

Forest Mapping Management Ges.m.b.H.  
CEO Wiltraud & Ing. Hermann Novak



# EuroSDR - project

## Benchmark on Image Matching

13th/14th of June 2013

DI Bernhard Brunner



# FMM company – Salzburg Austria

## history/resources

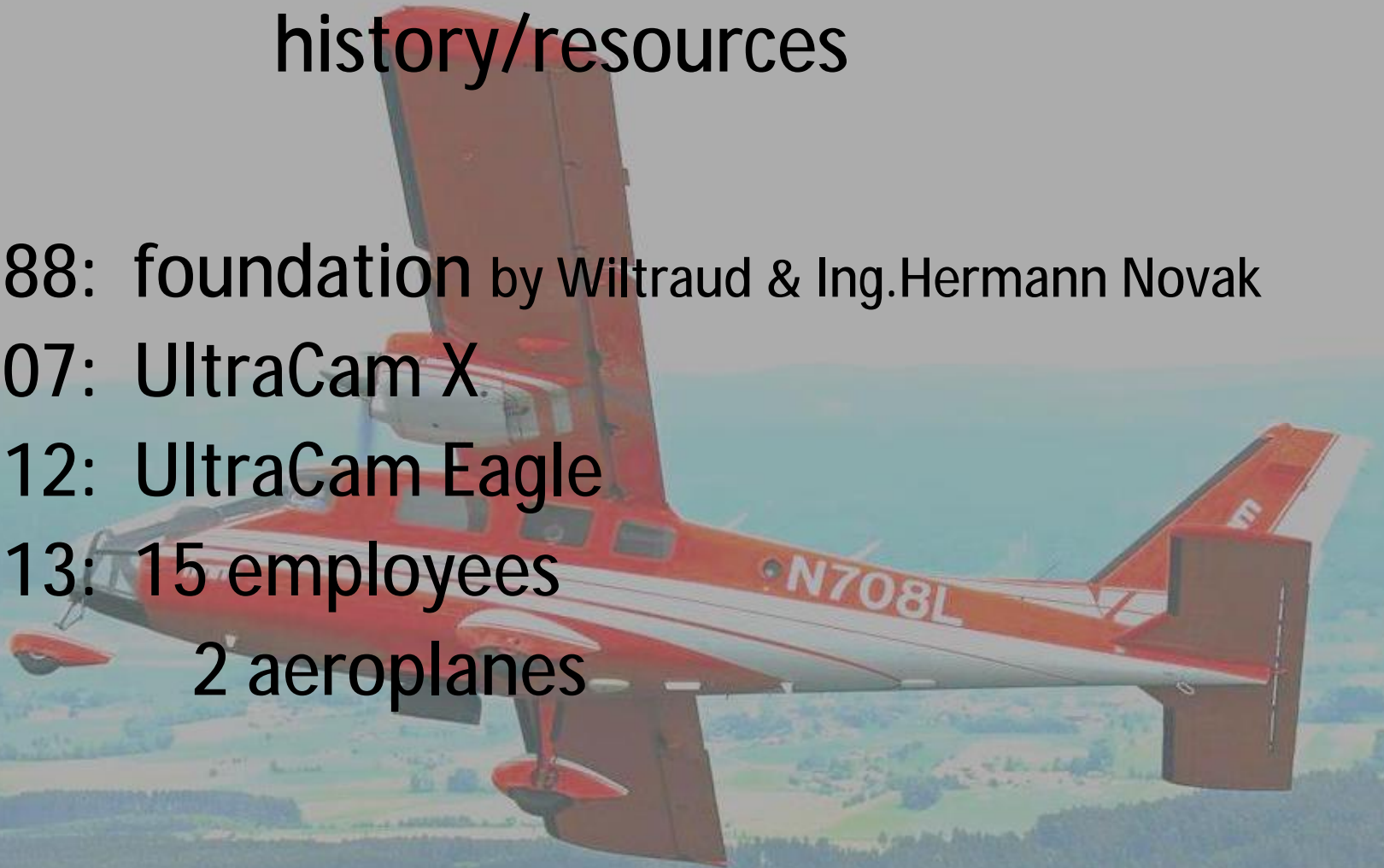
1988: foundation by Wiltraud & Ing.Hermann Novak

2007: UltraCam X.

2012: UltraCam Eagle

2013: 15 employees

2 aeroplanes



# FMM company – Salzburg Austria services

- forestry management
- photoflights for official and private customers
- airborne laser scanning
- true ortho and dsm production
- fleet management



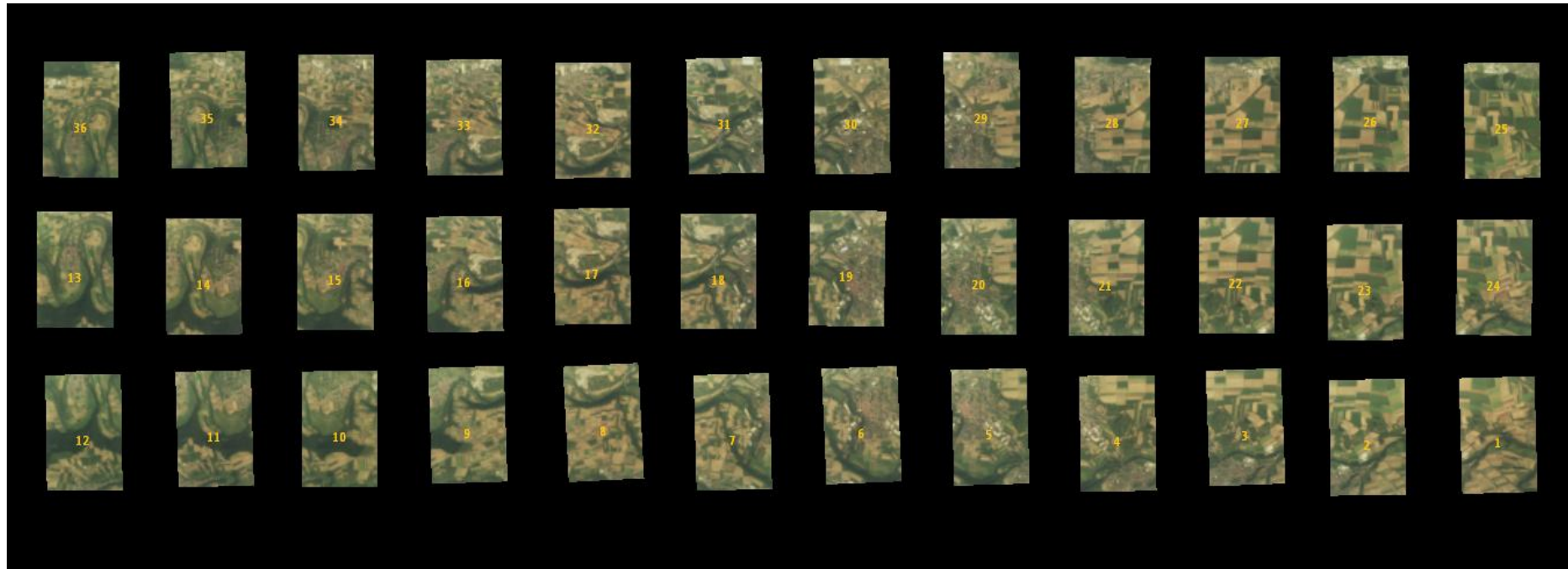


# Vaihingen/Enz – test area



# Test-dataset : 36 UCX – images (GSD 20cm)

flight height about 2800 m AGL



UCX: 9420\*14430/ f=100.5mm  
/pix=7.2 $\mu$ m



# Software and workflow

Microsoft UltraMap V3.1 with Modules:

0) „Lvl02“-data required

1) UltraMap AT

valid calibration files

here: ready made eo-data

tiepoint matching

bundle-adjustment with BINGO

2) UltraMap Radiometry

color adjustment (especially for DOP)

3) UltraMap OP

DSM and Ortho-production with AT and colouradj.





# 1) UltraMap AT – tiepoint collection

The screenshot displays the Microsoft UltraMap V3.1 - Aerial Triangulation software interface. The main window shows a grid of aerial images. A dialog box titled "20cm - Tie Point Collection" is open, with the following settings:

- Name: 20cm
- User: felix
- Priority: Normal
- Cluster: [Dropdown]
- Subscribe for E-mail Notifications
- Tie Point Collection
  - Destination: Tesla2 > Testprojekt\_EuroSDR > AT > AT\_test > AT-ver
  - Tie Point Density: Normal
- Project Based Color Balancing
  - Destination: Tesla2 > Testprojekt\_EuroSDR > AT > AT\_test >
- Precise Input Orientation
- Start Job Monitor

The Project Explorer on the right shows a workflow diagram:

- Images (36) -> create... -> Tie point collection (NaN)
- Tie point collection (NaN) -> bundle... -> Bundle result (NaN)
- Measurements (0) -> bundle... -> Bundle result (NaN)
- EO (Current exterior orientation) -> bundle... -> Bundle result (NaN)

The Project Explorer table shows the following data:

AT Block	Action	Name	Created	Status	Iter
20cm	Block created				
AT-time	Tie Points	20cm	10.06.2013 13:41:48	Initial	

Project Explorer Table:

AT Block	Action	Name	Created	Status	Iter
20cm	Block created				
AT-time	Tie Points	20cm	10.06.2013 13:41:48	Initial	

Project Explorer Diagram:

```
graph LR; Images[36] -- create... --> Tie[Tie point collection NaN]; Tie --> Bundle(bundle...); Measurements[0] --> Bundle; EO[EO Current exterior orientation] --> Bundle; Bundle --> Result[Bundle result NaN];
```

Project Explorer Table:

AT Block	Action	Name	Created	Status	Iter
20cm	Block created				
AT-time	Tie Points	20cm	10.06.2013 13:41:48	Initial	

Project Explorer Diagram:

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graph LR; Images[36] -- create... --> Tie[Tie point collection NaN]; Tie --> Bundle(bundle...); Measurements[0] --> Bundle; EO[EO Current exterior orientation] --> Bundle; Bundle --> Result[Bundle result NaN];
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Project Explorer Table:

AT Block	Action	Name	Created	Status	Iter
20cm	Block created				
AT-time	Tie Points	20cm	10.06.2013 13:41:48	Initial	

# 1) UltraMap AT – bundle adjustment

The screenshot displays the Microsoft UltraMap V3.1 - Aerial Triangulation software interface. The main window shows a grid of images with green tie points and a network of green lines representing the bundle adjustment process. The Project Explorer on the right shows a table of AT Blocks and a flow diagram of the bundle adjustment process.

AT Block	Action	Name	Created	Status
20cm	Tie Points	20cm	30.04.2013 13:03:48	Completed
	Bundle	20cm	30.04.2013 13:31:10	Completed
	Bundle	20cm	02.05.2013 08:00:05	Completed

The flow diagram shows the bundle adjustment process:

```
graph LR; Images(36) -- create... --> TiePointCollection(0.26); TiePointCollection --> Bundle(bundle...); Bundle --> BundleResult(1.6); EO(Current exterior orientation) --> BundleResult;
```

**Analysis overlay**

- Tie point strength
- Tie point accuracy
- Link diagram

**General**

Number of Images:	36
Number of Tiepoints:	1513
Number of Measurements:	7235

**Link Diagram**

Link Length	Number of Links
2	~150
3	~350
4	~150
5	~100
6	~250
7	~50
8	~50
9	~50



## 2) UltraMap Radiometry

The screenshot displays the Microsoft UltraMap V3.1 - Radiometry software interface. The main window shows a grid of satellite images. A 'Curves' dialog box is open, showing a graph with a spline curve. The 'Type' is set to 'Spline' and the 'Channel' is 'Red'. The 'Master' radio button is selected. The graph shows a curve that rises steeply and then levels off. The 'Project Explorer' window on the right shows a tree view with 'Recorded Blocks' and 'User-defined Blo' (20cm). Below the Project Explorer, a 'Radiometry' panel shows 'Master' selected, 'Channel: Red', and a histogram with 'Shadow: 0 / Highlight: 65535'. The status bar at the bottom indicates 'Project: P:\Testprojekt\_EuroSDRAT\AT\_test\At\_final\_2\_130502.dfp Images: 309' and 'World Position x: n/a y: n/a'.

Project: P:\Testprojekt\_EuroSDRAT\AT\_test\At\_final\_2\_130502.dfp Images: 309

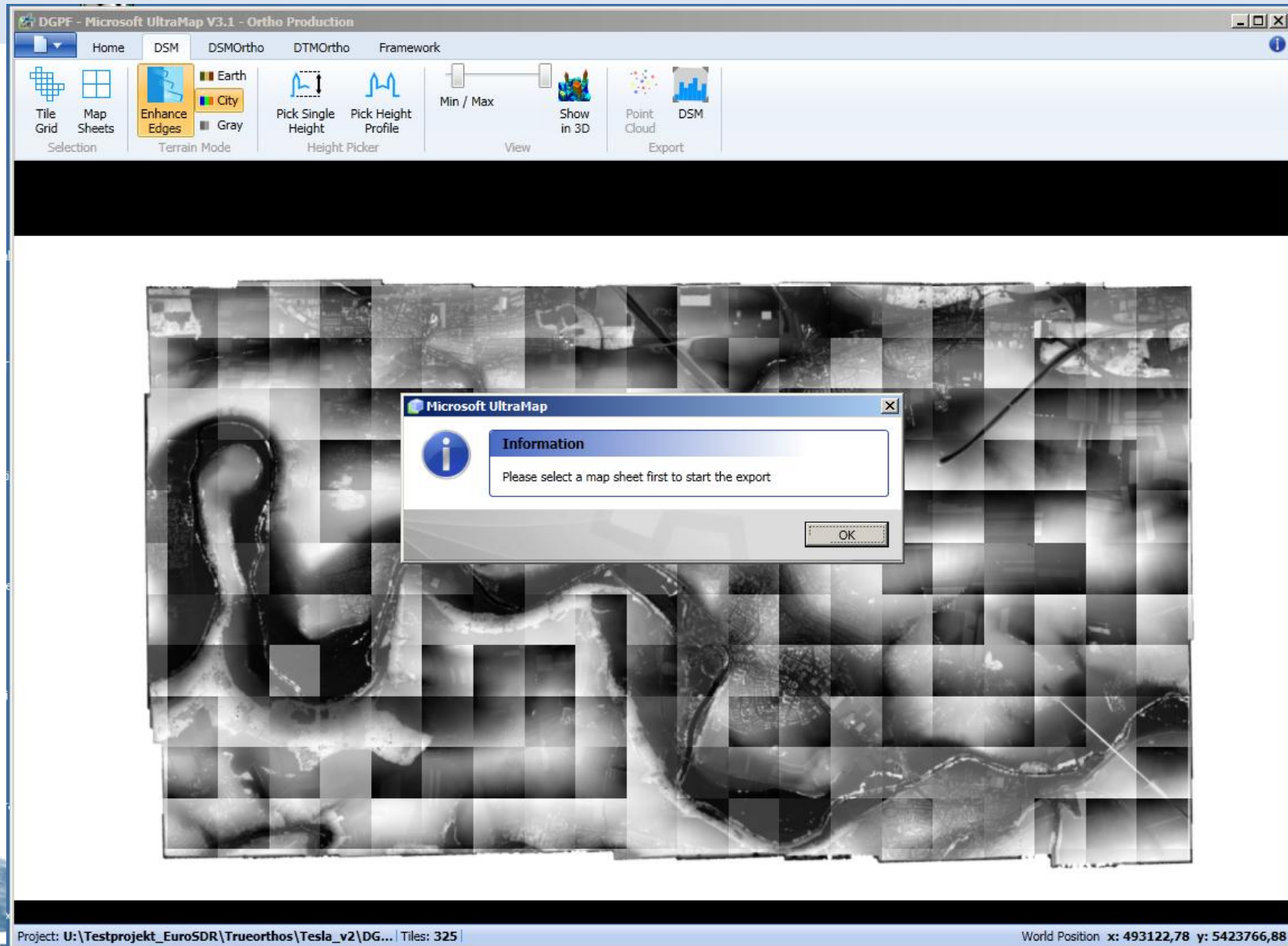
# 3) UltraMap OP – dsm production

The screenshot displays the Microsoft UltraMap V3.1 - Ortho Production software interface. The main window shows a satellite map of a rural area with a winding river. The 'Generate DSM/Ortho' dialog box is open on the right side, containing the following fields and options:

- Name: DGPF
- User: thinx
- Priority: Normal
- GPU processing
- Cluster: Ortho
- Subscribe for E-mail Notifications
- Destination: Tesla2 > Testprojekt\_EuroSDR > DGPF\_testbb
- Content**
  - DSM
  - Point Cloud
  - DSMOrtho
  - DTMOtho
- DSM Processing Mode: Standard
- Crop input images for DTMOtho
  - Top: 0 [%] Bottom: 0 [%]
  - Left: 0 [%] Right: 0 [%]
- Number of Work Partitions: 13
- Info**
  - 325 Tile(s) selected
  - Estimated forward overlap for DSM: 61,22% below 75%! Set "DSM Processing Mode" to "Robust"!

At the bottom of the dialog, there is an 'Estimate Data Consumption' button and a 'Start Job Monitor' checkbox. The 'Submit' and 'Cancel' buttons are at the bottom right. The status bar at the bottom of the application window shows 'Project: | Tiles: 325 |' and 'World Position x: 2078,38 y: 1097,56'.

# 3) UltraMap OP - export





# UltraMap – distributed processing

The screenshot displays the Microsoft UltraMap V3.1 - Job Monitor interface. The main window is titled "Microsoft UltraMap V3.1 - Job Monitor" and has a menu bar with "File", "View", "Job", "Nodes", "Tools", and "Help".

**Job Control Panel:** Includes buttons for "All", "Pause", "Resume", "Abort", "Delete", and "Change Cluster". Below these are "Job Control" and "View" tabs. A table lists jobs with columns for "Id", "Name", "Requirements", "Cluster", and "State".

Id	Name	Requirements	Cluster	State
50	UM-Ortho-Content: DGPF <small>Submitted at 10.06.2013 14:26:25 by thinix</small>	S R G	Ortho	Running
19	UM-Ortho-Content: Salzburg <small>Submitted at 03.06.2013 09:44:55 by thinix</small>	S R G	Ortho	Finished
2	UM-Ortho-Content: Stainz <small>Submitted at 28.05.2013 14:56:07 by thinix</small>	S R G	Ortho	Finished

**System Overview:** Shows "Usable Nodes: 6 of 18", "Usable Clusters: 3 of 4", "CPU Process Utilization: 0 of 56", "GPU Process Utilization: 6 of 6", and "Tasks running: 3".

**License Utilization:** Displays usage for "Base CPU" (0 of 48), "AT CPU" (0 of 32), "DM CPU" (0 of 32), "DM GPU" (6 of 8), and "Ortho CPU" (0 of 32).

**Job Overview:** Shows details for job "#50 UM-Ortho-Content: DGPF", including "Children: 2 Sequential", "Cluster: Ortho", and "Requirements: S|R|G". The state is "Running".

State	Description	Children	Start Time	End Time
In Progress	Match HighRes	13 Parallel		
Running	Match HighRes #1		10.06.2013 14:26:25	- not finished yet -
Running	Match HighRes #2		10.06.2013 14:26:25	- not finished yet -
Running	Match HighRes #3		10.06.2013 14:26:26	- not finished yet -
Queued	Match HighRes #4		- not started yet -	- not started yet -
Queued	Match HighRes #5		- not started yet -	- not started yet -
Queued	Match HighRes #6		- not started yet -	- not started yet -
Queued	Match HighRes #7		- not started yet -	- not started yet -
Queued	Match HighRes #8		- not started yet -	- not started yet -

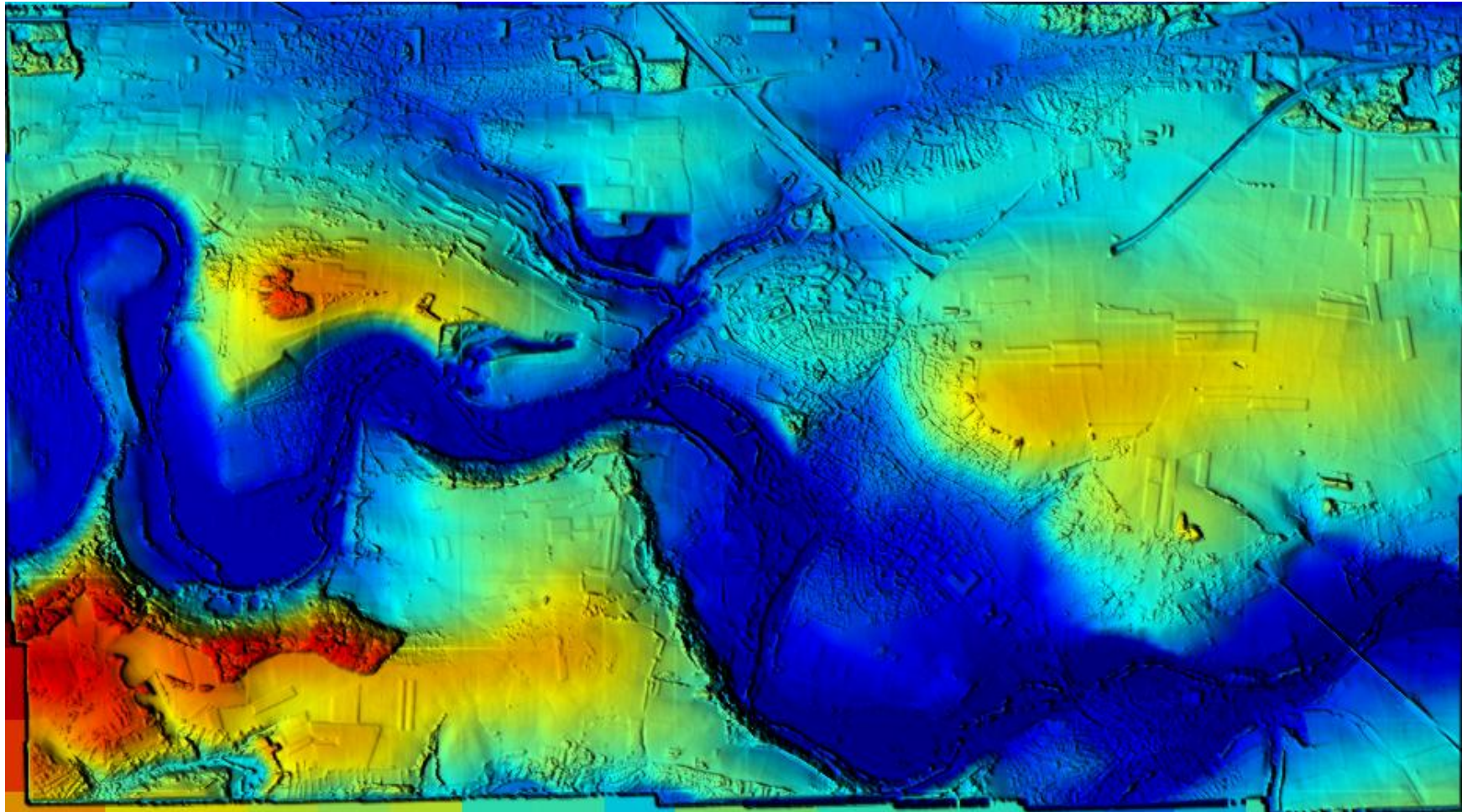
**Nodes List:** Shows a list of nodes including "Nostrix9", "Scanix", "Ortho", "tesla1", and "Tecla2", each with its own resource utilization (CPU/GPU).

**Footer:** The "thinix" logo is visible in the bottom right corner.



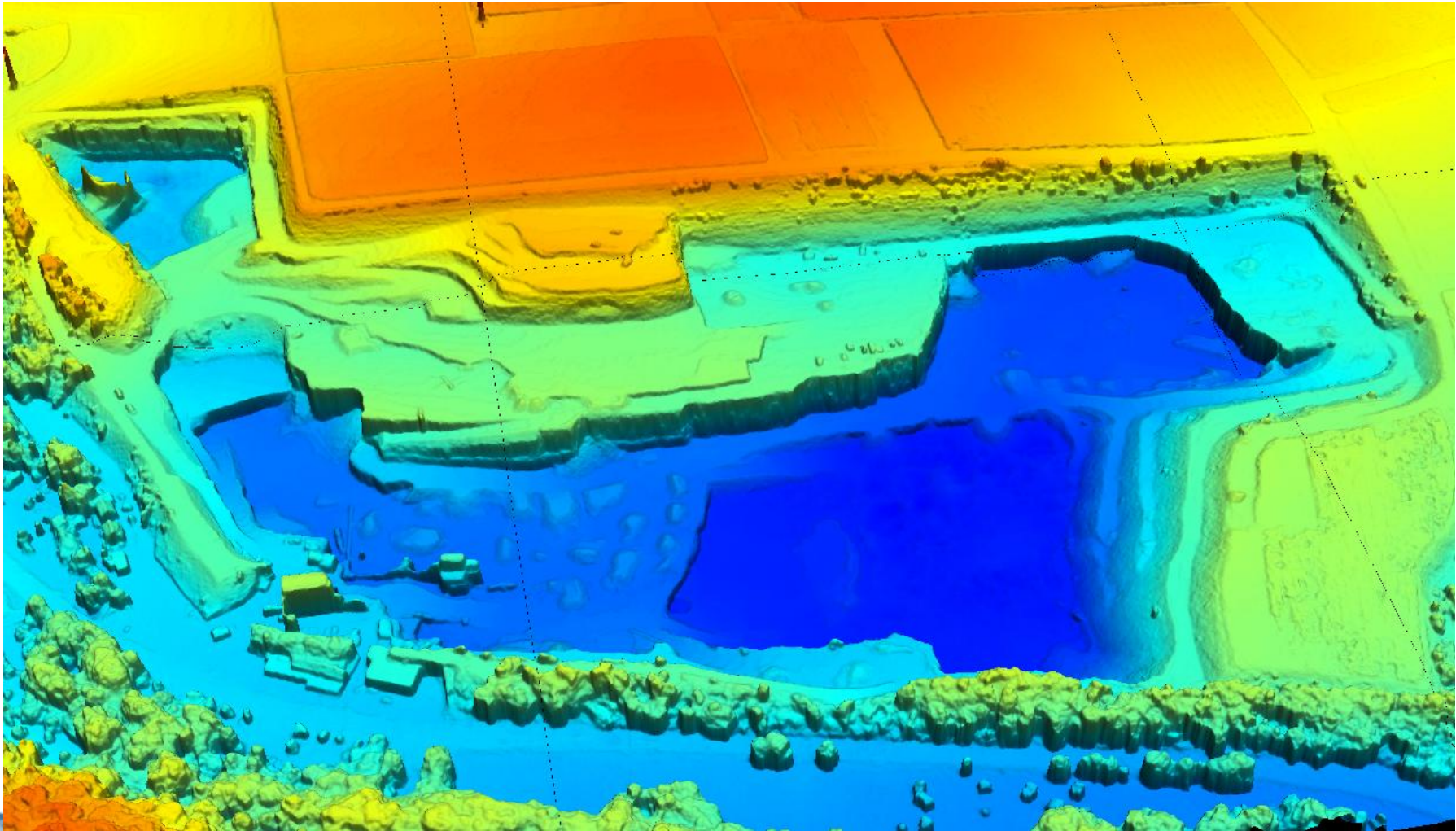


# Resulting DSM (8km\*4.5km)



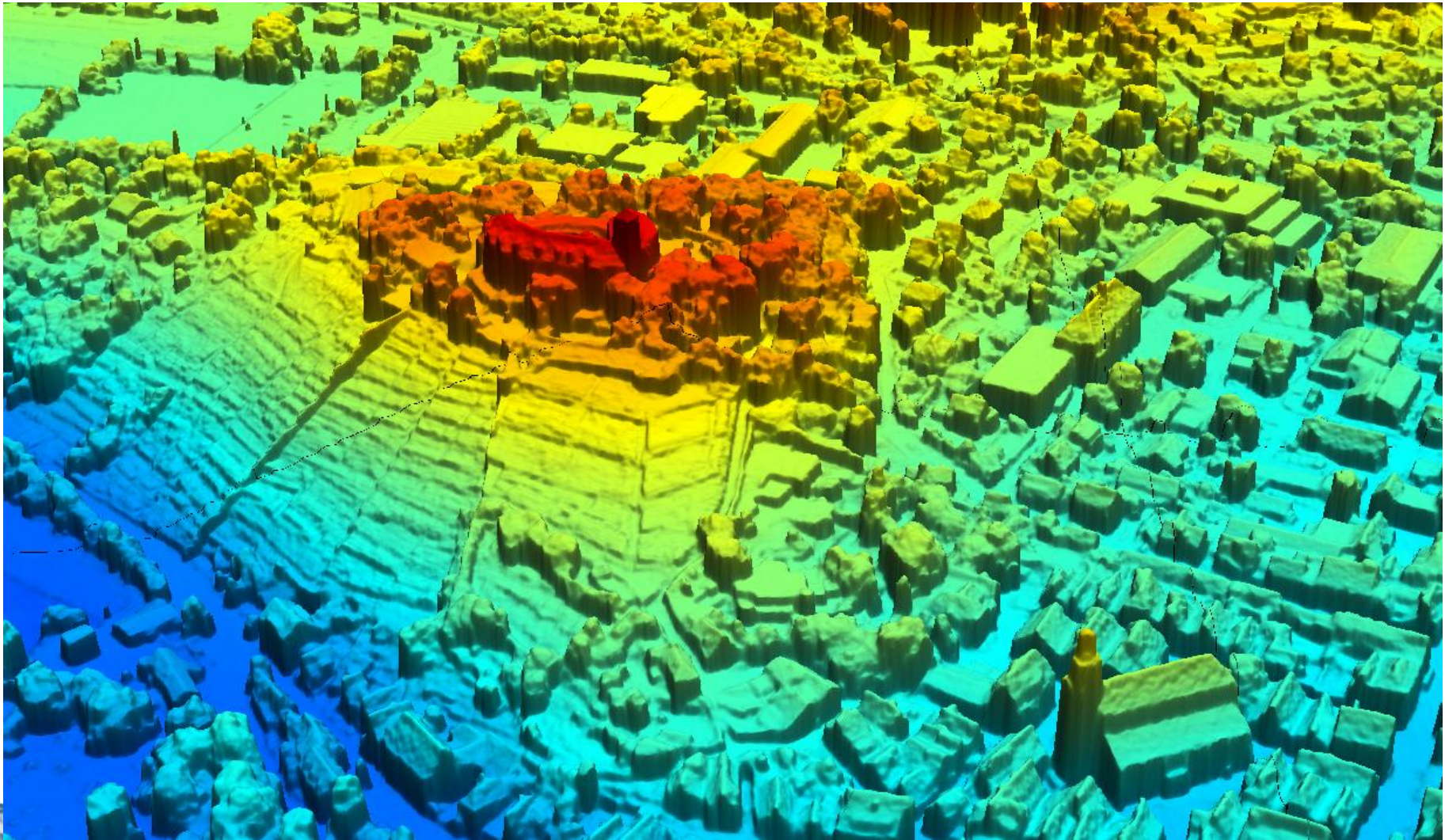


# DSM-Example: quarry



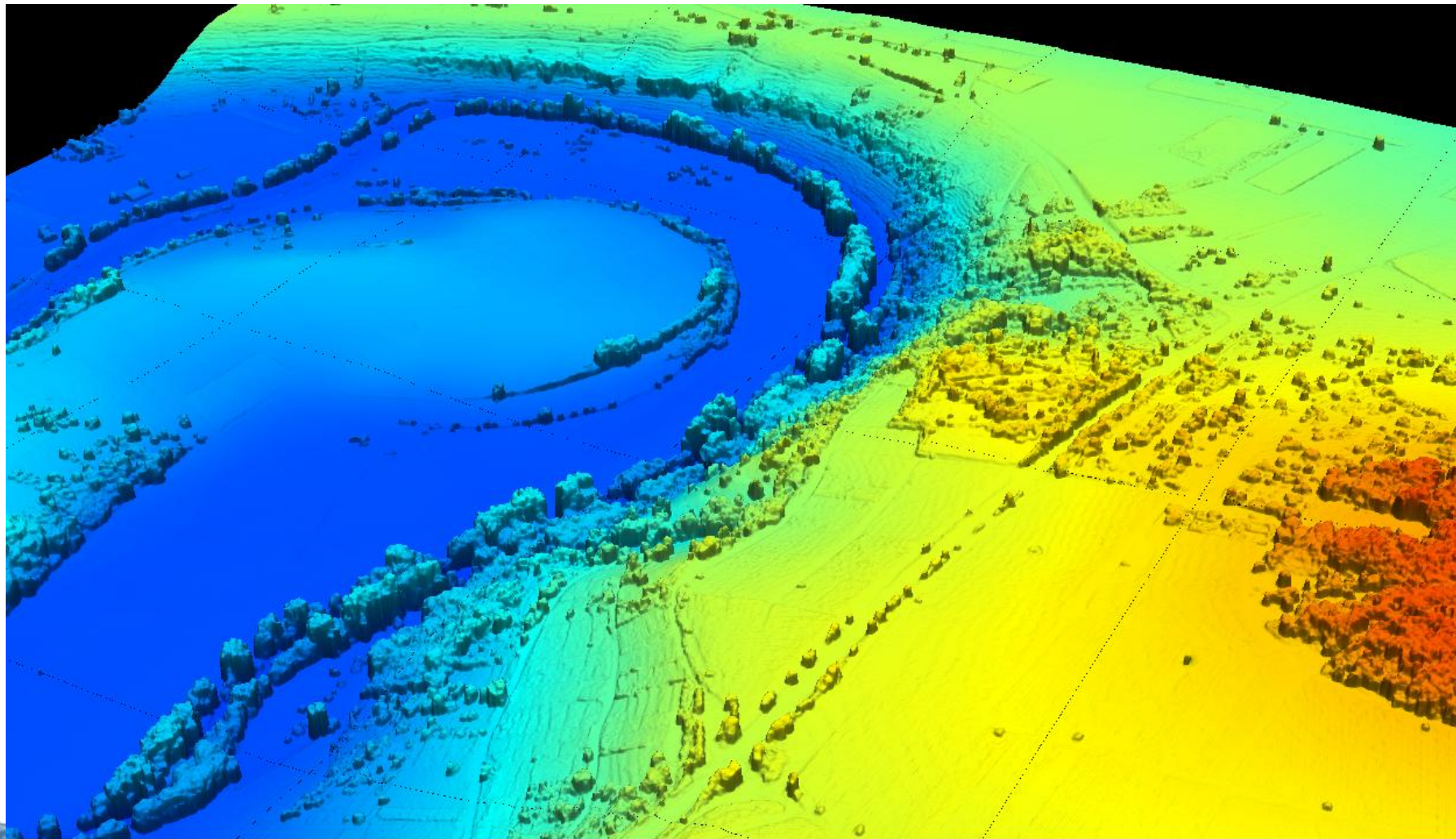


# DSM-Example: part of city



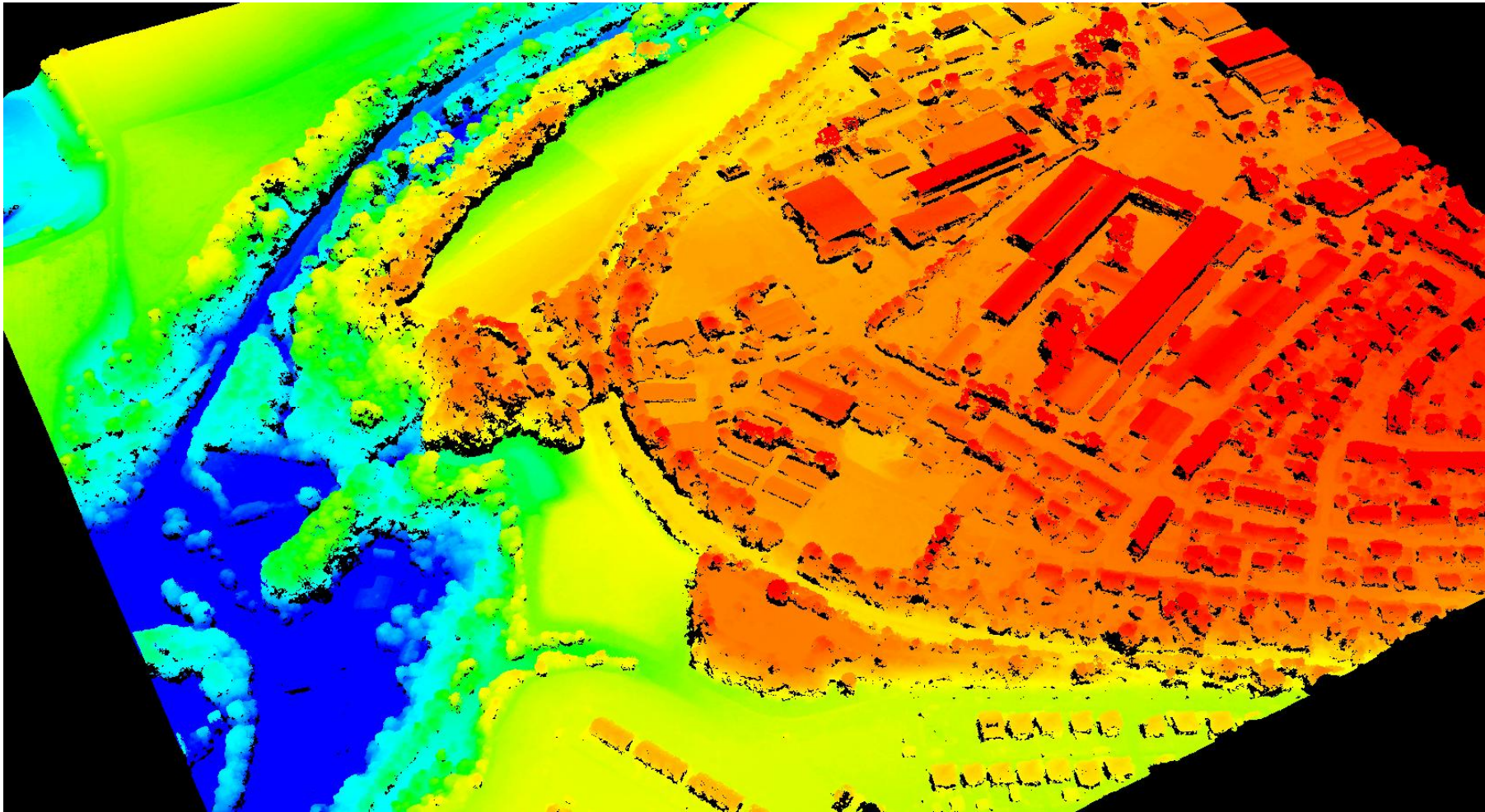


# DSM-Example: hills & river

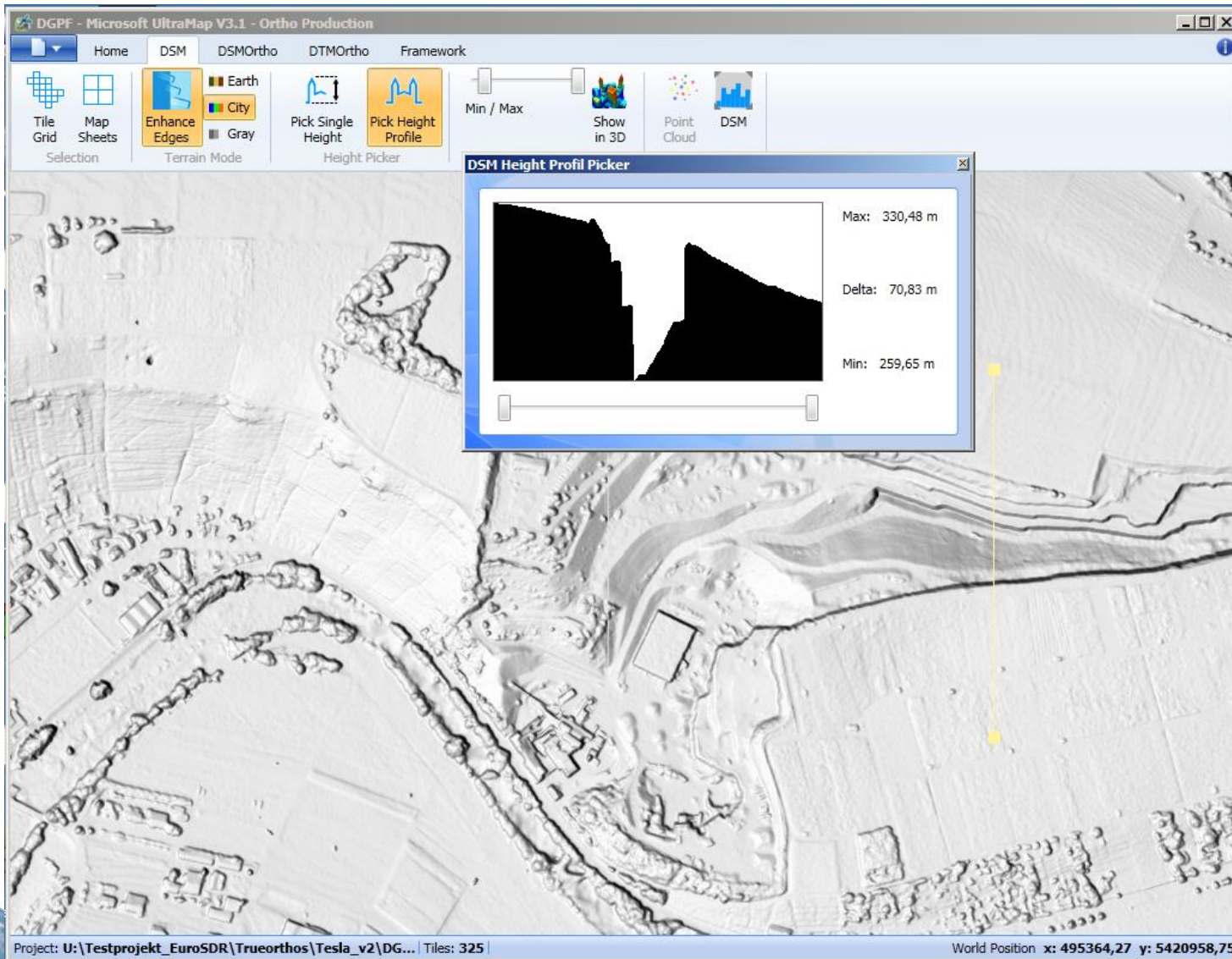




# Point cloud-example

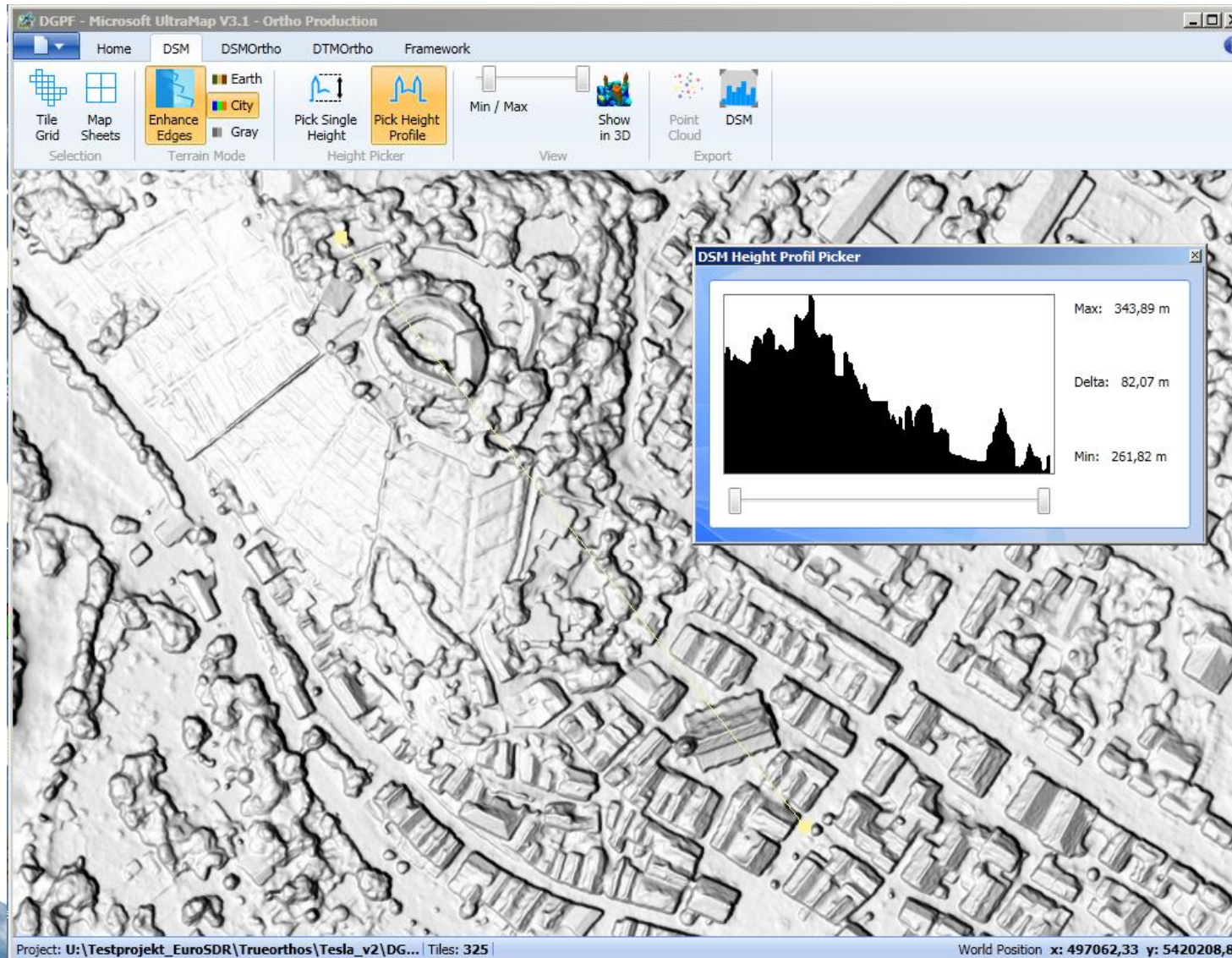


# Profile –example 1





# Profile –example 2



# DSM-matching method

- 1) Range-image computation using image pairs  
(Image based correlation methods are used)
- 2) Range-image fusion with optimization
- 3) Representation as 2.5D(DSM) or 3D (point-cloud)





# Processing – time for 36 images

Data-ingest ... About 35 min copying lvl02 images to server  
(from lvl00: copying 1min from rec  
processing lvl02 10min)

AT (tiepoints) ... 13 min

AT (bundle ) ... 1 min (but several iterations)

DSM ... 27 min (Tesla)

Output (DSM or pointcloud) ... 2 min

(DSM-Ortho ... 34 min)



# IT environment / computer system

32 Xeon E5-2630/i7 cores - 2,3 GHz

64 Gbyte RAM (DDR3 DIMM 1600MHz) each workstation/server

5 GPU`s (1 Tesla K10, 4 Tesla M2090)



# IT environment / storage system

RAID – System (SAS Mega-Raid Controller)

Speed: 7200 RPM

Size: 104 TB





# IT environment / network

LAN - Network

Transfer speed : 1 Gb



# Competence of operator

Flight design – overlap (ideal 80% / 70%)

Quality of aerial images (free of shadows/clouds..)

Quality of AT





# Problems

Many parallel processes -> overload of network (sometimes)

Crash of coordinator -> complete reprocessing of projects

Errors in DSM -> no editing possible at the moment



# Summary

Complete workflow with UltraMap (acquisition of images -> DSM)

Scaleable system (licenses / hardware)

Highly automated workflow (important block design/overlap)

Very detailed and accurate DSM (about GSD)

Sometimes problems with mismatches (lakes/rivers)

