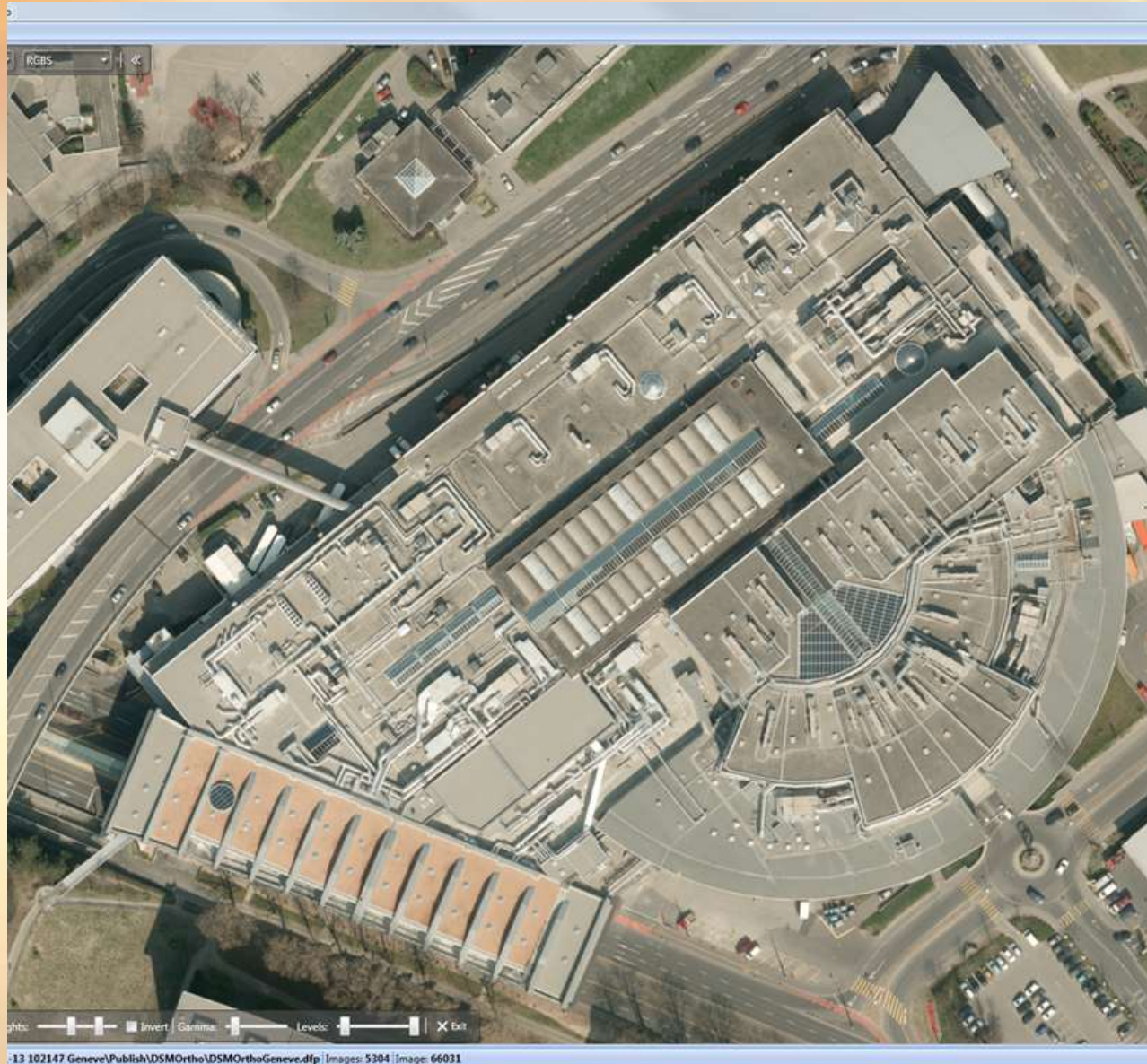
DSMOrtho, Graz, 10cm GSD



DSM, Graz, 10cm GSD



DSMOrtho, Graz, 10cm GSD



Summary

- A point cloud is no longer restricted to Lidar
- Each set of images can automatically generate a very dense point cloud
 - With much higher collection efficiency
 - For the costs of today available IT systems
 - With a strong co-registration between multispectral images & the point cloud
- Serving especially DSM driven applications
 - TBI: dense DTM & thin linear features
- Integrating an automated high-resolution true-ortho & ortho image workflow

Conclusion



**Automation
&
Integrated Workflow**

=> key drivers of the future!