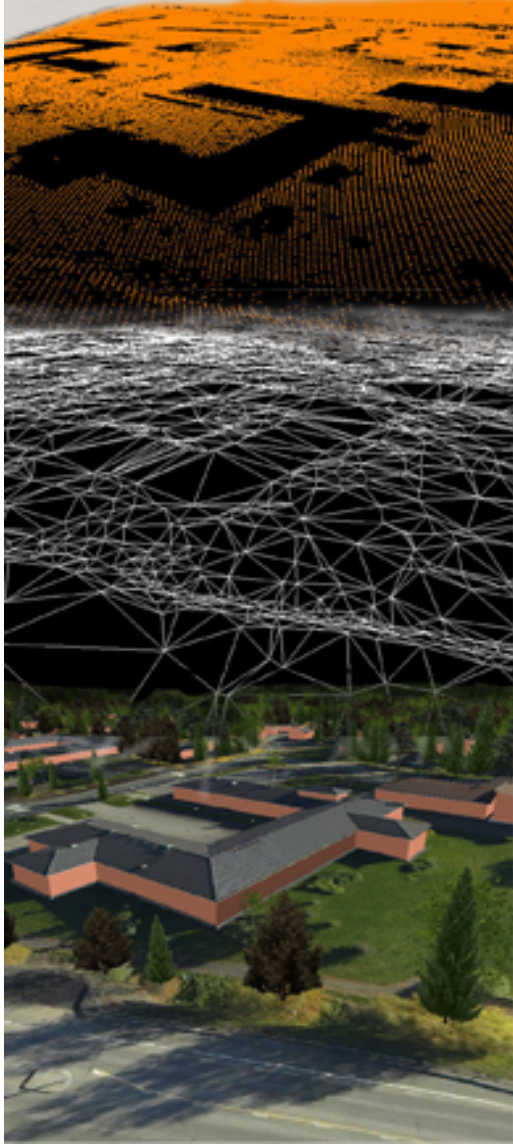
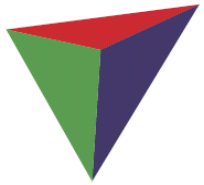


Terrasolid

Danish Civil SIG meeting

4.11.2009



Terrasolid

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Business Development Manager

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www.terrasolid.fi

Arttu Soininen
CTO
Terrasolid Ltd.

Agenda

- Terrasolid update
- Laser scanning overview
- Mobile laser scanning
- Automatic building vectorization
- Discussion

Terrasolid Oy

- Founded in 1989 – 20 years history
- Infrastructure software development and sales
- Revenues in 2008 ~ 3,5 M€
- Customers in 80+ countries
- Global market leader in airborne and mobile laser scanned point cloud processing software
- Market share around 85%
- Based in Finland

展商名录（排名不按顺序）

展商名称	展位号
北京市东城区人民政府	B02
ESRI中国(北京)有限公司	B02
北京数字政通科技股份有限公司	B02
中国移动通信集团公司	B02
中国联合网络通信有限公司	A08
中国电信集团公司	D07
北京华美博弈软件开发有限公司	B01
北京水晶石数字科技有限公司	D06
易建科技有限公司	C07-2
北京超图软件股份有限公司	A09-1
中南集团控股有限公司	B04-1
北京通世舟数字科技有限责任公司	D04
深圳市中视典数字科技有限公司	C01
北京海澄华图科技有限公司	C02
北京建设数字科技股份有限公司	A03
中地数码集团	A06
北京东方道迩信息技术有限责任公司	A05
立得空间信息技术有限公司	B03/B05
金鹏电子信息机器有限公司	C07-1
武汉市国土资源和规划局	C03
天津滨海激光雷达技术产业有限公司	C09
麦格集团	B04-2

展商名称	展位号
北京中软强网信息技术有限公司	B06
芬兰Terrasolid公司	F023
中国惠普有限公司	E100/E101
西安大奥信息科技有限公司	E093
上海迅图数码科技有限公司	F028
松原市人民政府宣	E094
北京同创艺彩数码图像技术有限公司	E102
北京国遥新天地信息技术有限公司	E089/E090
广州城市信息研究所有限公司	E096
广东南方数码科技有限公司	F013
广州奥格智能科技有限公司	F012
北京思亿达科贸有限公司	E099
北京伟景行数字城市科技有限公司	F017/F018
杭州阿拉丁信息科技股份有限公司	E095
深圳市斯维尔科技有限公司	F019
北京天地适图科技有限公司	E097
北京时代凌宇科技有限公司	F022
中国工程建设行业软件产业联合体（中国BLM联盟）	F024/F025/
北京慧点科技开发有限公司	E091/E092
北京炫色科技发展有限公司	E098
北京星天地信息科技有限公司	A02

支持媒体	展位号
中国建设报	F020
《建设科技》杂志	F007
《智能建筑》杂志	F021
《3S世界》杂志	F015
《智能交通》杂志	F016
中国物流产品网	F009
千家网	F014
国际数字地球学会《国际数字地球学报》	F011
中国知识	F003
中国国	F008
搜狐焦点	F029/030
《数字城 国建设信息》	E087/E088
新	F002
国	F010
无	F001

Terrasolid-applications
Laser scanning

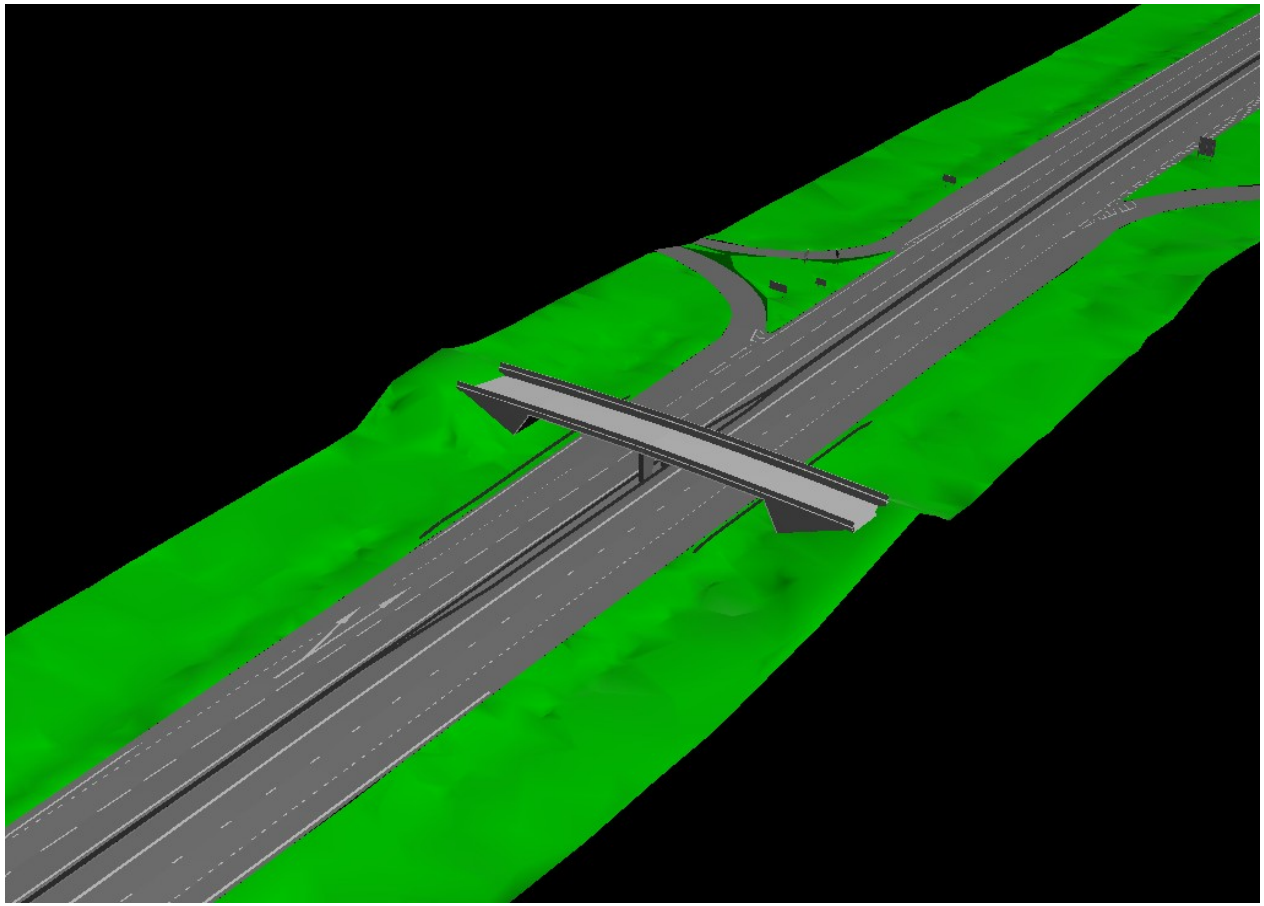
- TerraScan
- TerraMatch
- TerraPhoto
- TerraModeler
- TerraSurvey

Terrasolid

Terrasolid-applications

Infrastructure design

- TerraStreet
- TerraPipe
- TerraGas
- TerraHeat
- TerraBore



Terrasolid

Laser scanning

Wikipedia – Lidar

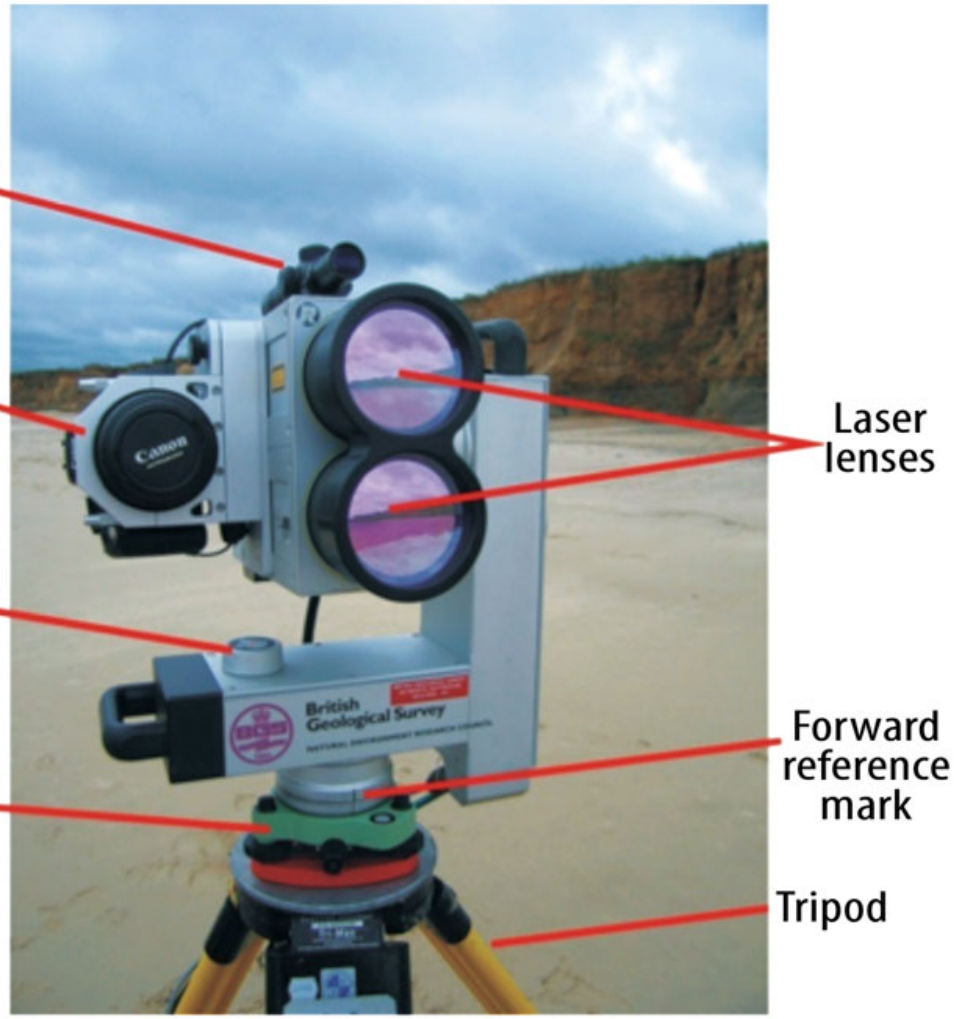
- LIDAR (Light Detection And Ranging) is an optical remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target. The prevalent method to determine distance to an object or surface is to use laser pulses. Like the similar radar technology, which uses radio waves, which is light that is not in the visible spectrum, the range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal.
- The primary difference between lidar and radar is lidar uses much shorter wavelengths of the electromagnetic spectrum, typically in the ultraviolet, visible, or near infrared range. In general it is possible to image a feature or object only about the same size as the wavelength, or larger.

Laser scanning

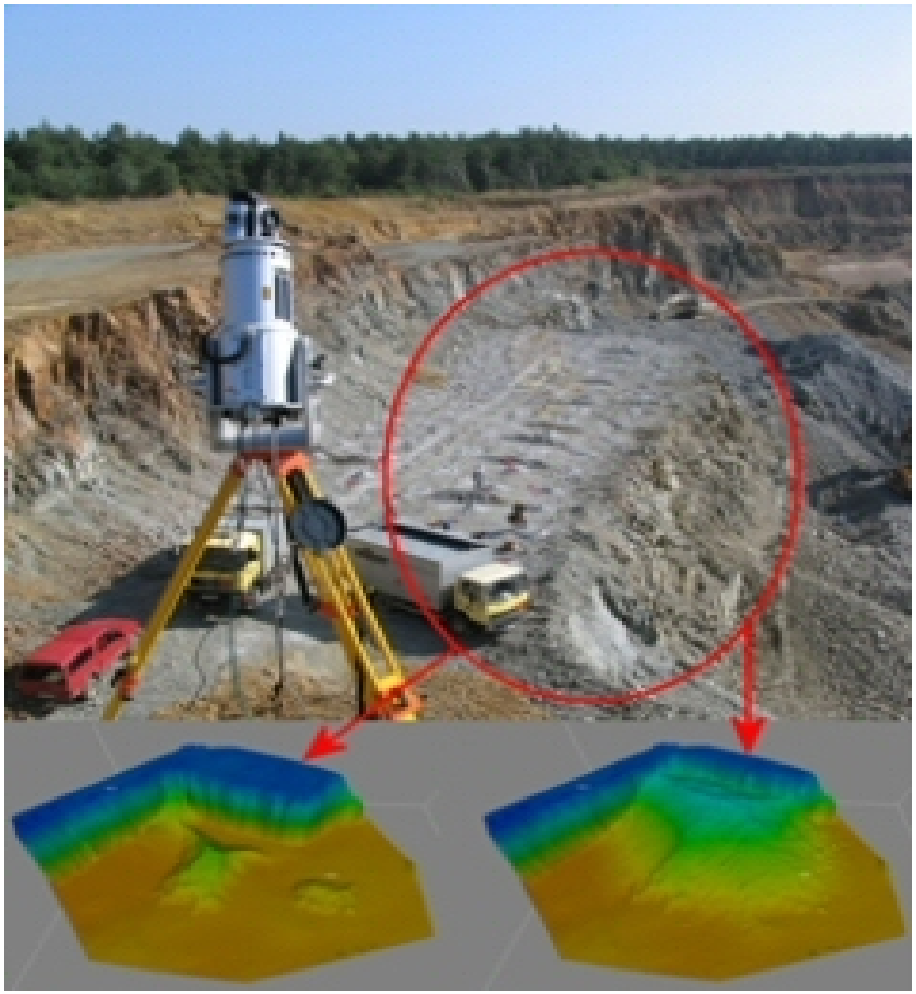
- Terrestial
  - Static tripod
- Airborne
  - Aeroplane
  - Helicopter
- Mobile
  - Car
  - Train

Terrestial laser scanning

- Laser scanner on tripod
- Scanner may rotate
- Up to 300 kHz
- 100 x 360 degrees



Terrestial laser scanning

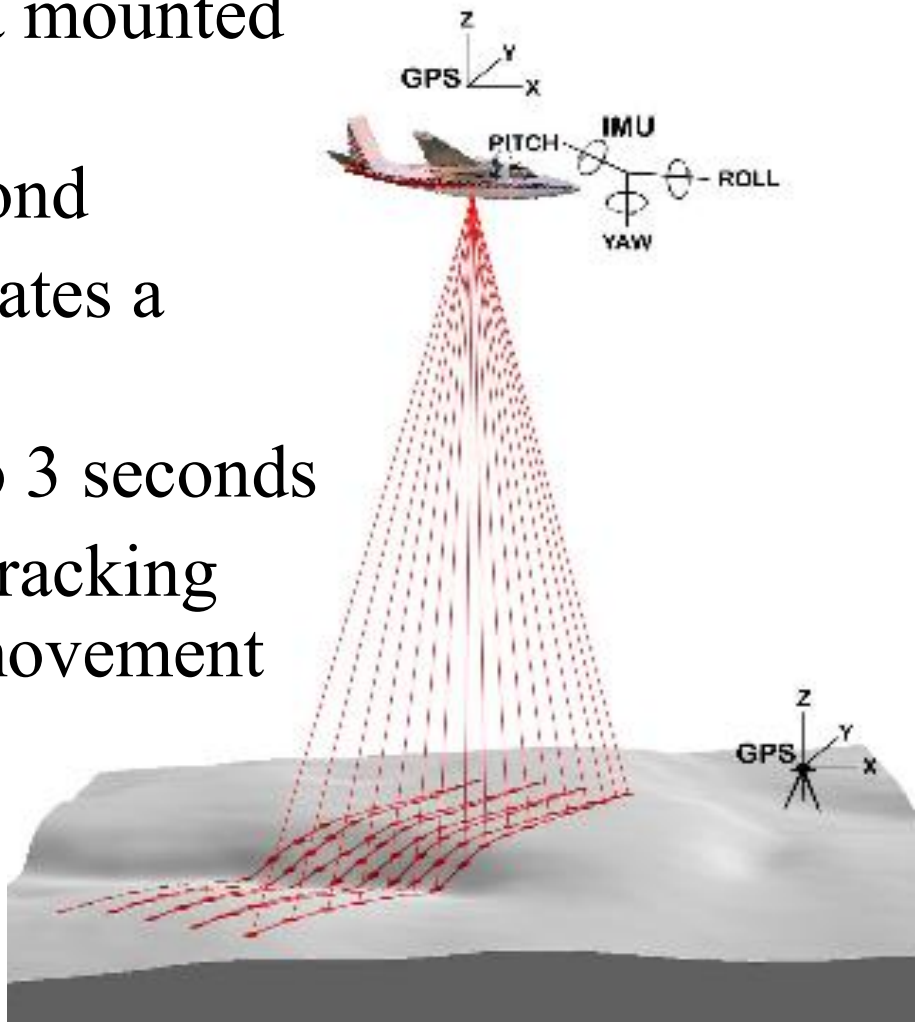


Airborne laser scanning

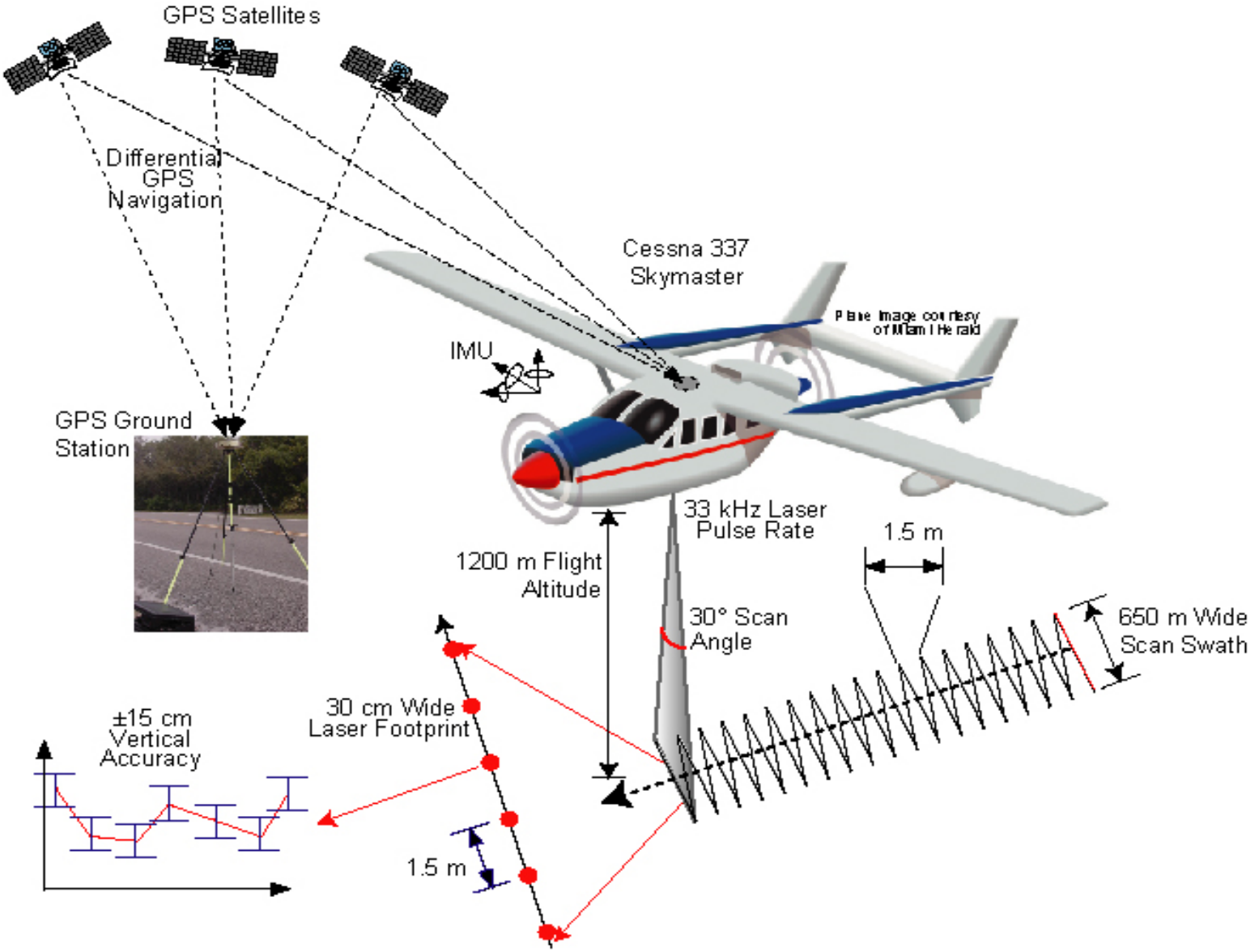
Airborne laser scanning

Laser scanner and digital camera mounted into an aeroplane or helicopter

- Upto 250,000+ points per second
- Scanner mirror rotates and creates a scanning pattern
- Digital photographs every 1 to 3 seconds
- Precise location and position tracking with GPS and IMU (Inertial movement unit)



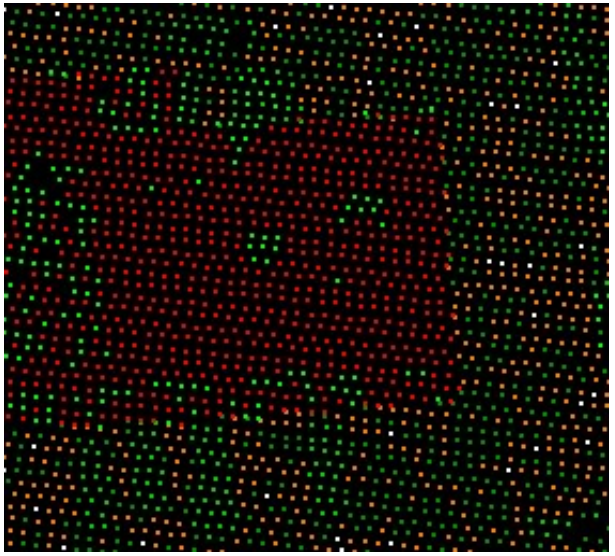
Leica ALS 60 -laitteisto


GPS Satellites
Differential GPS Navigation
Cessna 337 Skymaster
Plane image courtesy of Miami Herald
IMU
GPS Ground Station
33 kHz Laser Pulse Rate
1.5 m
1200 m Flight Altitude
30° Scan Angle
650 m Wide Scan Swath
30 cm Wide Laser Footprint
±15 cm Vertical Accuracy
1.5 m

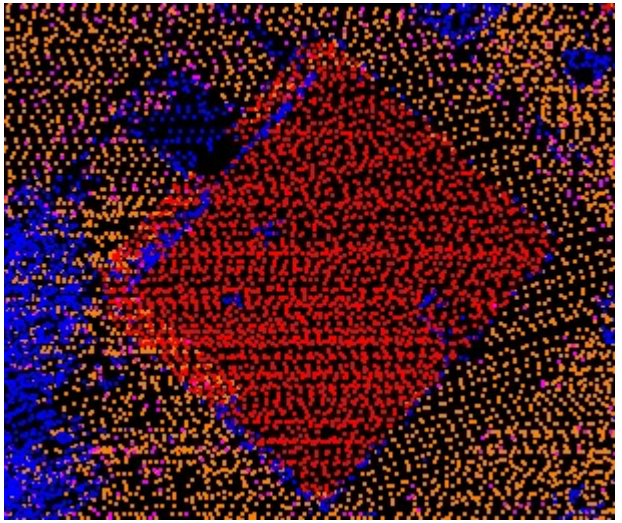
Terrasolid

Point density

- Aeroplane
  - 600 meters ~10 points/m²
  - 2000 meters ~0,7 points/m²

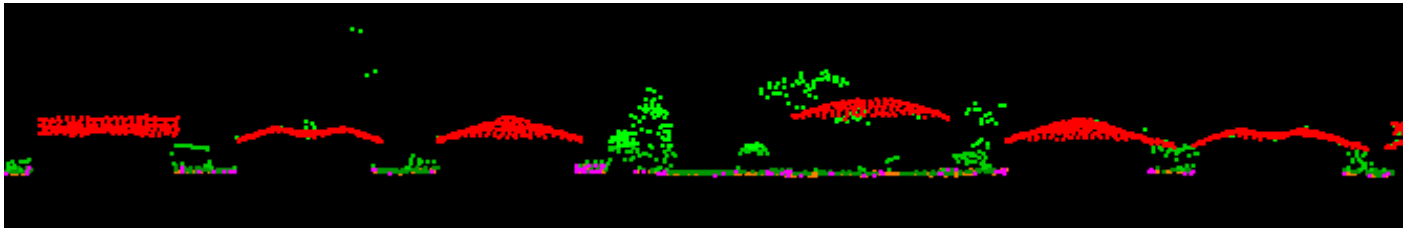


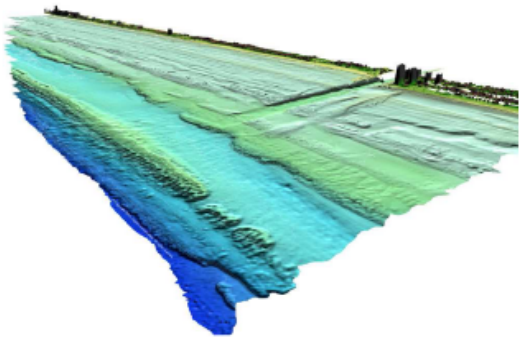
- Helicopter
  - 150 meters ~30 points/m²

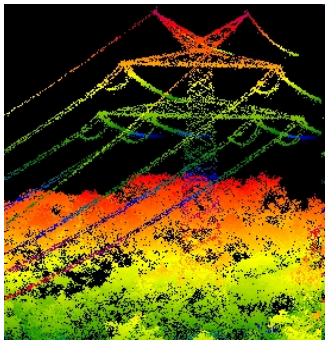


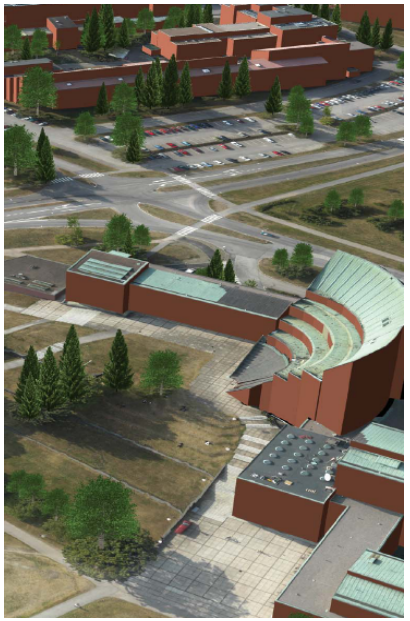
Terrasolid applications

- After the flight 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

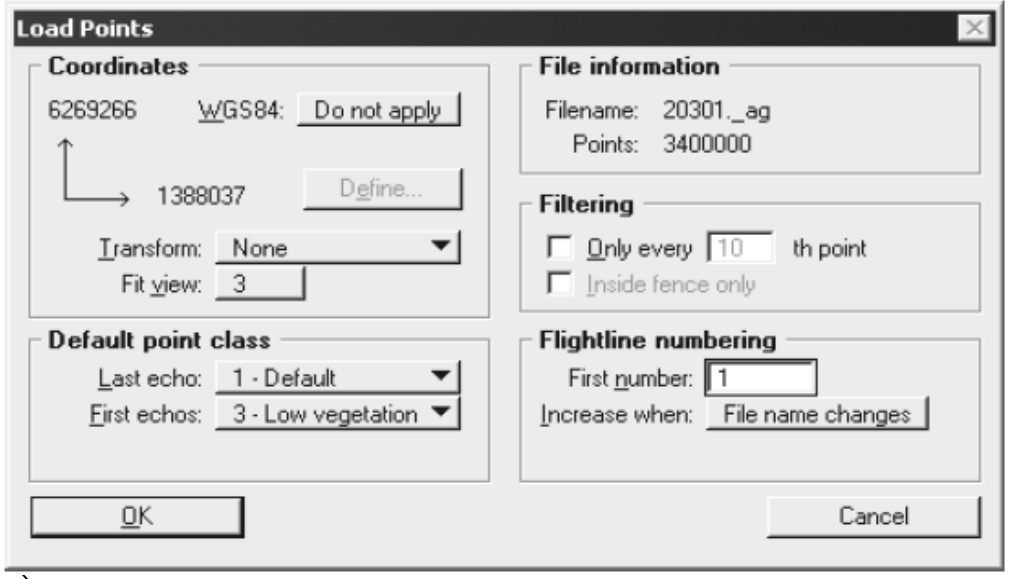








Prosessi



Import RAW laser data and trajectories

Calibrate and align point clouds from multiple flightlines

Classify the points with rules

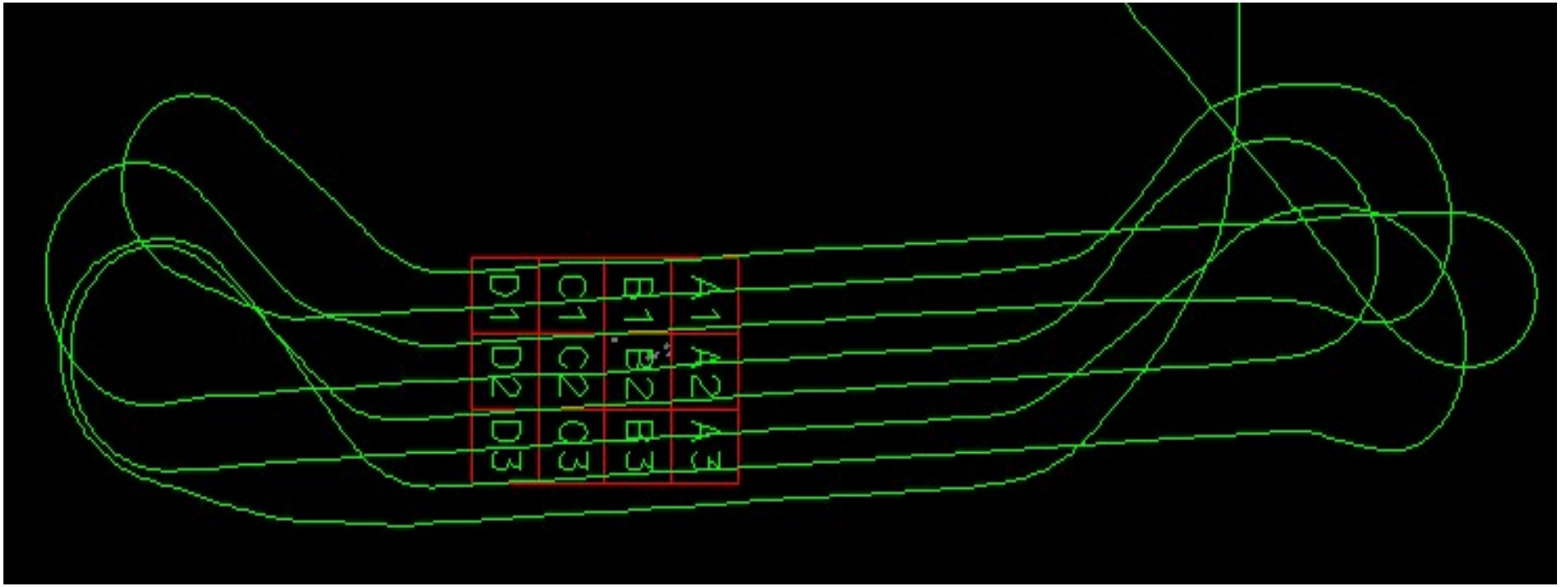
Process airborne images and produce orthos

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…**

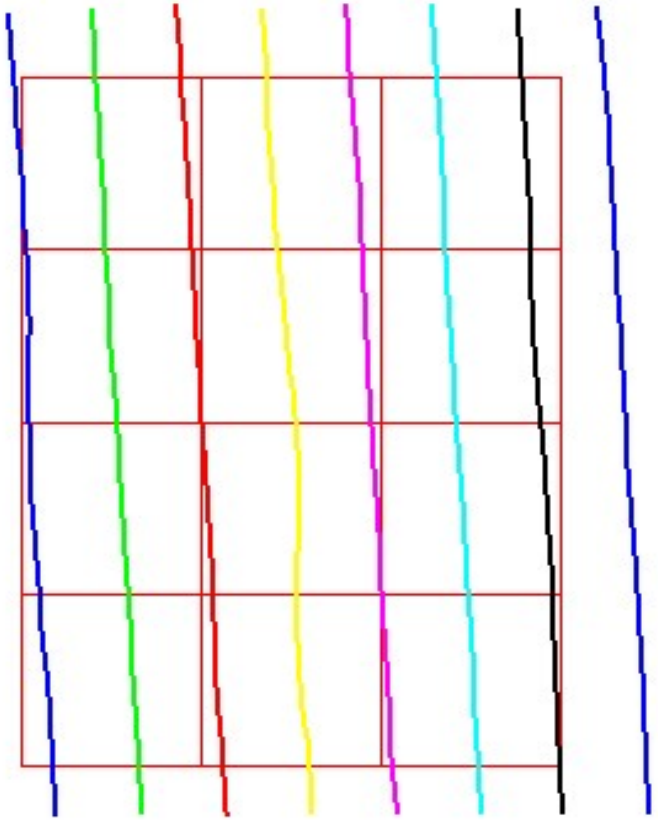
TerraScan

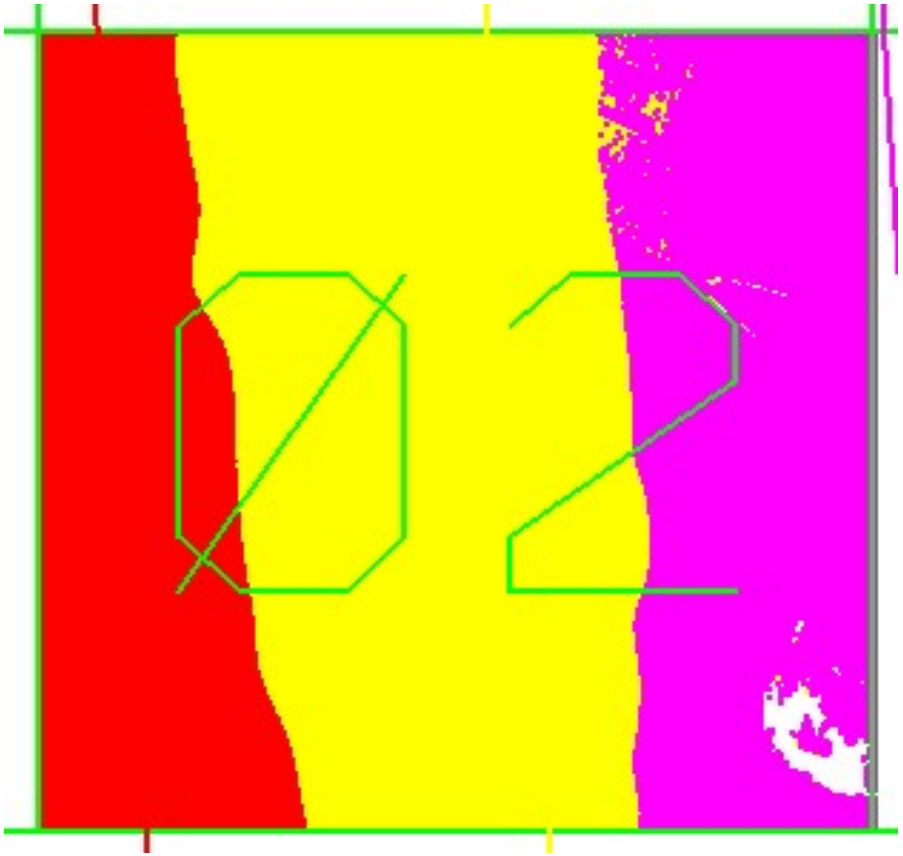
- Read the points into the correct coordinate system
- Divide the points into blocks



TerraScan

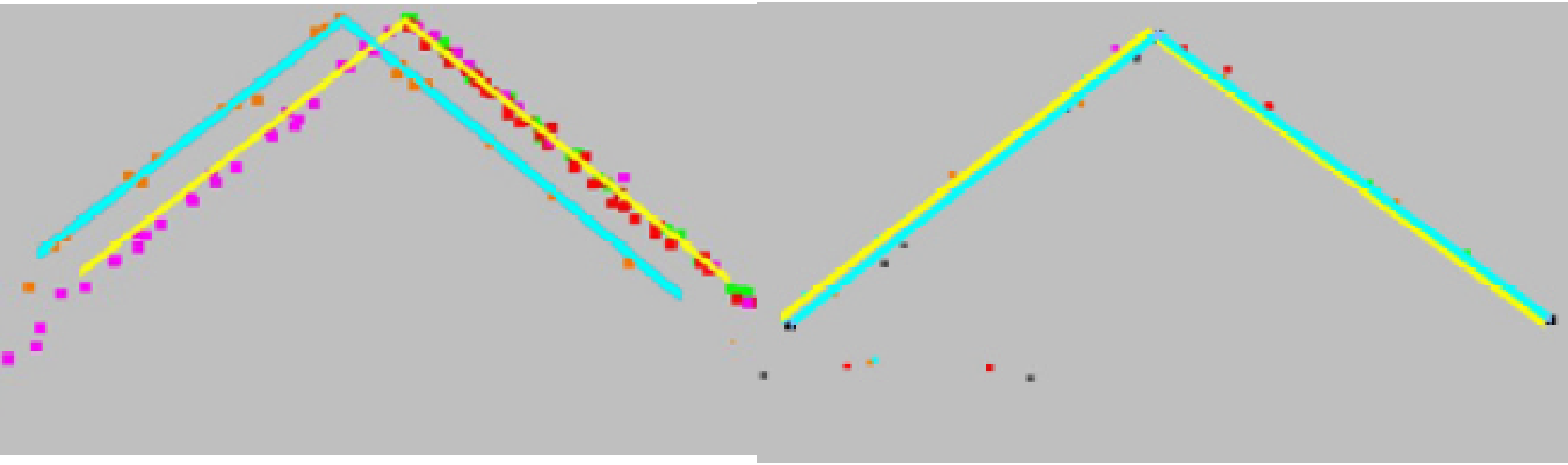
- Classify the points by flight lines





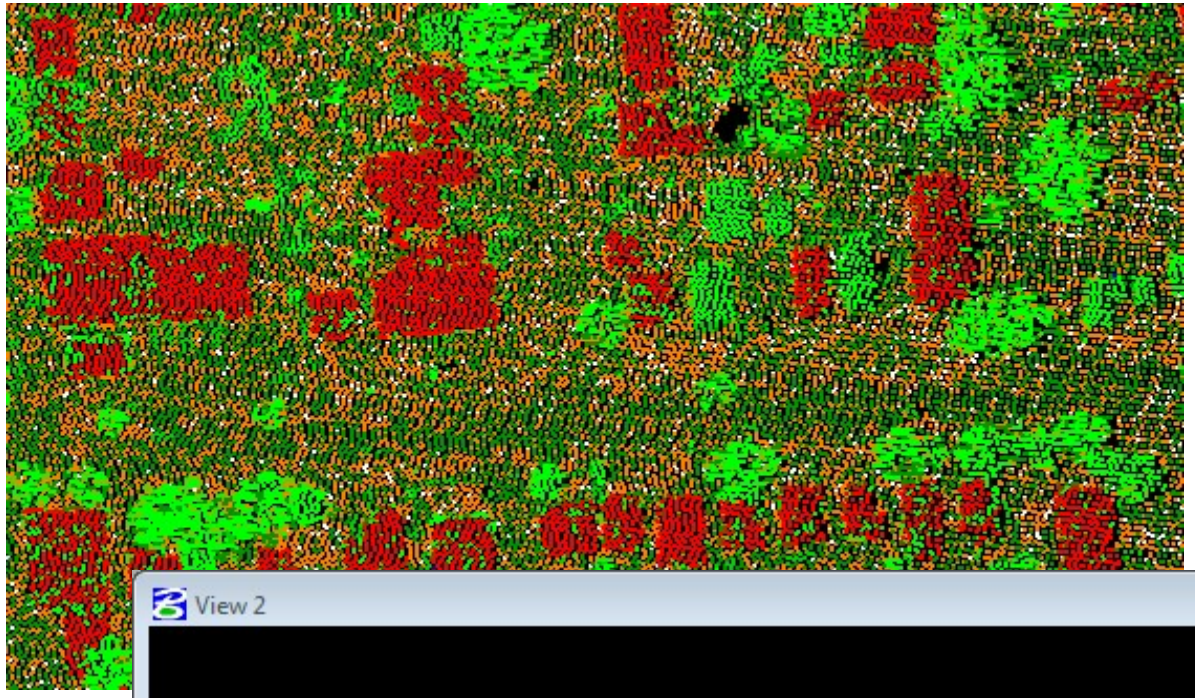
TerraMatch

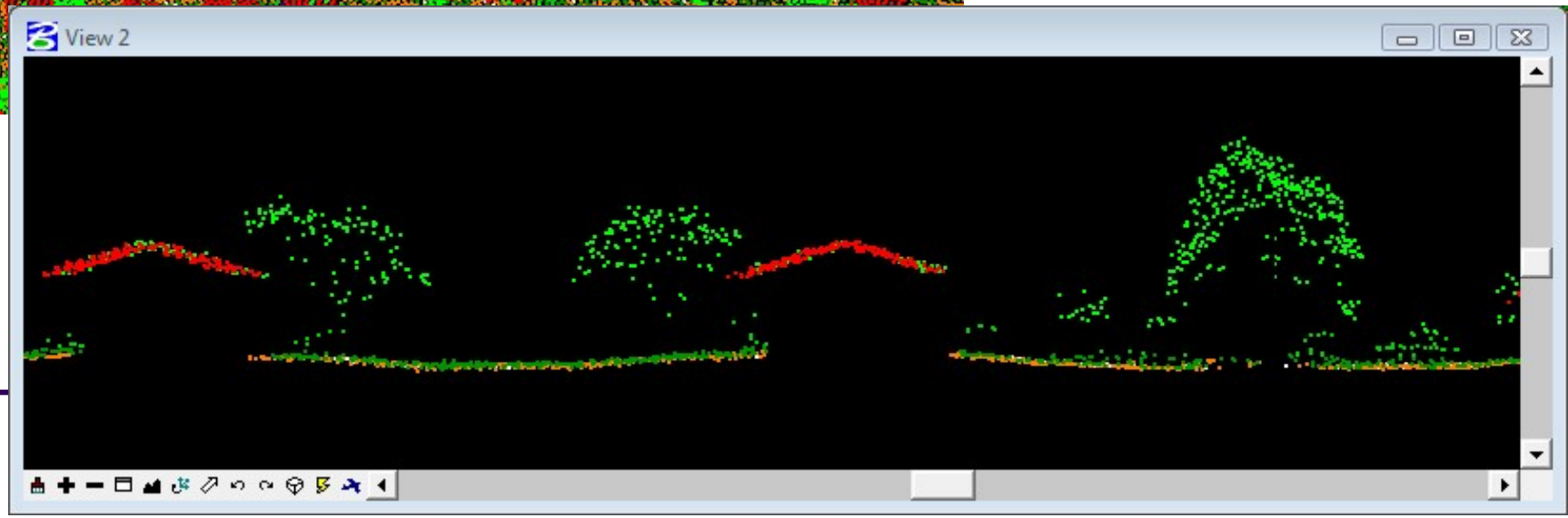
- Match the multiple flight passess by tie lines



TerraScan

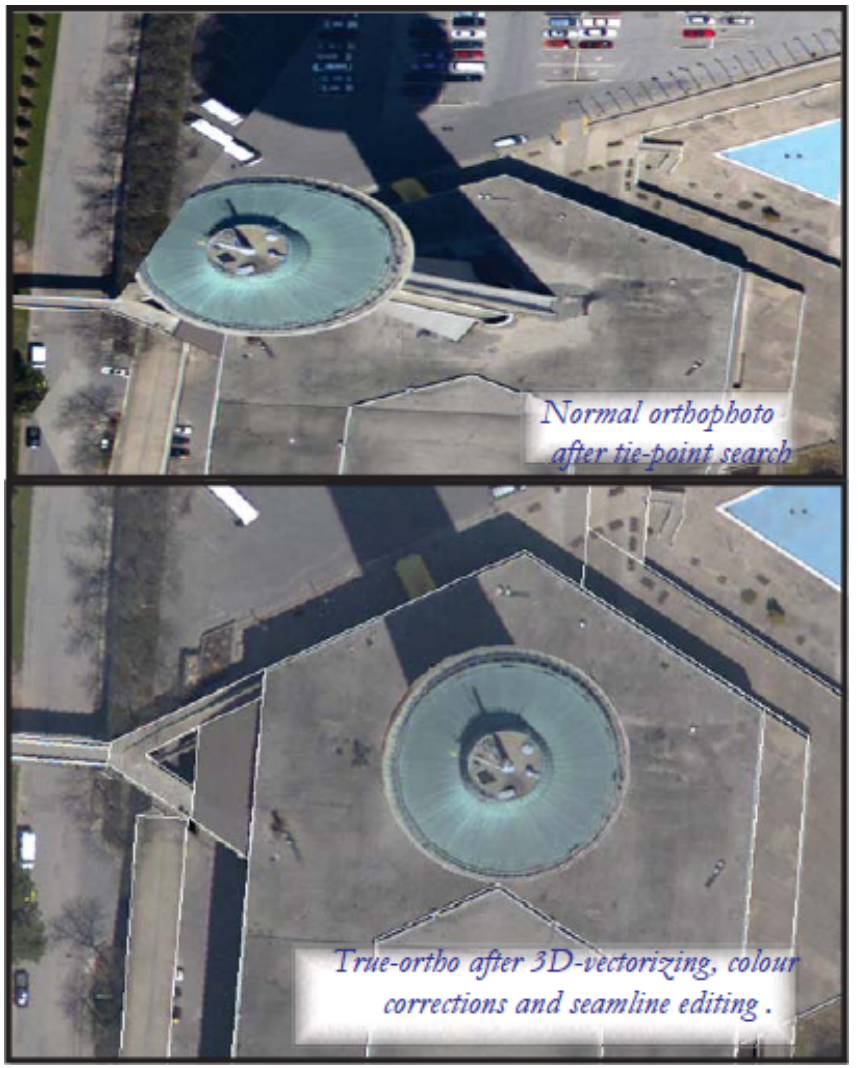
- Classify the points





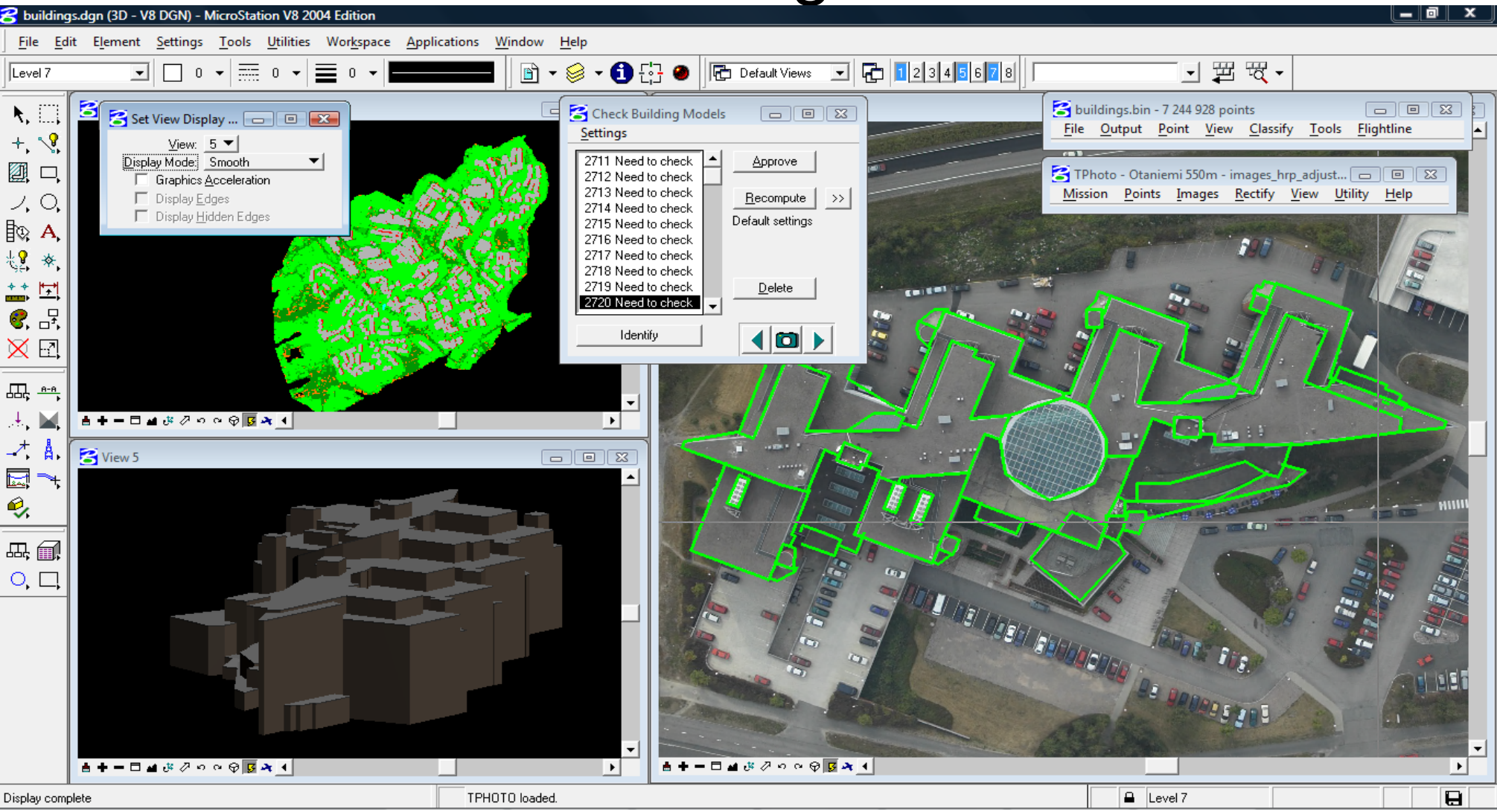
TerraPhoto

- TrueOrtho-production
- Supports the point classification process

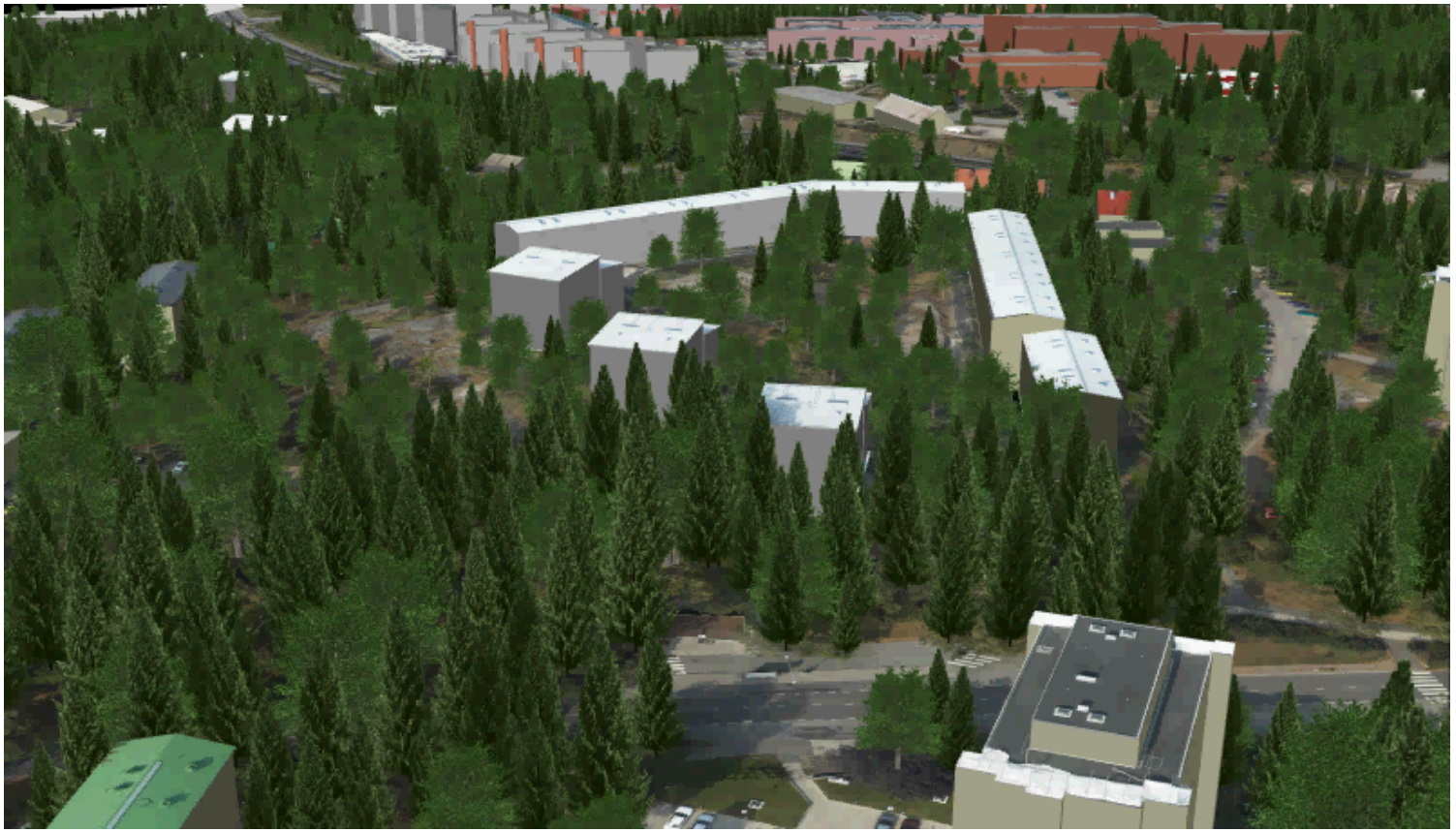


Terrasolid

Automatic building vectorization



Terrasolid



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Mobile laser scanning

Stop and Go (ILRIS)

- In general one scanner on vehicle roof or separate telescope (extra support to be sure about stability)
- Operation pattern: drives 10…20 m and scans
- Lower performance than in continuous scanning
- Needs accurate control point network
- Difficulties in busy traffic

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Continuous scanning

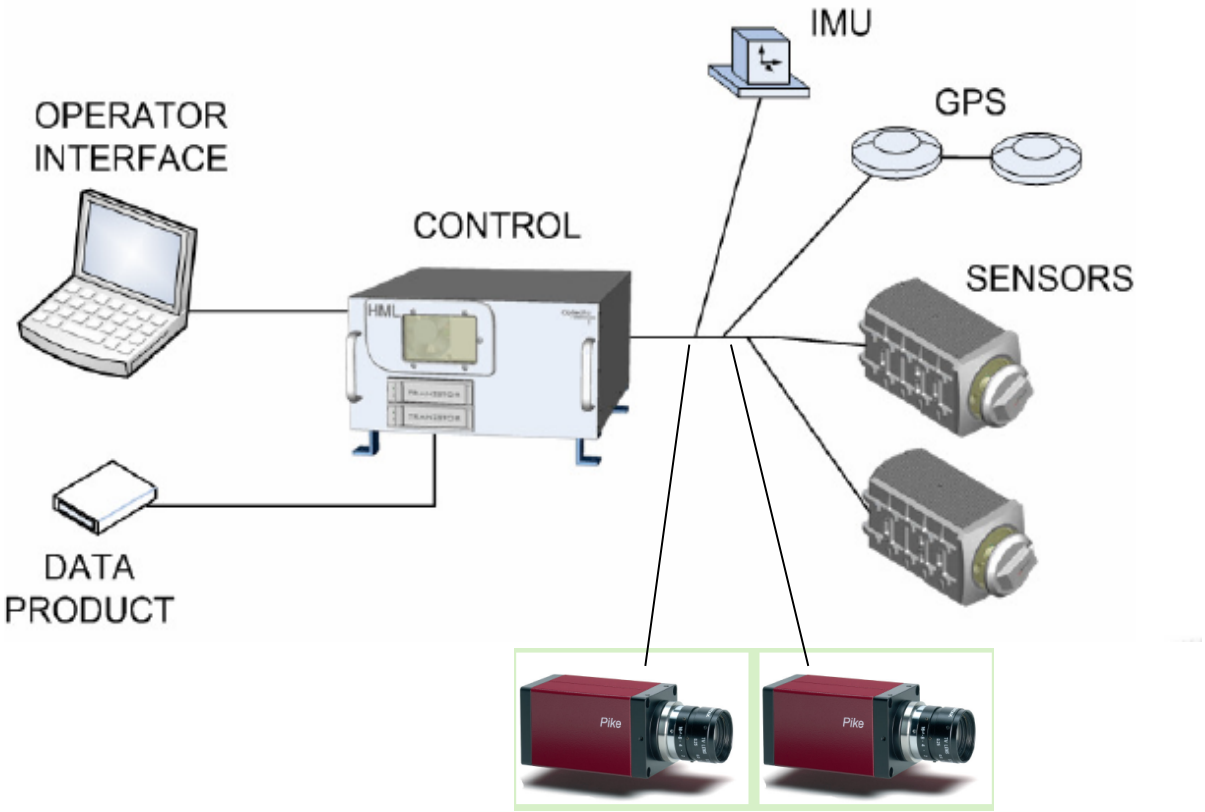
- Several scanners covering whole driving path and surrounding areas
- Integrated GPS/ IMU positioning
- Operation speed 60 –80 km/hour
- Point density, coverage and accuracy depends on driving speed and distance to the objects.

Mobile laser scanning

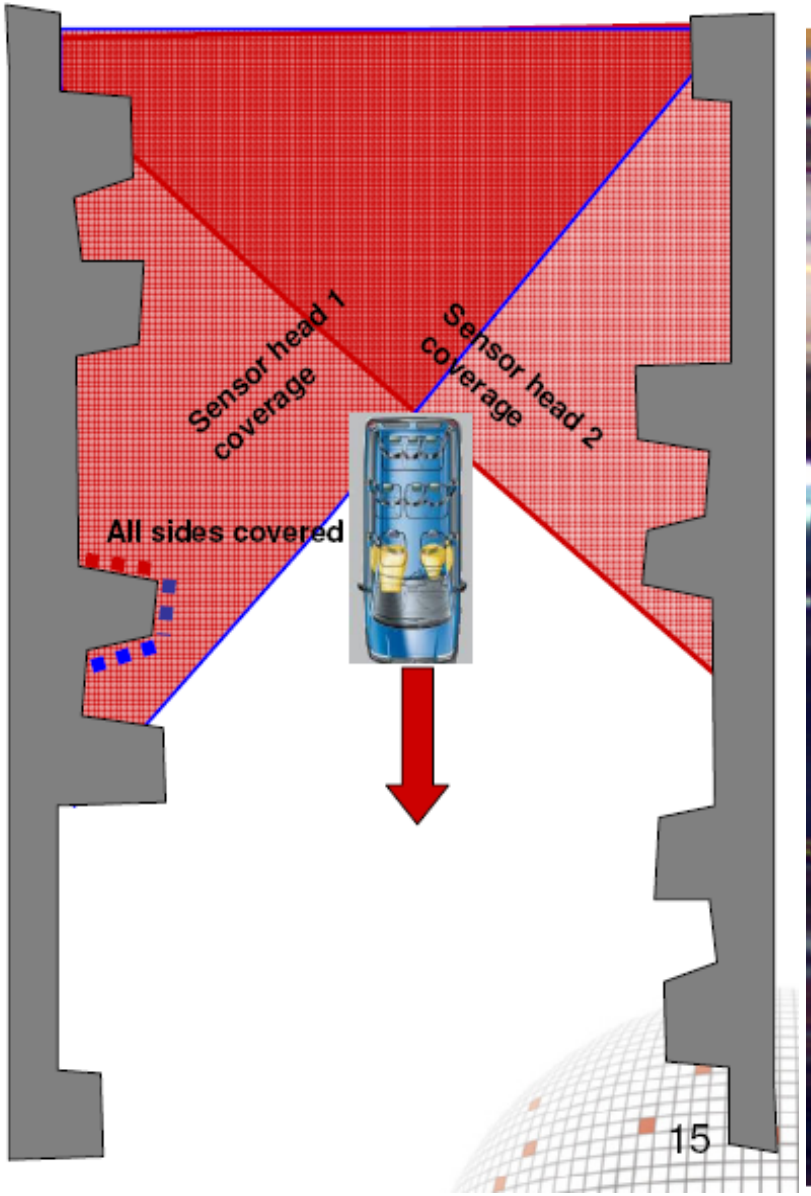
- 3D Laser Mapping – StreetMapper
- Optech – Lynx
- Riegl
- Topcon
- Mitshubishi

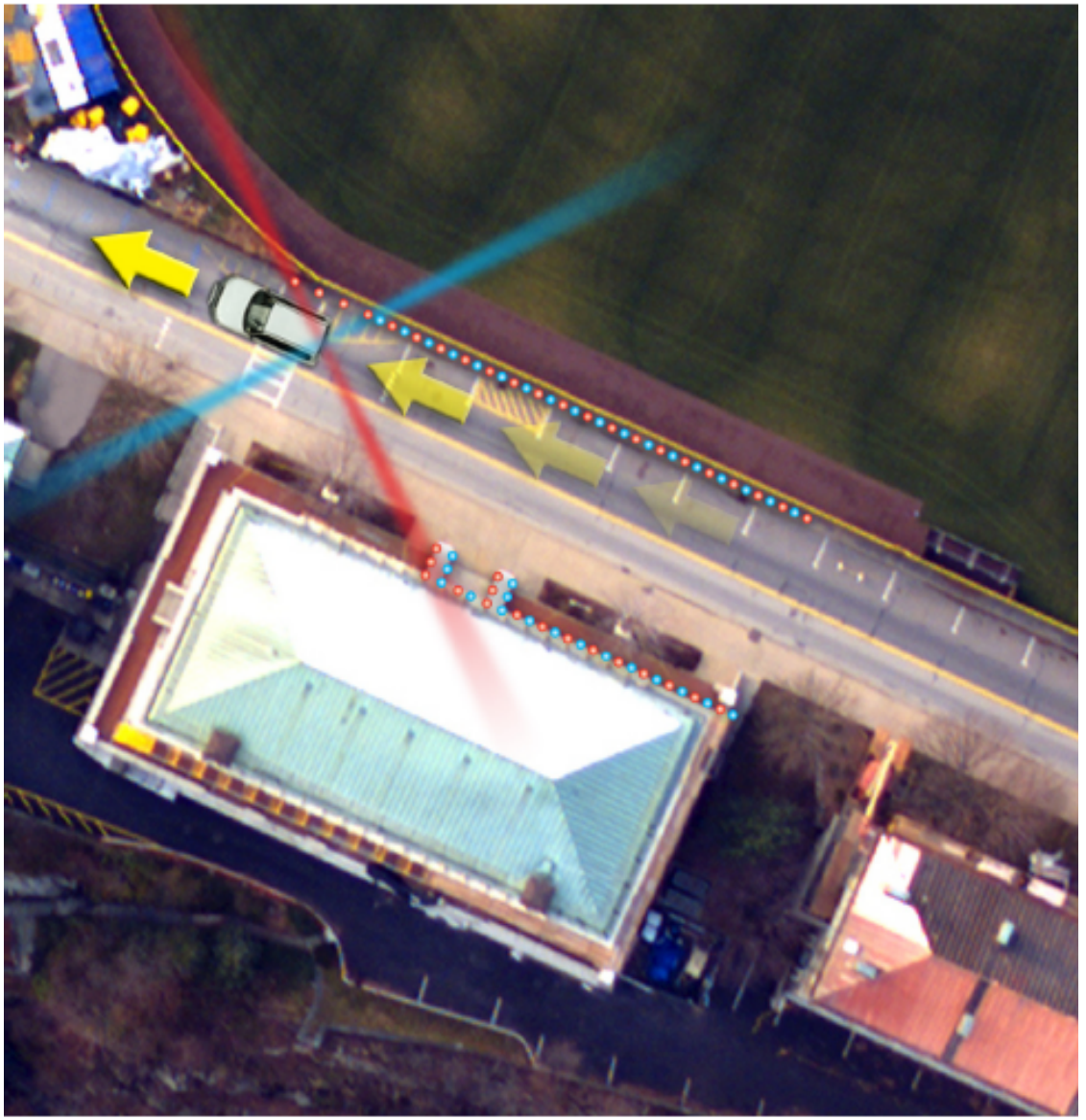
Terrasolid

Equipment


IMU
GPS
OPERATOR
INTERFACE
CONTROL
SENSORS
HMI
DATA
PRODUCT
Pike
Pike


RS100
RS100
IGI


Sensor head 1 coverage
Sensor head 2 coverage
All sides covered
15



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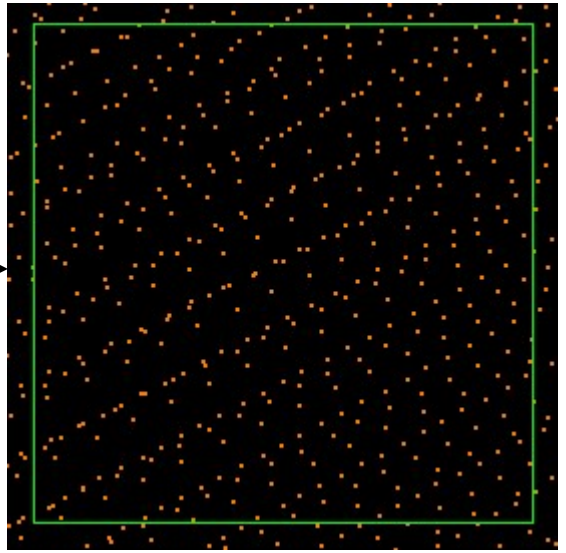
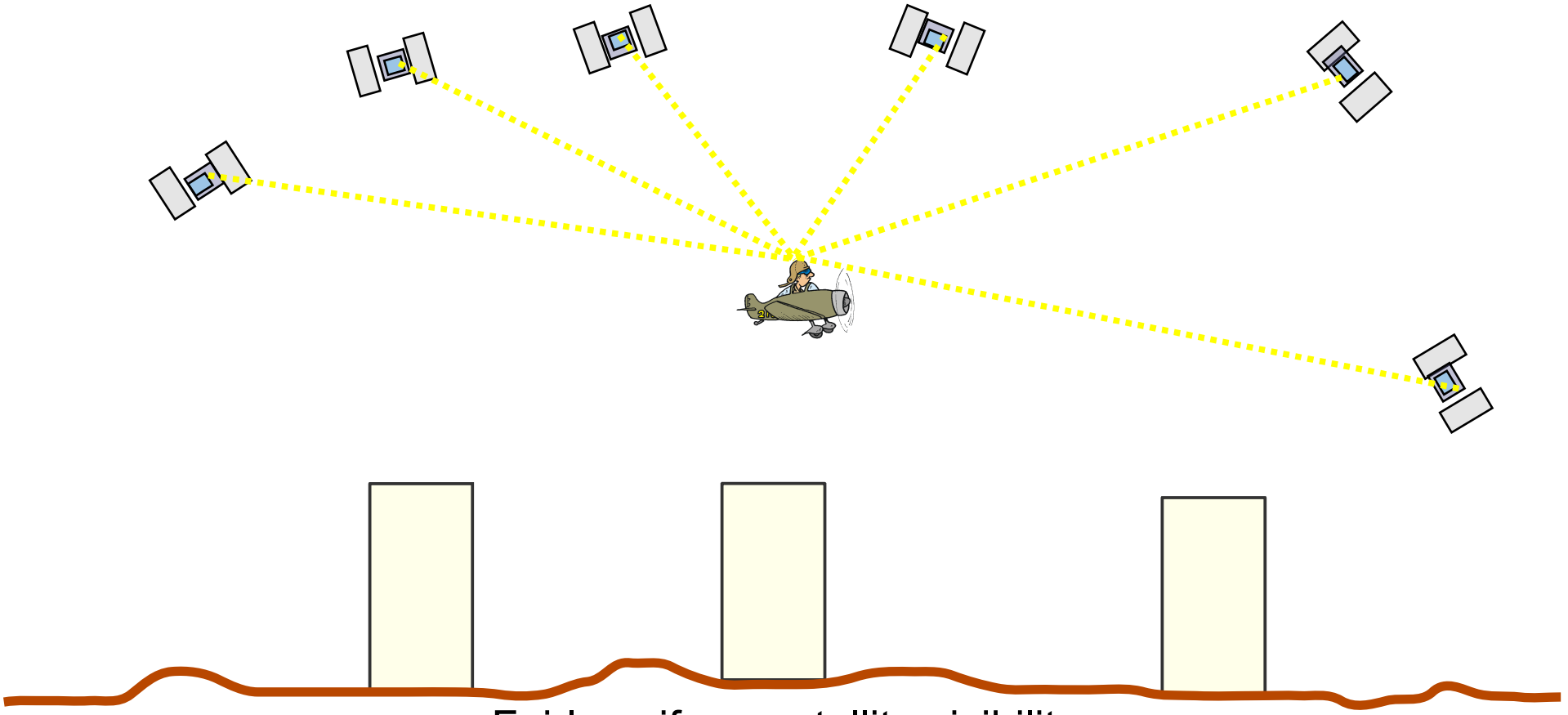
Vehicle speed and point density

StreetMapper

- 25 km/h 1440 points/m²
- 40 km/h 900 points/m²
- 60 km/h 600 points/m²
- 80 km/h 450 points/m²
- 100 km/h 360 points/m²



Airborne Positioning

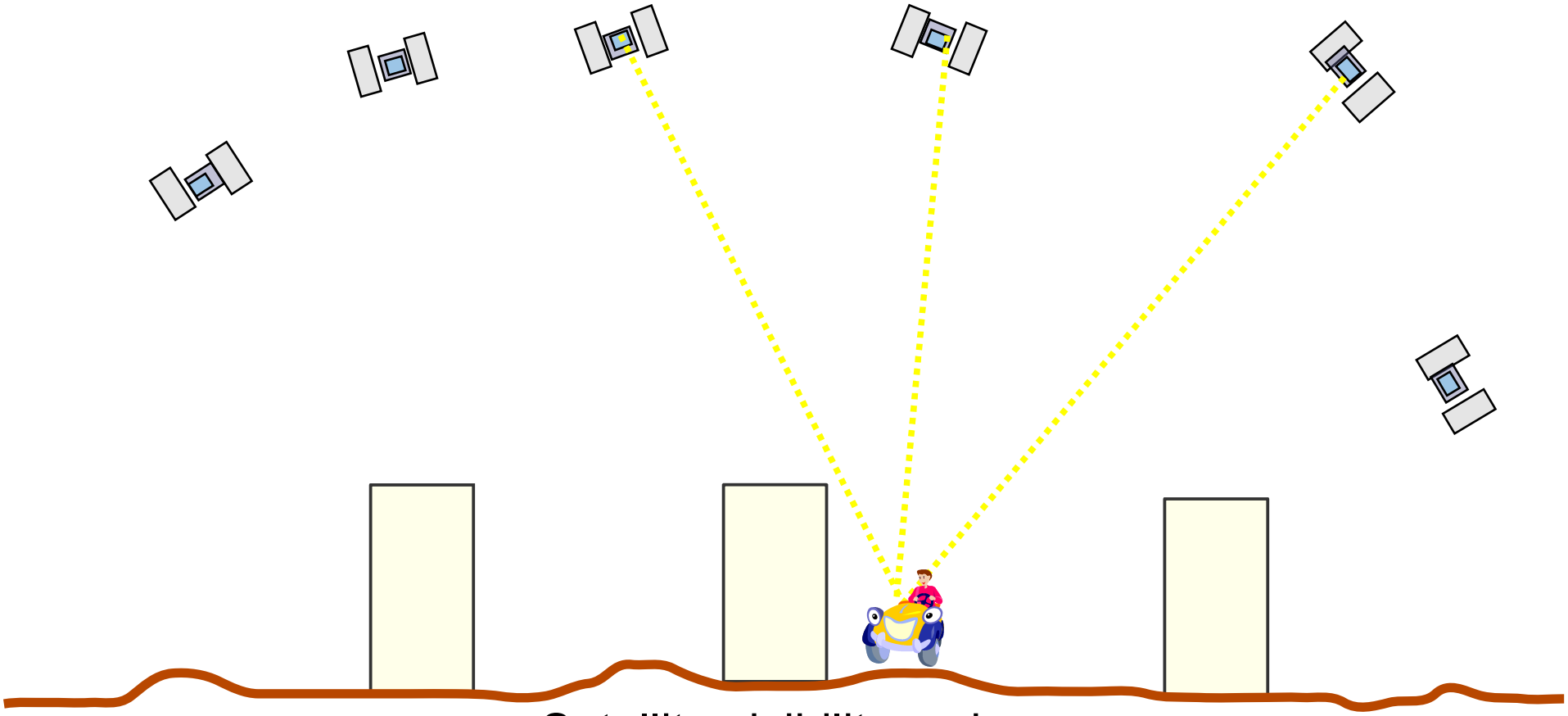


Fairly uniform satellite visibility

Fairly uniform positional accuracy

Terrasolid

Mobile Positioning



Satellite visibility varies

Positional accuracy varies

Terrasolid

Sources of Positional Inaccuracy

- System calibration
  - Scanner – IMU misalignment angles
  - Other parameters
- Range measurement (point-to-point noise)
- Trajectory solution xyz (GPS)
- Trajectory solution hrp (IMU)

Same sources as with airborne data sets

Terrasolid

Magnitude of Error Sources

- System calibration
  - Relatively small in project data sets if system has been carefully calibrated
- Range measurement
  - Small – 1 cm level
- Trajectory xyz
  - ? ? ? ?
- Trajectory hrp
  - ? ? ? ?

Mobile Scanner Calibration

- Task: Solve misalignment angles heading, roll and pitch for each scanner in the system

- Misalignment issues are visible in the point cloud as differences between:
  - Points from different drive passes
  - Points from different scanners

- Known points are not really needed for misalignment

Distance

- Misalignment visible only at a distance from the scanner

0.01 Degree Angle

Distance	Effect
5 m	0.09 cm
10 m	0.17 cm
20 m	0.35 cm
50 m	0.87 cm
100 m	1.75 cm

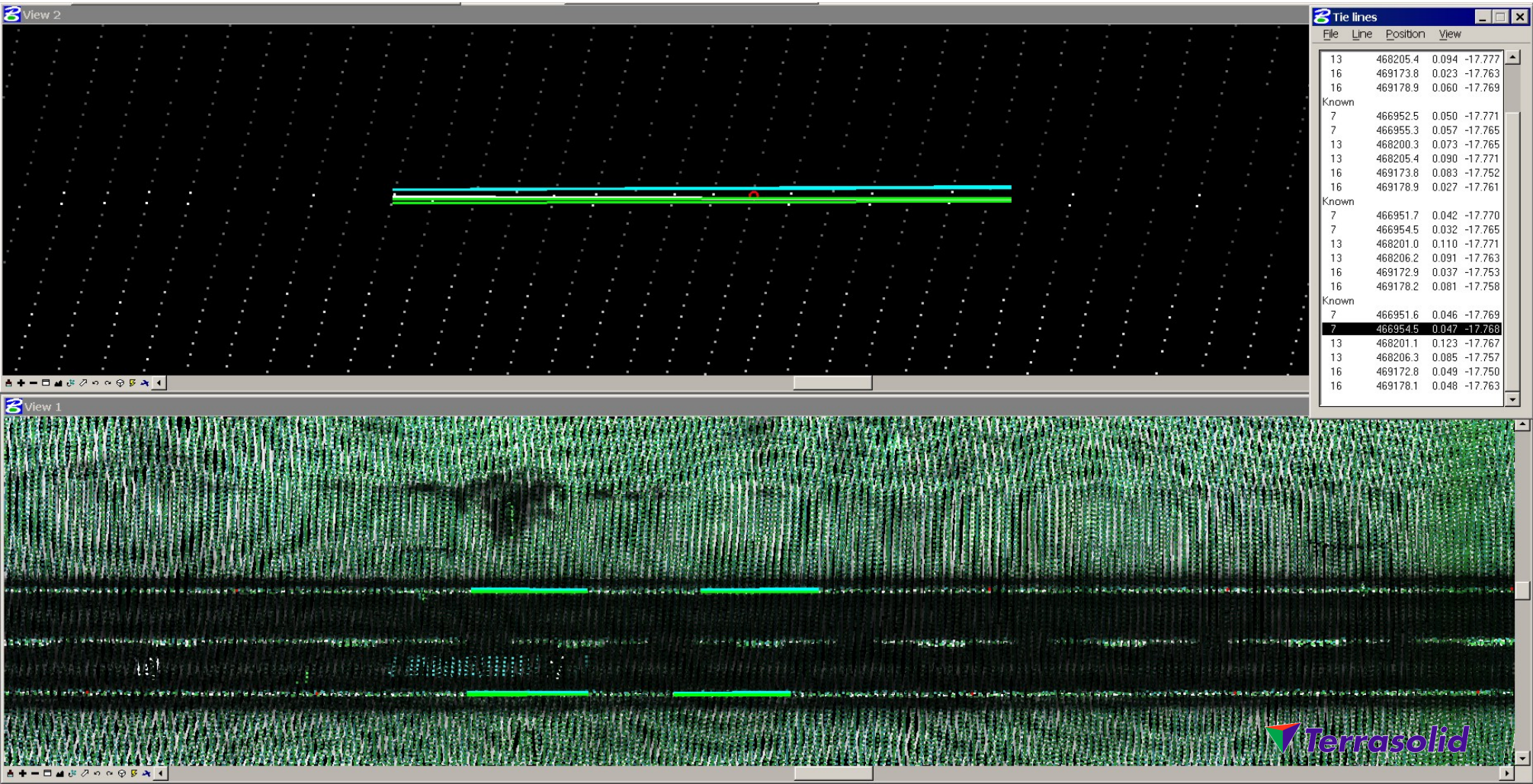
0.10 Degree Angle

Distance	Effect
5 m	0.87 cm
10 m	1.75 cm
20 m	3.49 cm
50 m	8.73 cm
100 m	17.45 cm

- Close by objects:
  - High point density, we can identify location accurately
  - Misalignment has practically no effect
  - Trajectory xyz inaccuracies dominate
- Far away objects:
  - Low point density, can identify location accurately only if a long linear feature or large planar feature

Tie lines

- Matching based on intensity or xyz features in LIDAR
- Matching based on linear features in images



Tie line types

- **Ground point** – point feature on ground, seen by multiple passes
- **Xy point** – xy point feature, multiple lines
- **Known point** – known xyz point on ground

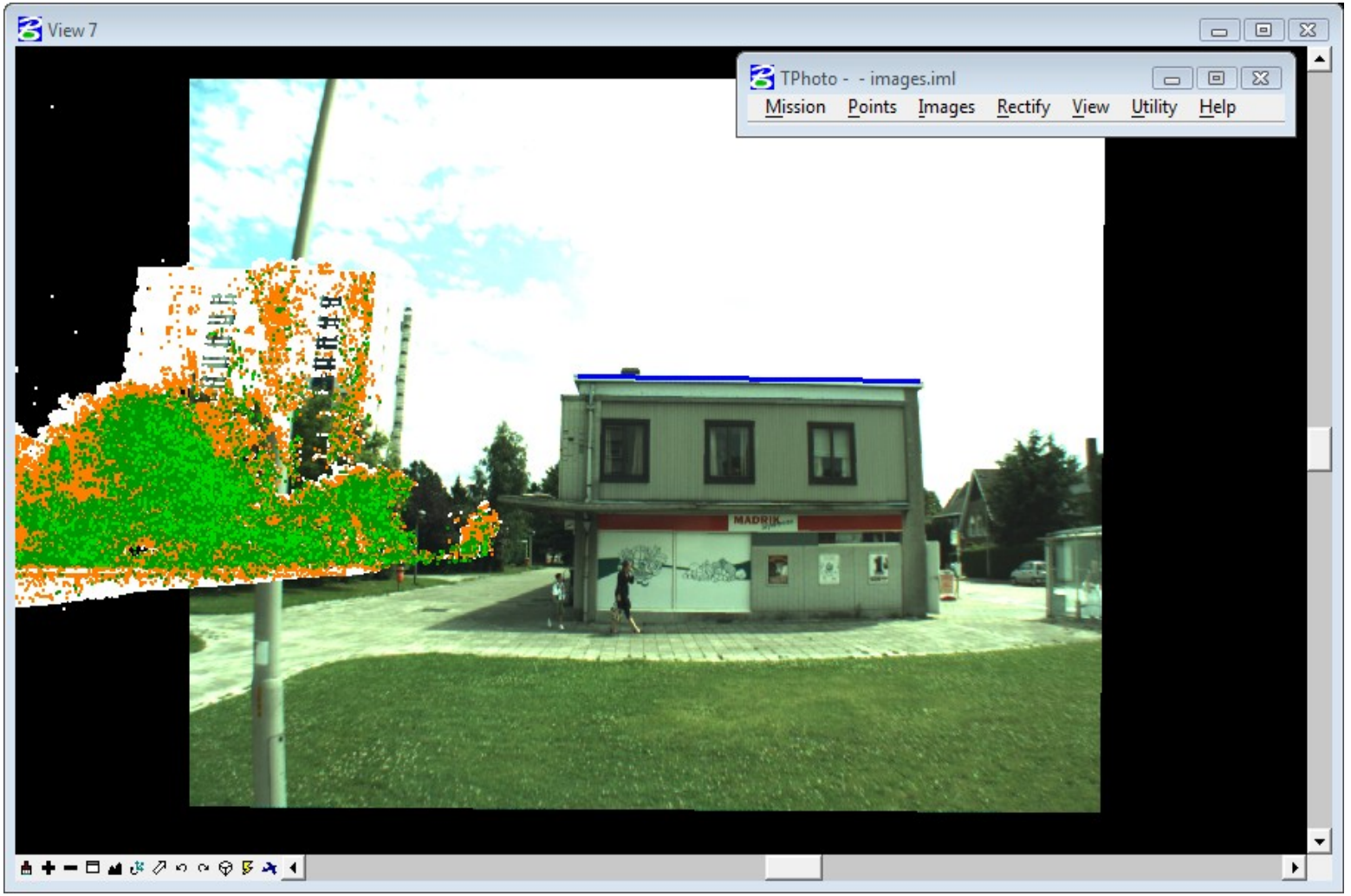
- **Ground line** – linear feature on ground, multiple lines
- **Section line** – xyz line on terrain slope, roof or wall, multiple lines
- **Known line** – known xyz point on ground, one or multiple lines, line runs thru known point

Terrasolid

Mobile data and camera calibration

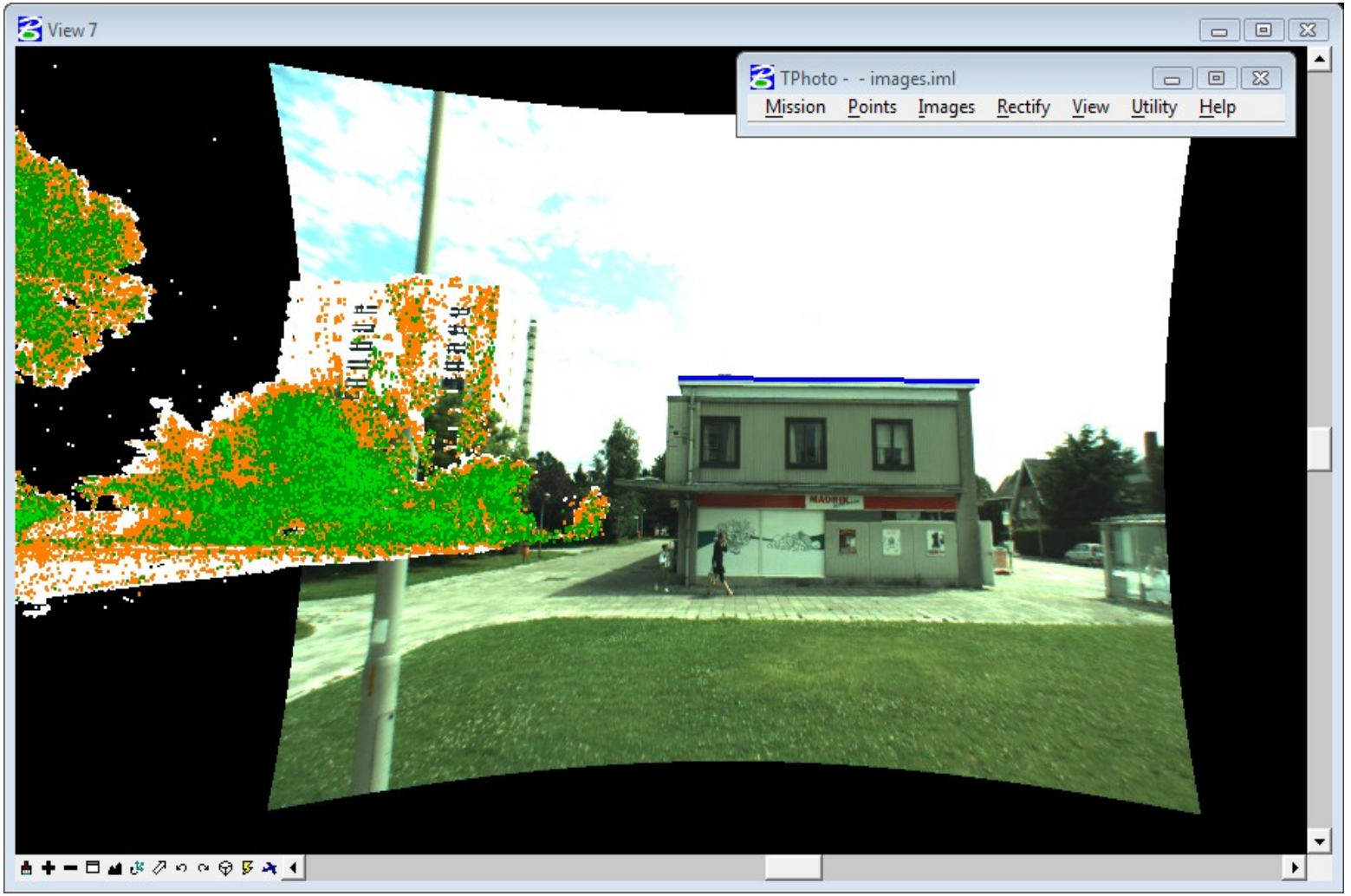
Terrasolid

Mobile data and camera calibration



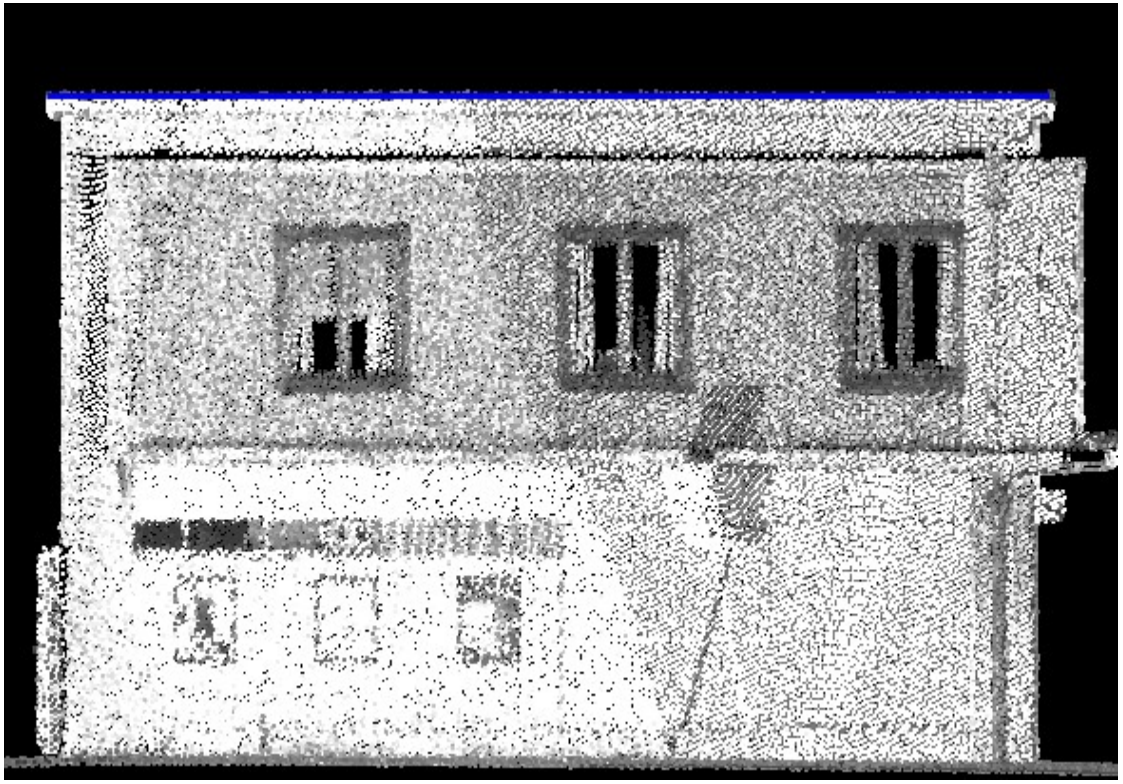
Terrasolid

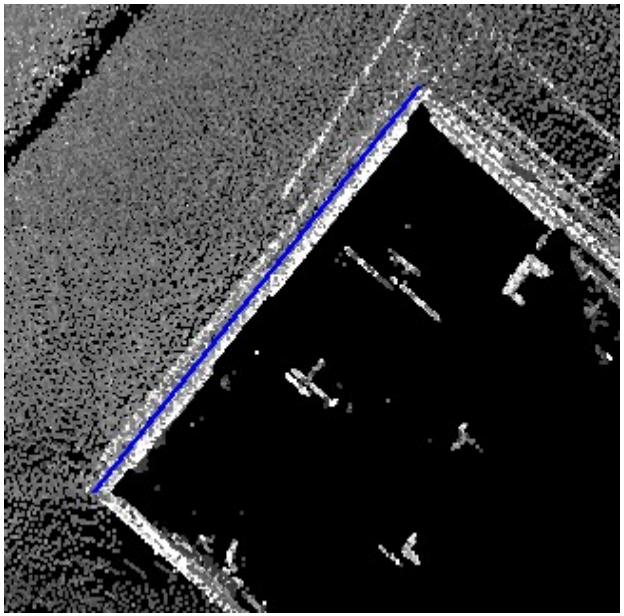
Mobile data and camera calibration

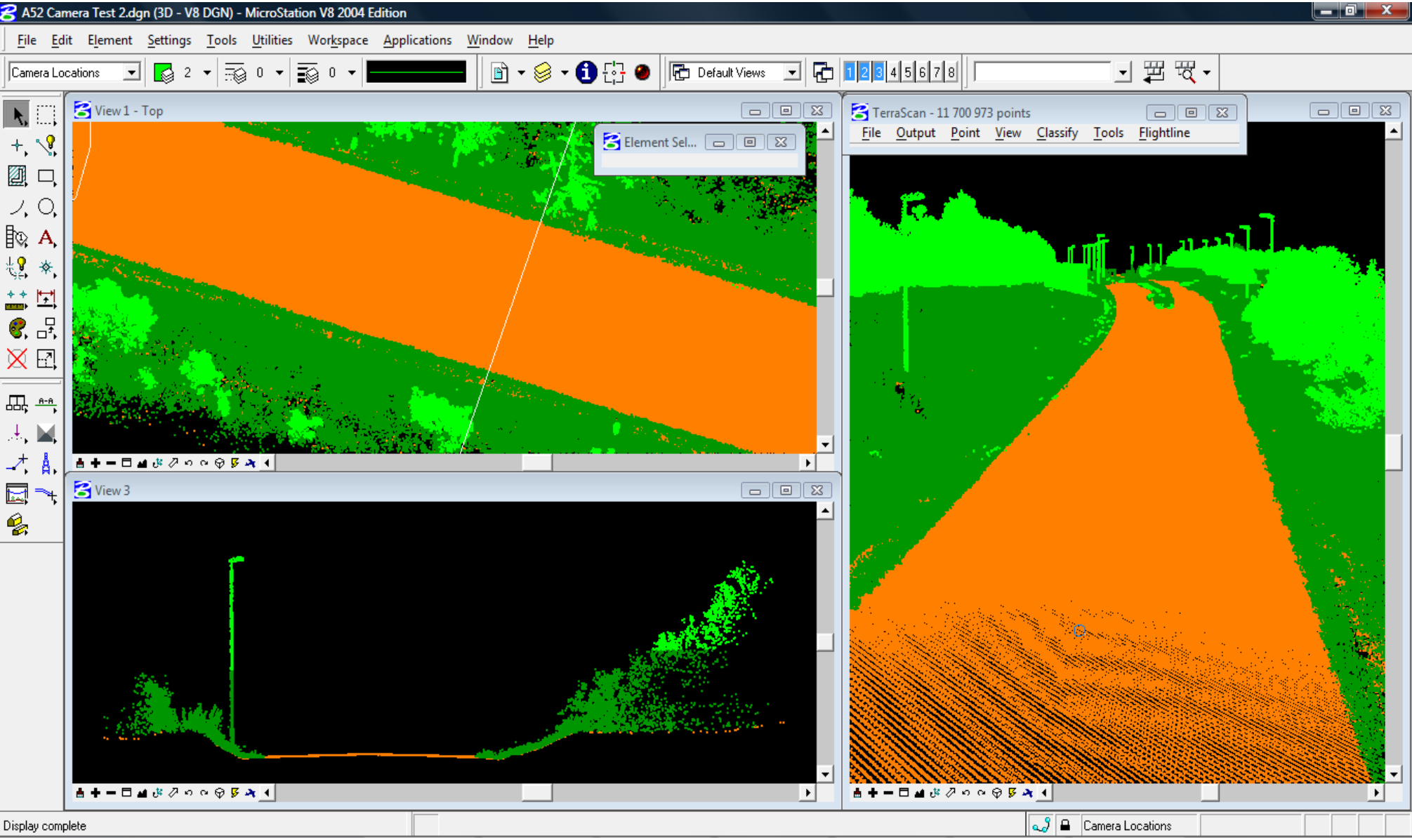


Terrasolid

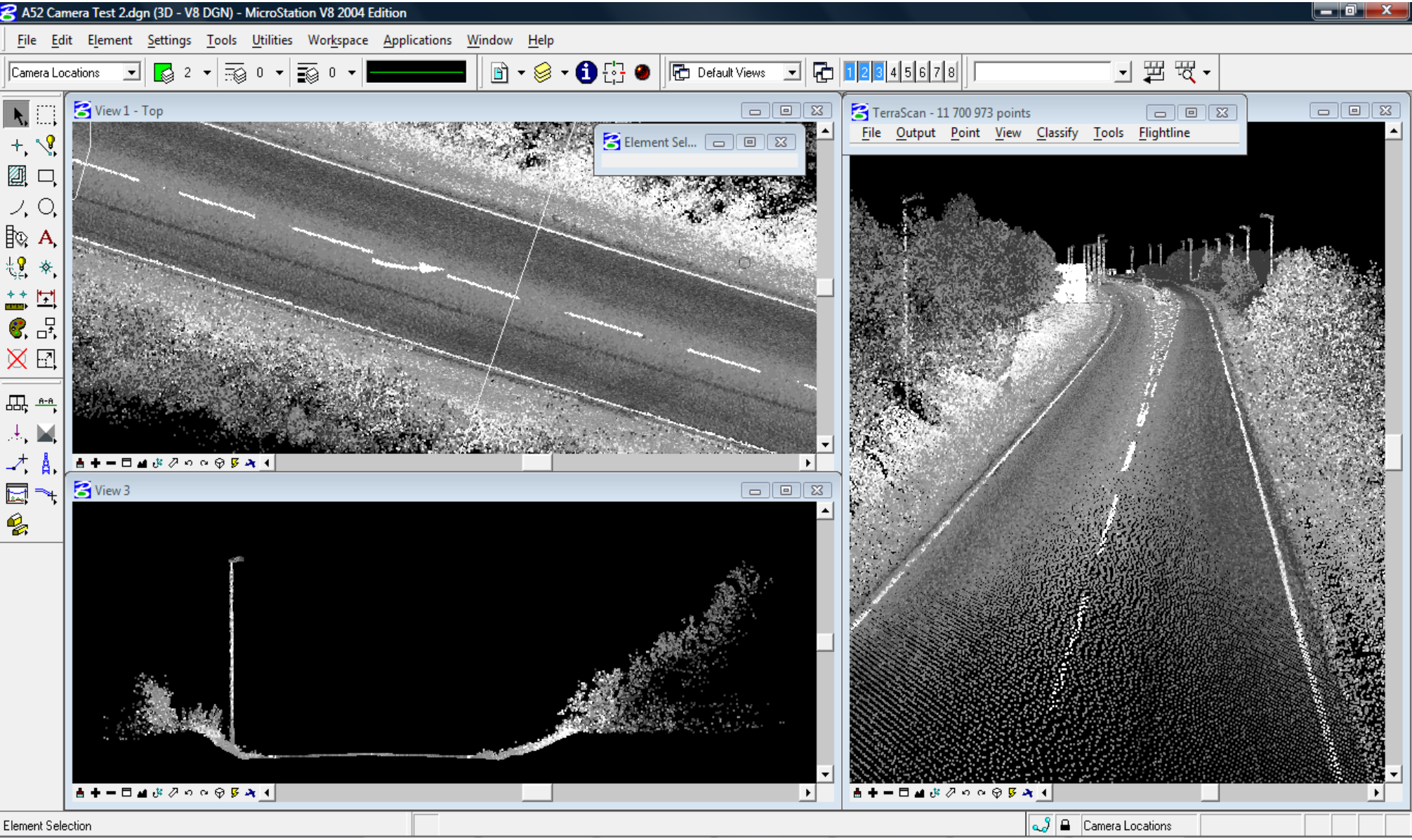
Mobile data and camera calibration



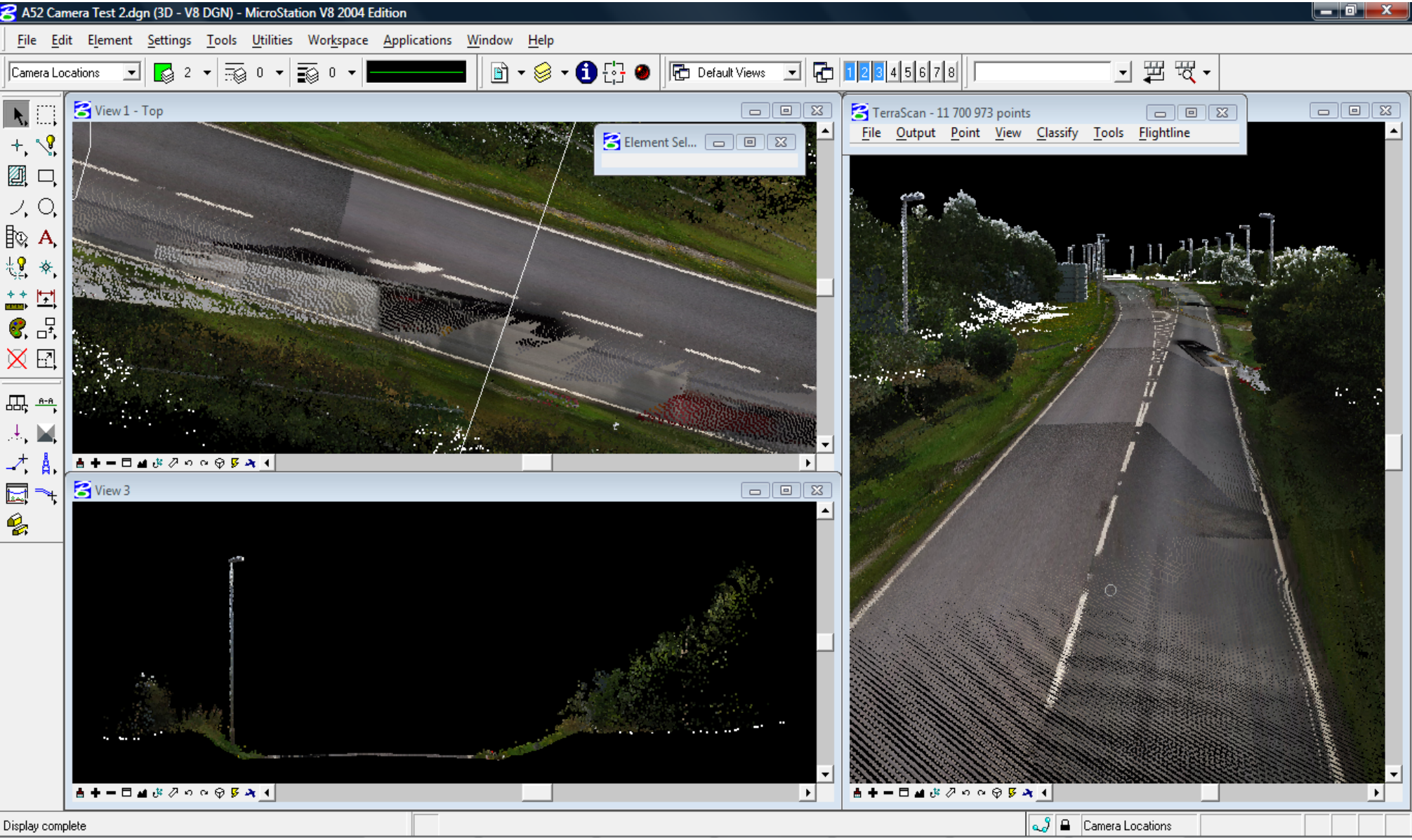



A52 Camera Test 2.dgn (3D - V8 DGN) - MicroStation V8 2004 Edition
File Edit Element Settings Tools Utilities Workspace Applications Window Help
Camera Locations
Default Views
View 1 - Top
Element Sel...
View 3
TerraScan - 11 700 973 points
File Output Point View Classify Tools Flightline
Display complete
Camera Locations

Terrasolid


A52 Camera Test 2.dgn (3D - V8 DGN) - MicroStation V8 2004 Edition
File Edit Element Settings Tools Utilities Workspace Applications Window Help
Camera Locations
Default Views
View 1 - Top
Element Sel...
View 3
TerraScan - 11 700 973 points
File Output Point View Classify Tools Flightline
Element Selection
Camera Locations

Terrasolid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Element Sel...
View 3
TerraScan - 11 700 973 points
File Output Point View Classify Tools Flightline
Display complete
Camera Locations

Terrasolid

Terrametrix™
terrestrial lider in motion
www.terrametrix3d.com

StreetMapper Passes the Test

The world's most accurate mobile mapping system StreetMapper, has achieved accuracies of less than 1cm on a test area specifically designed to evaluate mobile laser scanning systems. Operated by Terrametix, LLC and designed by UK based 3D Laser Mapping the StreetMapper system was put through its paces on a stretch of highway in San Diego. The route was chosen by the Californian Department of Transportation (Caltrans) to help companies advance mobile laser scanning technology through independent evaluation against known control points.

"For years we have been anticipating this technology in hopes that it could collect high accuracy pavement data, allowing us to remove one of the riskiest tasks from our work," commented Dave Olander, Field Survey Officer for Caltrans. "The test area was designed for anyone working on mobile laser scanning to have an area to evaluate their systems and supports other projects we are working on to advance developments in mobile laser scanning technology."

The Caltrans test area covers a half-mile stretch of High Occupancy Vehicle (HOV) lane highway in San Diego. The route was originally selected as it was accessible to field crews to establish the control points and offered a variety of traffic conditions to 'test' the mobile mapping systems performance in real world conditions. The route also had changes in elevation and obstructions (signs and overpass) to further challenge the systems. A two-lane section of the highway was measured by Caltrans using calibrated, high accuracy surveying equipment and techniques in order to establish the 1,500 plus control points.

Using StreetMapper Terrametrix surveyed the test area in just 45 minutes and raw processed data was delivered to Caltrans and University College Davis for inclusion in a mobile terrestrial LiDAR study. Initial reports are very positive showing a RMS error report as follows: Number of Control Points 1567, Average dz -0.003, Minimum dz -0.052, Maximum dz +0.061, Average magnitude 0.018, Root mean square 0.022, Standard deviation 0.022.

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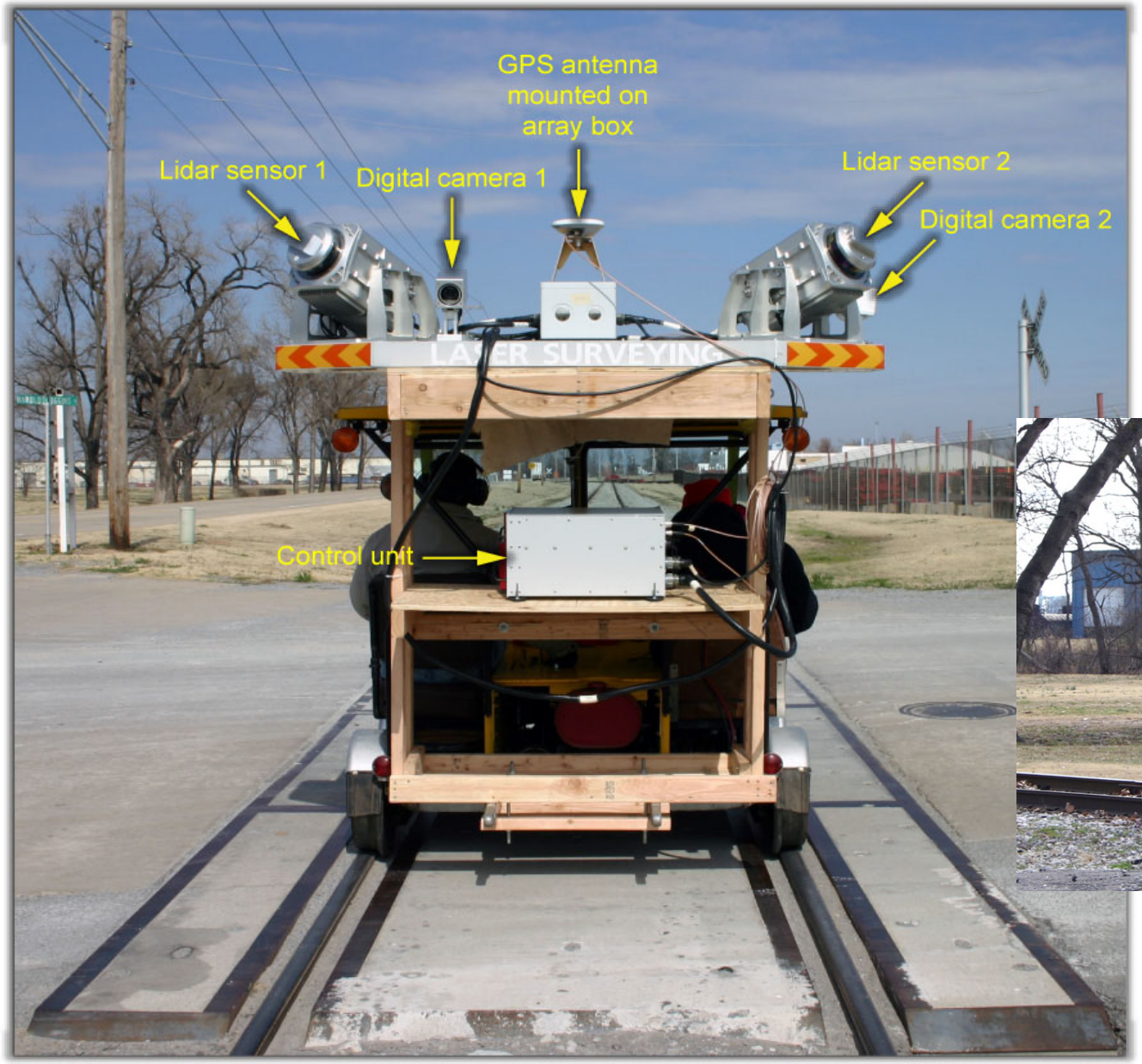
Rail based laser scanning


GPS antenna
mounted on
array box
Lidar sensor 1
Digital camera 1
Lidar sensor 2
Digital camera 2
Control unit

Terrasolid

Terrasolid

Other application areas

- Digital terrain model production
- Road and rail measurements
- Water and wastewater design and analysis
- Flood protection analysis
- Automatic contour production
- Forest inventory
- Noise protection modeling
- …

Summary

- Both airborne and vehicle based laser scanning are precise, efficient and safe data collection methods
- With Terrasolid applications you can calibrate and classify the point clouds to reach the maximum accuracy and produce different delivery products
- You can also use point clouds directly with design applications

Latest news...

In The Scan

Bentley Licenses Pointools' Vortex API

Posted: 14 Oct 2009 04:53 AM PDT

1. Finally a BIG story to report on.
2. This is a tremendous boost to the Pointools technology and business.
3. In the end this will be all about integration – how much and how fast.

Finally, some really big news to report. Things have been quiet from the major vendors for some time, but this announcement has the potential to have a significant impact on on the 3D infrastructure marketplace. Interesting – a quick check of both companies' websites did not find a mention of the announcement.

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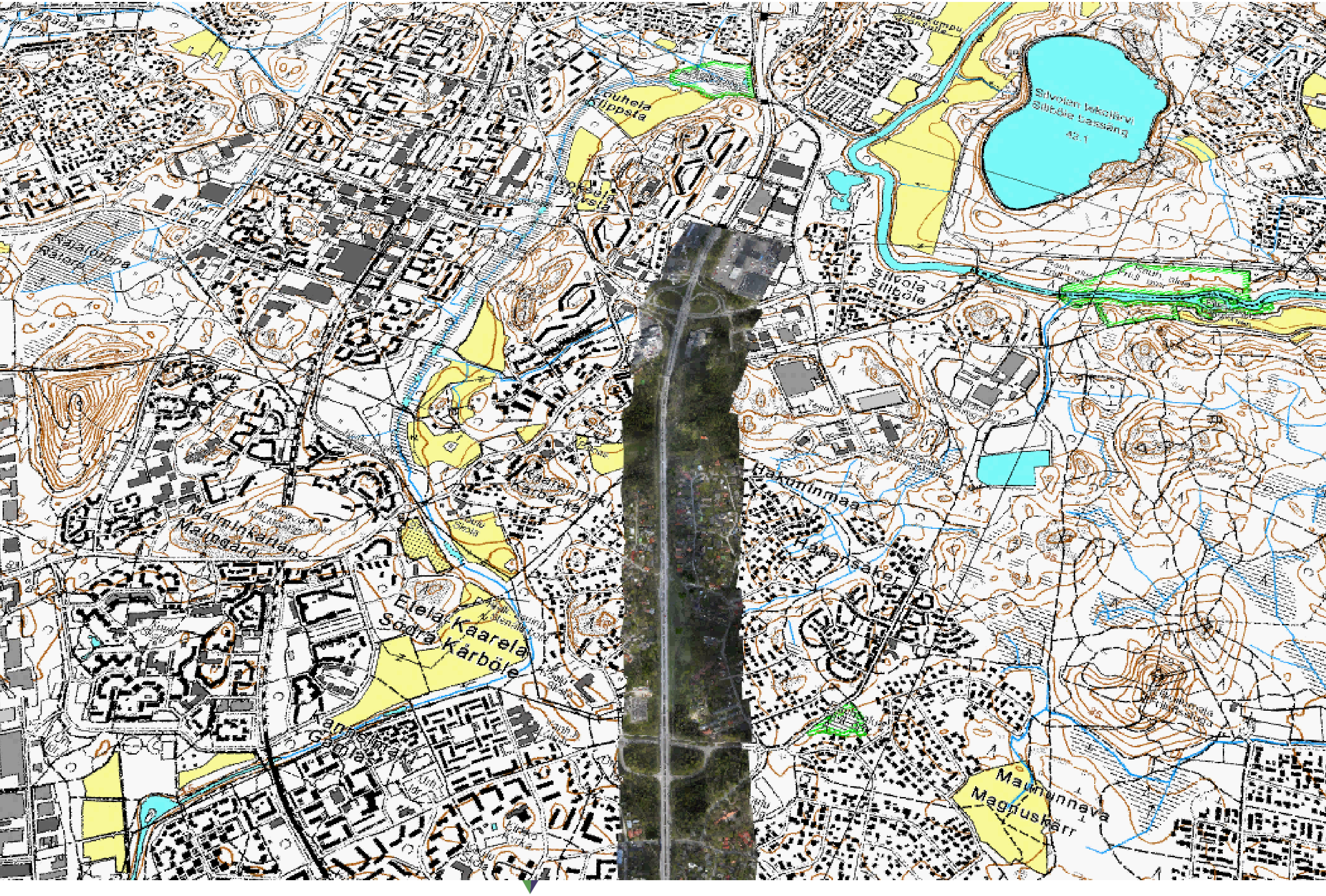
In The Scan

Autodesk Announces Support for Point Clouds

Posted: 22 Oct 2009 05:22 PM PDT

1. Autodesk just announced the release of their point cloud feature.
2. It will only be available to Map 3D and Civil 3D customers via the subscription center.
3. Now that Autodesk is in the game it will be interesting to track how this progresses.

For the second week in a row there is BIG news from a CAD vendor. On Wednesday Autodesk announced the long expected release of their support for point clouds. Initially the point cloud feature is being offered to Map 3D and Civil 3D subscription customers only as a free download from the online subscription center. This is the first support for point clouds inside AutoCAD.
...


Silvola
Sillböle
Hakuninmaa
Hakansåker
Malminkartano
Malmgård
Södra Kårböle
Maununneva
Magnuskärr

Thank you