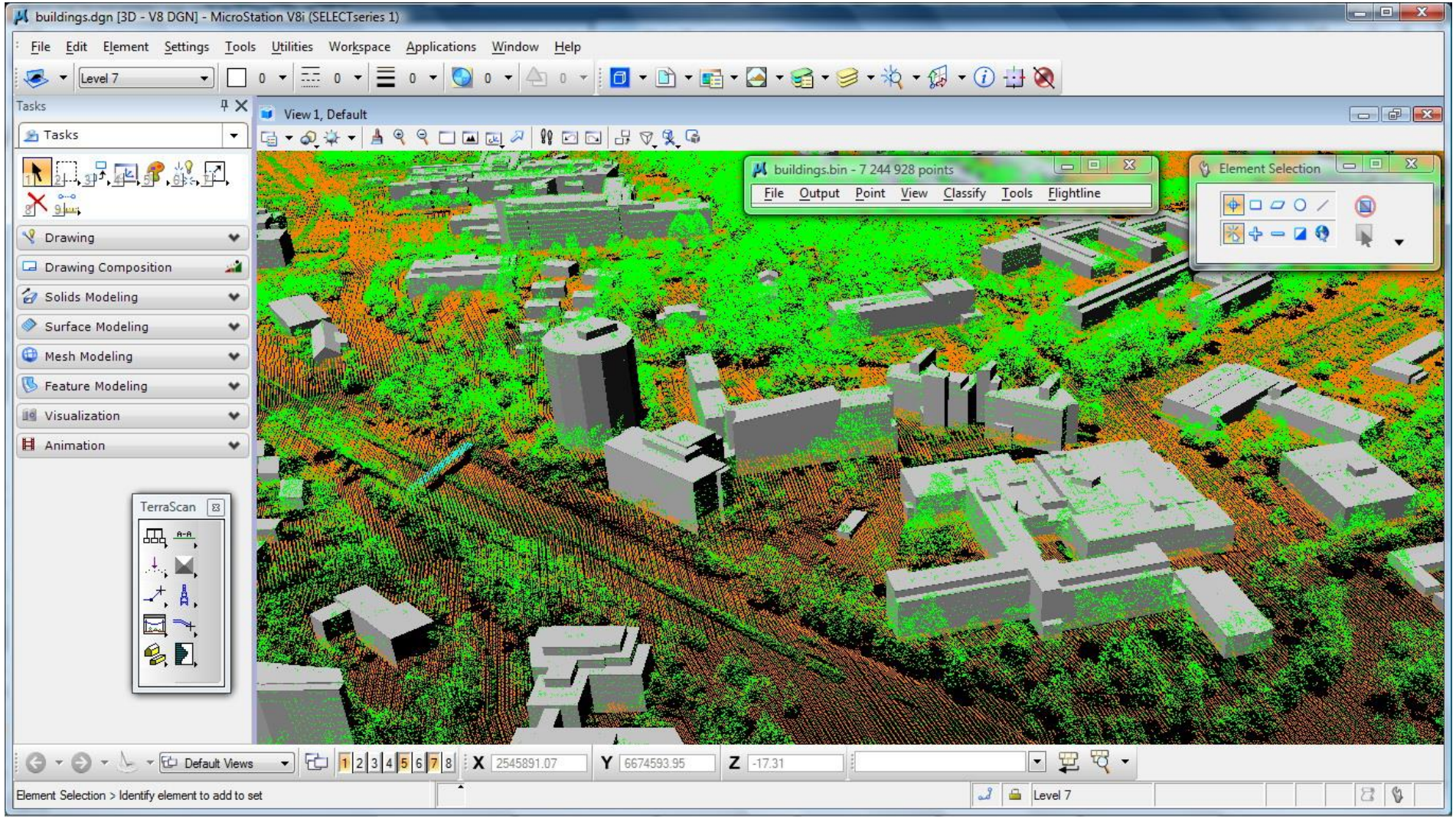

Terrasolid – Software for LiDAR processing

Terrasolid

Terrasolid

Mika Salolahti

Business Development Manager

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E-mail: mika.salolahti@terrasolid.fi

Kanavaranta 7 B 28 FIN-00160 Helsinki Finland

www.terrasolid.fi

Terrasolid Ltd.

- Founded in 1989, privately held
- 25+ years of software development on MicroStation
- 15+ years of point cloud software development
- Last fiscal year revenues 4 M€
- Based in Finland

Kanavaranta 7B, Helsinki

Upseerinkatu 3C Espoo

Terrasolid

Terrasolid Ltd.

- Over 4500 TerraScan licenses sold
- Customers in over 90 countries
- Global market leader in airborne and mobile laser scanned point cloud processing with an estimated 85% market share
- Bentley Platform Partner Agreement

Terrasolid products

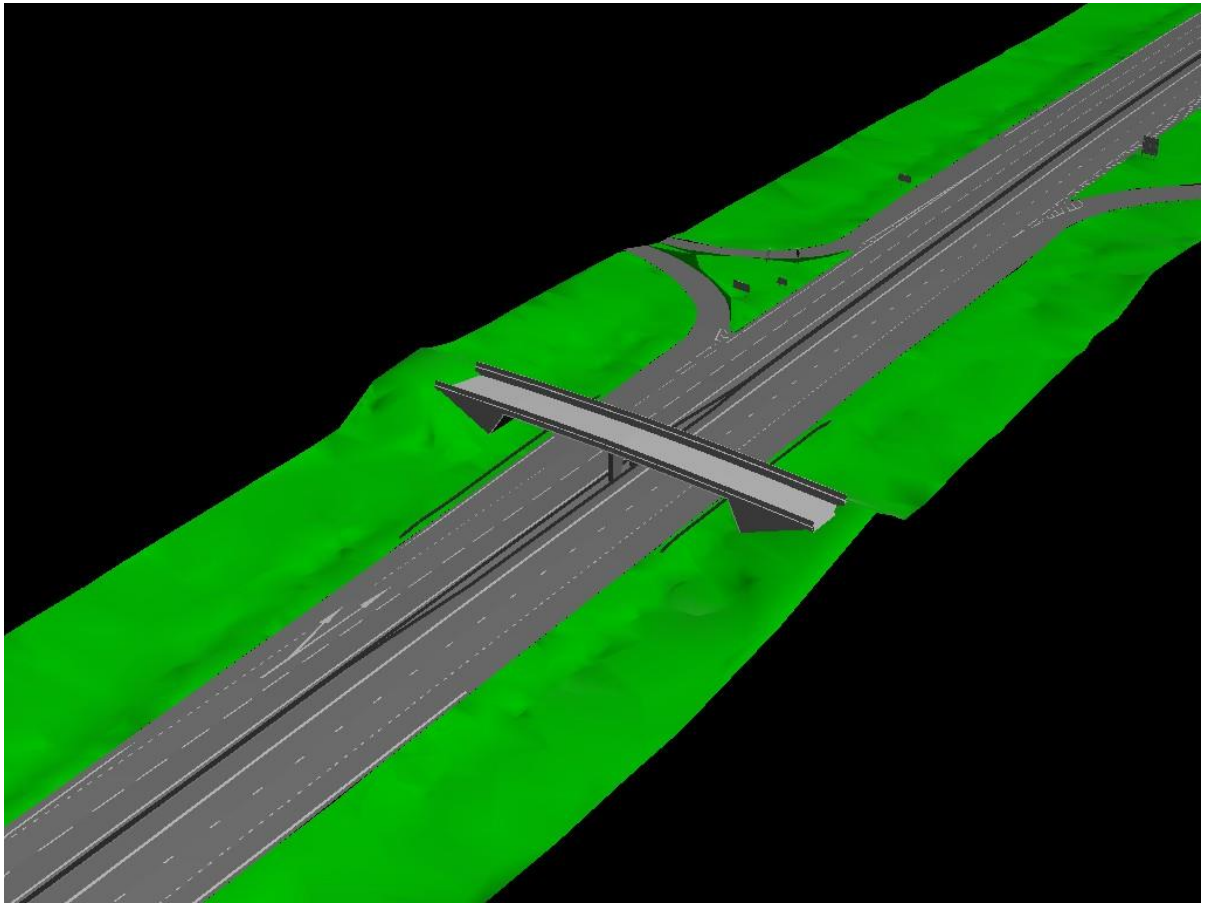
LiDAR processing

- TerraScan
- TerraMatch
- TerraPhoto
- TerraModeler
- TerraSurvey
- TerraStereo

Terrasolid products for Infrastructure

Infrastructure design

- TerraStreet
- TerraPipe
- TerraGas
- TerraHeat
- TerraBore



Terrasolid

City of Jyväskylä, Finland

Video

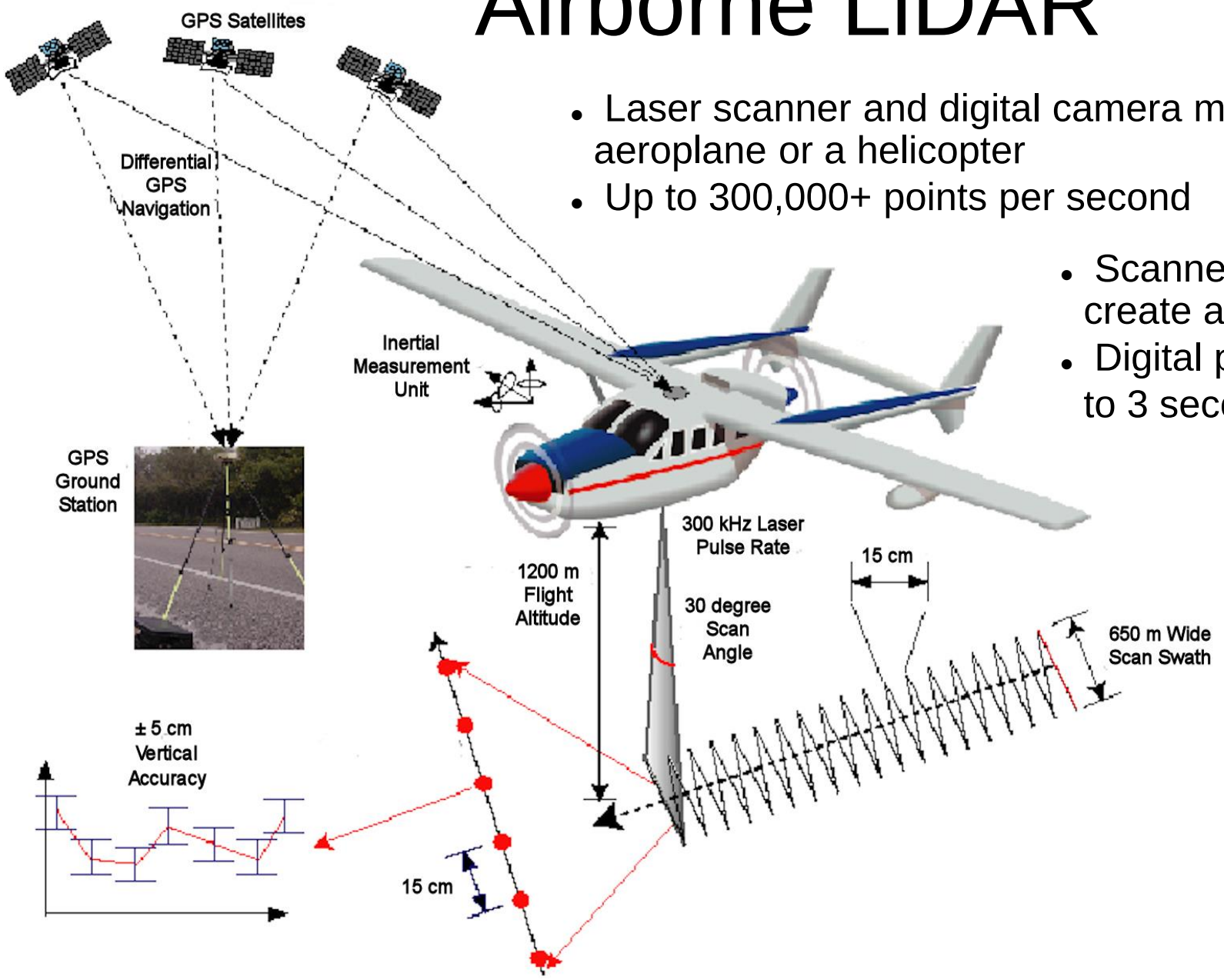
Platforms

- MicroStation V8i SS2/SS3 or V8 2004 Edition
- Bentley Map
- Bentley Map PowerView
- Bentley PowerCivil

Laser scanning

- Terrestial
  - Static tripod
- Airborne
  - Aeroplane
  - Helicopter
- Mobile
  - Car
  - Train

Airborne LiDAR

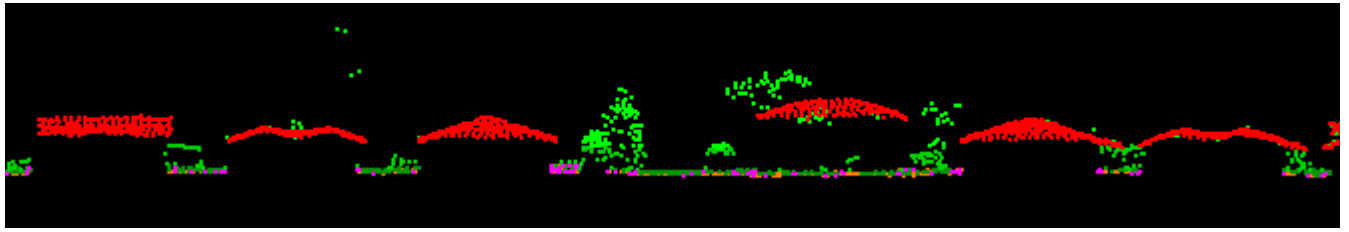


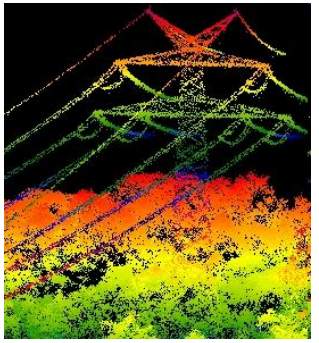
- Laser scanner and digital camera mounted into an aeroplane or a helicopter
- Up to 300,000+ points per second
- Scanner mirror rotates to create a scanning pattern
- Digital photographs every 1 to 3 seconds
- Precise location and position tracking with GPS and IMU (Inertial measurement unit)

Terrasolid

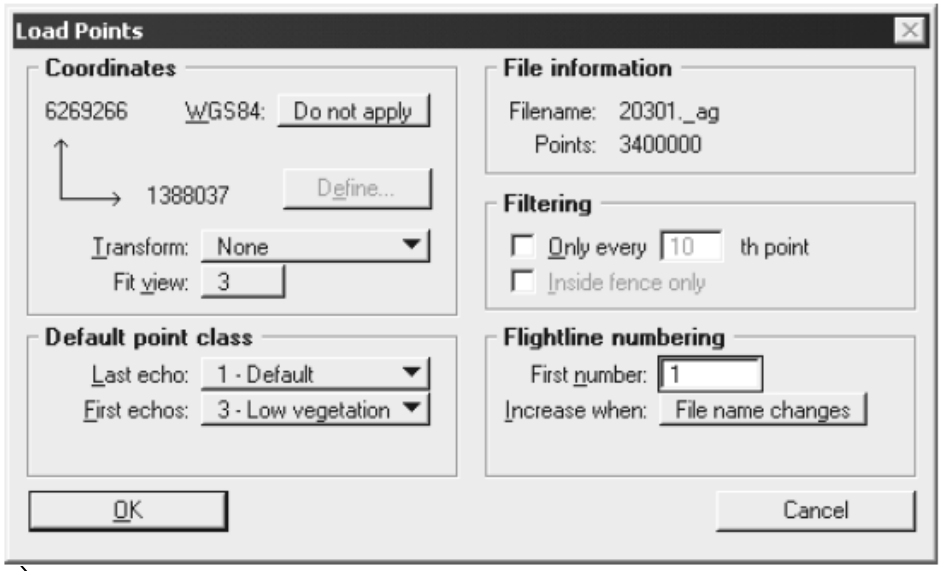
What do you do with Terrasolid's applications?

- After the flight or drive the point clouds are pre-processed with the hardware vendors specific application
- After that the point clouds are calibrated and the precisioon is improved with Terra applications
- Once calibrated you can produce different feature extractions such as automatic building vectorization





LiDAR processing



Import RAW laser data and trajectories

Calibrate and align point clouds from multiple flightlines

Classify the points with rules

Process airborne images and produce orthos

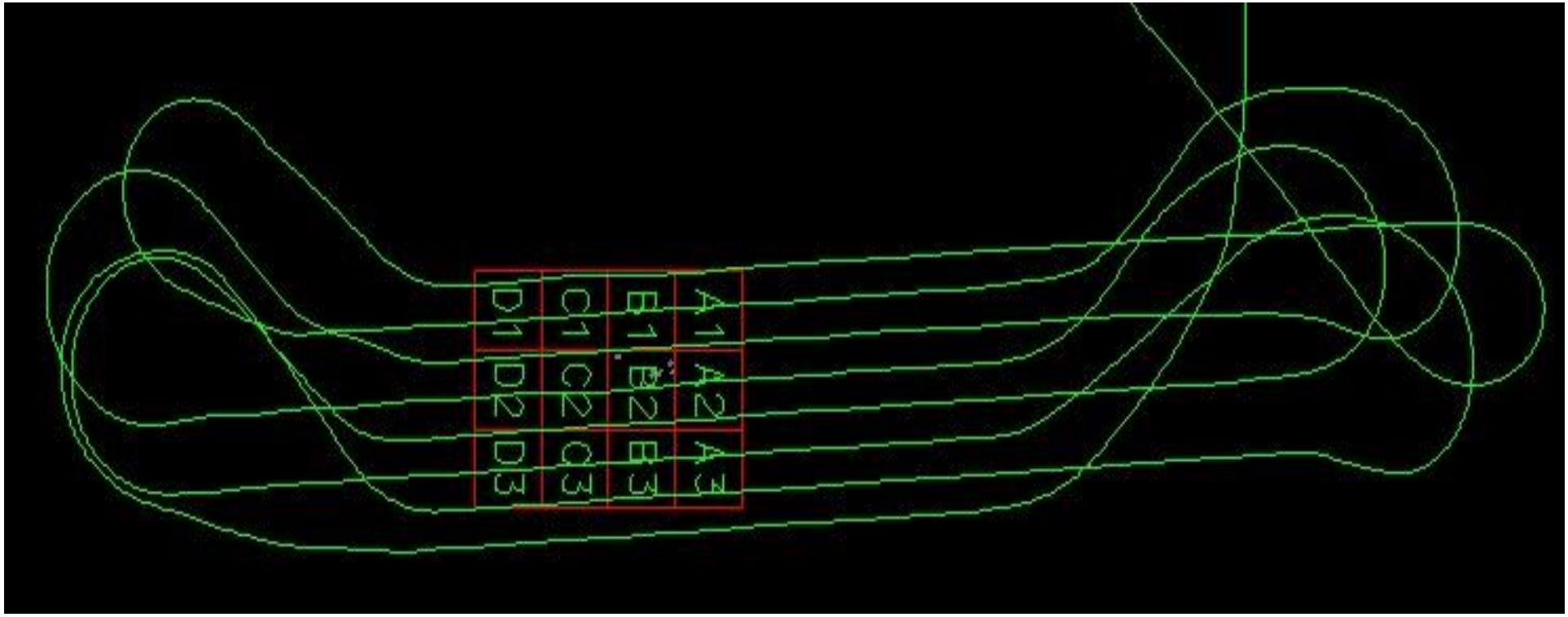
Produce delivery products

- **Surface models with breaklines**
- **Accurate 3D road and bridge models for design purposes**
- **Contours**
- **Building models**
- **True orthos**
- **Digitized transmission power lines for efficiency calculations**
- **Digitized transmission lines for vegetation maintenance**
- **Flood models**
- **etc…**

Terrasolid

TerraScan

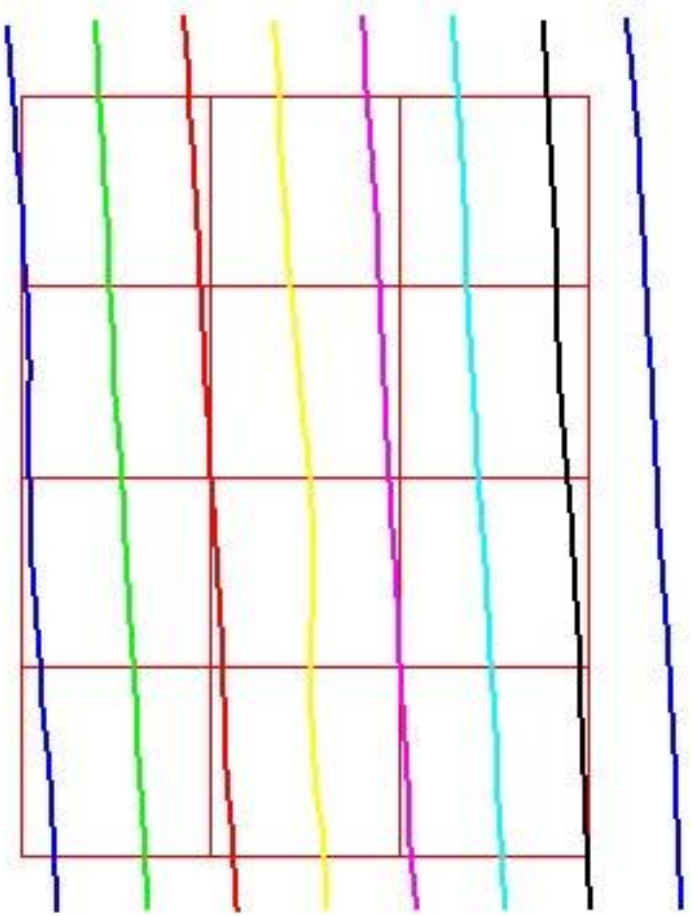
- Read the points into the correct coordinate system
- Divide the points into blocks

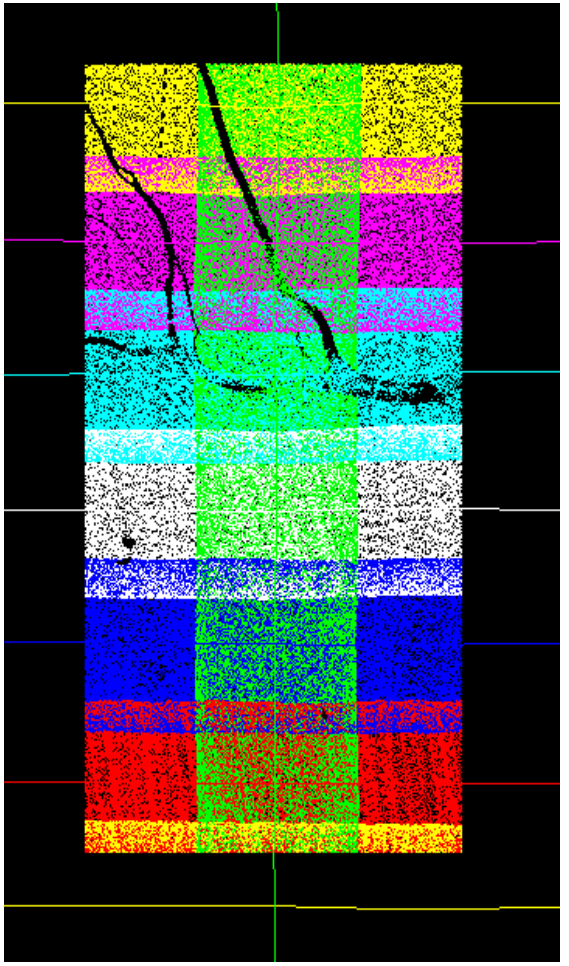


Terrasolid

TerraScan

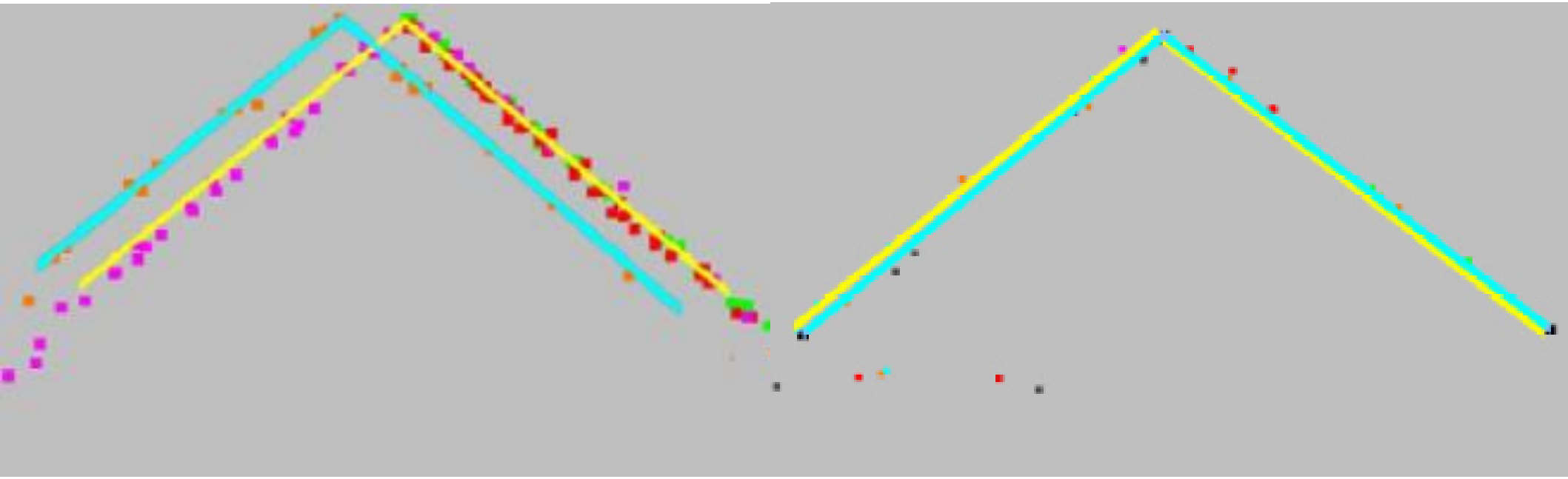
- Classify the points by flightline





TerraMatch

- Match the multiple flight passess by tie lines
- Tie to ground control



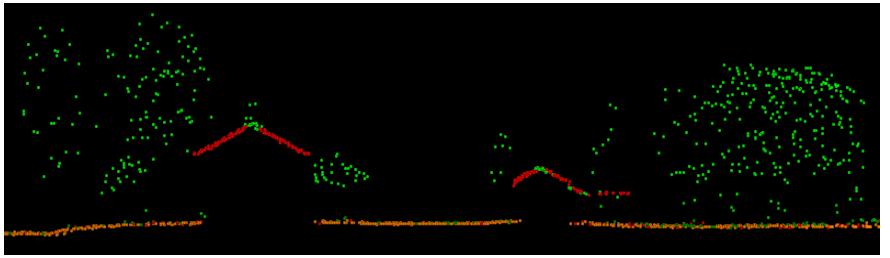
Before matching the flight lines

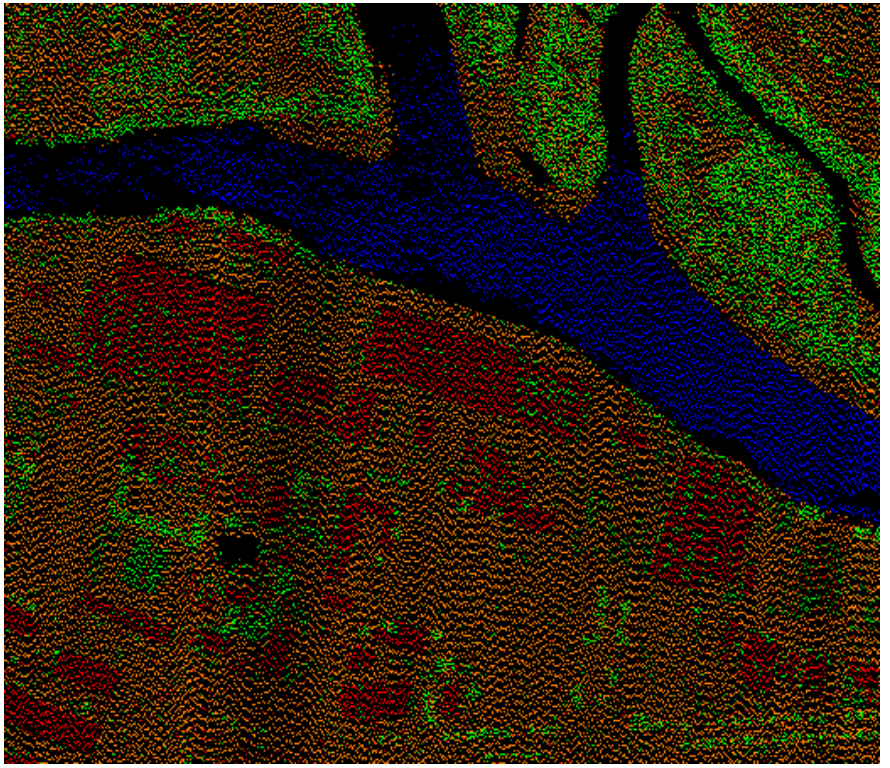
After matching the flight lines

Terrasolid

TerraScan

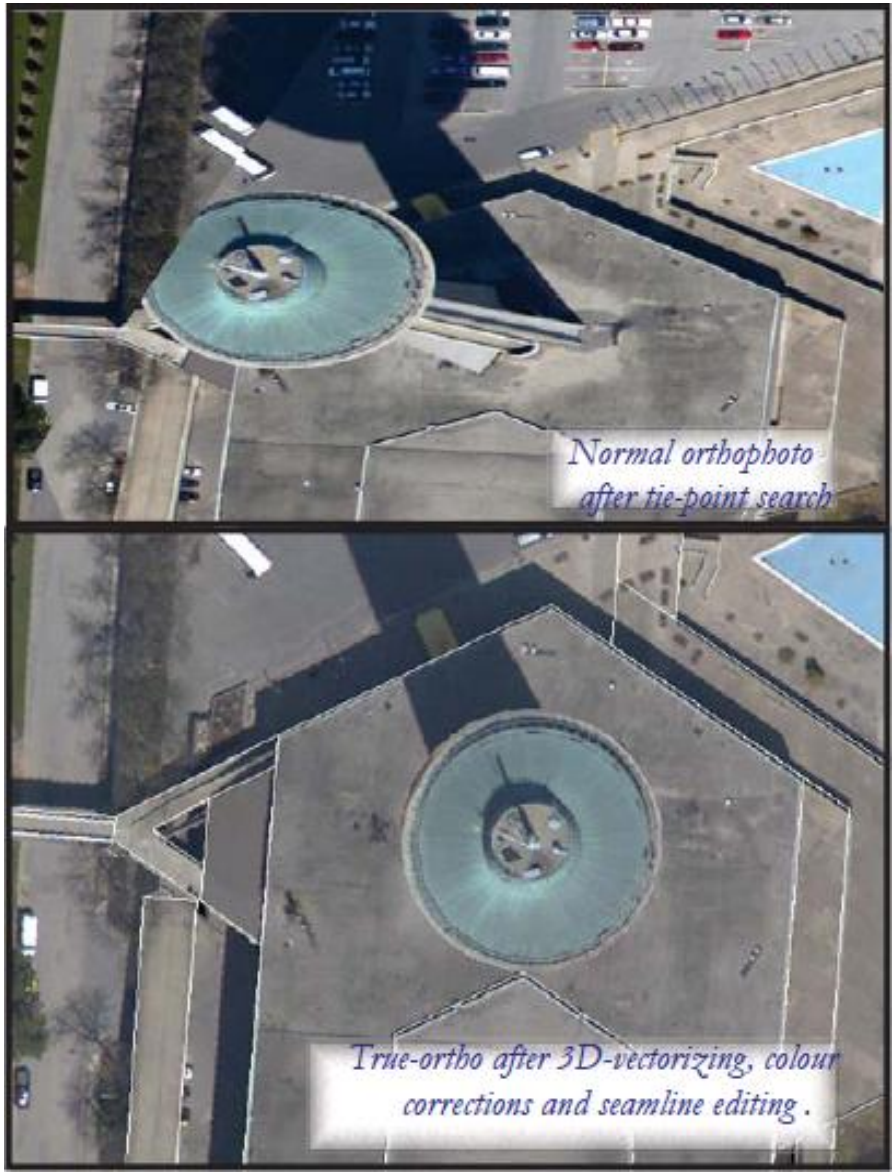
- Point classification
  - Ground
  - Vegetation by height from ground
  - Buildings
  - Model keypoints
- Manual editing





TerraPhoto

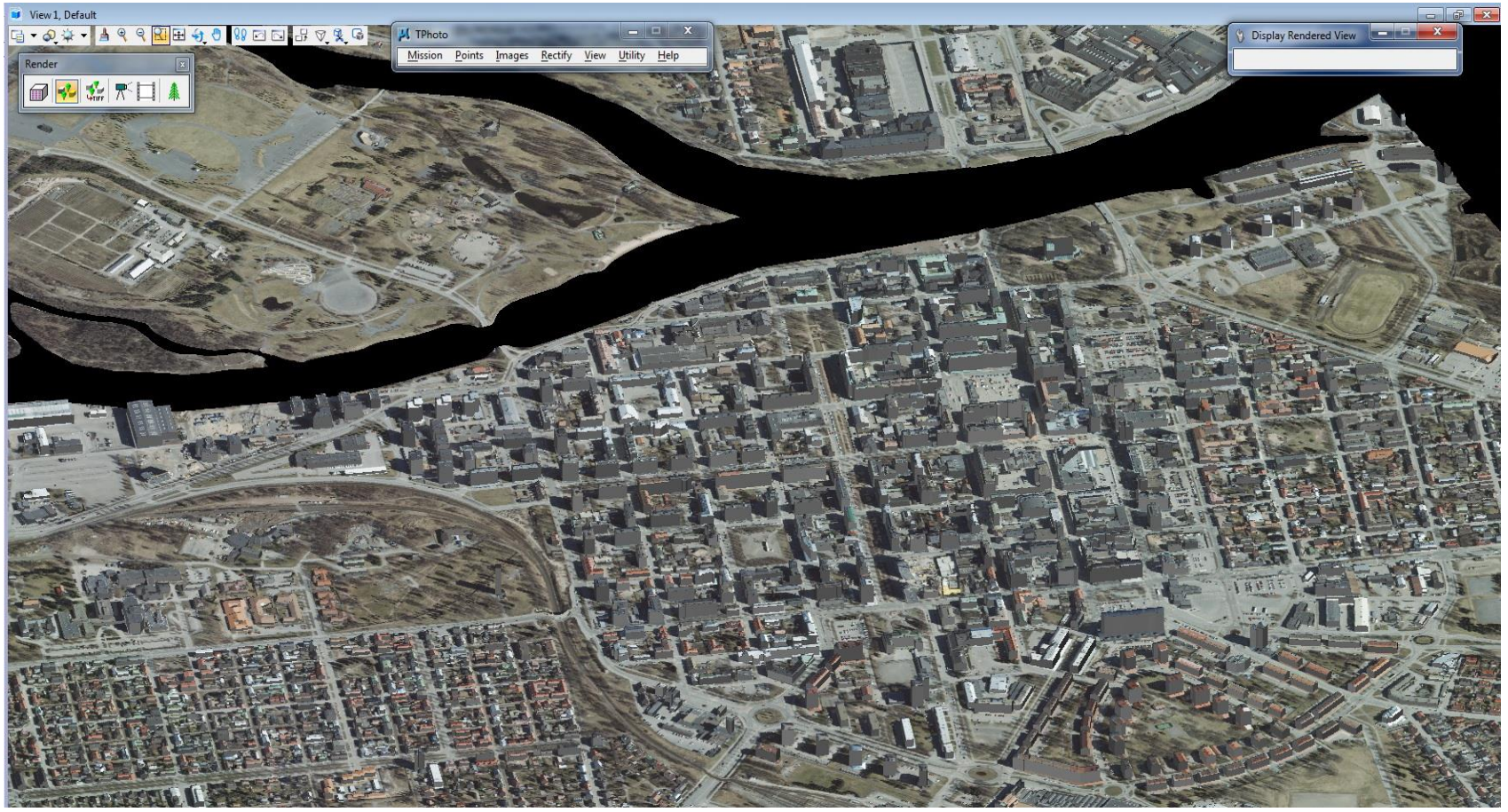
- Create and rectify ortho mosaic
- TrueOrtho-production
- Supports the point classification process
- Laser point coloring
- Building wall texturing from oblique images
- Visualizations and animations



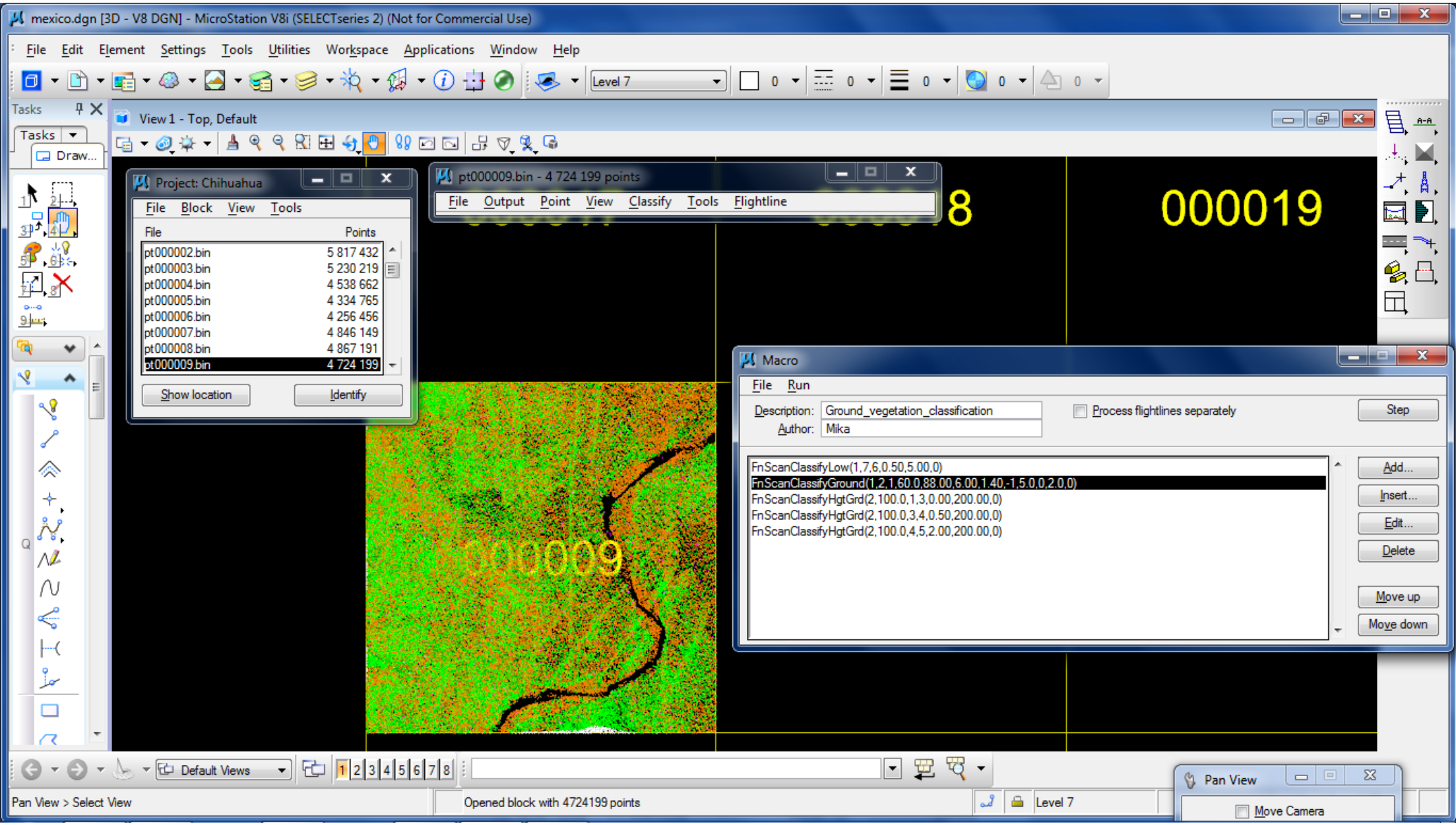
Terrasolid

TerraPhoto

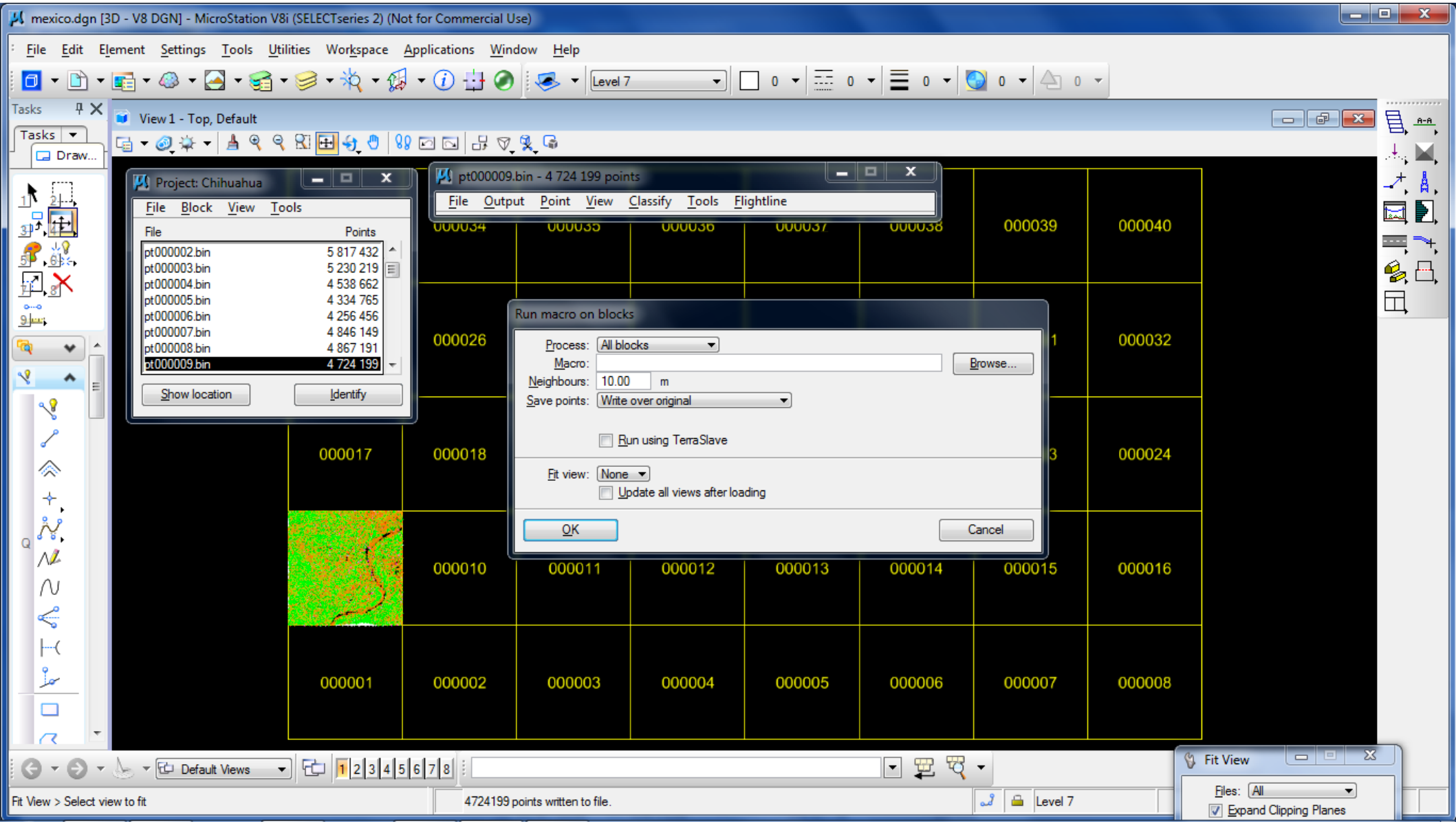
- Draping an ortho on to the ground



Terrasolid


mexico.dgn [3D - V8 DGN] - MicroStation V8i (SELECTseries 2) (Not for Commercial Use)
File Edit Element Settings Tools Utilities Workspace Applications Window Help
Level 7
Tasks
View 1 - Top, Default
Project: Chihuahua
File Block View Tools
File Points
pt000002.bin 5 817 432
pt000003.bin 5 230 219
pt000004.bin 4 538 662
pt000005.bin 4 334 765
pt000006.bin 4 256 456
pt000007.bin 4 846 149
pt000008.bin 4 867 191
pt000009.bin 4 724 199
Show location
Identify
pt000009.bin - 4 724 199 points
File Output Point View Classify Tools Flightline
000019
Macro
File Run
Description: Ground_vegetation_classification
Author: Mika
Process flightlines separately
Step
FnScanClassifyLow(1,7,6,0.50,5.00,0)
FnScanClassifyGround(1,2,1,60.0,88.00,6.00,1.40,-1,5.0,0,2.0,0)
FnScanClassifyHgtGrd(2,100.0,1,3,0.00,200.00,0)
FnScanClassifyHgtGrd(2,100.0,3,4,0.50,200.00,0)
FnScanClassifyHgtGrd(2,100.0,4,5,2.00,200.00,0)
Add...
Insert...
Edit...
Delete
Move up
Move down
Default Views
Pan View
Move Camera
Pan View > Select View
Opened block with 4724199 points
Level 7

Terrasolid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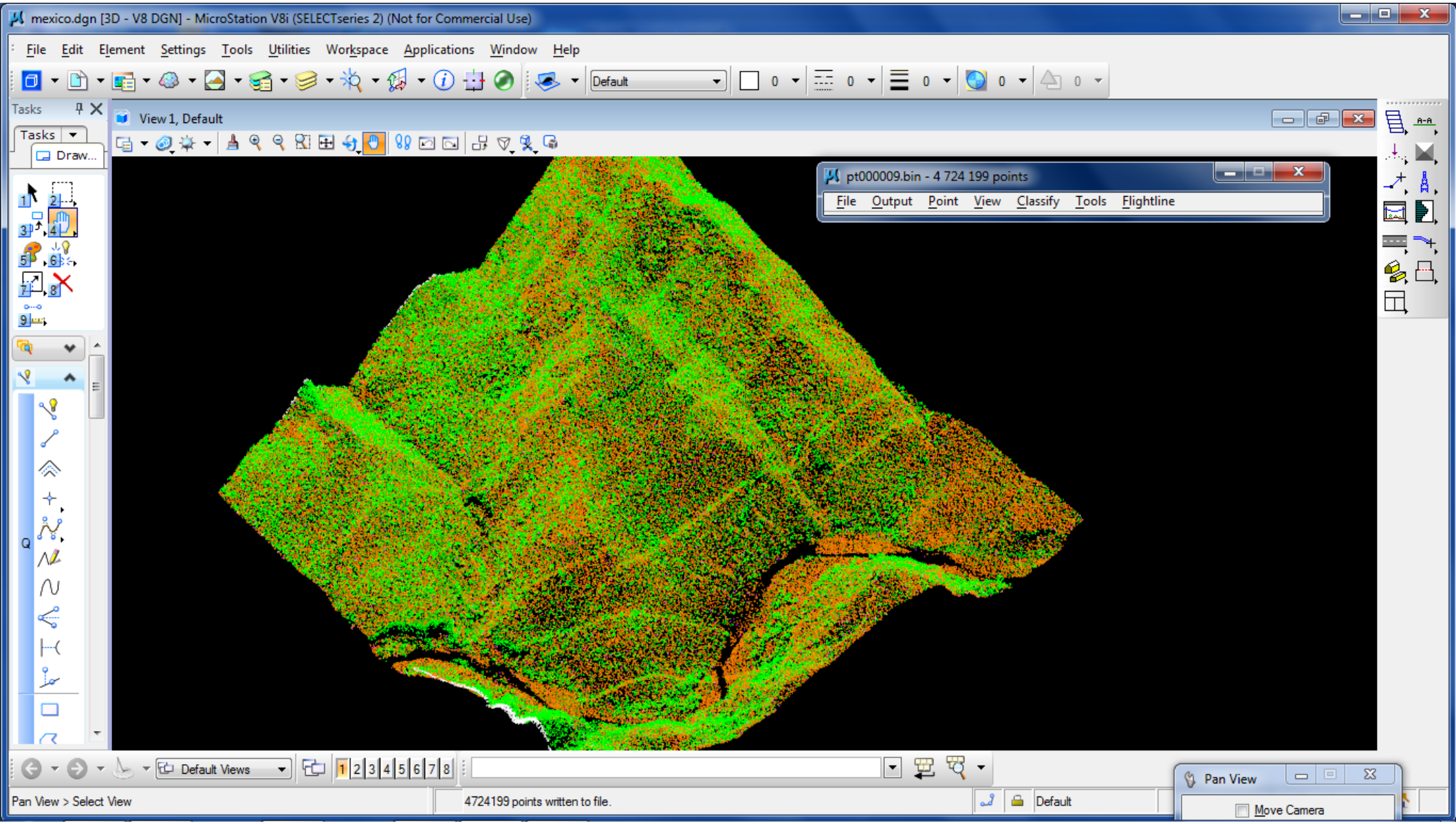
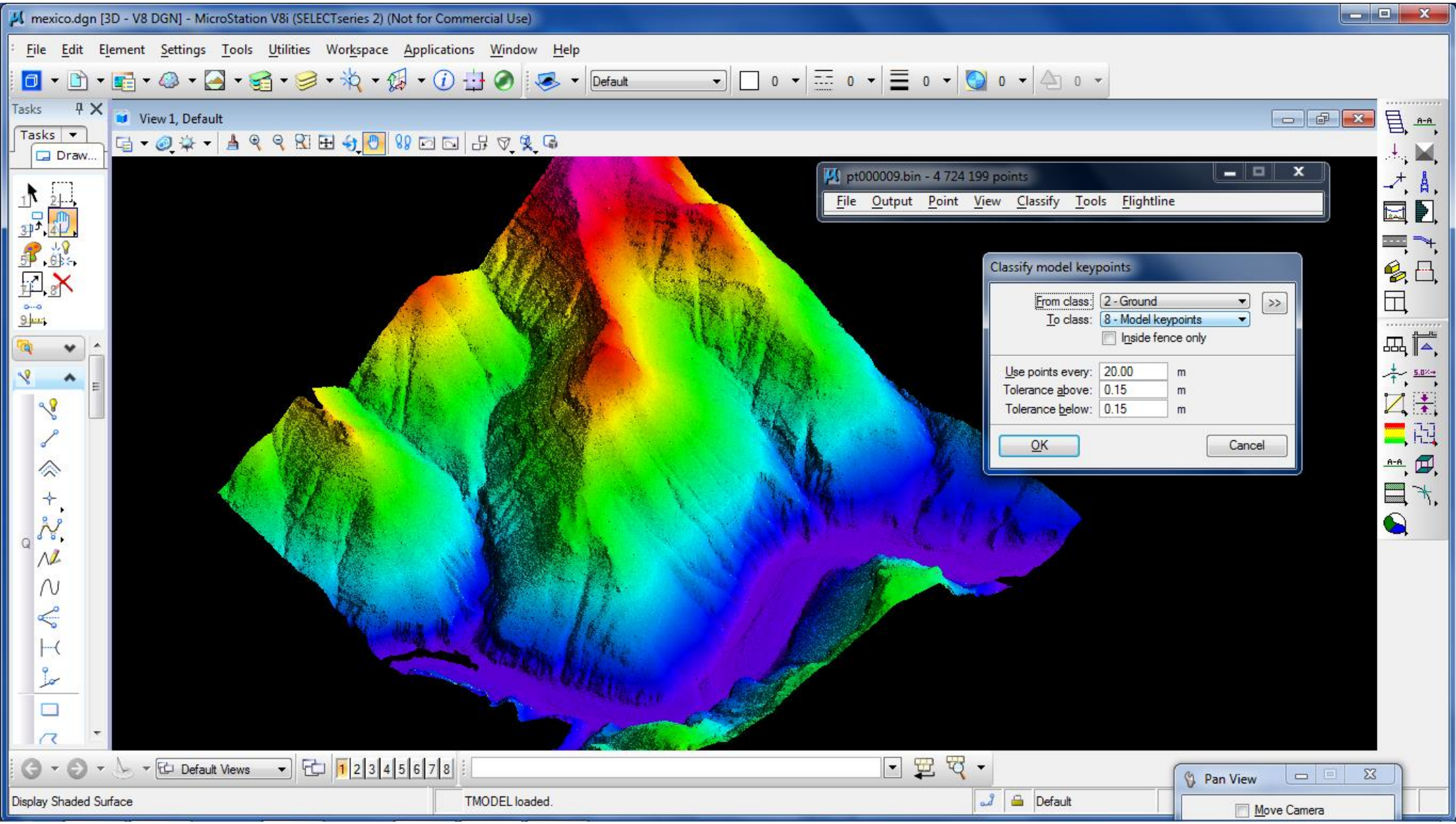
File Edit Element Settings Tools Utilities Workspace Applications Window Help
Level 7
Tasks
View 1 - Top, Default
Project: Chihuahua
File Block View Tools
File Points
pt000002.bin 5 817 432
pt000003.bin 5 230 219
pt000004.bin 4 538 662
pt000005.bin 4 334 765
pt000006.bin 4 256 456
pt000007.bin 4 846 149
pt000008.bin 4 867 191
pt000009.bin 4 724 199
Show location
Identify
pt000009.bin - 4 724 199 points
File Output Point View Classify Tools Flightline
Run macro on blocks
Process: All blocks
Macro:
Browse...
Neighbours: 10.00 m
Save points: Write over original
Run using TerraSlave
Fit view: None
Update all views after loading
OK
Cancel
000001 000002 000003 000004 000005 000006 000007 000008
000010 000011 000012 000013 000014 000015 000016
000017 000018 000024
000026 000032
000039 000040
Default Views
Fit View > Select view to fit
4724199 points written to file.
Level 7
Fit View
Files: All
Expand Clipping Planes

Terrasolid


mexico.dgn [3D - V8 DGN] - MicroStation V8i (SELECTseries 2) (Not for Commercial Use)
File Edit Element Settings Tools Utilities Workspace Applications Window Help
Default
Tasks
View 1, Default
pt000009.bin - 4 724 199 points
File Output Point View Classify Tools Flightline
Default Views
Pan View
Move Camera
Pan View > Select View
4724199 points written to file.
Default

Terrasolid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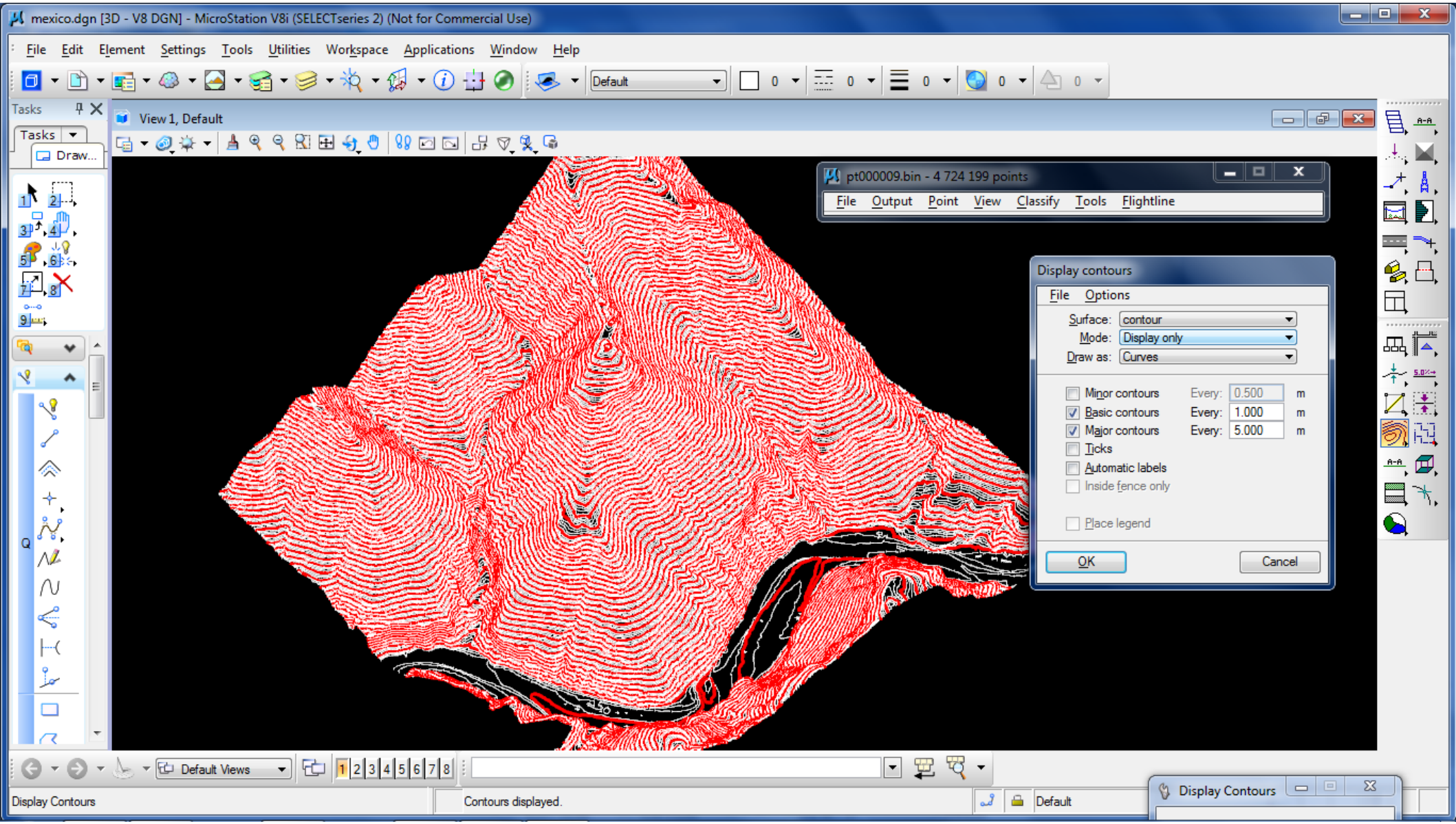
File Edit Element Settings Tools Utilities Workspace Applications Window Help
Default
Tasks
Tasks
Draw...
View 1, Default
pt000009.bin - 4 724 199 points
File Output Point View Classify Tools Flightline
Classify model keypoints
From class: 2 - Ground
To class: 8 - Model keypoints
Inside fence only
Use points every: 20.00 m
Tolerance above: 0.15 m
Tolerance below: 0.15 m
OK
Cancel
Default Views
Pan View
Move Camera
Display Shaded Surface
TMODEL loaded.
Default

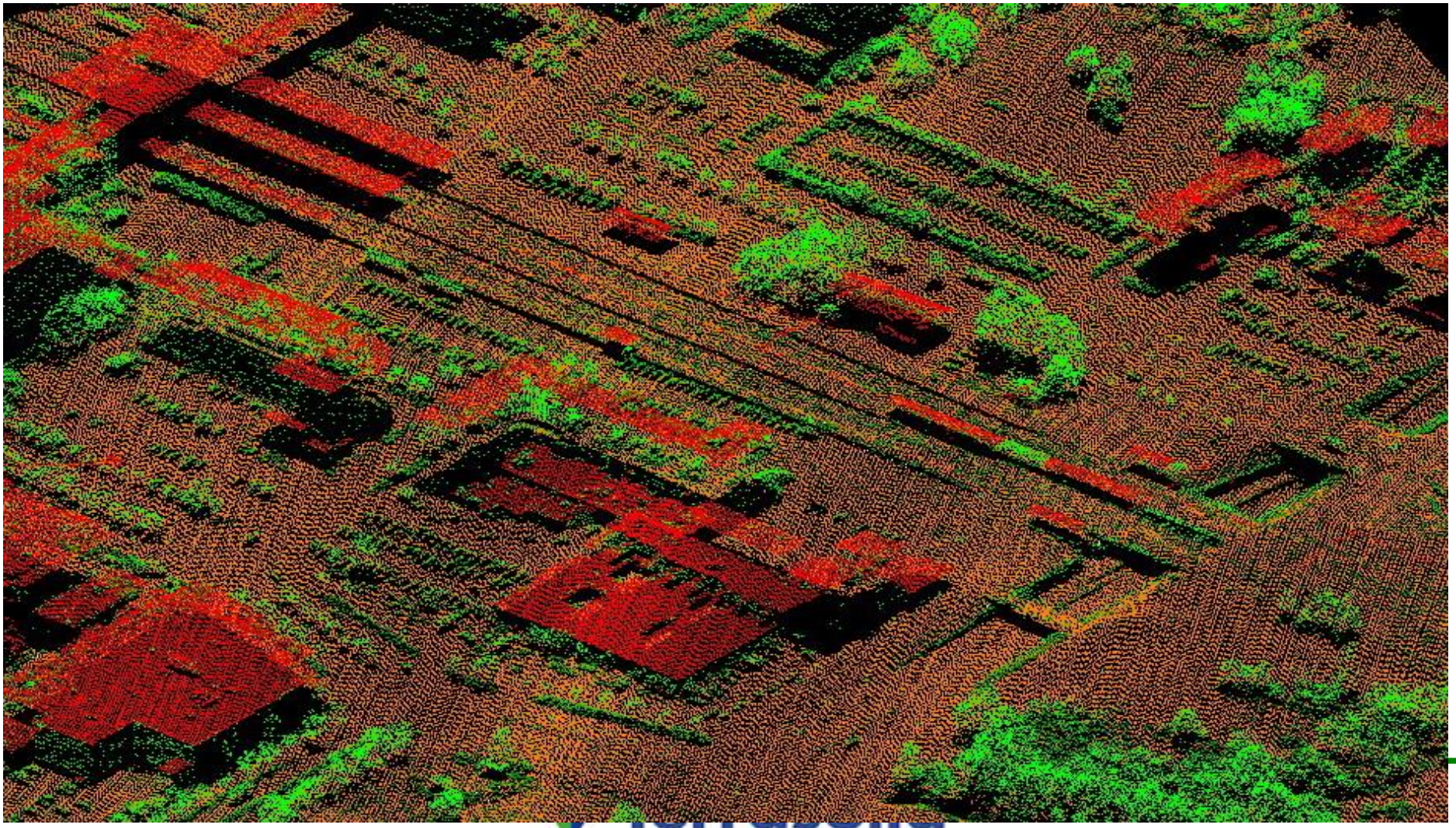
Terrasolid


mexico.dgn [3D - V8 DGN] - MicroStation V8i (SELECTseries 2) (Not for Commercial Use)
File Edit Element Settings Tools Utilities Workspace Applications Window Help
Tasks
View 1, Default
pt000009.bin - 4 724 199 points
File Output Point View Classify Tools Flightline
Display contours
File Options
Surface: contour
Mode: Display only
Draw as: Curves
Minor contours Every: 0.500 m
Basic contours Every: 1.000 m
Major contours Every: 5.000 m
Ticks
Automatic labels
Inside fence only
Place legend
OK
Cancel
Default Views
Display Contours
Contours displayed.
Default
Display Contours

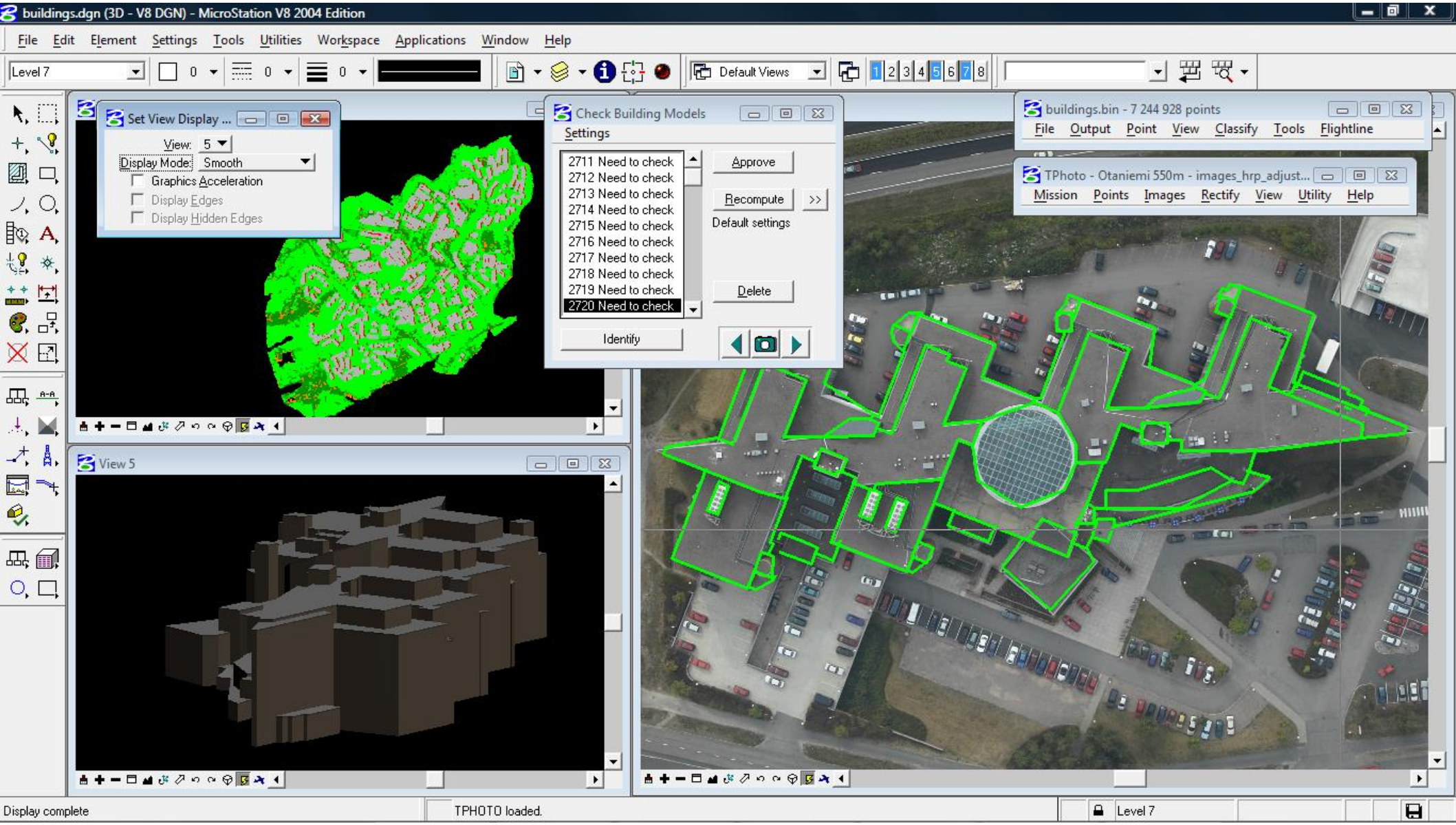
Terrasolid

High density airborne point cloud

20 points / m^2



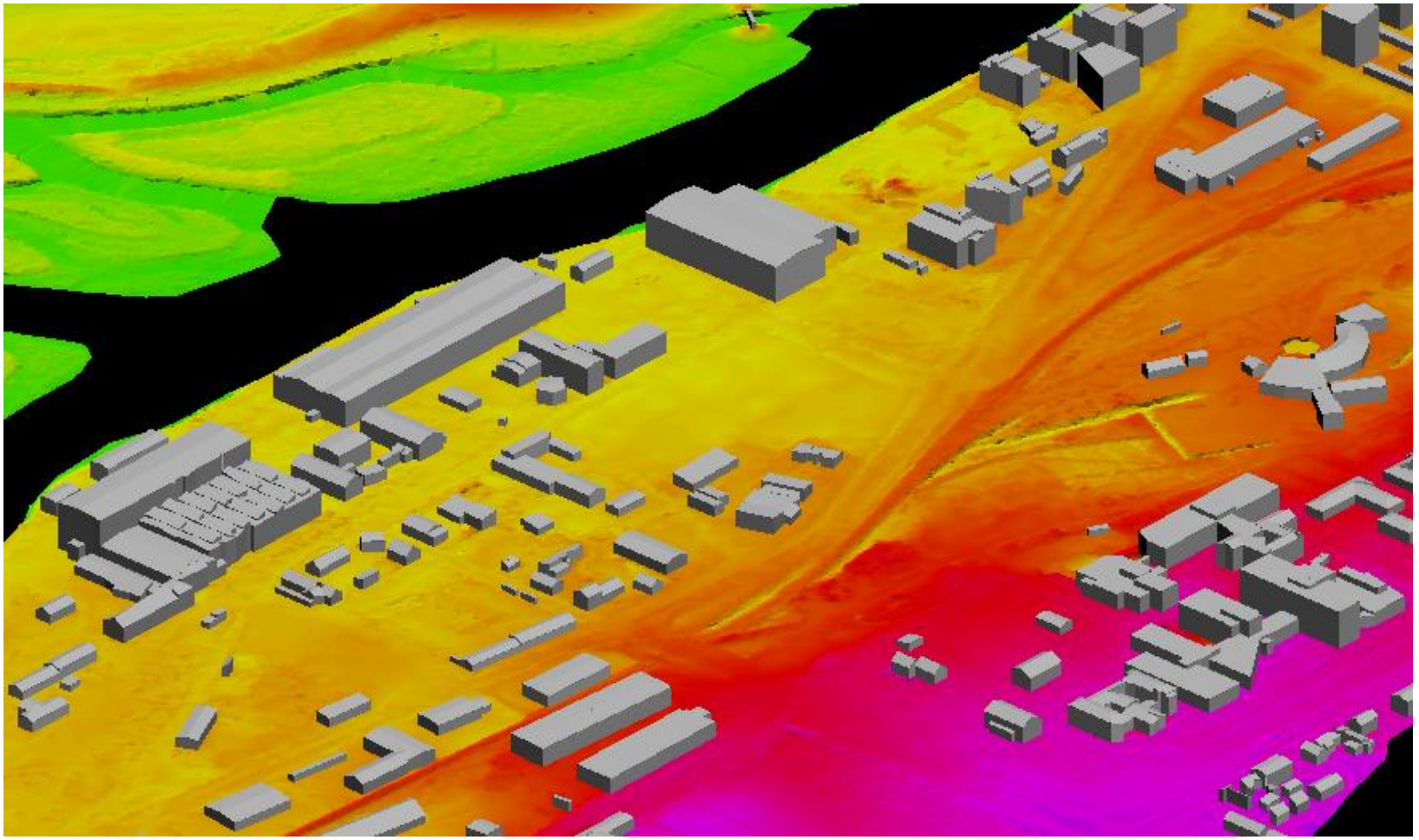
Automatic building vectorization



Terrasolid

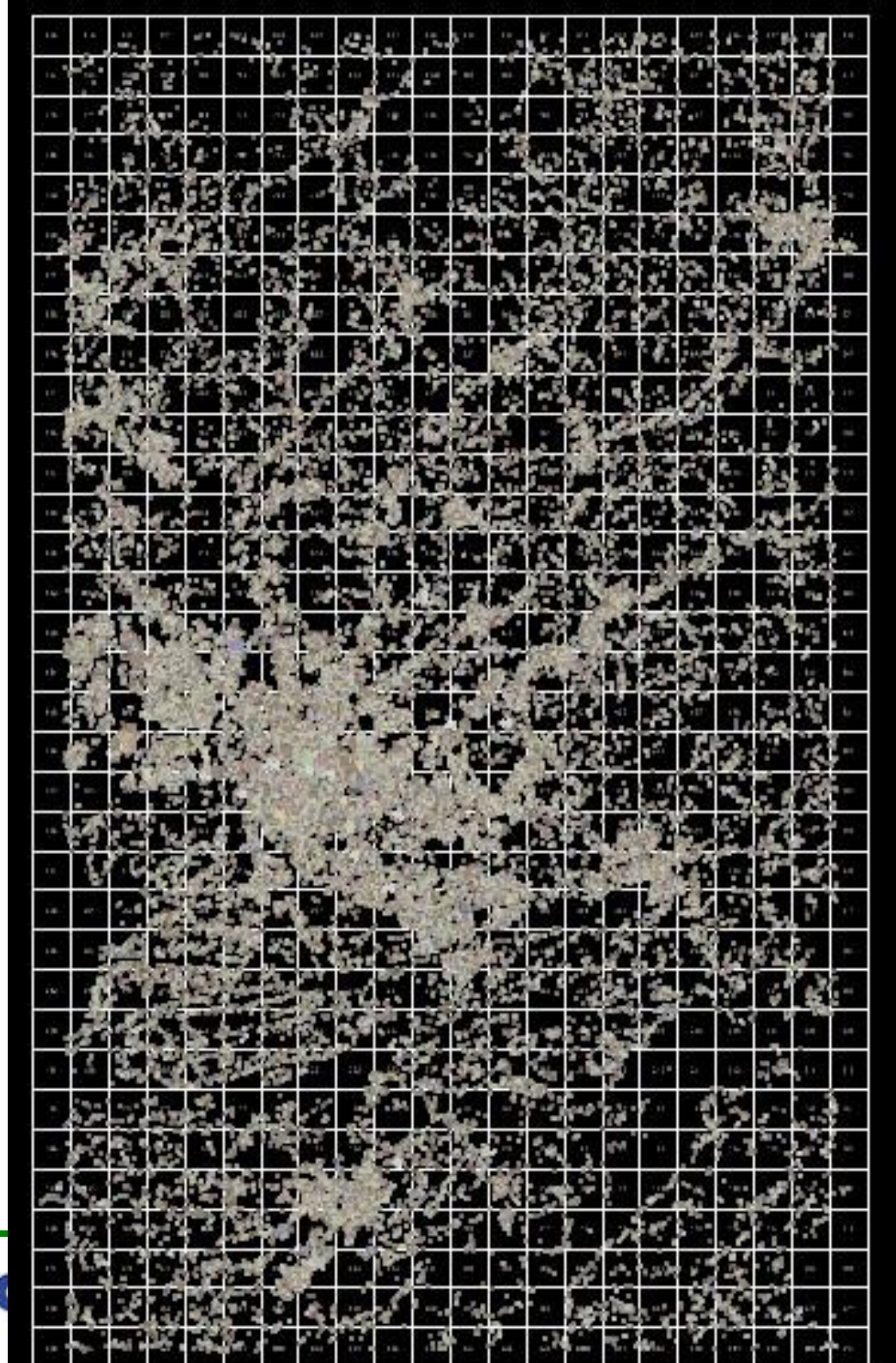
TerraScan

- Automatic building vectorization

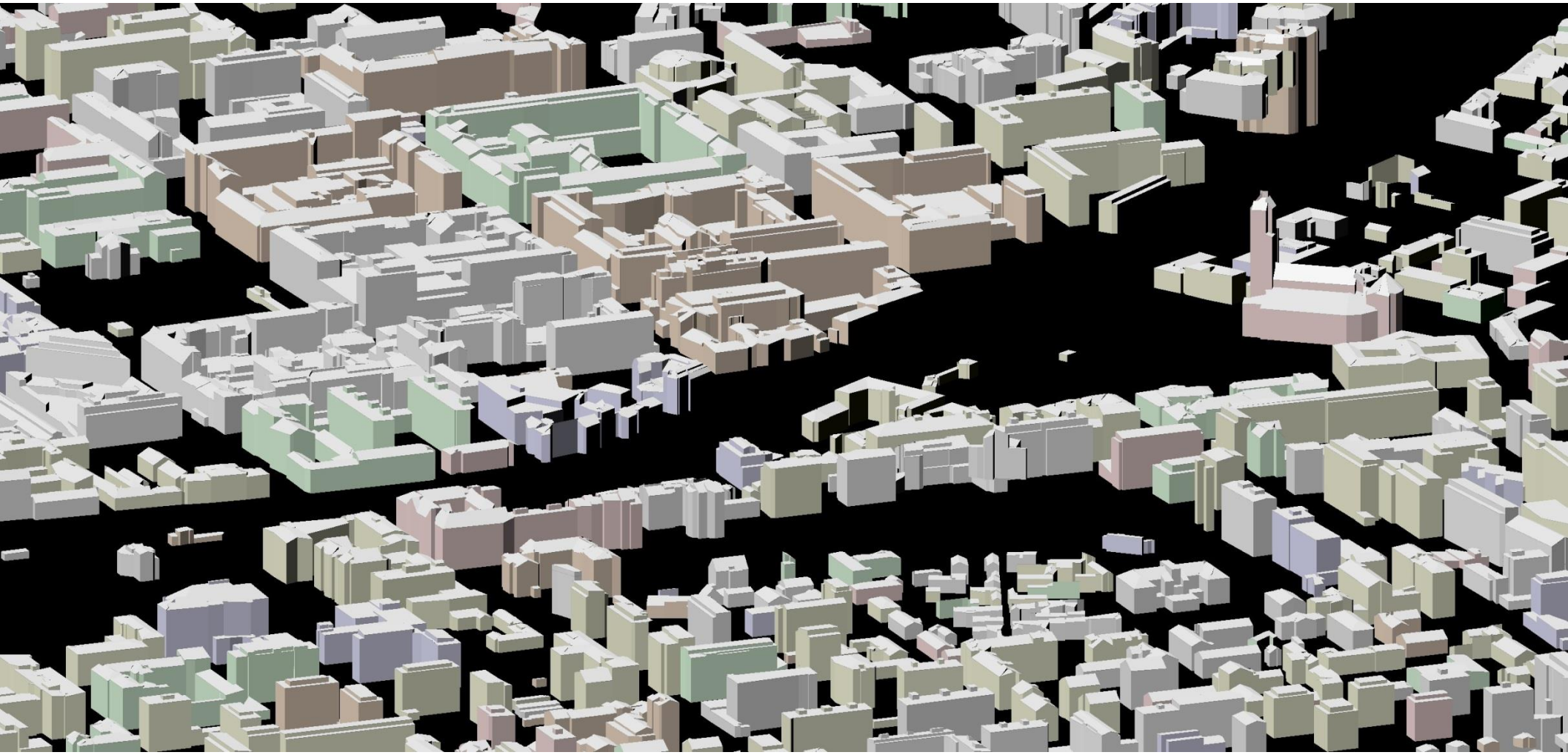


Terrasolid

- 33 km wide
- 51 km high
- 3 billion points
- Automatic building classification
- Automatic building vectorization
- 72,000+ buildings
- 6 hours vectorization



3D-building model

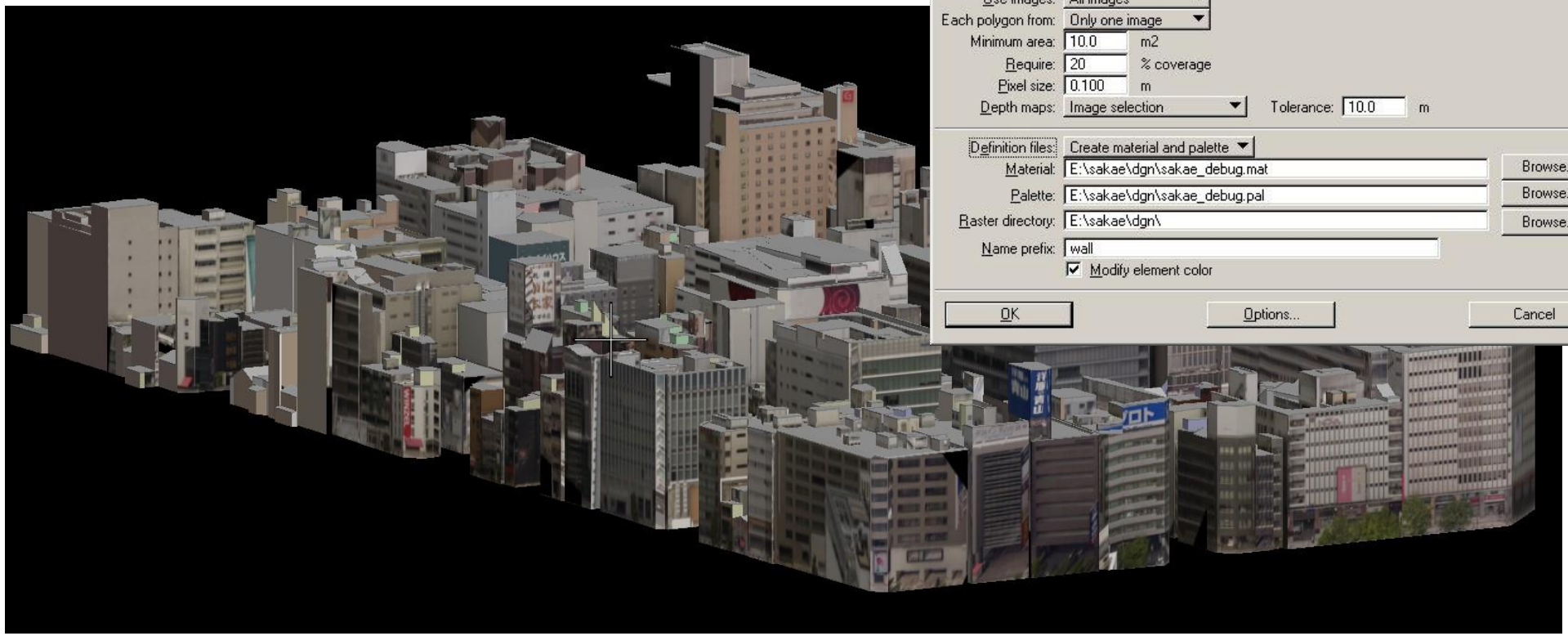


Terrasolid

Demo

Rectify / Wall rasters

- Creates visualization rasters for walls
- First version produces reasonable results from oblique airborne images



Terrasolid

City of Nagoya in Japan

Nakanihon Air Service

- Very high density point cloud, 40 points/sq.meter
- 3 camera oblique image system
- Automatic vectorization
- Automatic wall texturing
- 5000 wall textures in 5 minutes

City of Nagoya, Japan

Terrasolid

City of Bergen in Norway
Blom A/S

- Fairly low density point cloud, 2,5 points/sq.meter
- Roof vectors collected by stereo
- Midas 5 camera oblique image system
- Automatic vectorization
- Automatic wall texturing
- 19200 wall textures in 20 minutes

City of Bergen, Norway

Terrasolid

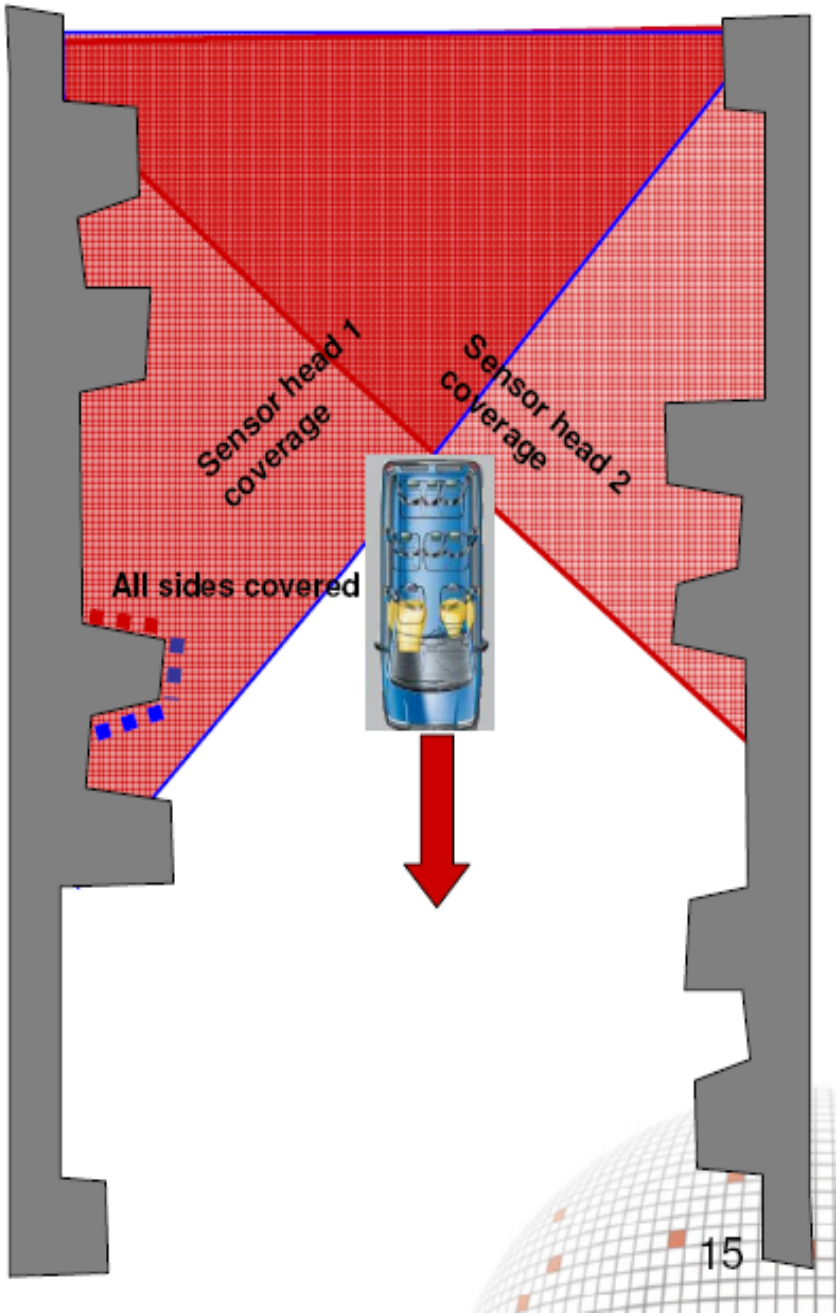
Video

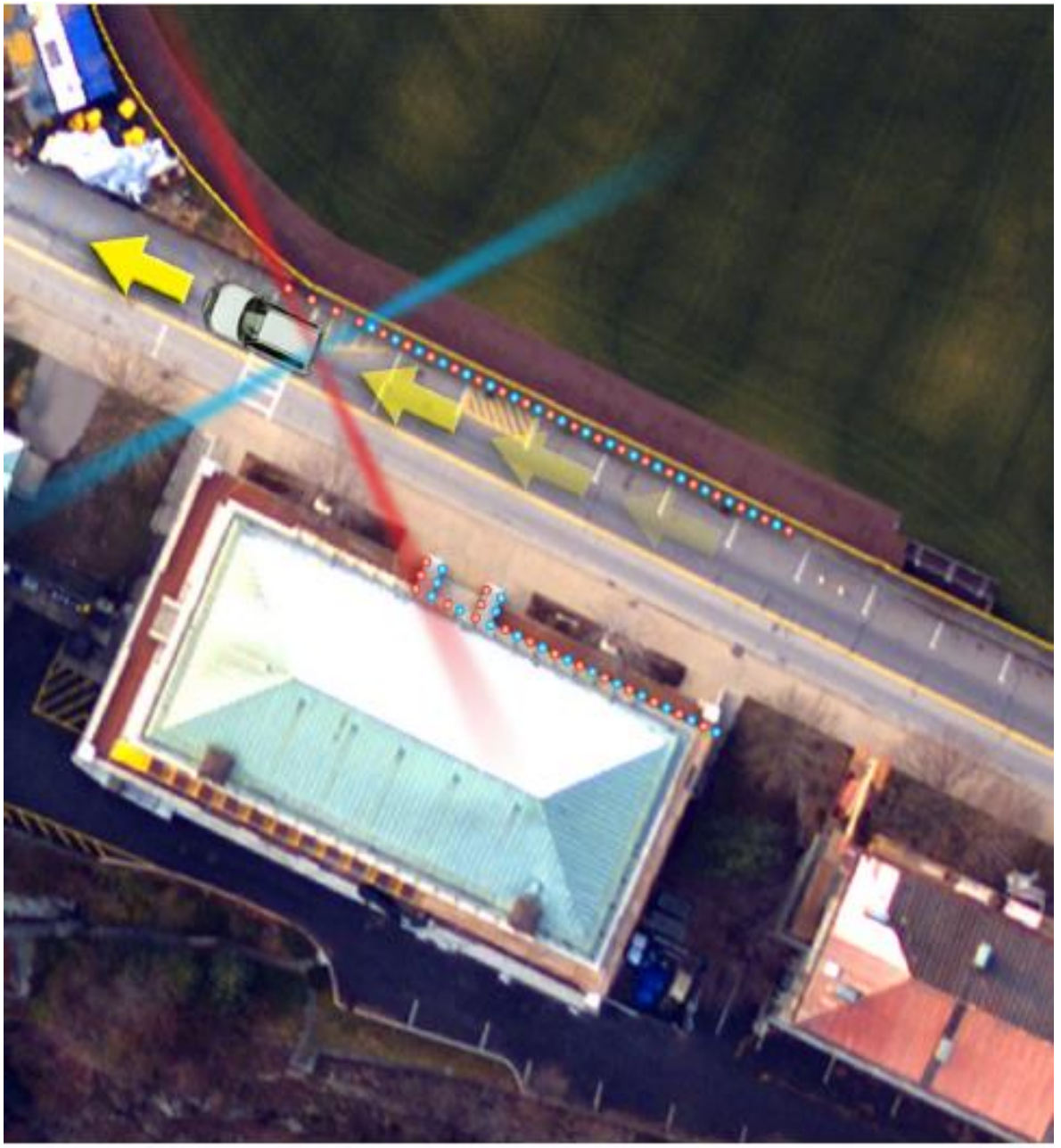
Mobile LiDAR mapping

- GPS / IMU location/orientation
- 2 rotating LiDAR sensors
- Up to 1,000,000 points/second
- Multiple cameras

- Data collection at highway speeds
- Very accurate, efficient and safe surveying method

Terrasolid


Sensor head 1 coverage
Sensor head 2 coverage
All sides covered



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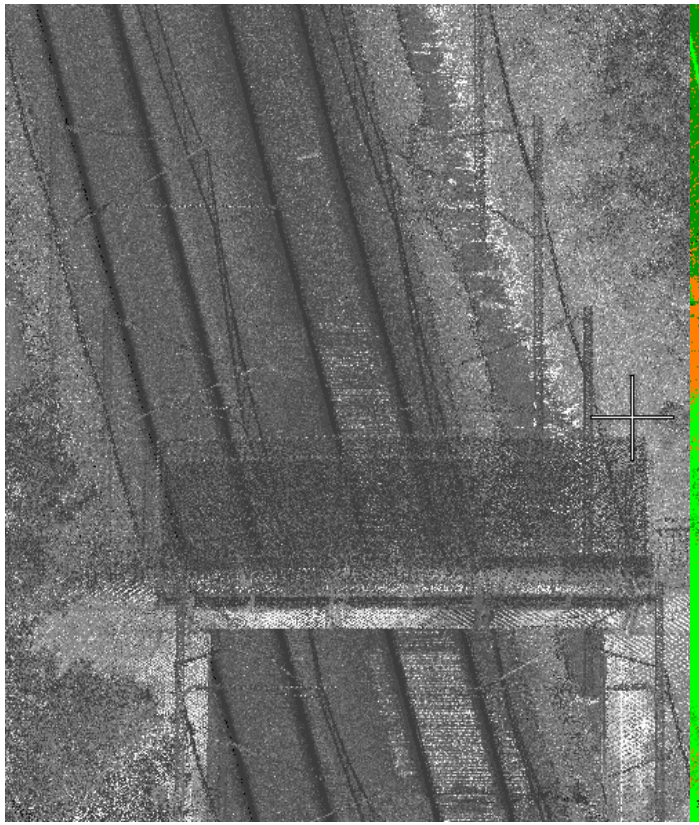
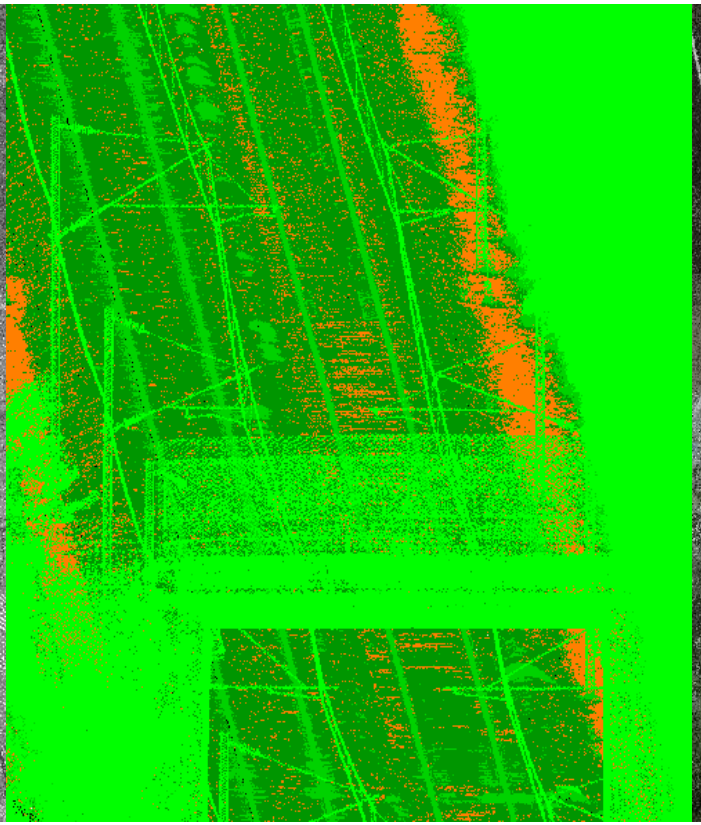
Georeferencing the point cloud

- The initial precision of the point cloud is poor due to only relying on GPS/IMU
- Ground signaling is needed to achieve survey precision
- A fluctuating correction is applied to the point cloud to meet the ground control measurements
- Resulting point cloud location precision is 2-3 centimeters

Point cloud classification



Raw point cloud



Classified point cloud

Colored point cloud

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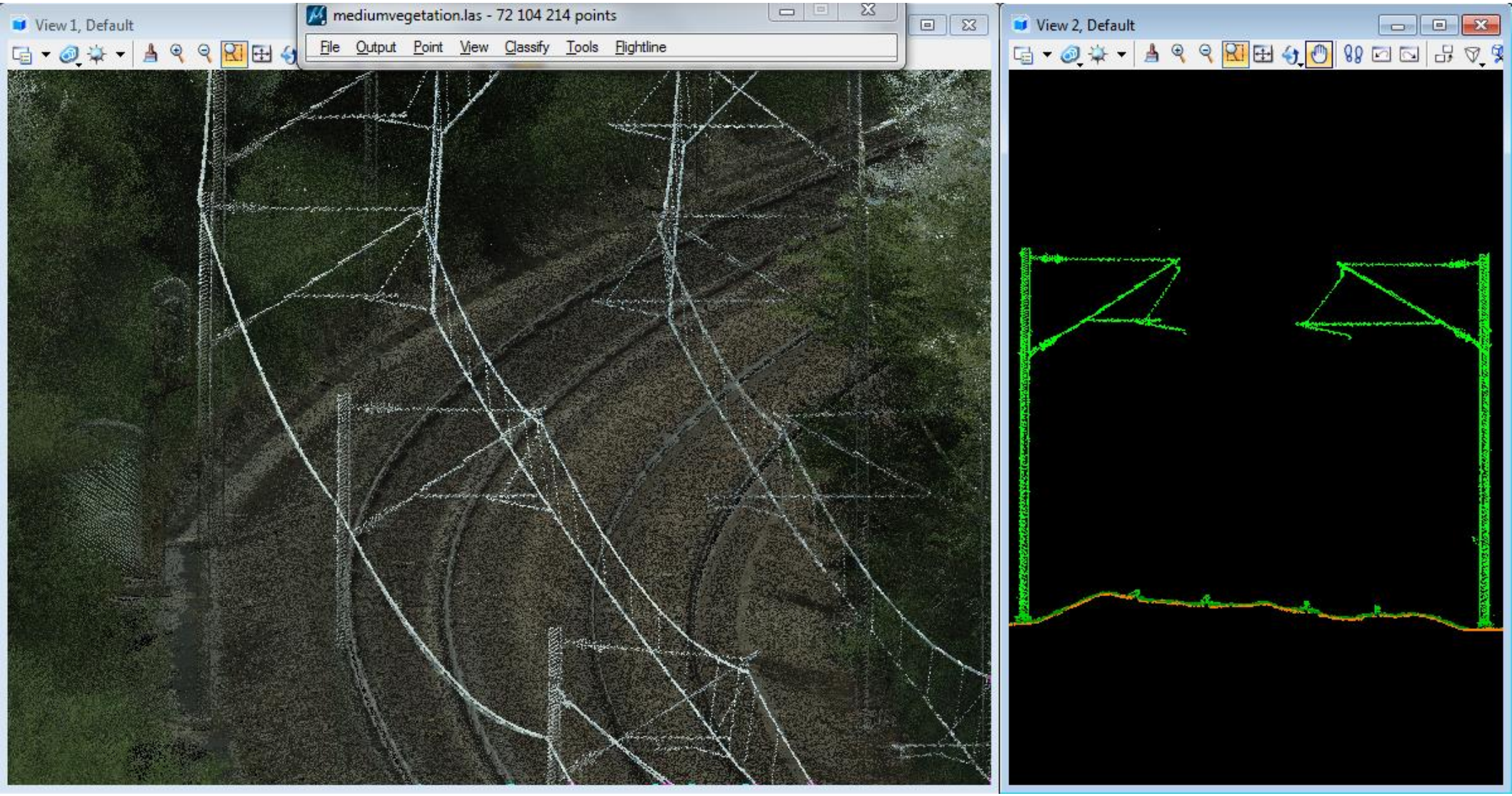
Feature extraction



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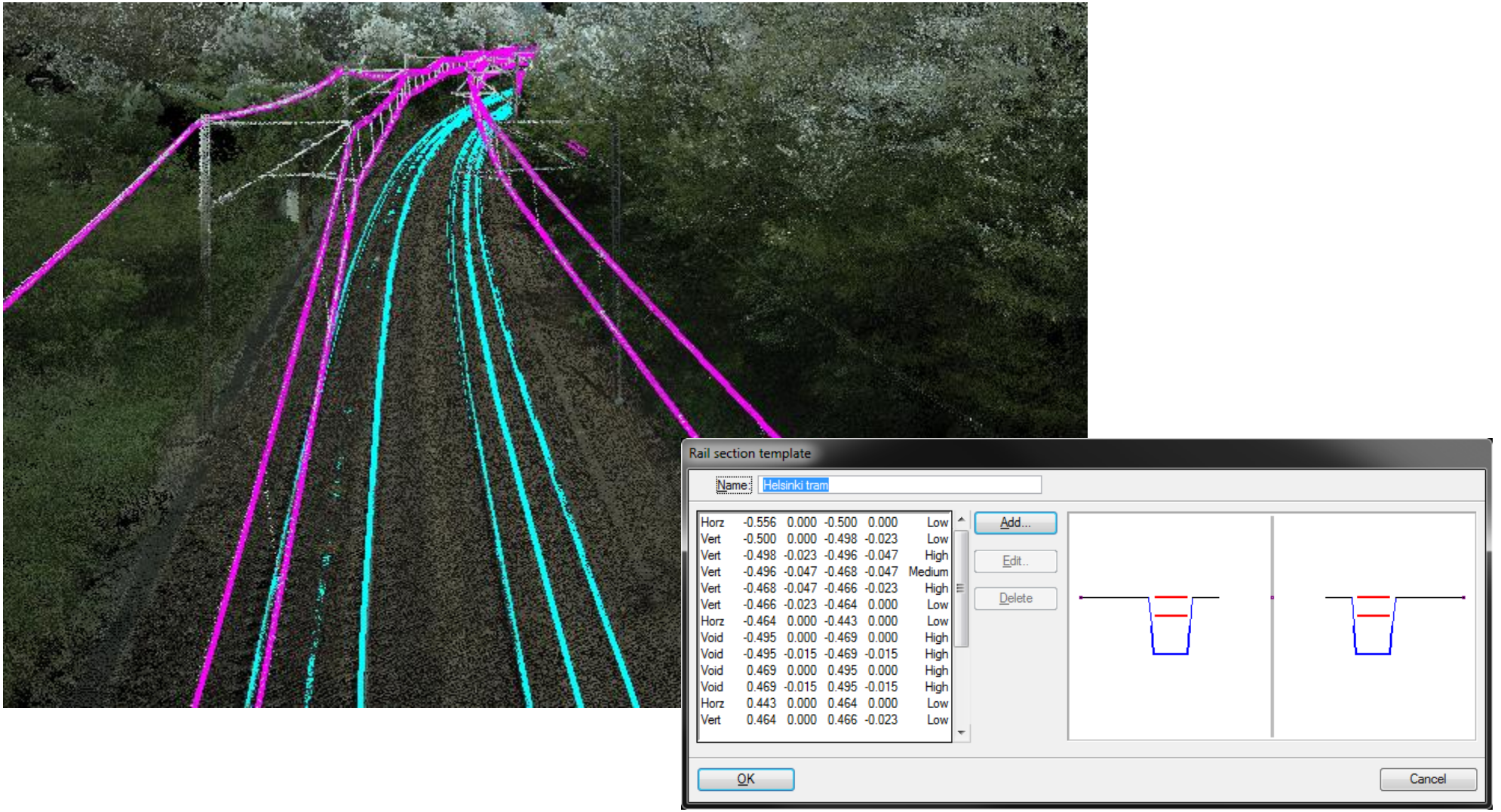
Automatic rail and wire vectorization



Terrasolid

Geometry Component Fitting

- Finds design geometry built from lines, arcs and clothoids which best match surveyed alignment of a road or a railroad
- Fitting for both horizontal and vertical geometry
- Goals:
  - View current geometry of road/railroad/pipeline in design software such as Bentley InRoads, Bentley Track etc passing geometry as LandXML file or similar
  - Is curvature right for this category of road?
  - Do component changes follow design principles?
  - Find long span deformations

Horizontal Geometry

List of road segments

File Tools View

Index	Station	Type	Radius	Cloth. A	Length	Avg.error	Mx.error
27	2856.91	Clothoid	-290.00	111.73	43.05	0.0730	0.2622
28	2899.95	Line			86.02	0.0243	0.0496
29	2985.97	Clothoid	0.00	114.72	71.13	0.0196	0.0624
30	3057.10	Arc	185.00		86.95	0.0648	0.1864
31	3144.06	Clothoid	185.00	89.22	42.89	0.0887	0.1389
32	3186.95	Line			124.68	0.0725	0.1867
33	3311.62	Clothoid	0.00	77.89	10.91	0.0837	0.1395
34	3322.54	Arc	556.00		49.06	0.0732	0.1692
35	3371.60	Clothoid	556.00	200.98	72.65	0.1372	0.2100
36	3444.24	Line			5.80	0.1042	0.1529

Modify Join Undo Change Refit

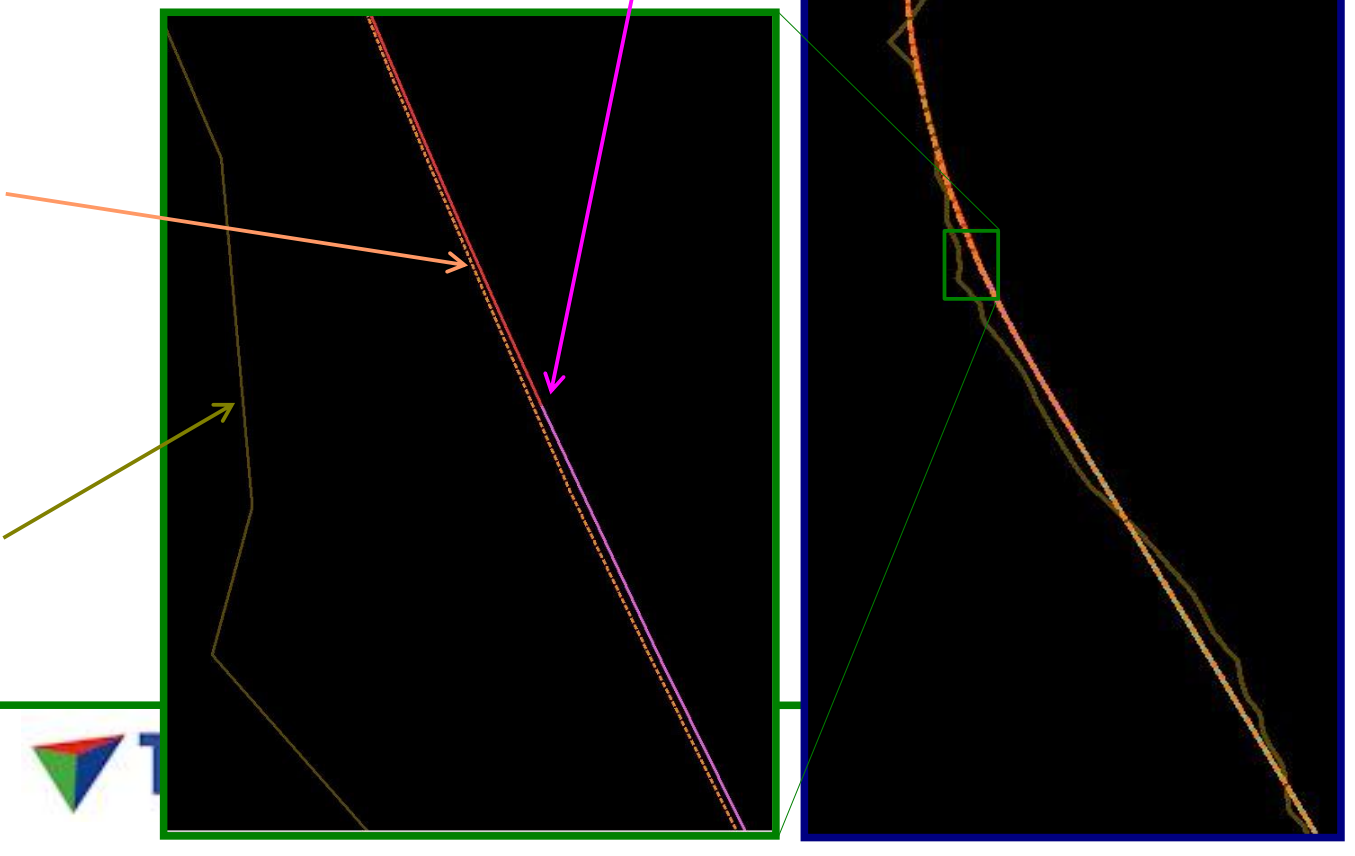
Show location Identify

Fitted components and differences to survey

Fitted components

Surveyed alignment

Exaggerated difference



Terrasolid

Summary

- Mobile LiDAR is the most efficient, safe and cost effective way to survey railways
- The resulting point cloud is a precise 3D model of the railway corridor
- It is possible to vectorize features and populate your asset management system
- You can automatically vectorize the rails and overhanging wires and with component fitting obtain the rail geometry in design format

Helsinki Tram LiDAR Survey

Terrasolid

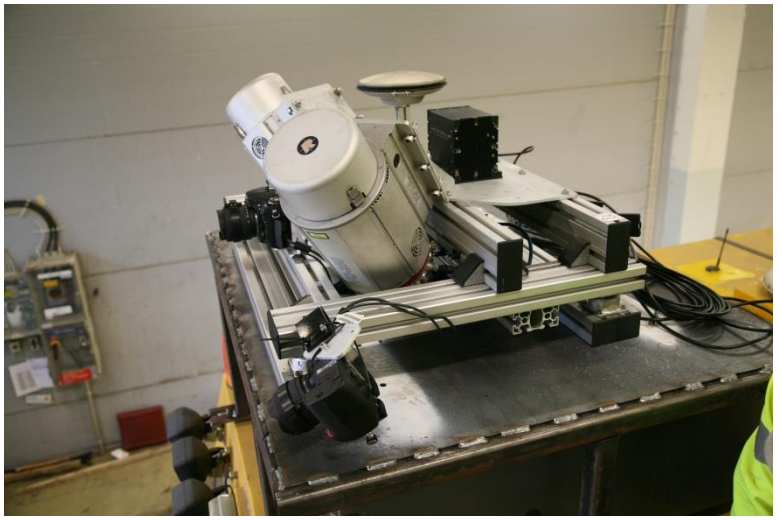
Helsinki Tram Network

- About 200 000 passengers per day
- Lines 1, 1A, 3T, 3B, 4, 4T, 6, 7A, 7B, 8, 9, 10
- 85 kilometers of commuter track
- 97 kilometers of track in total

Helsinki Tram Survey

1. Obtain precise data for maintenance system
2. Simulate new trams
3. ”High-asphalt” calculation

Data Collection



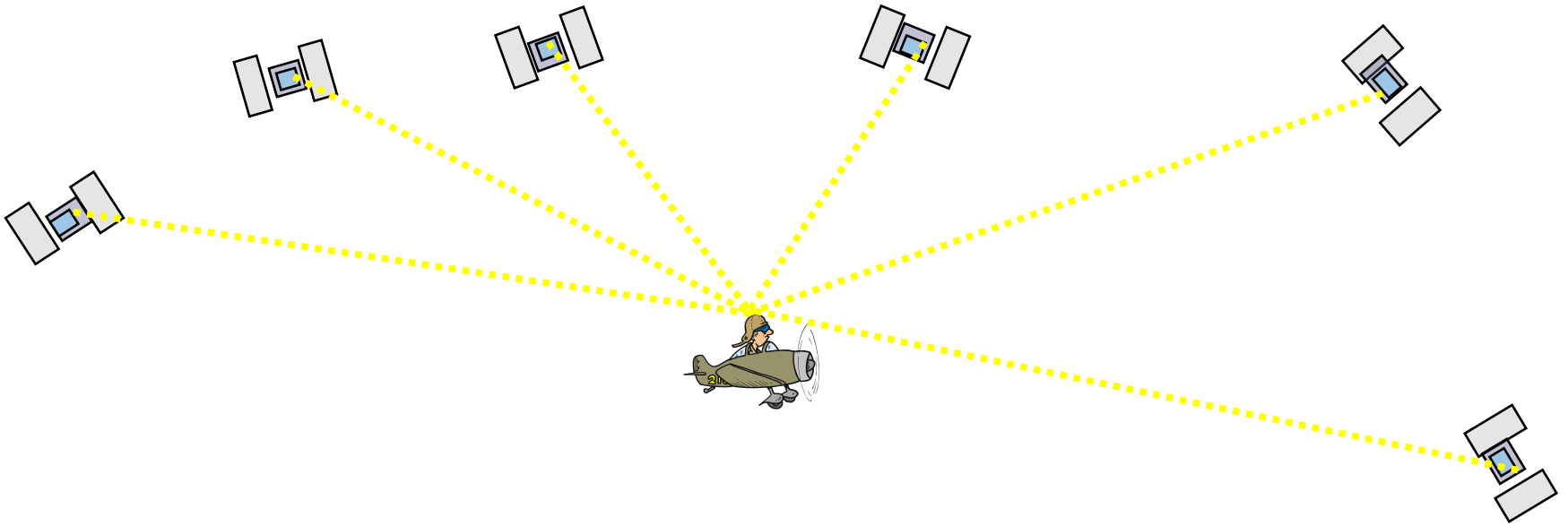
- Carried out by 3D Laser Mapping
- StreetMapper mounted on a tram
  - 2 * 200 000 Hz scanner
  - Forward looking 2144 * 1424 camera
- Tram installation 29th May 2011
- Data collection drives 29th - 31st May 2011
- Some images collected with system mounted on a car 1st June 2011

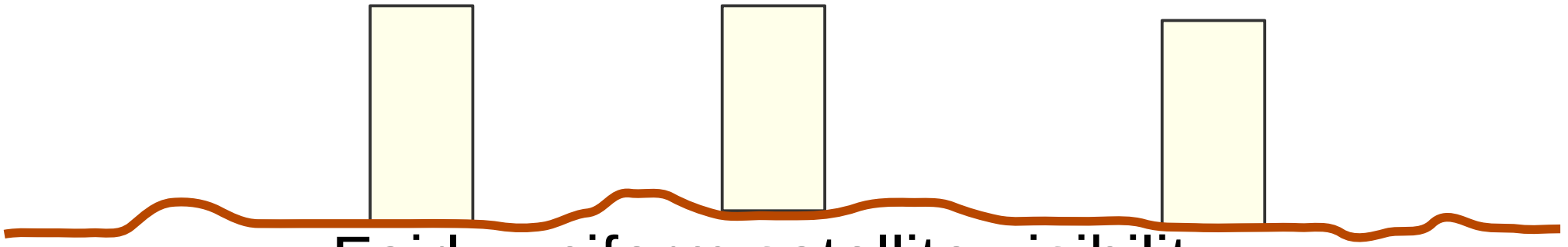
Data Volume

- 14 603 216 184 laser points collected
  - 462 GB as .las files

- 19 628 forward looking images recorded
  - 15 GB as .jpg images

Airborne Positioning



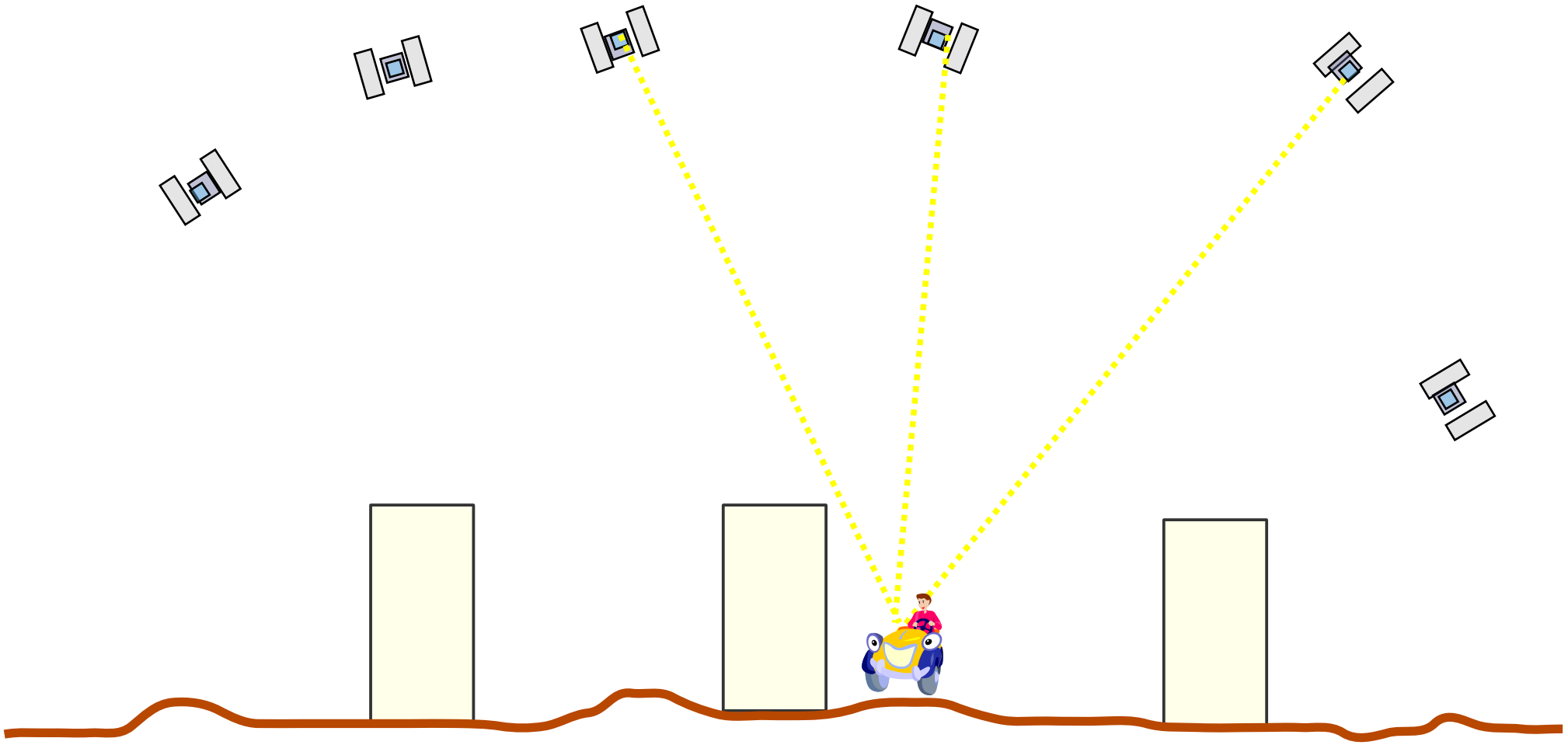


Fairly uniform satellite visibility

Fairly uniform positional accuracy

Terrasolid

Mobile Trajectory Solution

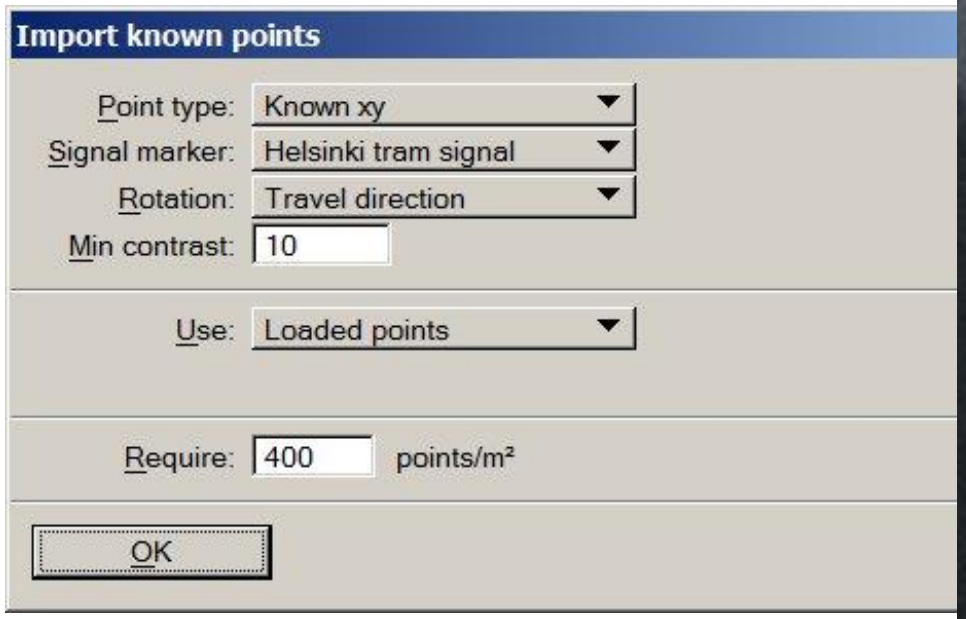


Satellite visibility varies
Positioning accuracy varies

Terrasolid

Automatic Search for Signal Markers

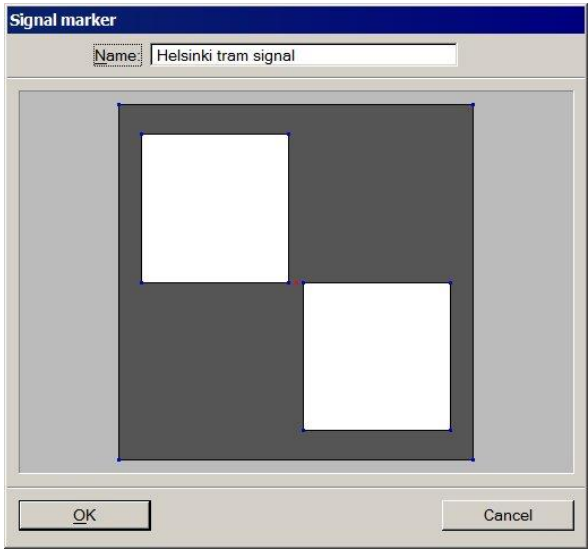
- Automatic search for known pattern control points
- Software finds location (and rotation) with biggest intensity difference between bright and dark polygons
- Rotation can be fixed or come from closest trajectory travel direction

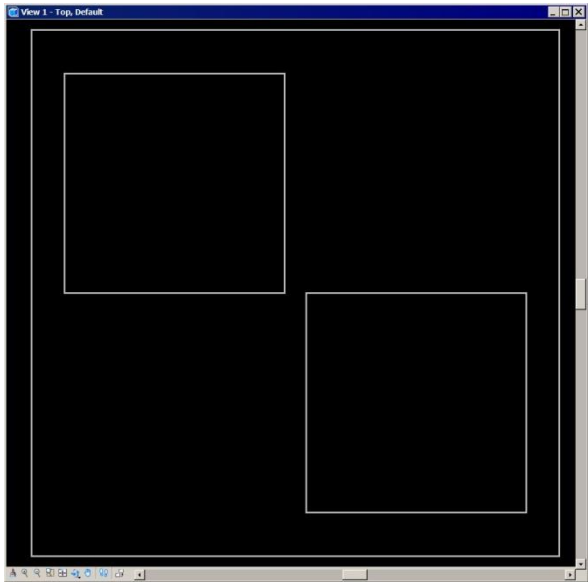


Terrasolid

How to Define a Signal Marker

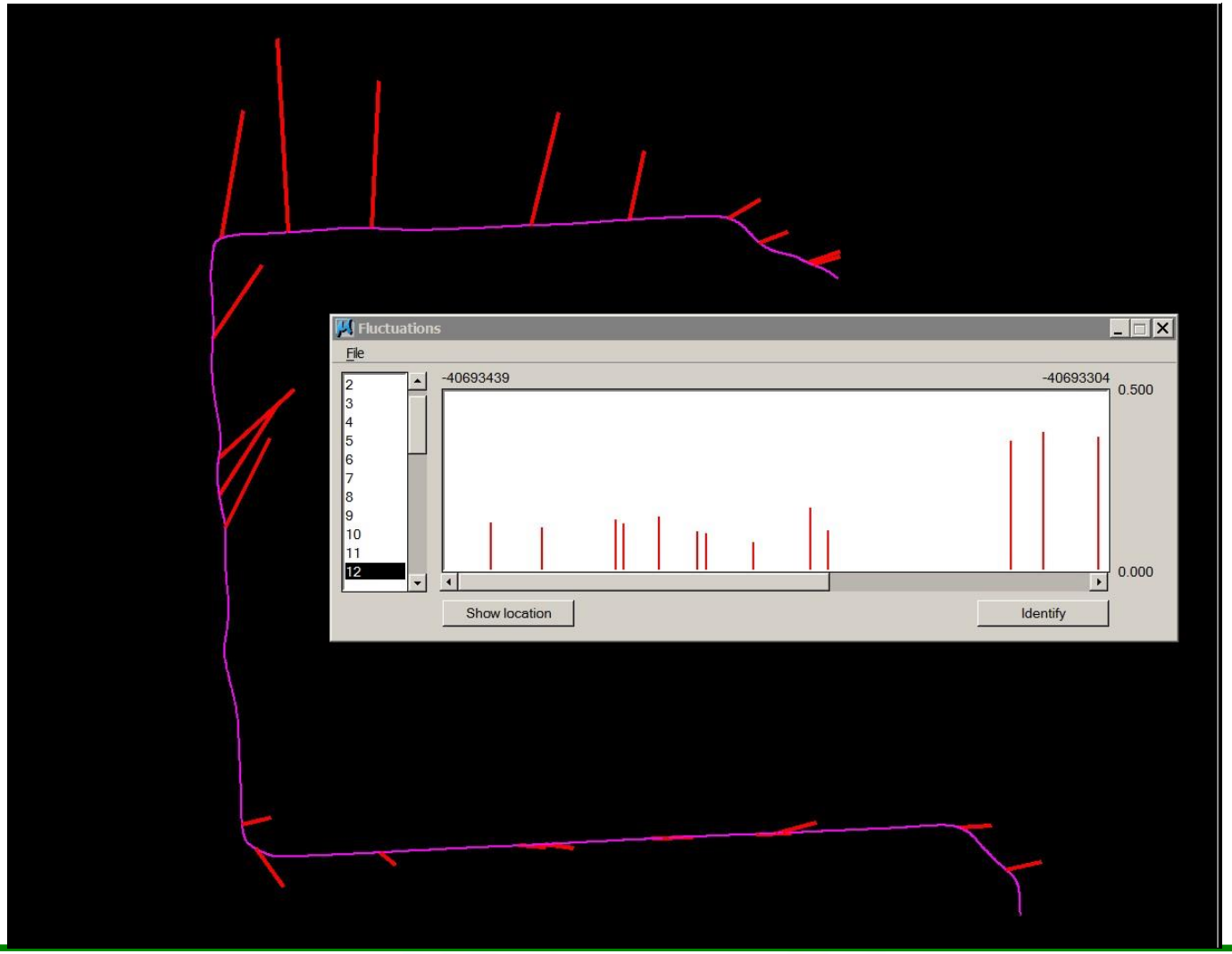
- Draw signal pattern in a top view window
- Draw polygons for bright areas
- Draw larger polygon for dark surrounding
- **Settings** tool and **Signal markers** category
- Select all polygons
- Select **Add**
- Click at location of the control point





Fluctuating Corrections

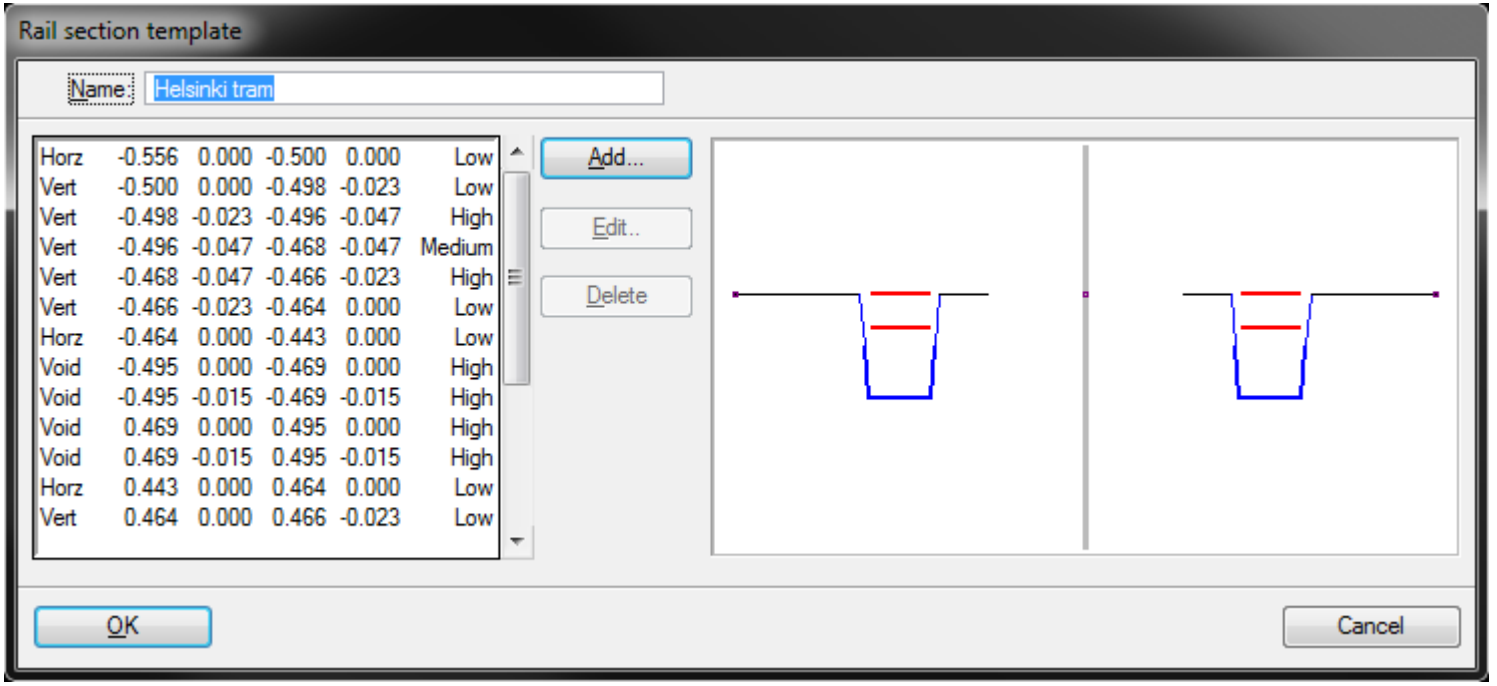
- Xy correction vectors for drive pass in difficult city environment

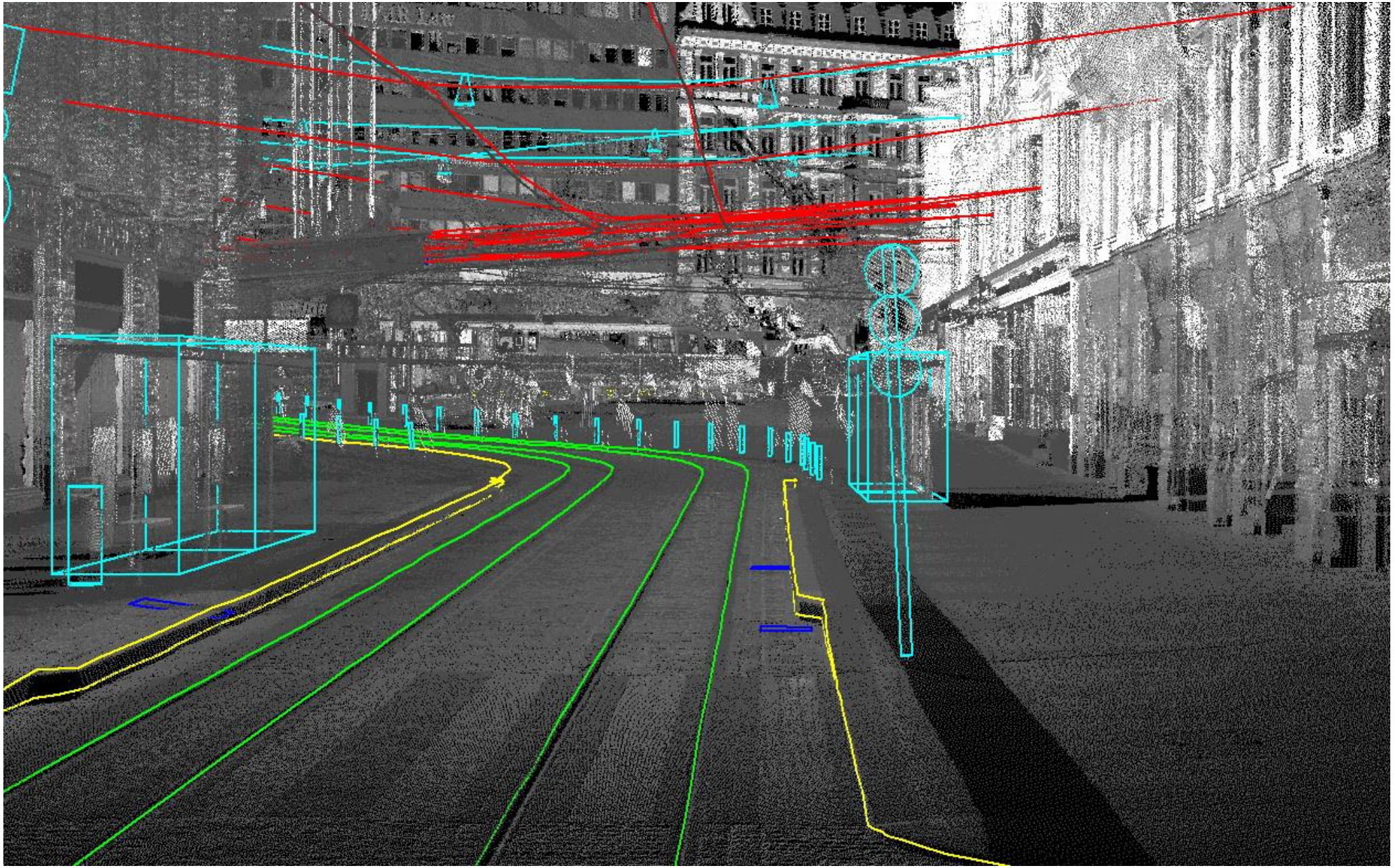


Terrasolid

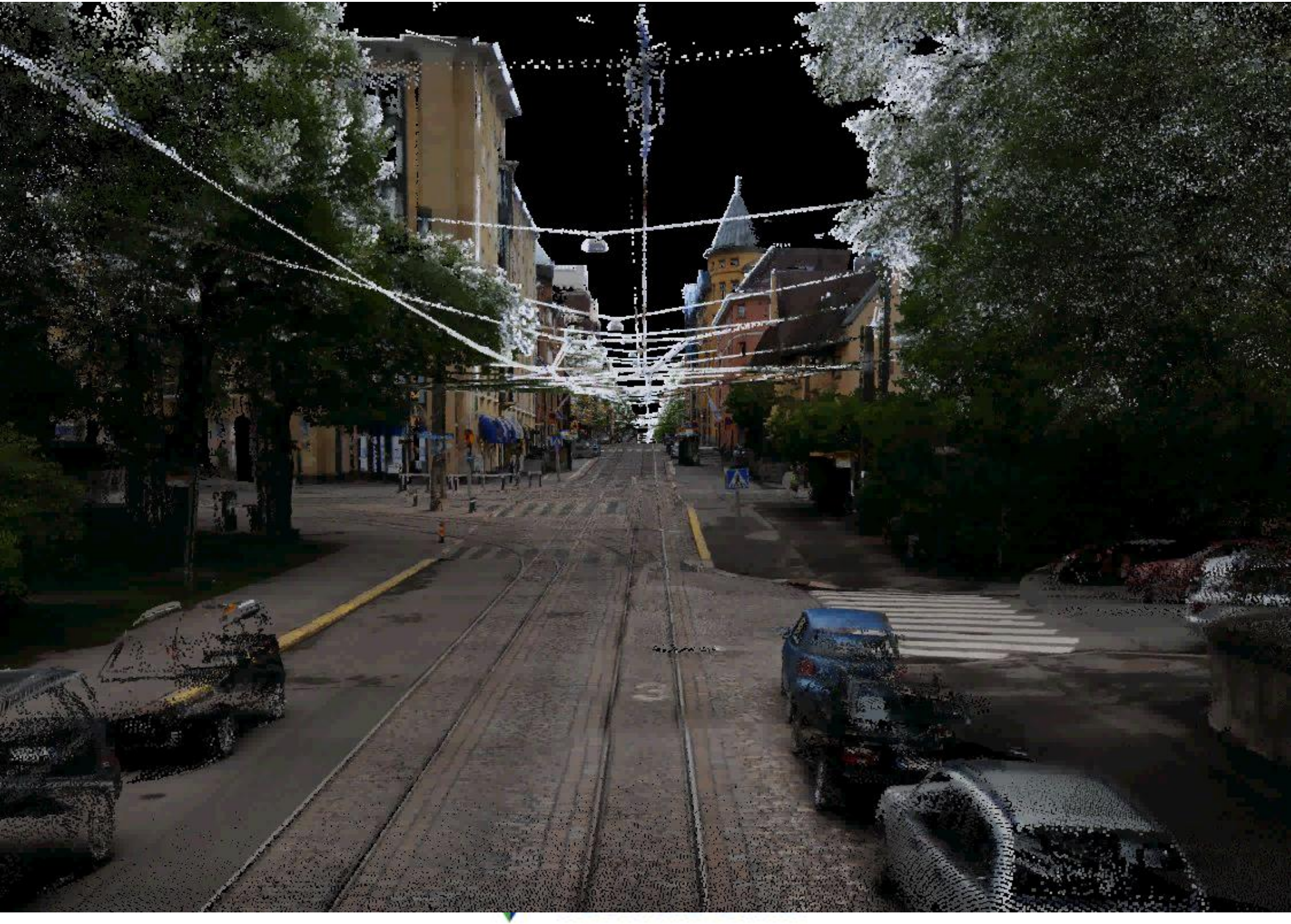
Automatic rail detection

- Define rail section template
- Detect rails





Terrasolid



Video

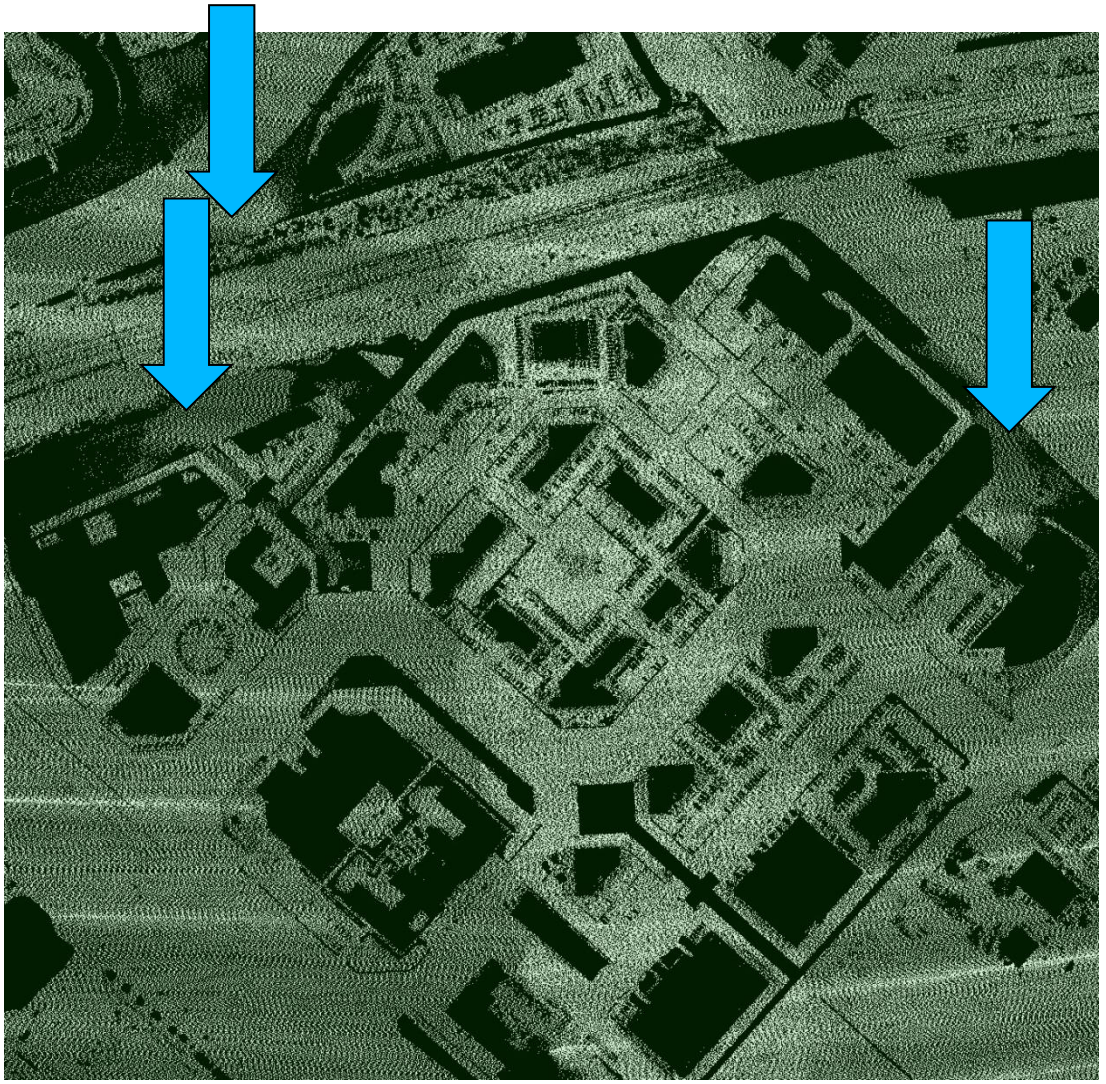
Welkom bij het Actueel Hoogtebestand Nederland (AHN)

- Het Actueel Hoogtebestand Nederland (AHN) is een bestand met voor heel Nederland gedetailleerde en precieze hoogtegegevens. Een digitale hoogtekaart, als het ware. Voor heel Nederland is van elke vierkante meter bekend wat de hoogte is. De waterschappen, provincies en Rijkswaterstaat laten het AHN maken voor hun dagelijks werk, met name voor waterbeheer en waterkeringbeheer. Maar ook voor andere toepassingen wordt het AHN gebruikt.
- Op deze website kunt u de hoogtekaart verkennen met de viewer, de hoogte voor een bepaalde postcode opvragen en voorbeelden van het AHN bekijken. Verder geeft deze website meer informatie over het AHN, de organisatie daarachter en de verschillende hoogtebestanden.
- **Sinds 6 maart 2014 zijn AHN1 en AHN2 beschikbaar als Open Data**. Dat betekent dat iedereen gratis en zonder restricties gebruik kan maken van de hoogtedata. De data wordt, als webservice en als download, beschikbaar gesteld via PDOK en het NationaalGeoregister.

Delivered in two files

- Fairly high density data, ~12 points / sq.meter
- 5 cm Z-accuracy
- Ground points
- Other points, unclassified
- Free

Ground class



The ground class has got quite a few water points also

The other points, unclassified

Demo