Latest News *March 2009*

RIEGL
LASER MEASUREMENT SYSTEMS

NEW

RIEGL VZ-400 Laser Scanners

The following document details some of the excellent results acquired with the new *RIEGL* VZ-400 scanners, including:

- **The calibrated amplitude (intensity) reading**
- **The unique 'calibrated relative reflectance' capability**
- **Time-optimised fine-scans**
- **The superior ranging precision**
- **Details on the multiple target capability**

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Calibrated Amplitude Reading

Up to now, 3D laser sensors have provided amplitude readings for every measurement result, as a number without specifying the physical meaning. The new V-Line instruments provide an amplitude reading for every target echo, which is defined as the ratio of the actual detected optical amplitude of the echo pulse versus detection threshold. The ratio is stated in dB (decibels).

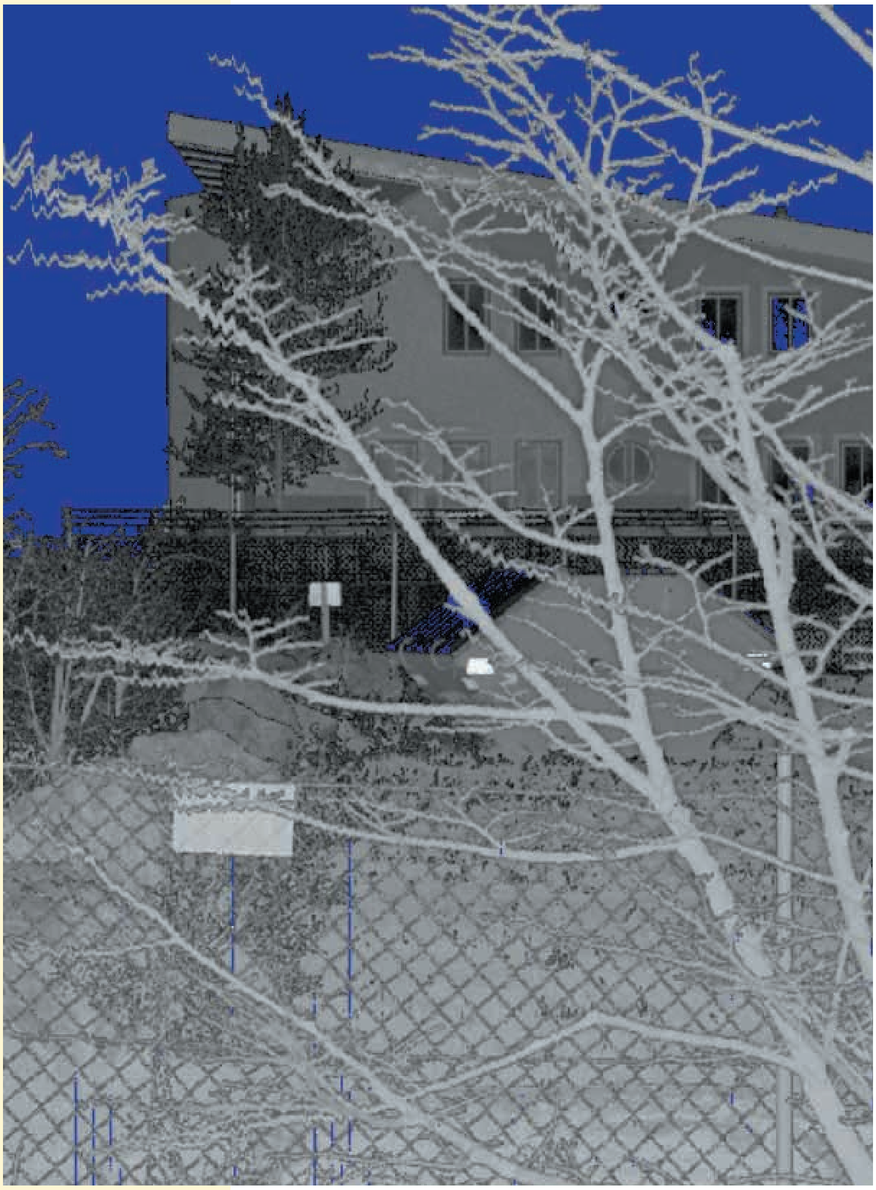

Fig. 1

Grey scale encoding of point cloud according to calibrated amplitude. Range of encoding 0dB to 50dB above detection threshold.

Note that brightness decreases from near objects to far objects.

Calibrated Relative Reflectance Reading

Although amplitude, defined as 'dB above threshold', already provides useful data on detection characteristics, there is a strong dependence on amplitude with range. For example a white diffuse target at a range of 50m will provide an optical amplitude reading 4 times higher than the same target at 100m (4 times corresponds to 6dB, thus the calibrated amplitude reading of the *RIEGL* V-Line instrument will be 6dB higher at 50m compared to 100m).

The V-Line range of laser scanners has introduced some measure of the laser radar cross-section by providing a so-called reflectivity value for each target echo. The reflectivity value gives the ratio of the actual optical amplitude versus the optical amplitude of a diffuse white target at the same range (further assumptions are that the white target is larger than the laser footprint, 100% reflecting, flat, and its surface normal points towards the laser scanner). The value is again given in dB, with 0dB now corresponding to a white diffuse target.

This reflectivity value allows for easy estimation of the target's reflectivity. E.g., -3dB means a factor of 0.5 or 50% diffuse reflectivity, -10dB 10% reflectivity, -20dB 1% reflectivity. Reflectivity values above 0dB indicate that the target gives an optical echo amplitude larger than those of a diffuse white target, i.e., the target is (partially) retro-reflecting.

In a visual representation, where each point of a point cloud has assigned a brightness according to the reflectivity, objects with the same reflectivity have the same brightness regardless of the distance to the scanner. This gives a natural impression and a good potential for object recognition. By setting a threshold, e.g., +6dB, every retro reflecting target can be easily discriminated.

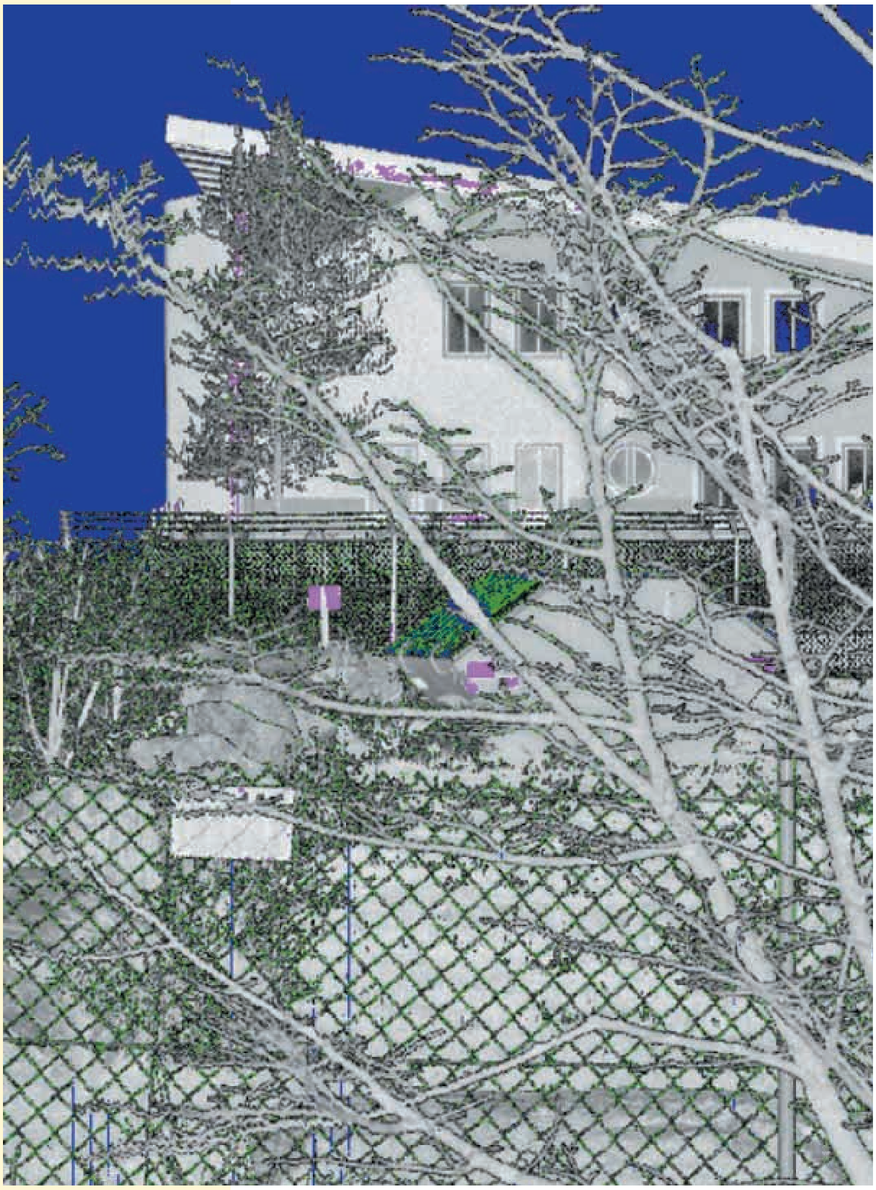

Fig. 2

Grey scale encoding of point cloud according to reflectivity of target. Range of encoding is -20dB to 3dB with respect to a white diffuse target.

Note that brightness is nearly independent from distance. Pink indicates a reflectivity above 3dB, green below -20dB.

Time-Optimised Fine-Scanning of Retro-Reflectors

The *RIEGL* VZ-400 introduces an additional measurement program especially designed for fine scanning of retro reflectors. In addition to the measurement programs 'long range capability', with 100kHz pulse repetition rate and 'high speed capability' up to 300kHz, the program 'reflector scan', with 300kHz pulse repetition rate and low laser output, enables fast, eye-safe scanning of retro reflectors for registration purposes.

The *RIEGL* VZ-400 automatically selects the best suited measurement program for performing a reflector scan. Usually, this will be the 'reflector scan' program for targets made from reflecting foil in the range up to 150m to minimize acquisition time. For reflectors at long ranges, e.g., 500m, it will select program 'high speed' to acquire the best data.

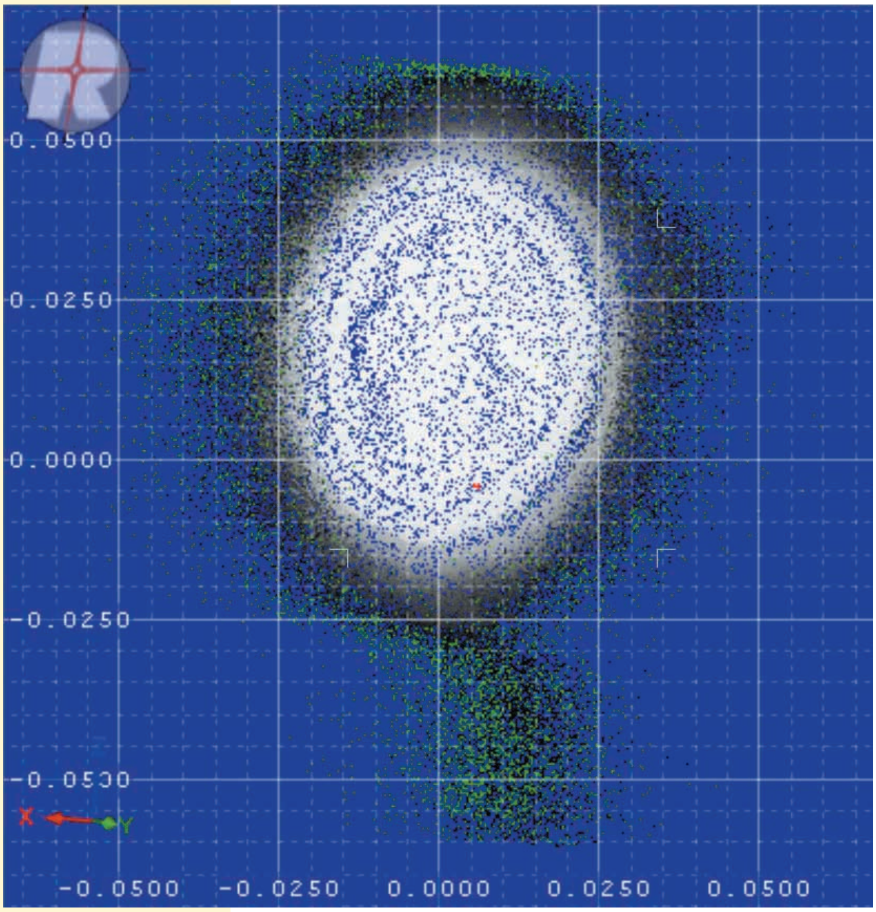

Fig. 3

High resolution scan of circular reflecting foil (50mm diameter) at a range 43m.

Grey scale encoding according to reflectivity from 0dB to 35dB.

Ranging Precision

The *RIEGL* VZ-400 shows a very high precision, i.e., a very low range noise. For example, with a white flat facade at 80m less than 2mm ranging precision (1-sigma value) are usually achieved. Exceptionally good results are observed even in critical measurement situations.

For example see point cloud of column behind fence *(see Fig. 5)*.

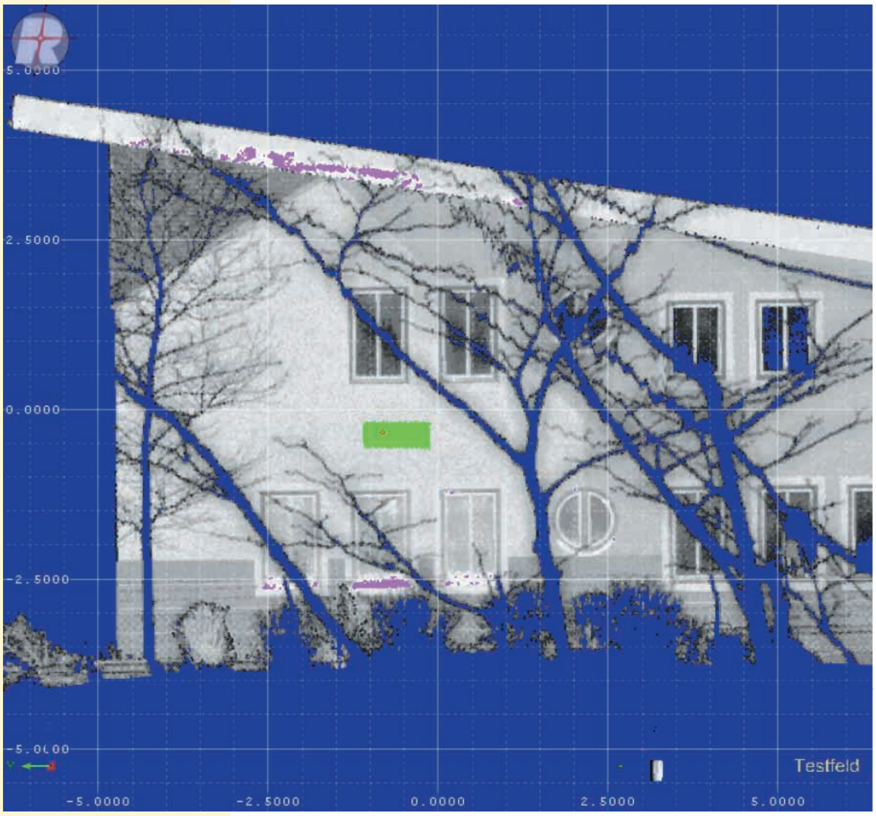

Fig. 4

Facade of building. Green area indicates selection of 3,000 points. Plane fitting and estimating precision gives a standard deviation of 1.8mm for that area.

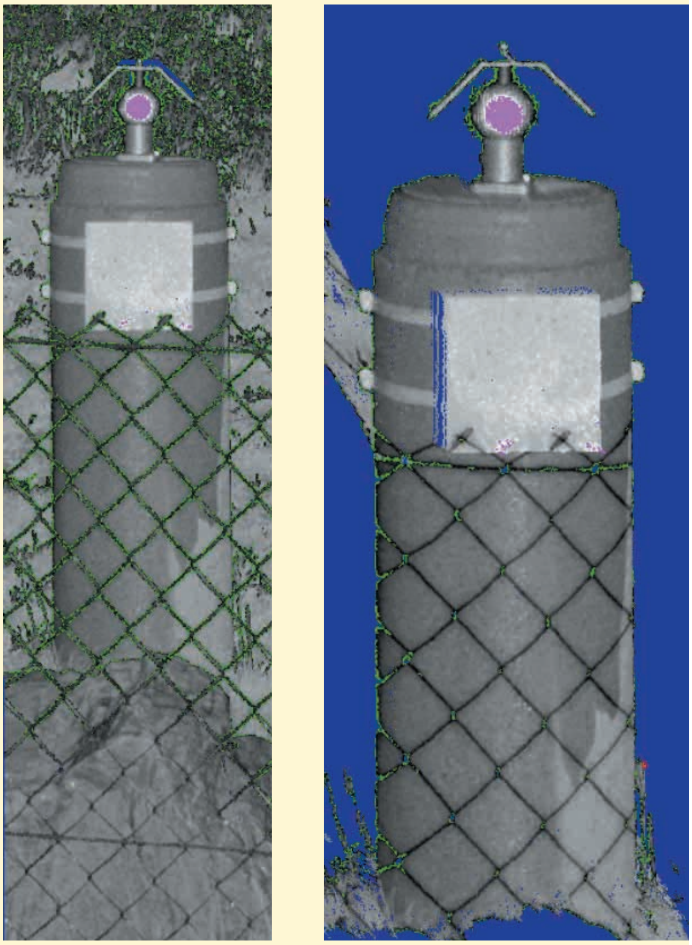

Fig. 5

Scene with retro reflector (top) and white plate (below) mounted on a concrete column at a range of 16m, behind a fence at a range of 9m.

Scan data acquired 1 hour after start of raining: Wet column on left side (dark) and dry on lower right side. Due to water droplets on the plate, some parts of the plate show up as retro-reflecting. Grey scale according to reflectivity in the range of -20dB to 10dB.

Right: virtual view from scanner position.

Left: virtual view from near the column.

Shadow of the mesh shows up as texture with lower effective reflectivity. However, no gaps in the dense point cloud are observed.

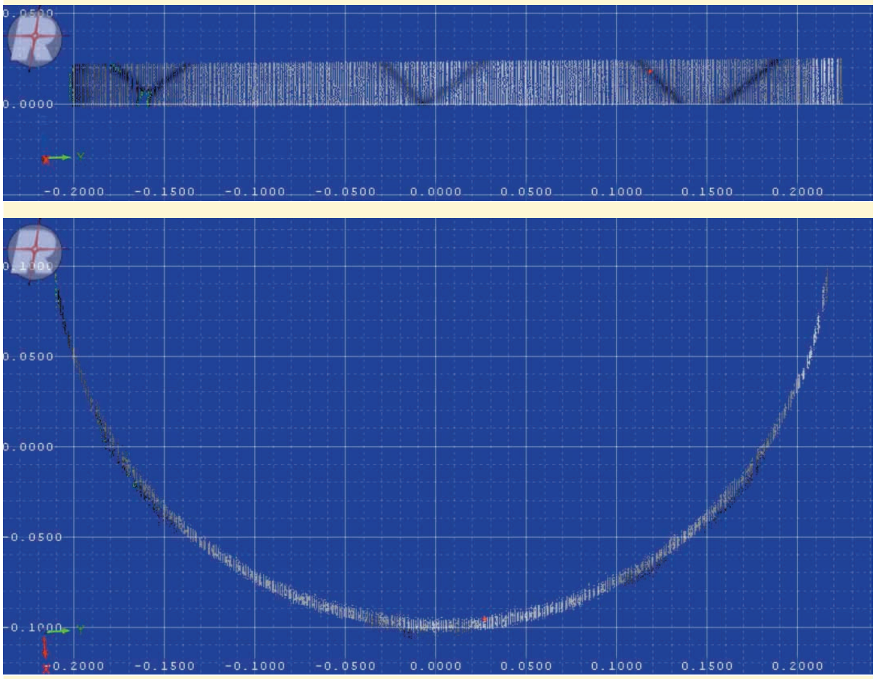

Fig. 6

Cross-section through point cloud.

Top: front view. Bottom: top view.

Superior low range noise even at the edges of column and in regions where the beam has been partly obscured by the mesh of the fence.

Multiple-Target Capability

The *RIEGL* VZ-400 provides a practically unlimited number of targets per pulse. The minimum distance between targets is about 0.8m. See, right, the example of a tree. For shorter distances between targets within the same laser shot, the V-Line instrument cannot discriminate between the echo pulse. However, it still provides valuable information about the pulse shape of the return pulse. In a situation near this multiple-target discrimination limit, this pulse shape figure clearly provides information whether the return echo originates from a single target or from a two nearby targets. A simple thresholding with respect to the pulse shape information can remove most of 'invalid' points and keep only the reliable 'real' targets.

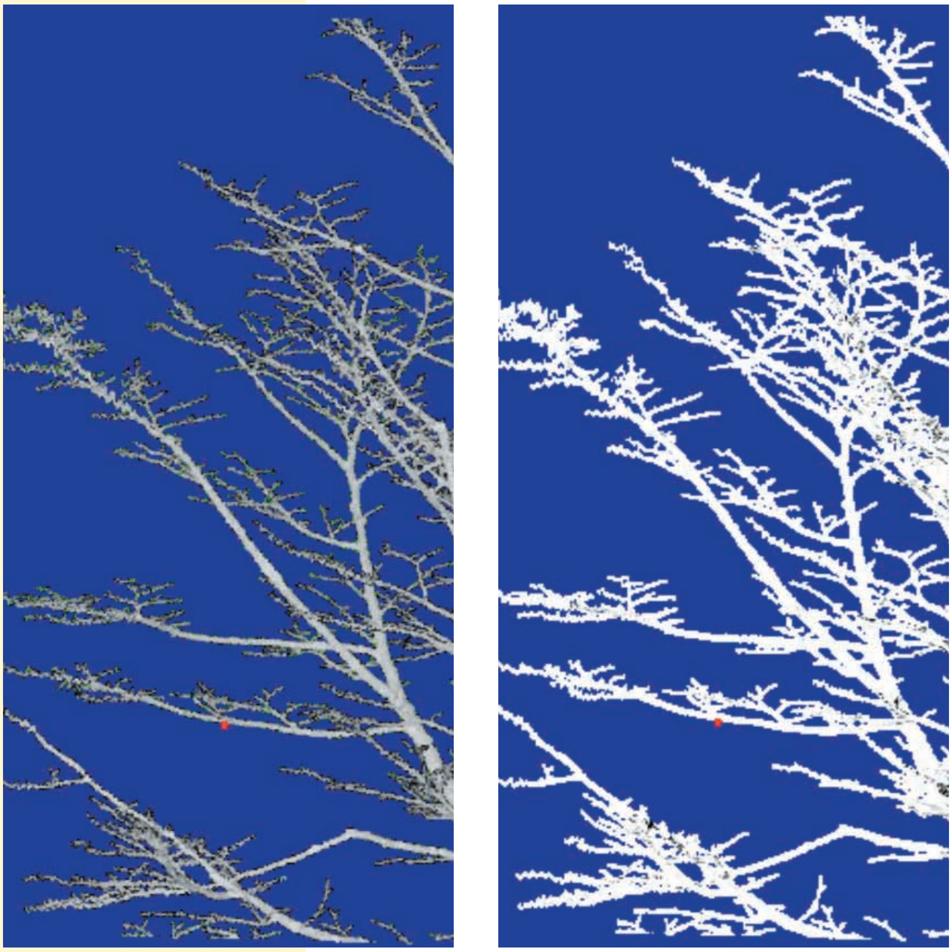

Fig. 7

Vegetation at short range (about 6m) as seen from scanner position.

Left: Grey scale according to reflectivity.

Right: Grey scale according to pulse shape figure - white: received pulse form equal to emitted pulse form, grey: strong deviation of pulse form.

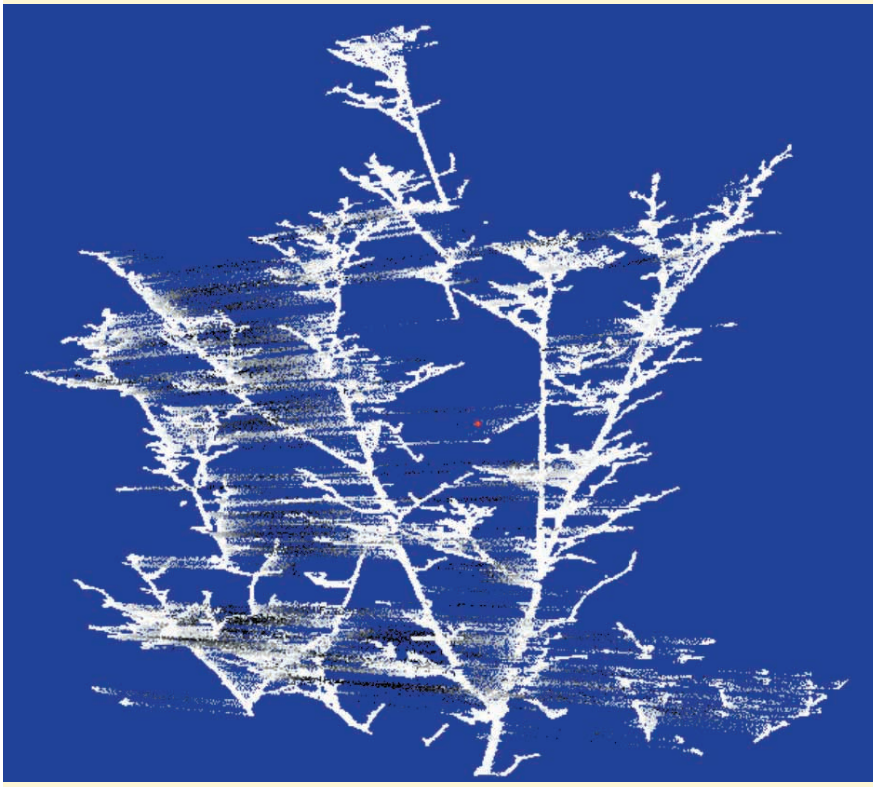

Fig. 8

Same object as Figure 7, but seen from the side. 'Flying points' between targets can be identified by pulse shape figure (grey to dark grey) and eliminated, if desired.

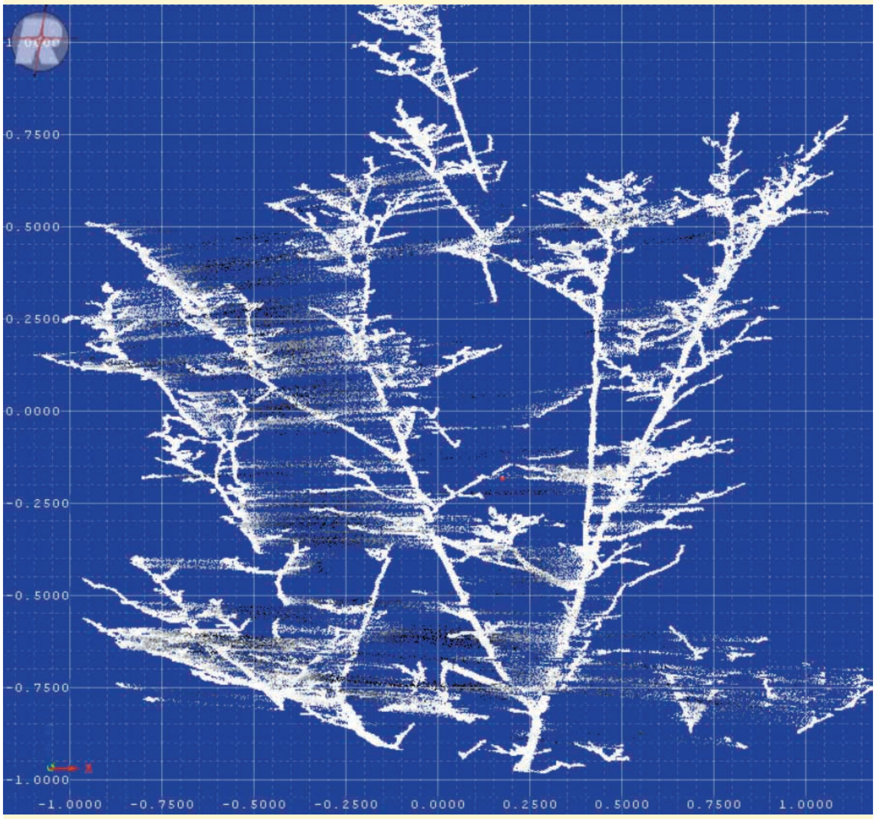

Fig. 9

Same as above but with grid. Scaling in metres.