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ROOT INVESTIGATION BY TREERADAR

CITY OF LONDON CORPORATION

HAMPSTEAD HEATH

LONDON

REF NO.3831_RP_001

STATUS: SURVEY

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1. INTRODUCTION

1.1. **Brief:** This report investigates the rooting of 4 veteran oak trees growing on Hampstead Heath, London, following the failure of another veteran oak tree due to advanced root decay. All 4 trees, together with the tree that failed, are located along a well-used footpath, and were identified by the client for investigation.

1.2. **Current site description**: The site of this survey is land either side of a surfaced footpath on Hampstead Heath and is indicated on the plan below, which was provided by the client. Three trees are located to the west of the path on the edge of the wooded area, with open grass areas beyond the footpath to the east. The fourth tree is located on the eastern side of the footpath in a belt of trees opposite the more wooded area. The failed tree is located to the north of the four surveyed trees at a crossing of paths. Significant compaction of soil was noted around the base of the tree, likely due to pedestrians and service vehicles cutting the corner of the path at the crossing. All the trees are located within 1.5m of the edge of the path, with the failed tree within 0.75m of the crossing.

1.3. **Scope of this report:** This report identifies locations, depth and spread of roots with a diameter greater than 20mm along scan lines using a TreeRadar Unit (TRU). This will inform the relative rooting densities for each of the 4 trees scanned and identify any areas showing a significant and potentially dangerous lack of tree roots and low root density.

1.4. Scanning conditions varied between the hard surfaced path and grass areas, but provided a generally favourable scenario.

2. BACKGROUND AND METHODOLOGY

2.1. The principal functions of roots are to uptake water, mineral nutrients (both of which are transported to the crown), to store carbohydrate and to provide anchorage of the tree. Literature cites that typically 90% of roots are in the top metre of soil, mostly in the upper 600mm. The morphology is dependent on ground conditions and species. Most tree roots extend beyond the canopy of the tree. Root growth is limited in soils with a high soil bulk density, such as a hard stony layer as it is mechanically difficult to penetrate hard soils.

2.2. The TreeRadar unit is a scanning cart with a 400MHz antenna which sends a beam every 1cm down to a depth prescribed by the operator (usually between 2 - 3m, which is the maximum depth). The reflection is recorded in a field computer and then analysed by the latest software, TBA. Water and metal reflect, therefore the machine records live roots which contain moisture, and cannot detect dead dried out roots. For each scan line a 'virtual trench' is produced which shows all roots with a diameter greater than 20mm. The machine cannot determine root diameter, other than it being greater than 20mm, due to the lack of correlation between the amounts of live root tissue in a root compared to the thickness of a root. A large root, for example, may only have a live central core.

2.3. The TreeRadar is able to identify the location of roots, but is unable to determine which tree the tree roots belong to. It is therefore important to try to minimise this overlap of rooting area to avoid falsely ascribing roots to a surveyed tree in an assessment of its rooting density.

2.4. A TreeRadar investigation was carried out on 3rd May 2016 on the 4 trees identified by David Humphries, Tree Management Officer for The City Of London Corporation. The location of the trees and scan lines are found at Appendix 1 on drawing reference 3831_DR_001, with the results for each group of scans in the report at section 4. Decisions relating to the number of scans undertaken and their locations relative to each tree were based on my professional judgement and experience, and were limited by the presence of other trees. Trees are referenced as VT1-VT4 on the plan and in the descriptions in this report.

2.5. Not all scan lines were within the root protection areas of the trees. The individual scan lines were measured from the tree and/or other fixed points, and a 'marker' (usually the tree trunk) was noted to assist plotting parallel lines. Photographs were taken, and the lines were then plotted on a plan and described in survey tables. Each scan line has a unique file number (e.g. file 001 scan 005) and the lines are shown on a digital plan.

2.6. Each group of scan lines is organised into a 'top down 'view and root density view, with the semi-circular scan lines also having a root morphology plan which is shown to scale. The software in effect 'joins the dots' of root hits to produce this, but the reality of the root growth between the root hits may be slightly different.

3. RESULTS

3.1. The location and orientation of the scan lines is described below, together with a summary of the results.

3.2. **File 001 - Scans 001 and 002:** Running from south to north within the footpath adjacent to VT2 and VT3 for a length of 40m. Line 001 starts at the curve in the path 0.5m from the western edge of the path with markers at VT3 and VT2, ending at the second curve in the path. Line **00**2 runs parallel to 001, 0.5m from the eastern edge of the path.

Comments:

Results found tree roots extending beneath the footpath at moderate to high densities and relatively even distribution along the line. Few roots were found in the upper 20cm due to the hard surfacing. The majority of roots were found at a depth of 20-100cm with few roots found below this depth.

3.3. **File 001 - Scans 003 and 004:** Running from south to north within the footpath adjacent to VT1 for a length of 24m. Line 003 starts at the end of line 001, 0.5m from the western edge of the path taking into account the curve of the path with markers at VT1, ending where the path curves again. Line 004 runs parallel to 003 along the eastern edge of the path for a shorter length due to the curvature of the path.

Comments

Results found tree roots extending beneath the footpath at moderate to high densities and relatively even distribution along the line. Few roots were found in the upper 20cm due to the hard surfacing. The majority of roots were found at a depth of 20-100cm with a number of roots found below this depth.

3.4. **File 002-Scans 001 to 015:** Running parallel to file 001 scan 002 to the east of the path within the grass area. Lines start at area of scrub running south to north for a length of 30m ending level with the end of file 001 Scan 002. Markers at VT3 and VT2. Scan 001 runs 0.5m from the edge of the path with successive lines 1m apart out to line Scan 015.

Comments

Roots were found to extend out into the grass area as far out as line 015 with the rooting densities moderate to high and evenly distributed. Rooting density falls gradually with increasing distance from the trees as would be expected. Most roots were found in the upper 80cm of soil.

3.5. **File 003 Scans 001 to 005:** Scan line 001 is a semi-circle in the grass around VT3 to the west of the path, 1m from the base of the tree. The marker is taken at west on the compass. Lines 002-005 run outside line 001, with each successive line 1m further out, ending with line 005 5m from the trunk.

Comments

Tree roots are present in moderate to high densities along all scan lines. Large reflections from non-root material in lines 002-005 meant only the top 50 cm of soil was analysed, though through comparison to the expected root morphology of a tree in grass this represents the majority of tree roots and still showed moderate to high root densities.

3.6. **File 004 Scans 001 to 005:** Scan line 001 is a semi-circle in the grass around VT2 to the west of the path, 1m from the base of the tree. The marker is taken at west on the compass. Lines 002-005 run outside line 001, with each successive line 1m further out, ending with line 005 5m from the trunk.

Comments

3.7. Tree roots are present in moderate to high densities along all scan lines. Large reflections from non-root material in lines 001-04 meant only the top 50 cm of soil was analysed, though through comparison to the expected root morphology of a tree in grass this represents the majority of tree roots and still showed moderate to high root densities. Results from scan 005 showed high rooting densities and deeper roots.

3.8. **File 005 Scans 001 to 005:** Scan line 001 is a semi-circle in the grass around VT1 to the west of the path, 1m from the base of the tree. The marker is taken at west on the compass. Lines 002-005 run outside line 001, with each successive line 1m further out, ending with line 005 5m from the trunk.

Comments

Tree roots are present in high density throughout the scan lines. The majority of the roots were found within the top 80cm of soil, but a significant number of roots found at greater depths.

3.9. **File 006 Scans 001-005:** Scan**s** are located parallel to file 001 line 004 within a triangle of grass to the east of the path. Lines are uneven lengths due to the angle of the unpaved track running from north west to south east at the edge of the grass triangle. Line 001 is 0.5m from the edge of the path with each subsequent line an additional metre from the path. Marker is at the trunk of VT1.

Comments

Roots are found at moderate to high density showing they have spread well beyond the footpath. The majority of the tree roots are found in the upper 80cm of soil but extend up to 170cm deep.

3.10. **File 007 Scans 001 and 002:** Scans are located within the footpath immediately to the west of VT4, running from south to north for a length of 18.5m. The location of this scan line is offset from VT4 due to the location of neighbouring trees which would confuse the survey with additional roots. Line 001 is located 0.5m from the western edge of the path, line 002 0.5m from the eastern edge of the path. Marker for the scan line is the trunk of VT4.

Comments

No roots were found in the upper 20cm of ground due to the hard surfacing. A thicker band of roots are present between 20-40cm in depth, with the remaining roots evenly distributed down to a depth of 180cm.

4. CONCLUSION

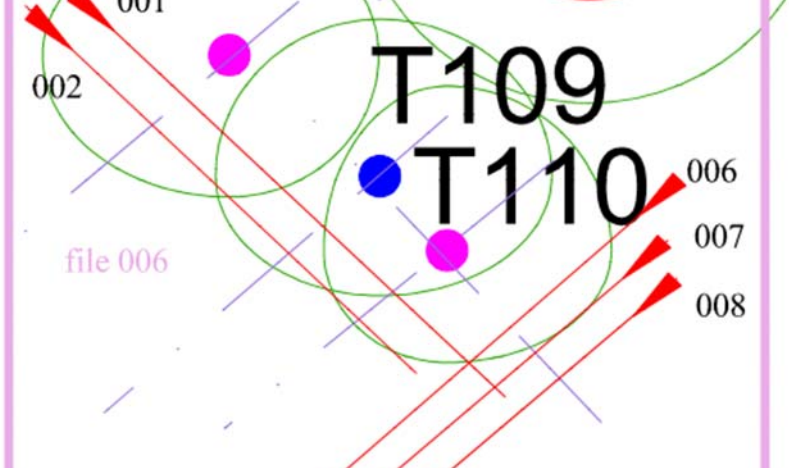
The TreeRadar unit will only pick up roots with a diameter greater than 20cm in diameter and does not take account of smaller advantageous roots. In the areas where it was possible to survey, all 4 trees showed moderate to high rooting density, with no obvious areas of low rooting density or gaps that would cause concern. The spread and depth of the root morphology indicates a healthy rooting system that spreads far beyond the crown spreads and the nominal root protection areas (as outlined in BS 5837:2012 Trees in relation to design, demolition and construction - 'Recommendations'), though, as expected, the density drops with increased distance from the trunk as roots branch out and their diameter decreases.

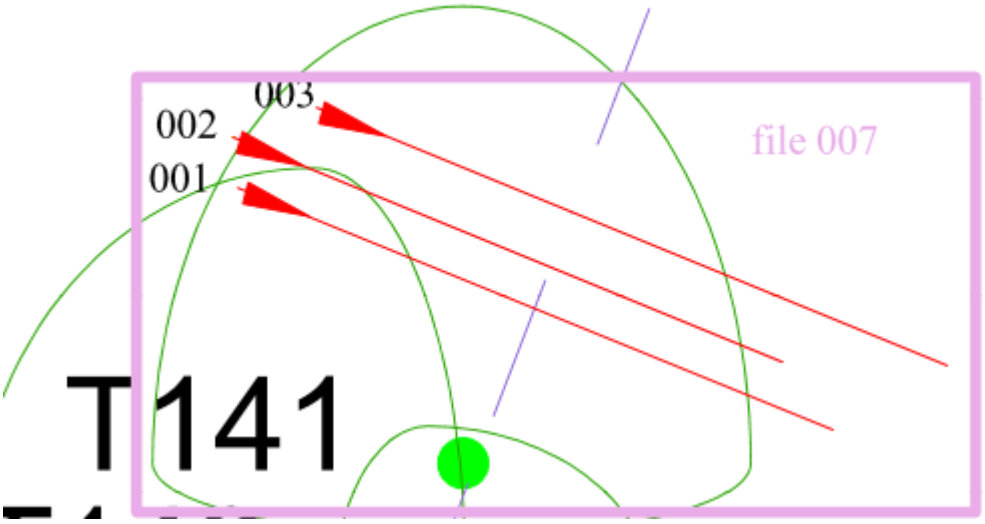
Given the high root density, even spread and lack of obvious gaps it is my opinion that the trees are maintaining a healthy root system and are therefore unlikely to suffer a similar failure to that experienced by the veteran tree at the path crossing.

This report gives an indication of current rooting health for these trees, but should not be used as a substitute for routine future arboricultural inspection as part of their long term management.

5. APPENDIX 1 -TREERADAR PLAN REFERENCE 3831_DR_001

6.


001
002
T109
T110
006
007
008
file 006

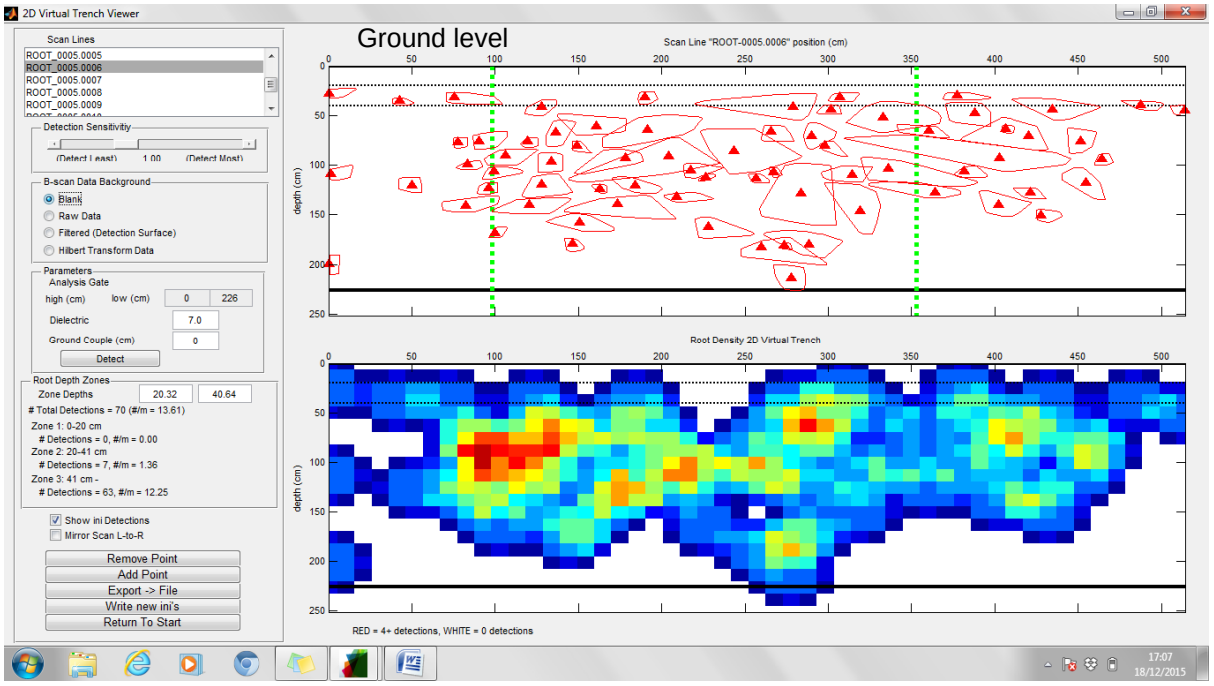

003
002
001
file 007
T141

The results are shown as a top down view (plan) and a cross section of each scan line. The plan extracts in Appendix 3 are not to scale. The location of the scan lines are based on the plotting from the survey, and the length of the line on the plan by the exact length of the scan

The cross section of each scan line shows where the roots are in relation to depth and distance. The coloured areas represent root density (relative to the scan area). An **example** is shown below:

Distance in cm

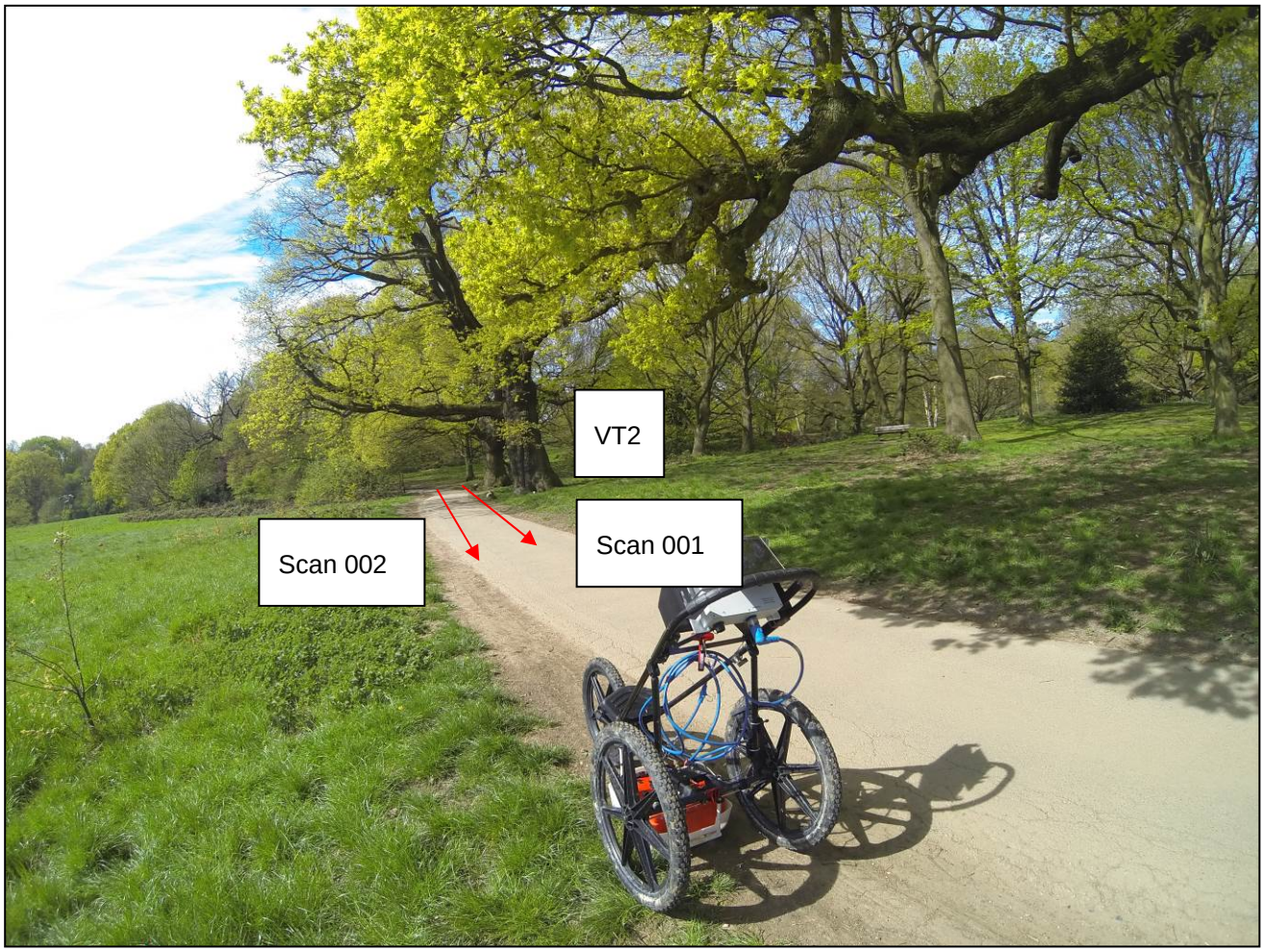
Depth



Red triangle = root

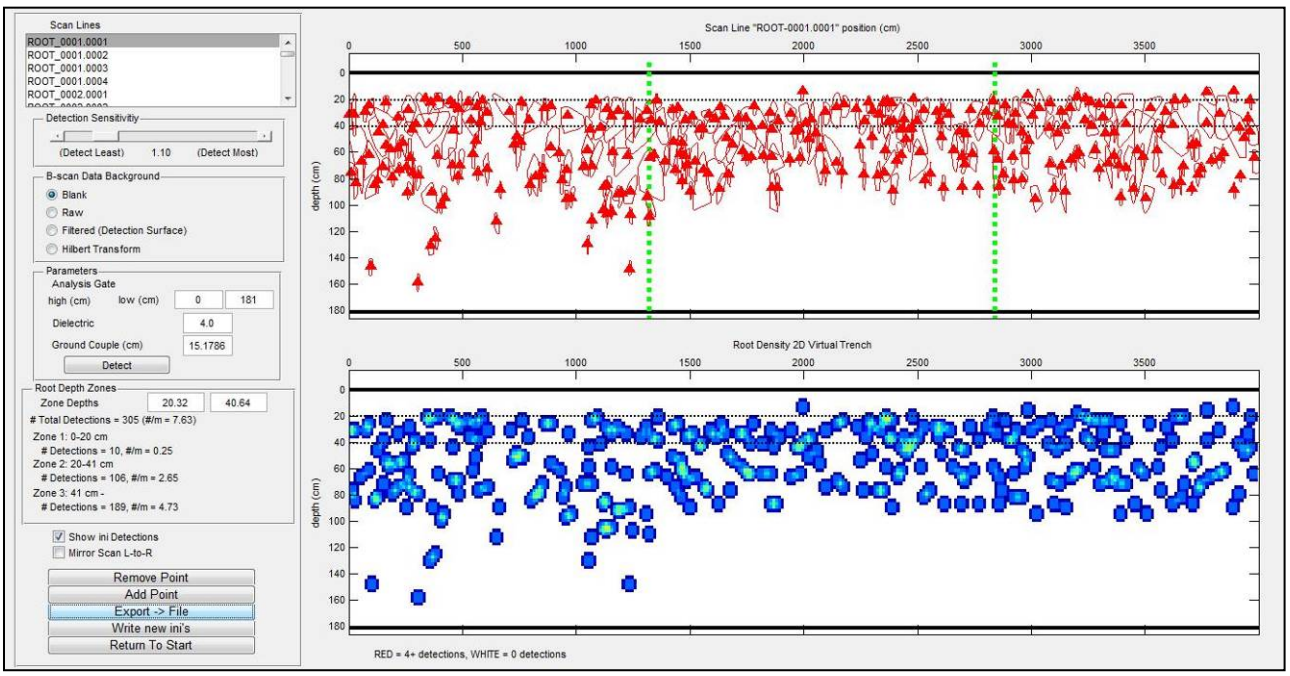
7. APPENDIX 3 - THE INDIVIDUAL RESULTS FOR SCAN LINE

File 001 Scan 001-004

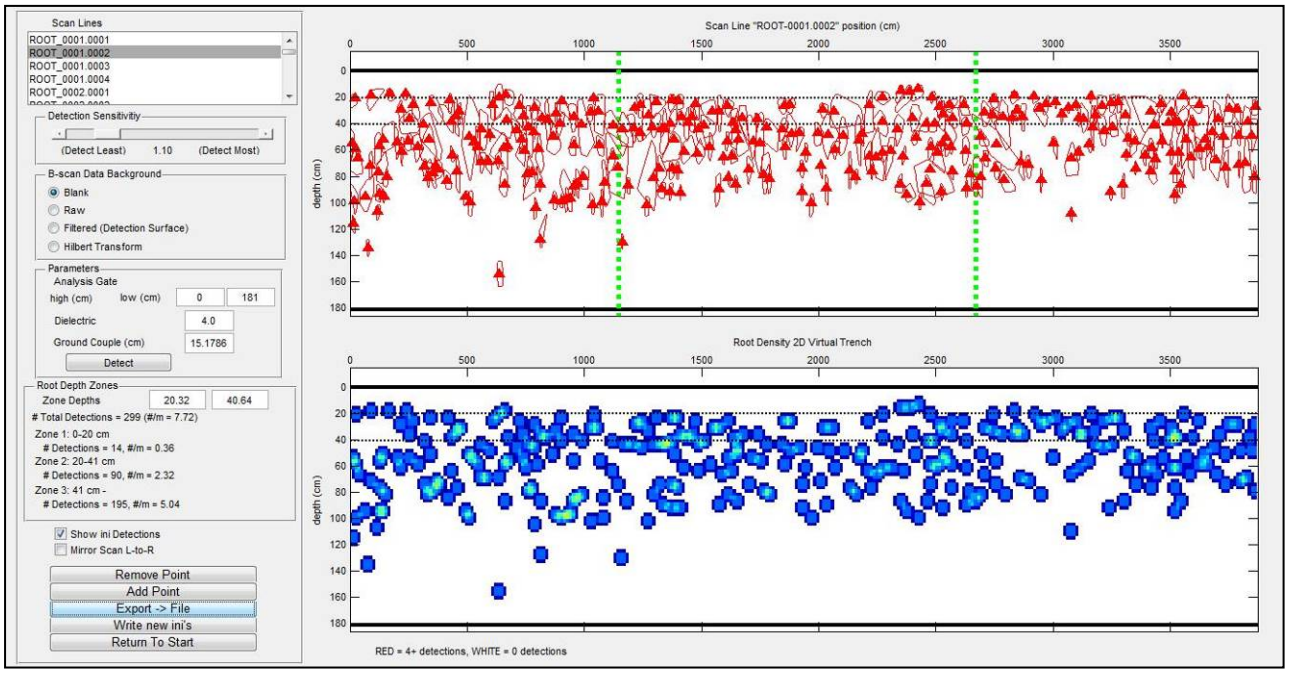



VT1
Scan 003
and 004

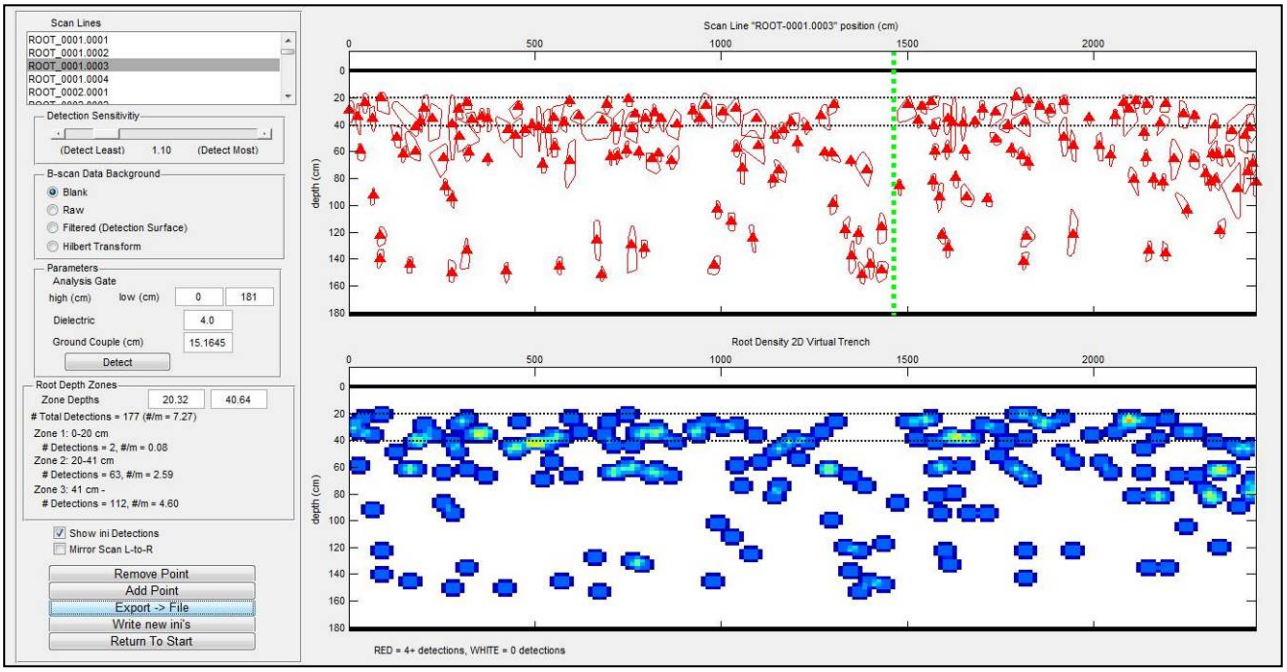
Scan 001



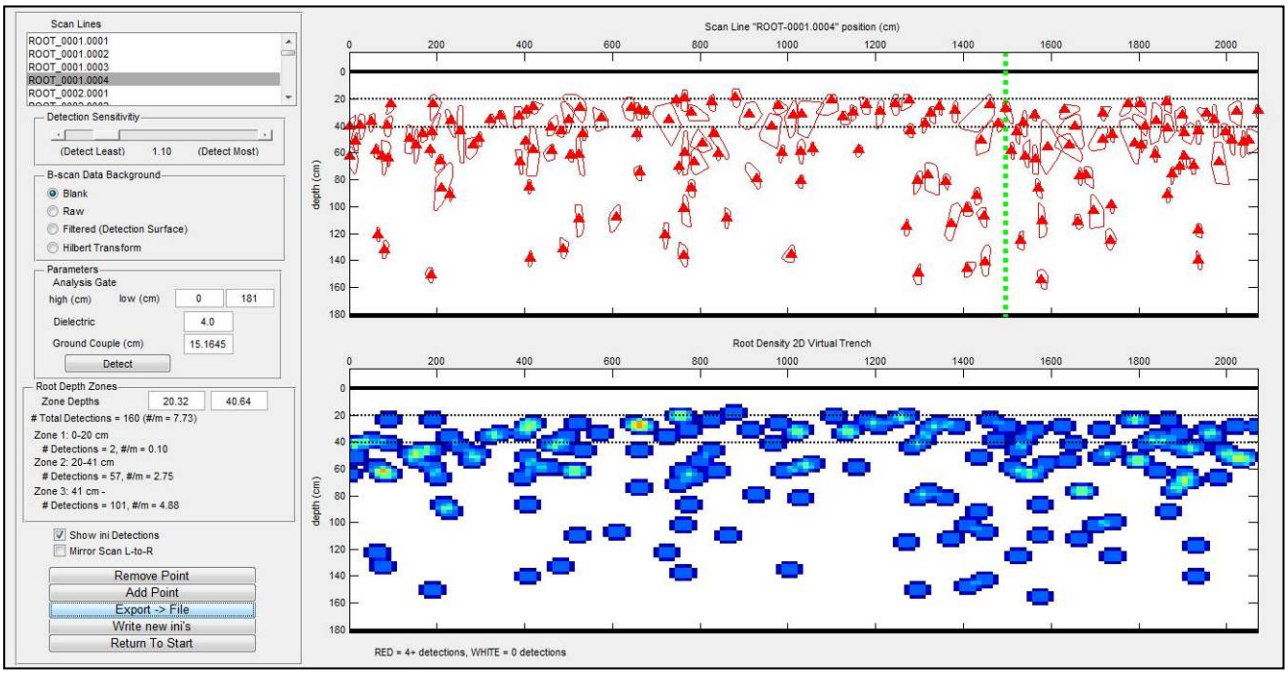
Scan 002



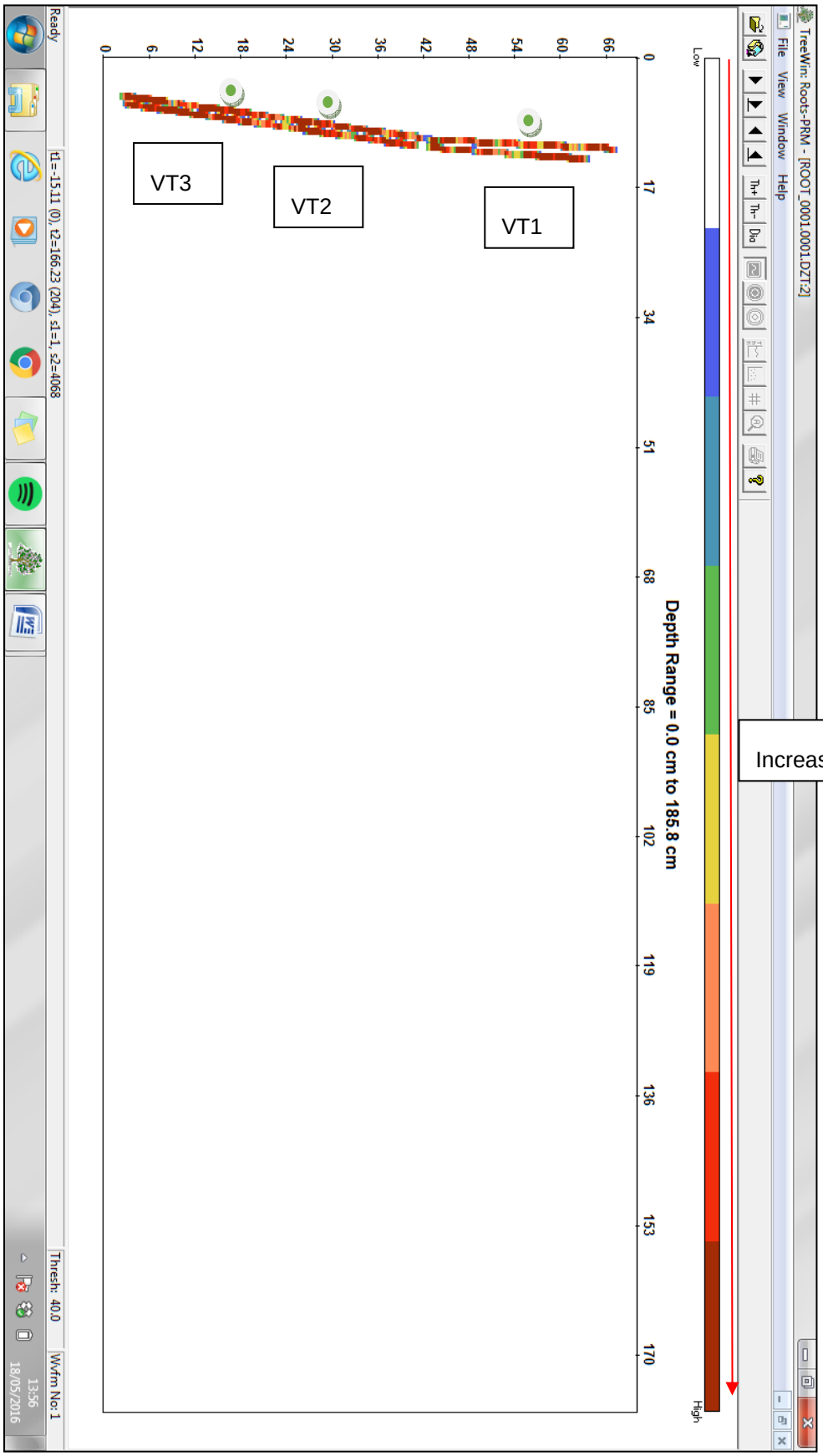
Scan 003



Scan 004

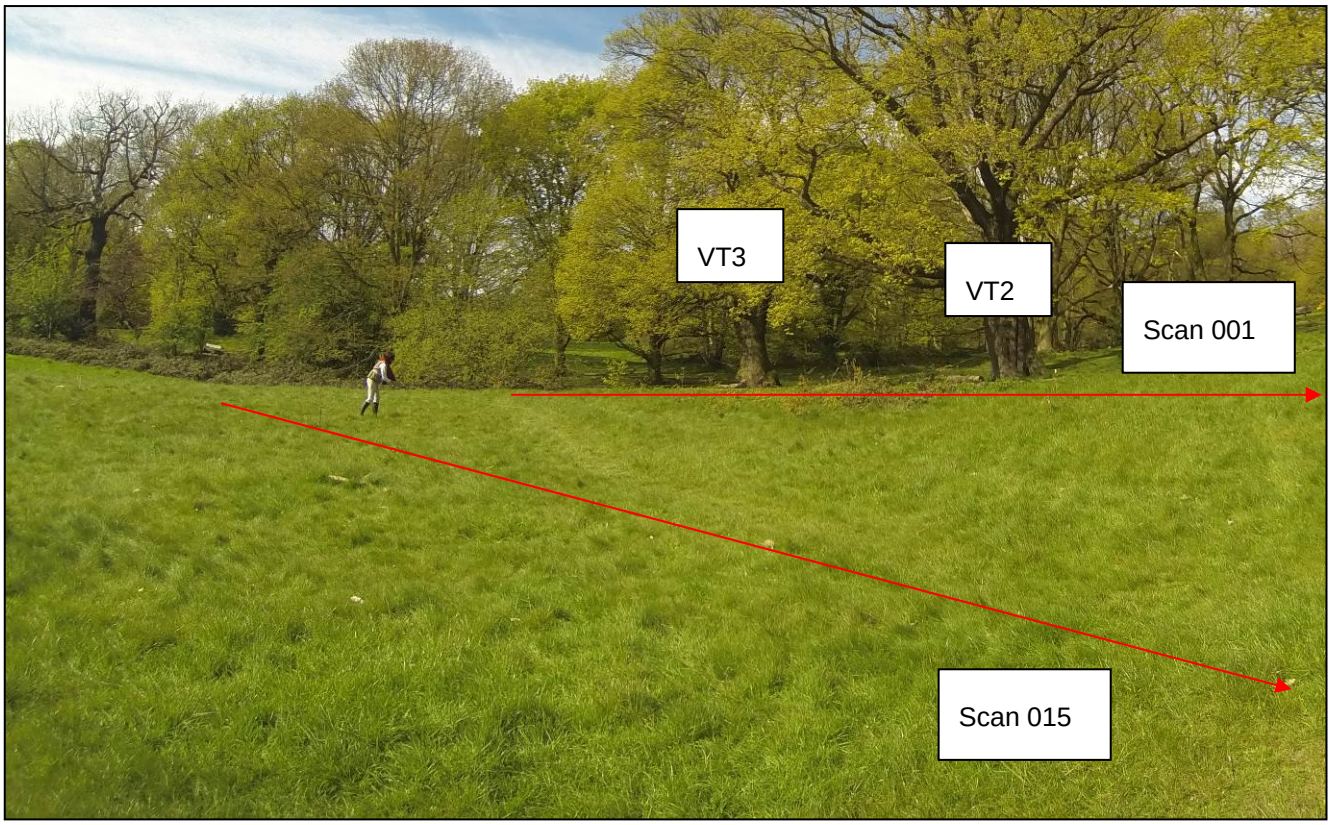


File 001 Scan 001-004 Root densities



Increasing root density

File 002 Scan 001-015



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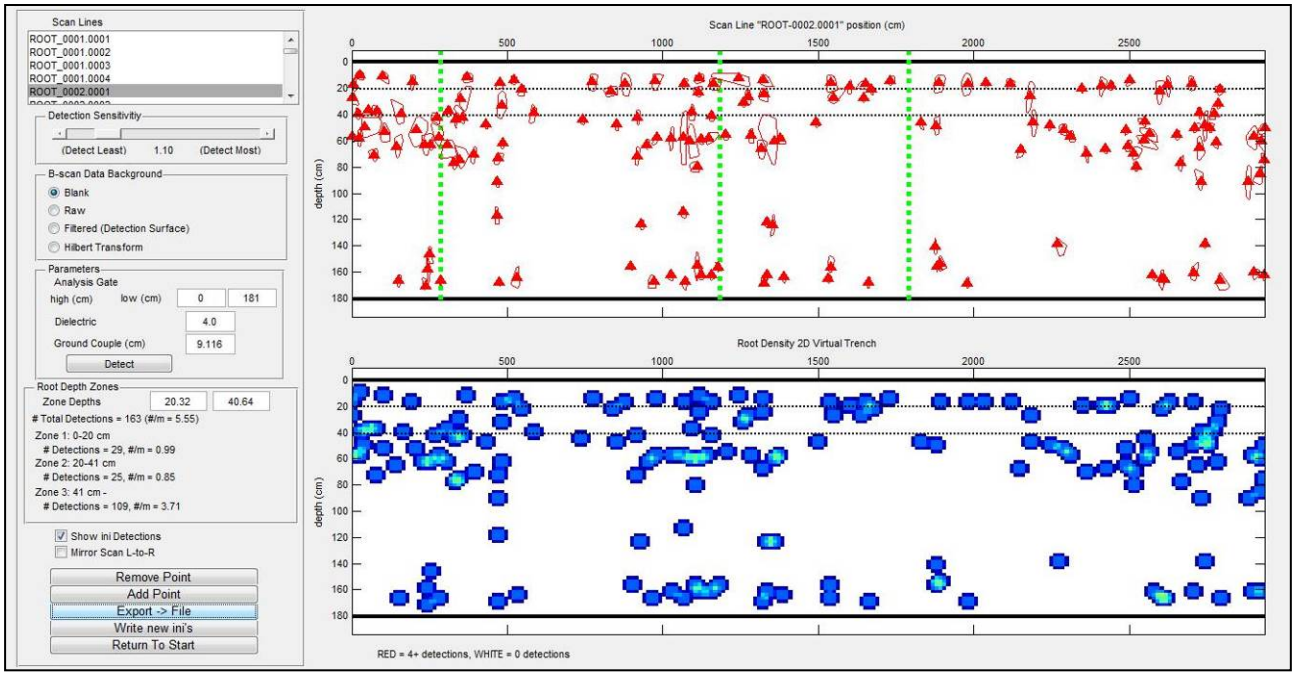

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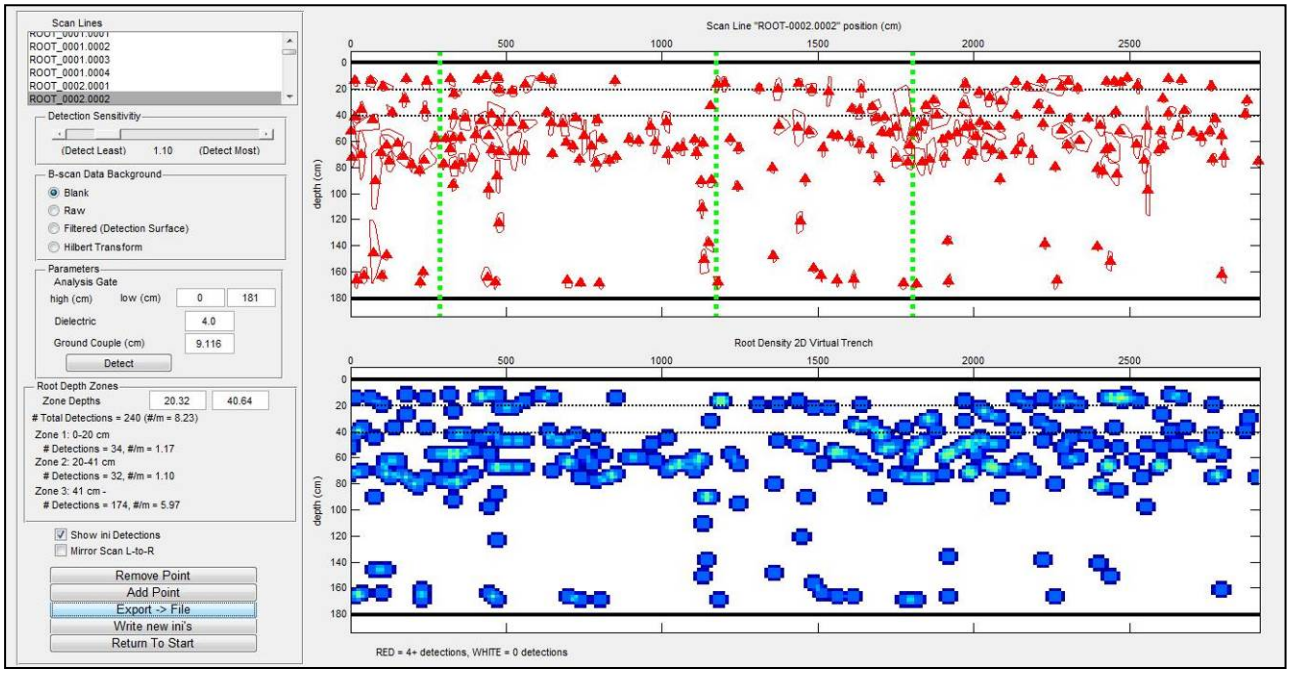

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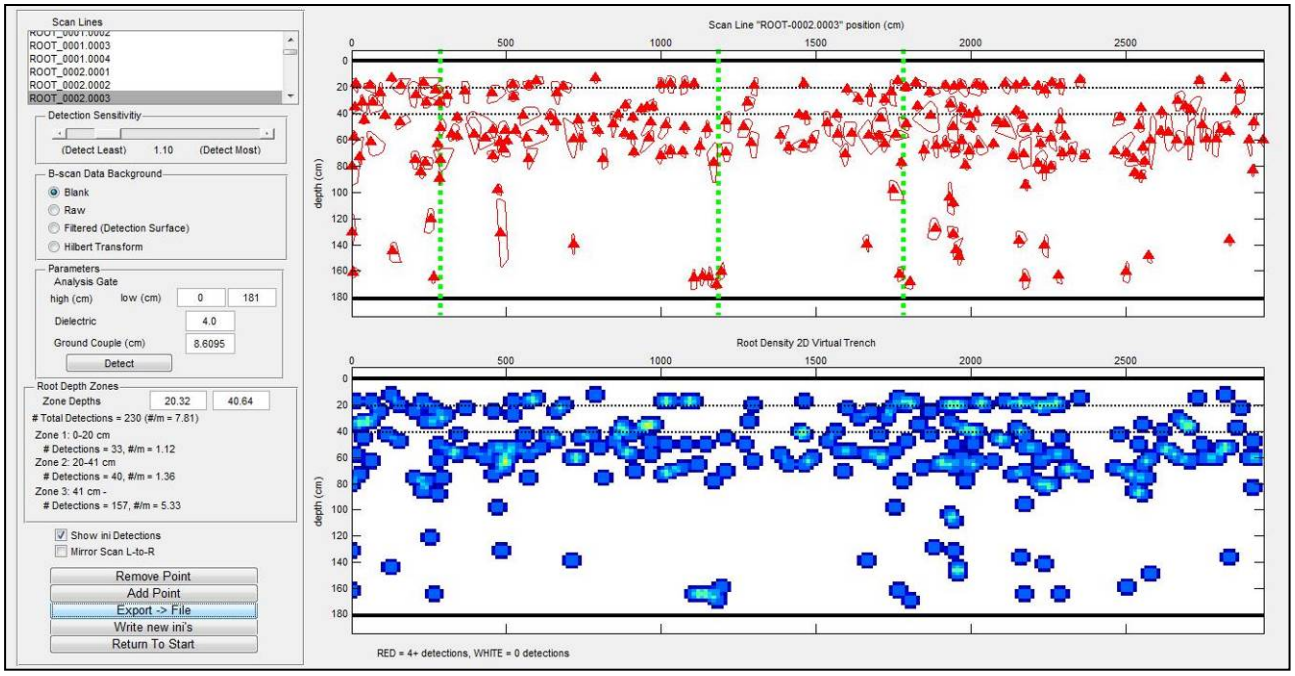

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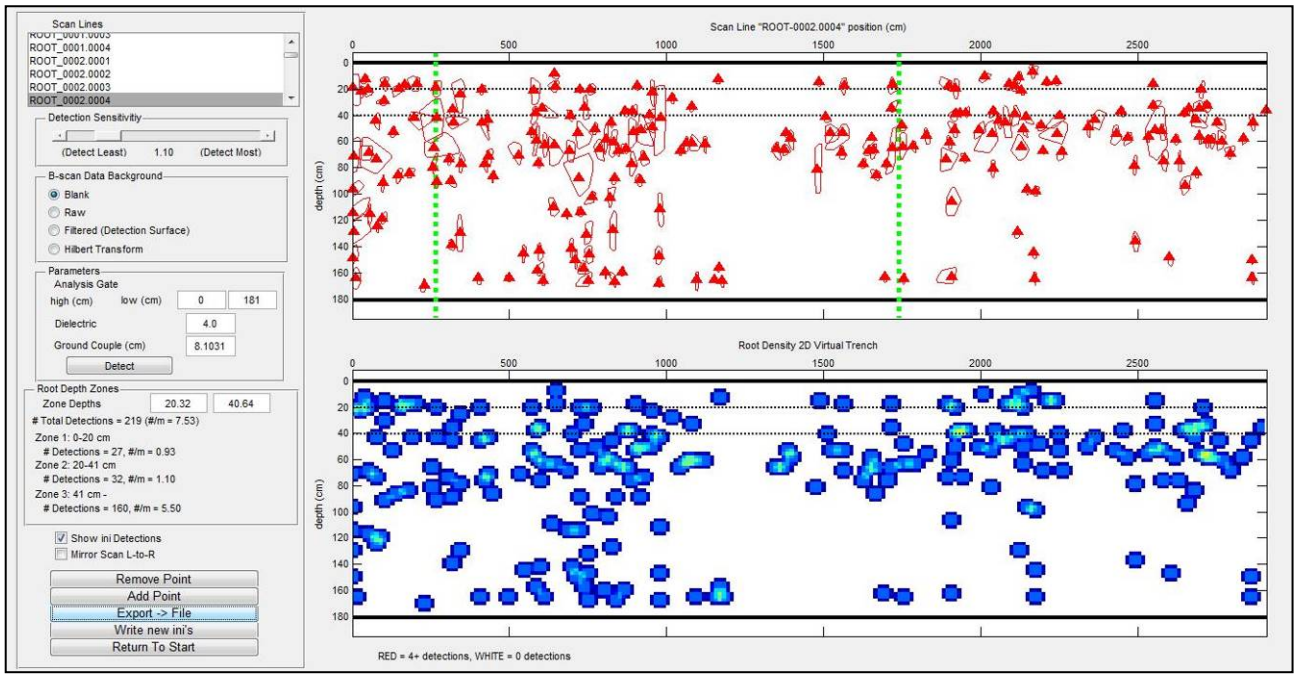
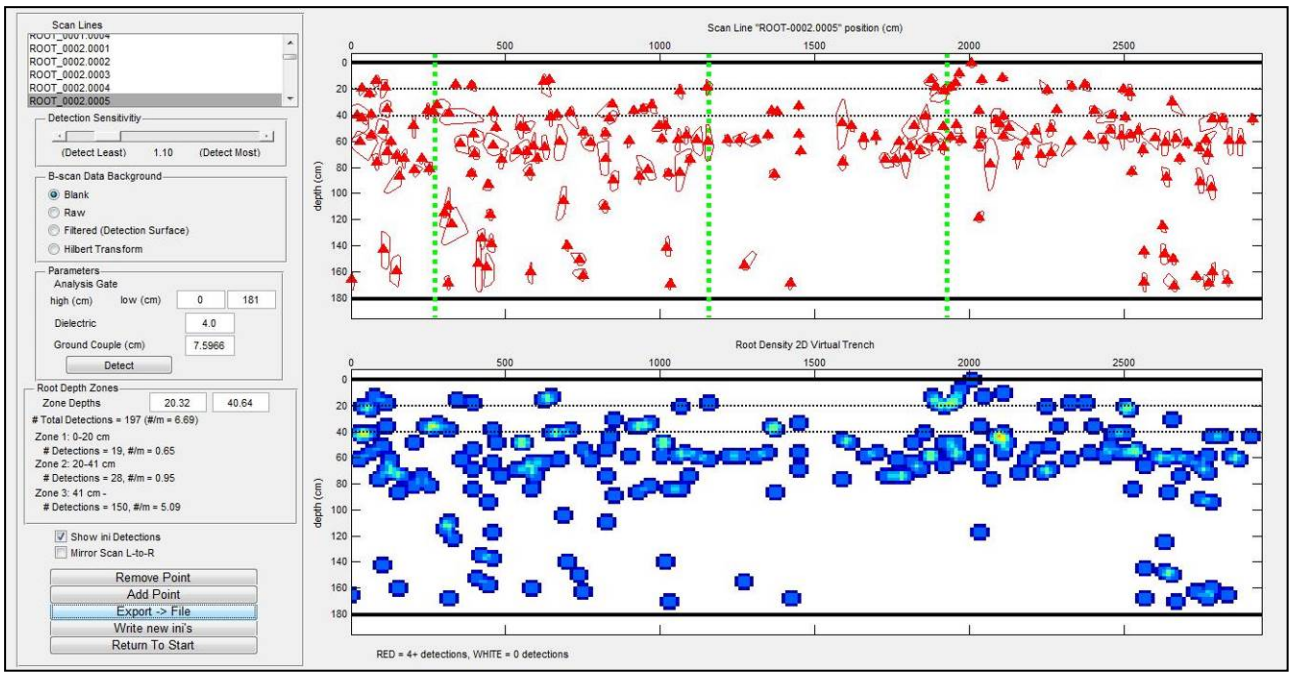
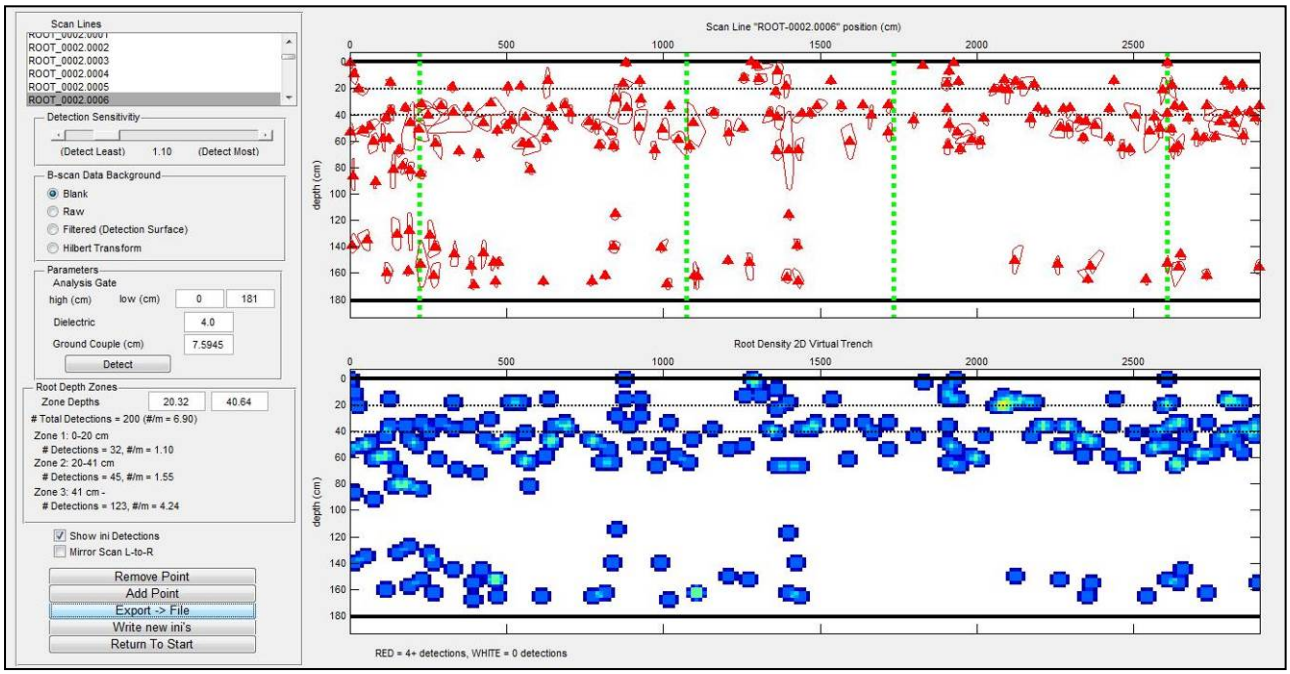


Scan 005



Scan 006



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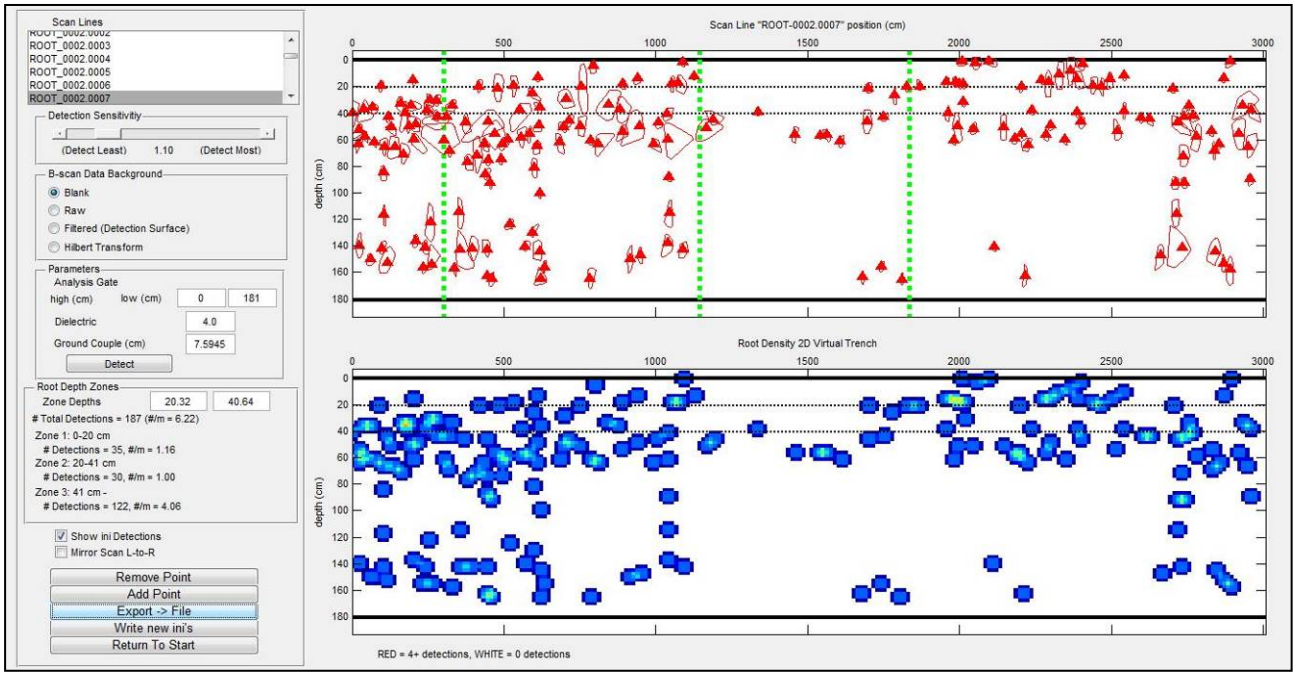

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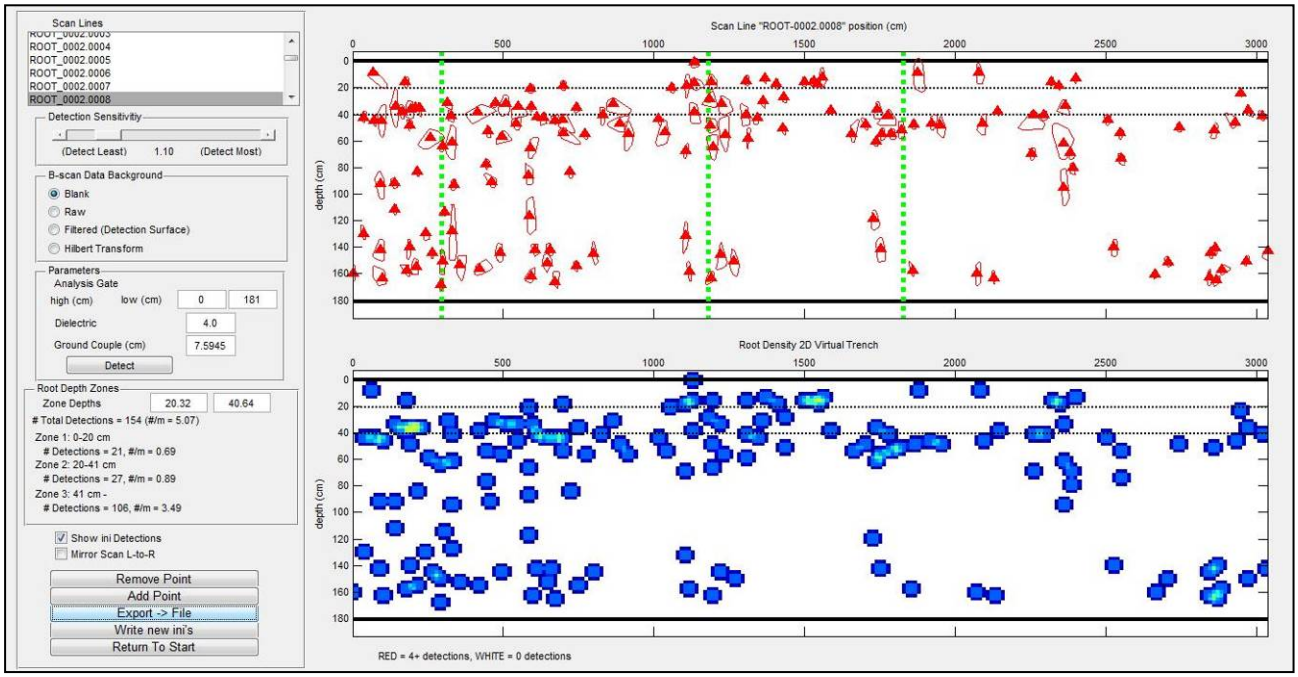

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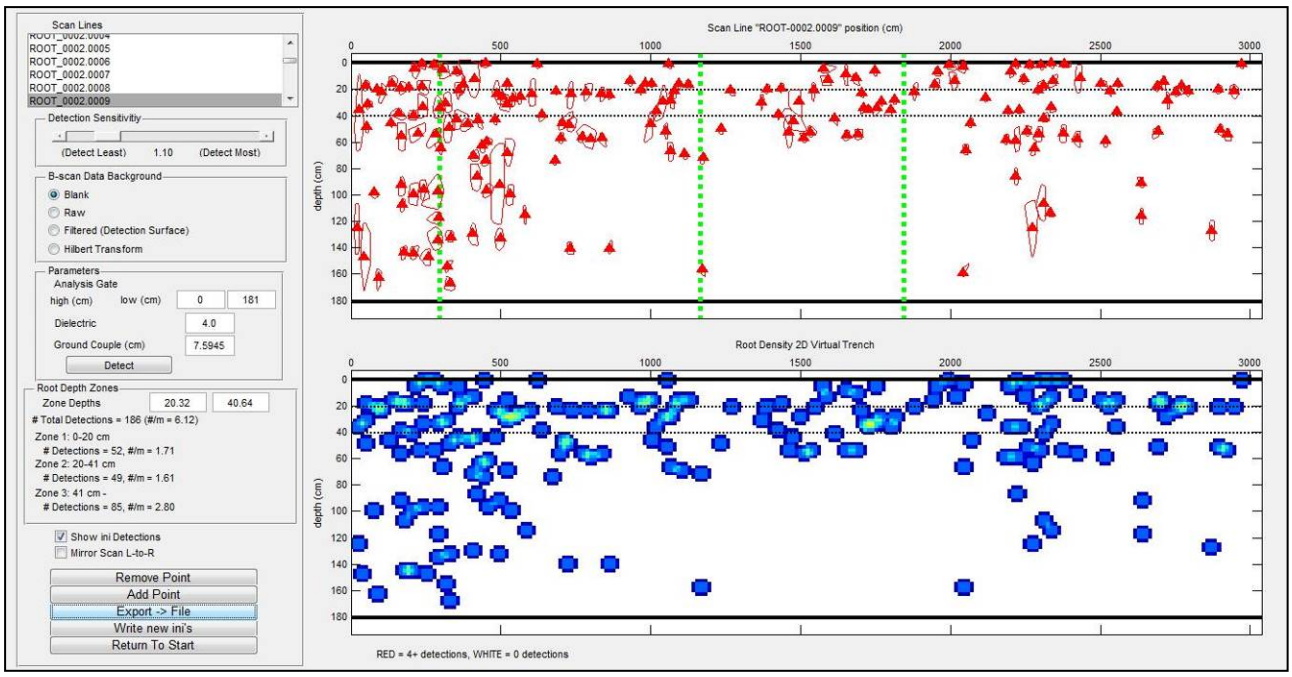

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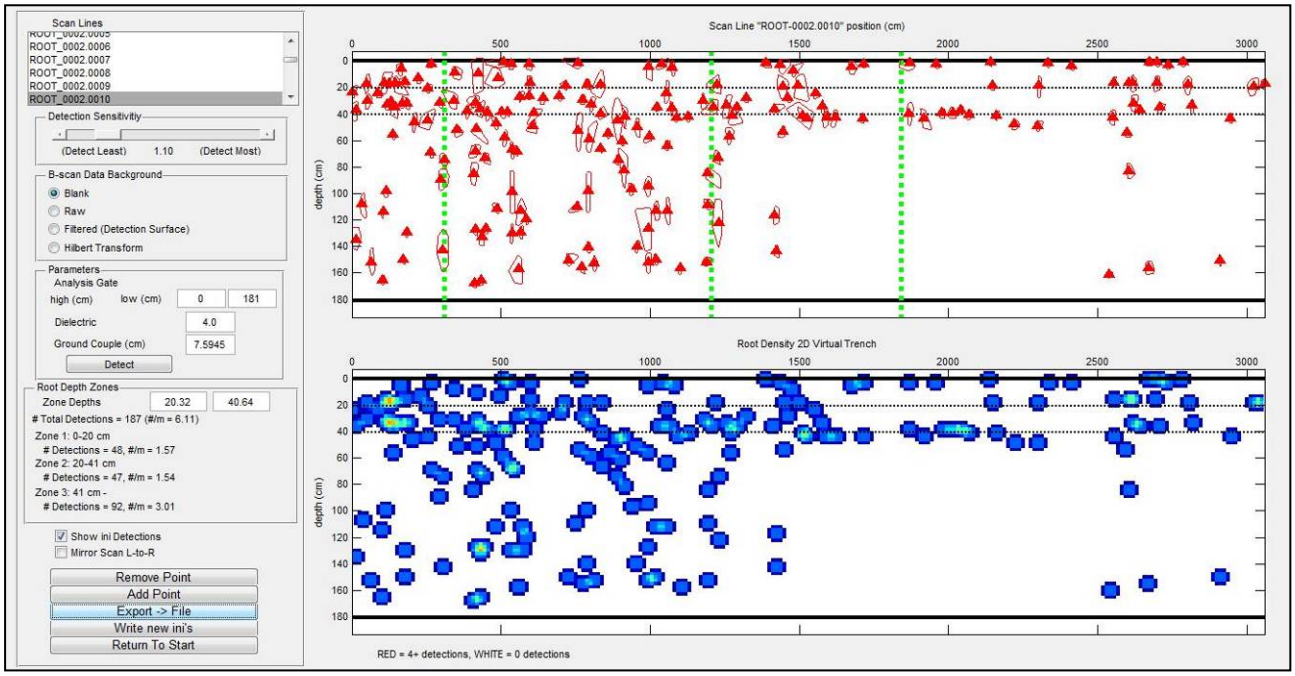

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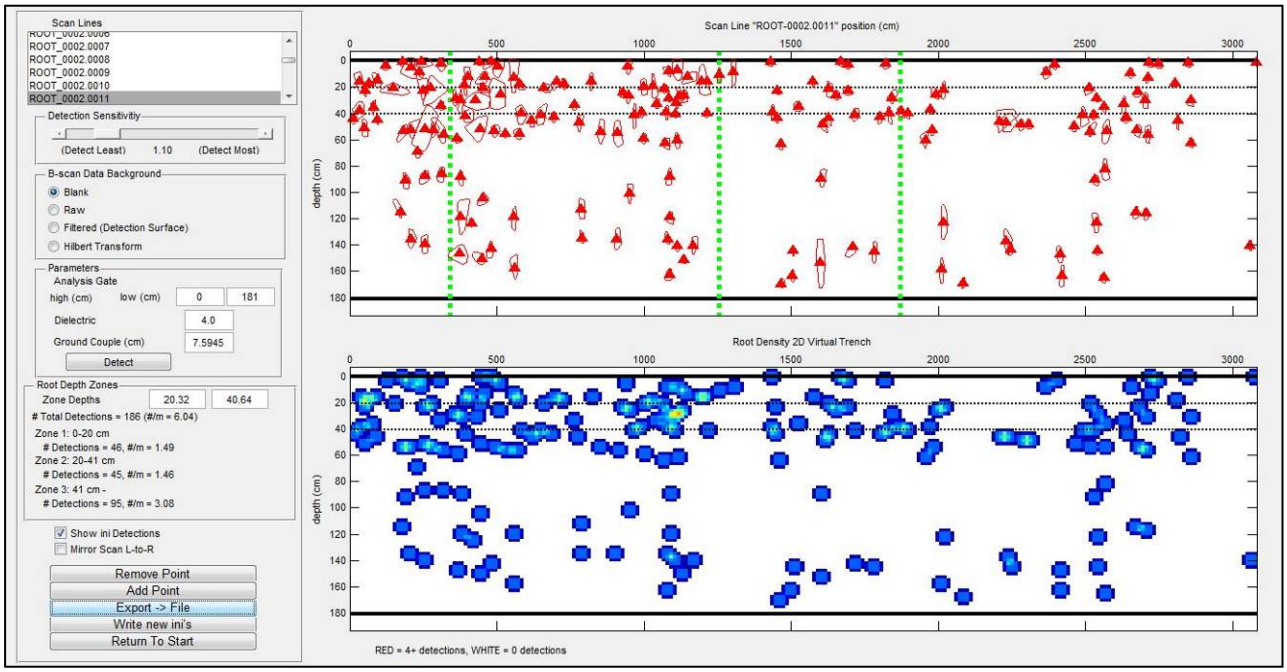

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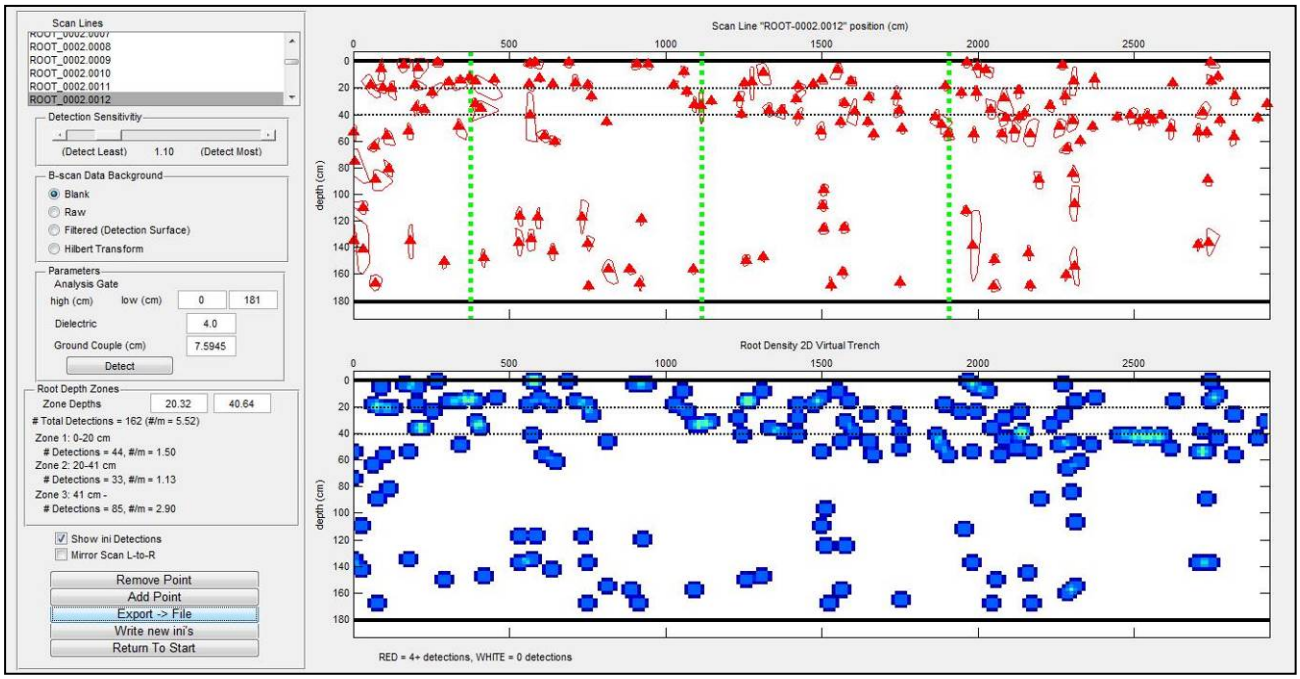

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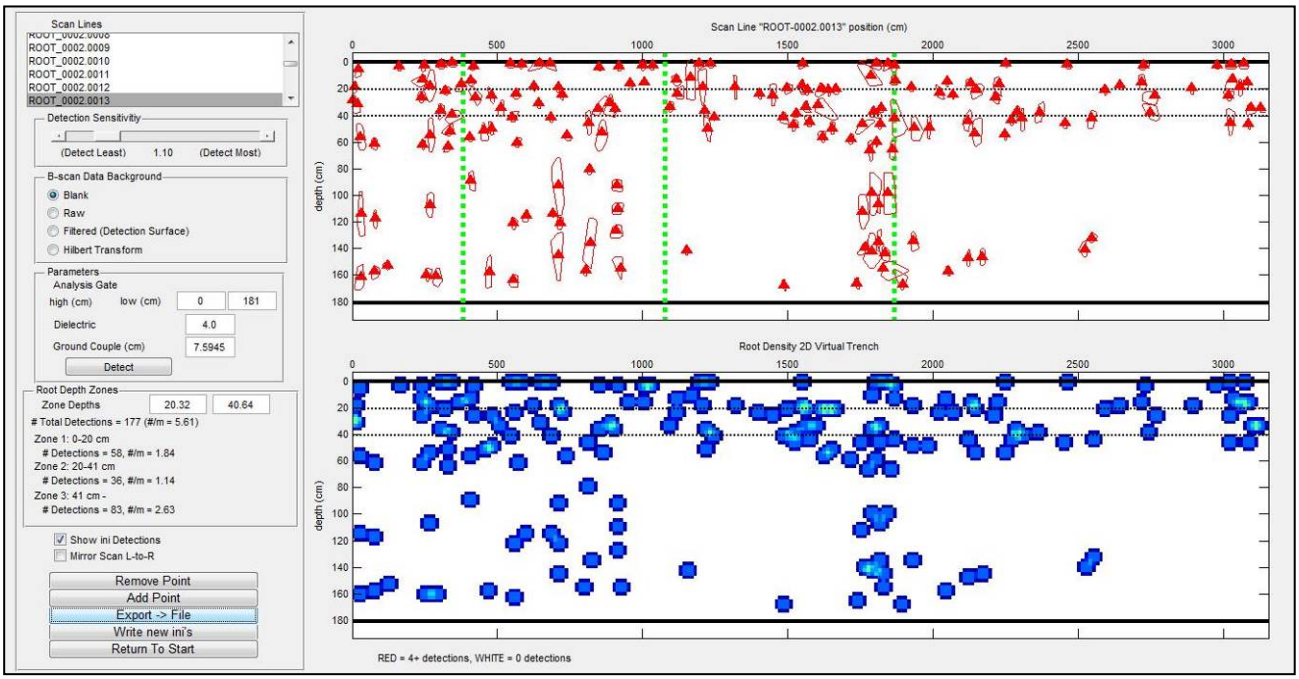

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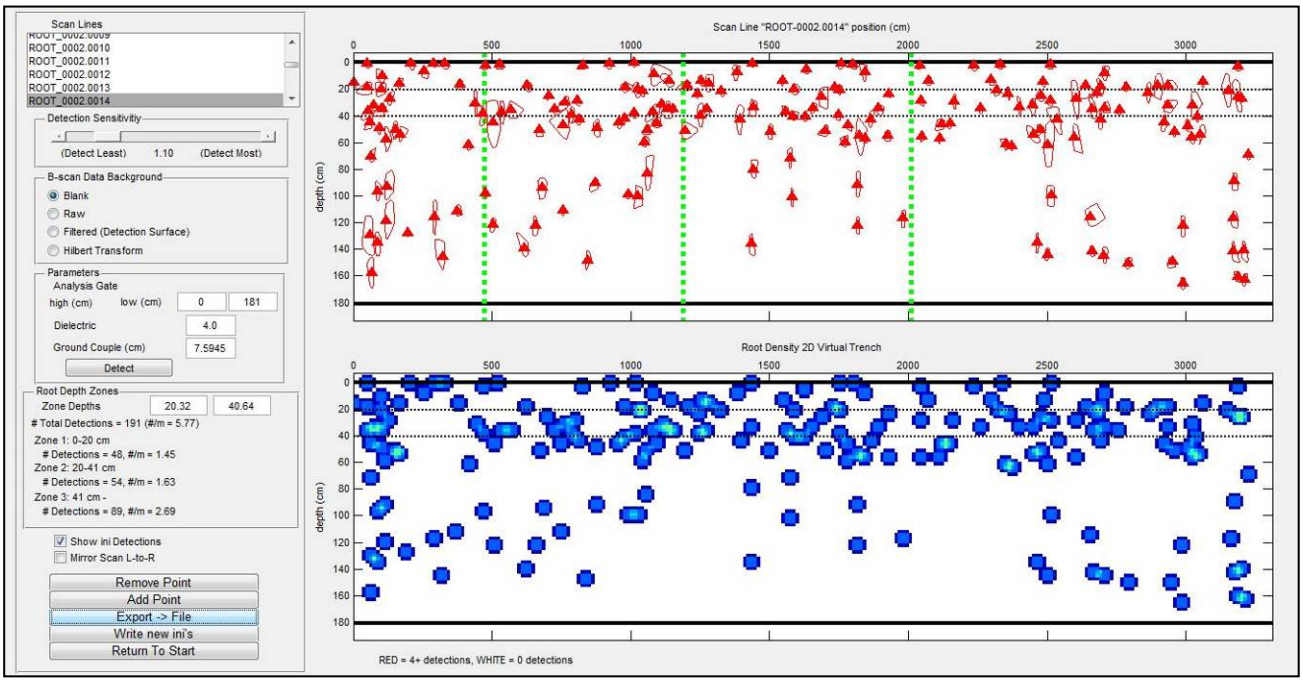

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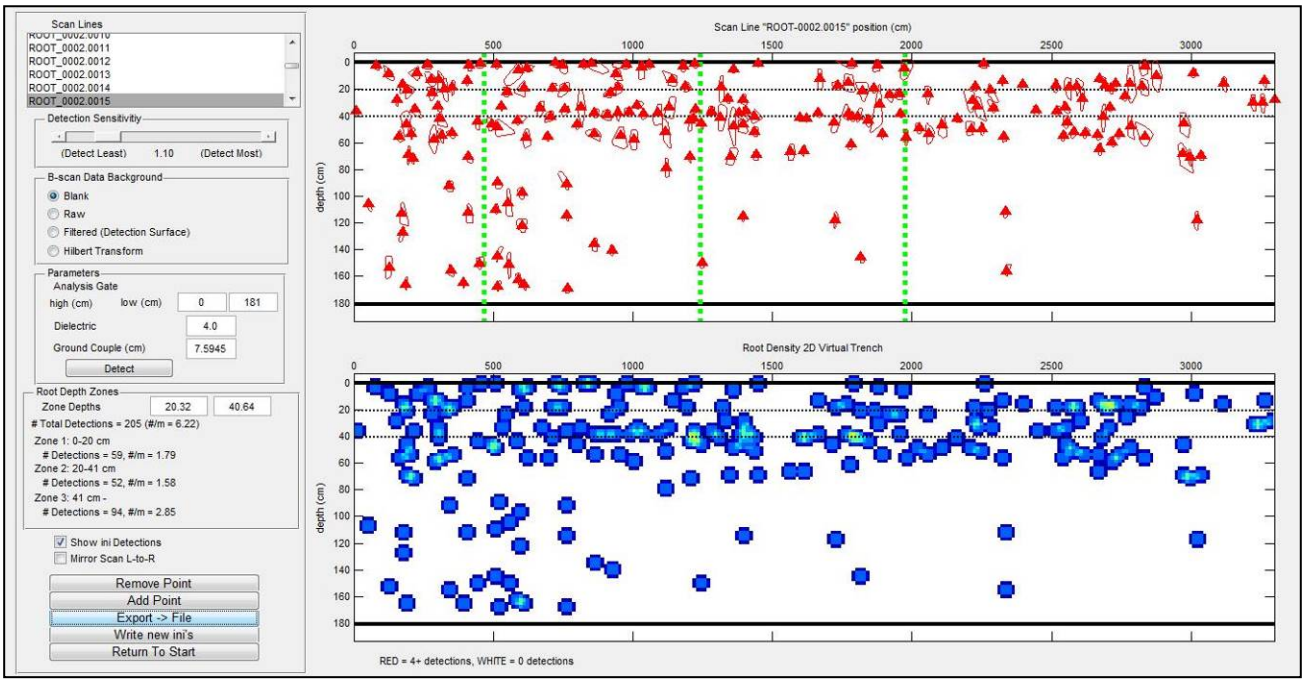
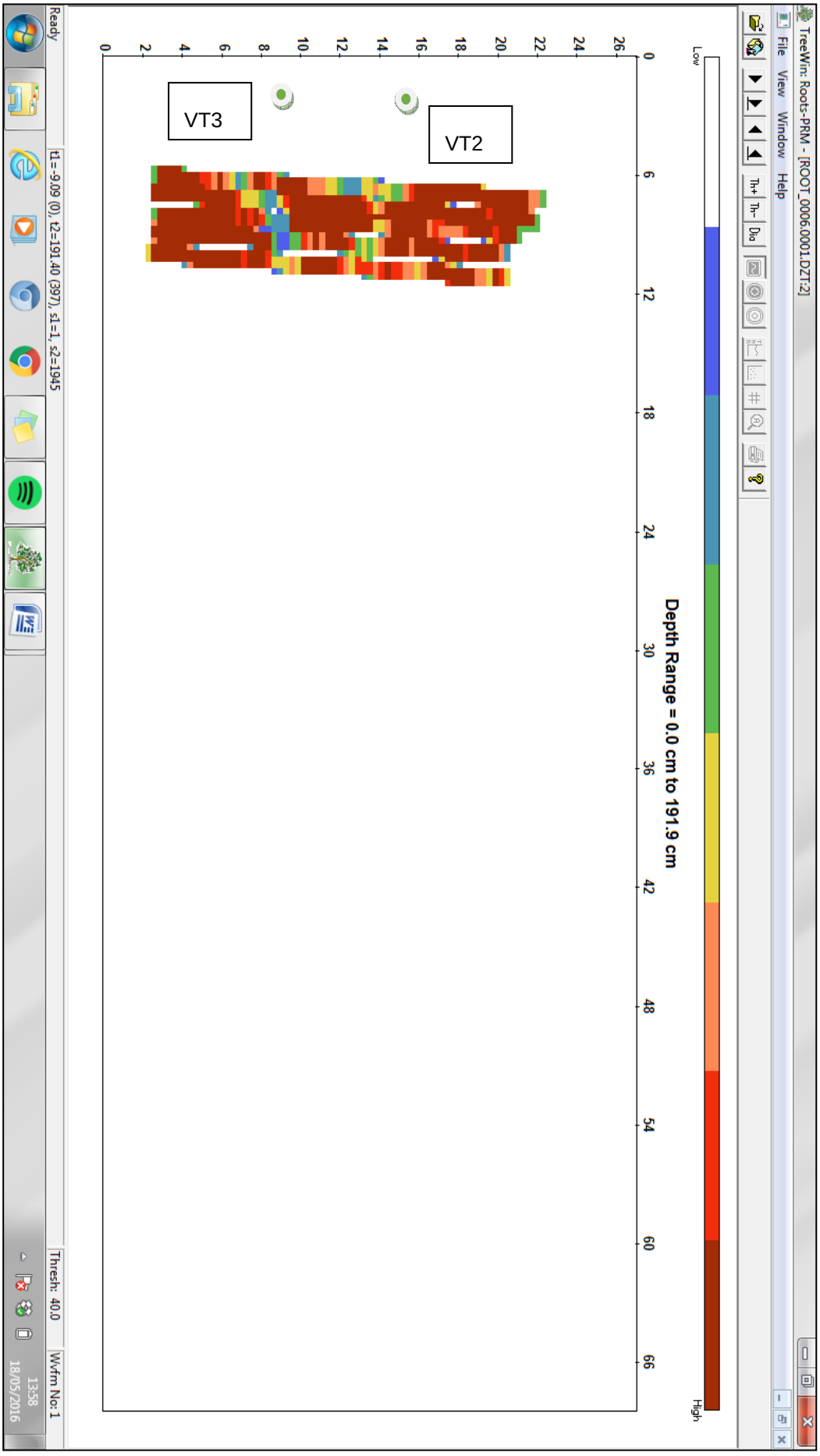

Scan Lines
ROOT_0002.0011
ROOT_0002.0012
ROOT_0002.0013
ROOT_0002.0014
ROOT_0002.0015
Detection Sensitivity
(Detect Least) 1.10 (Detect Most)
B-scan Data Background
Blank
Raw
Filtered (Detection Surface)
Hilbert Transform
Parameters
Analysis Gate
high (cm) low (cm) 0 181
Dielectric 4.0
Ground Couple (cm) 7.5945
Detect
Root Depth Zones
Zone Depths 20.32 40.64
Total Detections = 205 (#/m = 6.22)
Zone 1: 0-20 cm
Detections = 59, #/m = 1.79
Zone 2: 20-41 cm
Detections = 52, #/m = 1.58
Zone 3: 41 cm -
Detections = 94, #/m = 2.85
Show ini Detections
Mirror Scan L-to-R
Remove Point
Add Point
Export -> File
Write new ini's
Return To Start
Scan Line "ROOT-0002.0015" position (cm)
depth (cm)
Root Density 2D Virtual Trench
RED = 4+ detections, WHITE = 0 detections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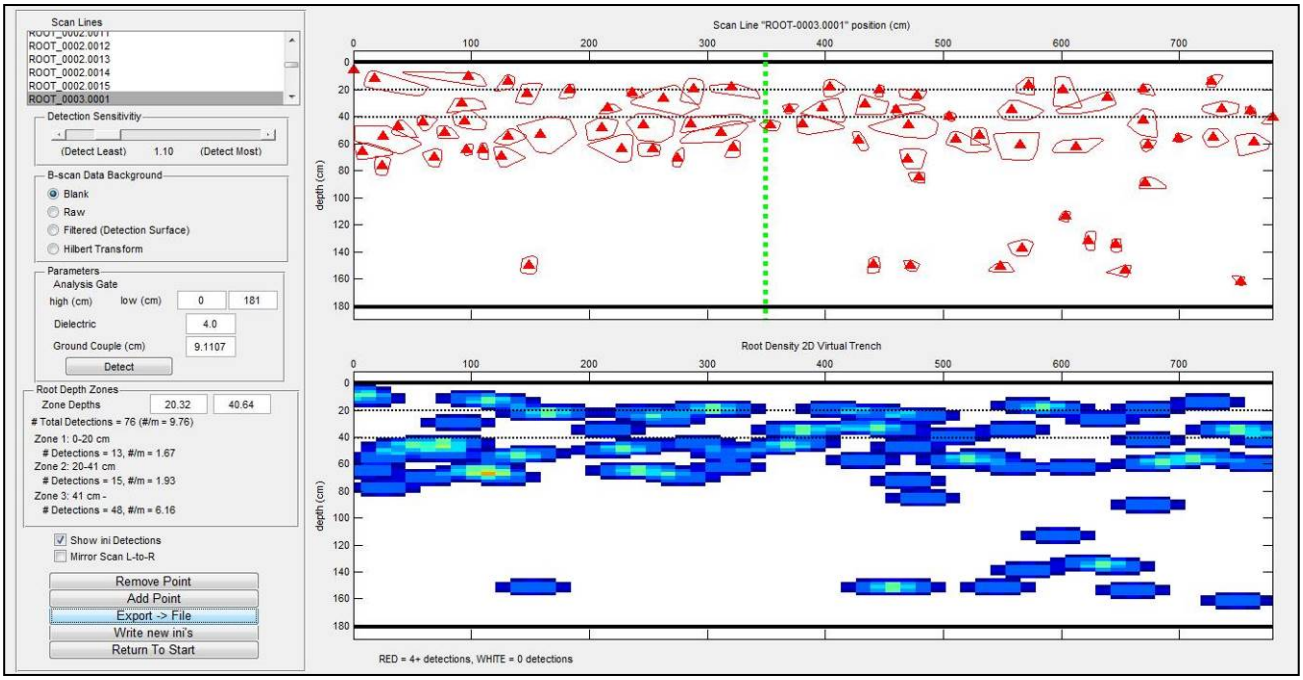
File View Window Help
VT3
VT2
Depth Range = 0.0 cm to 191.9 cm
Low
High
Ready
t1 = -9.09 (0), t2=191.40 (397), s1=1, s2=1945
Thresh: 40.0
W+fm No: 1
13:58
18/05/2016

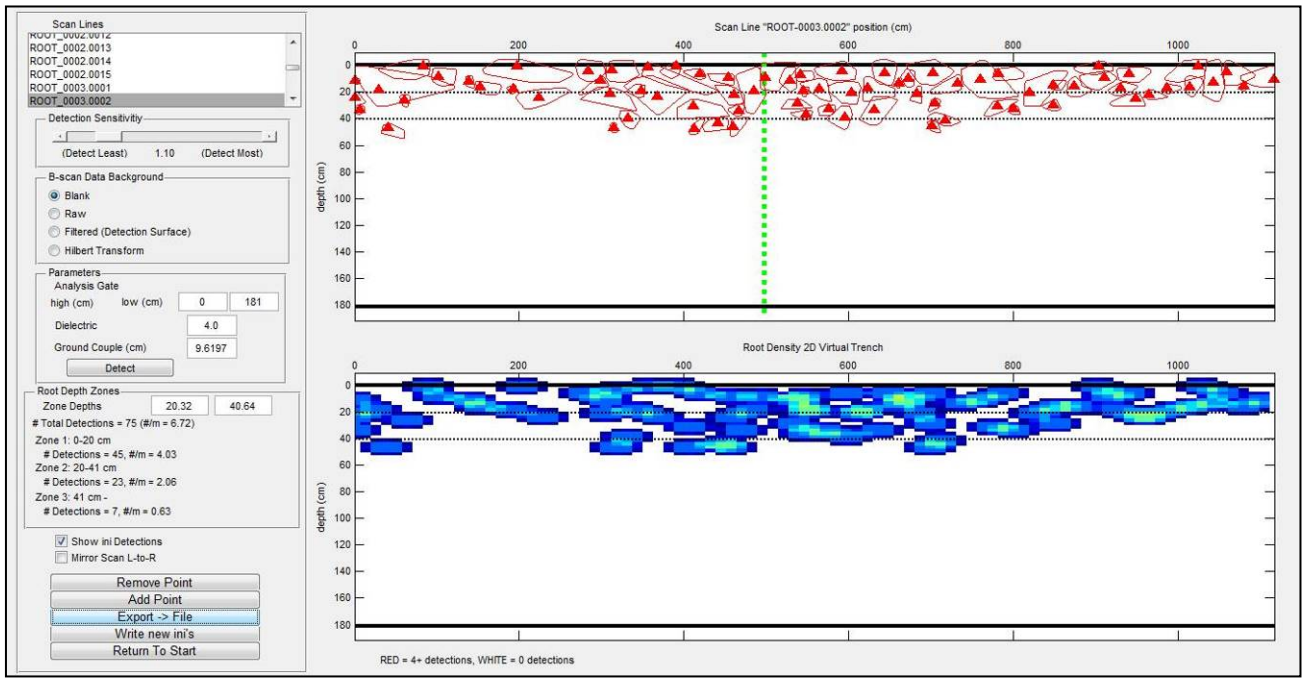
File 003 Scan 001-005

Please note, data is only analysed for the top 50cm of soil in scan lines 002-005

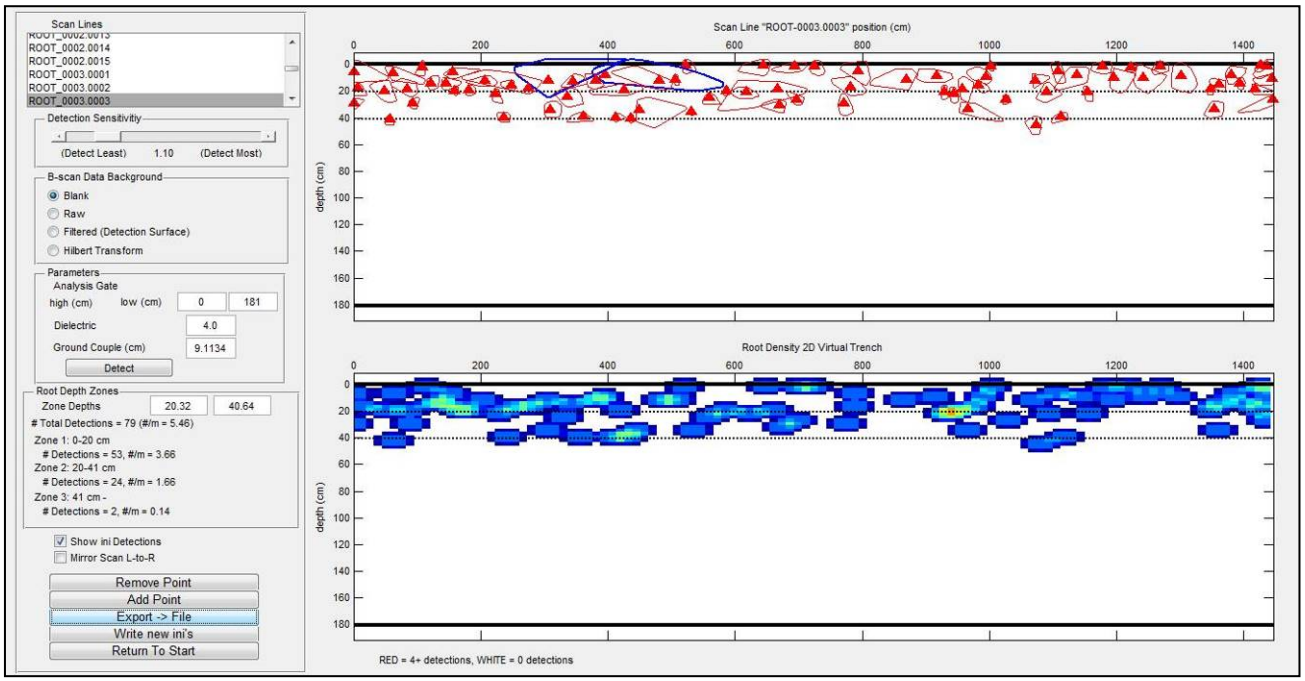
Scan 001



Scan 002



Scan 003



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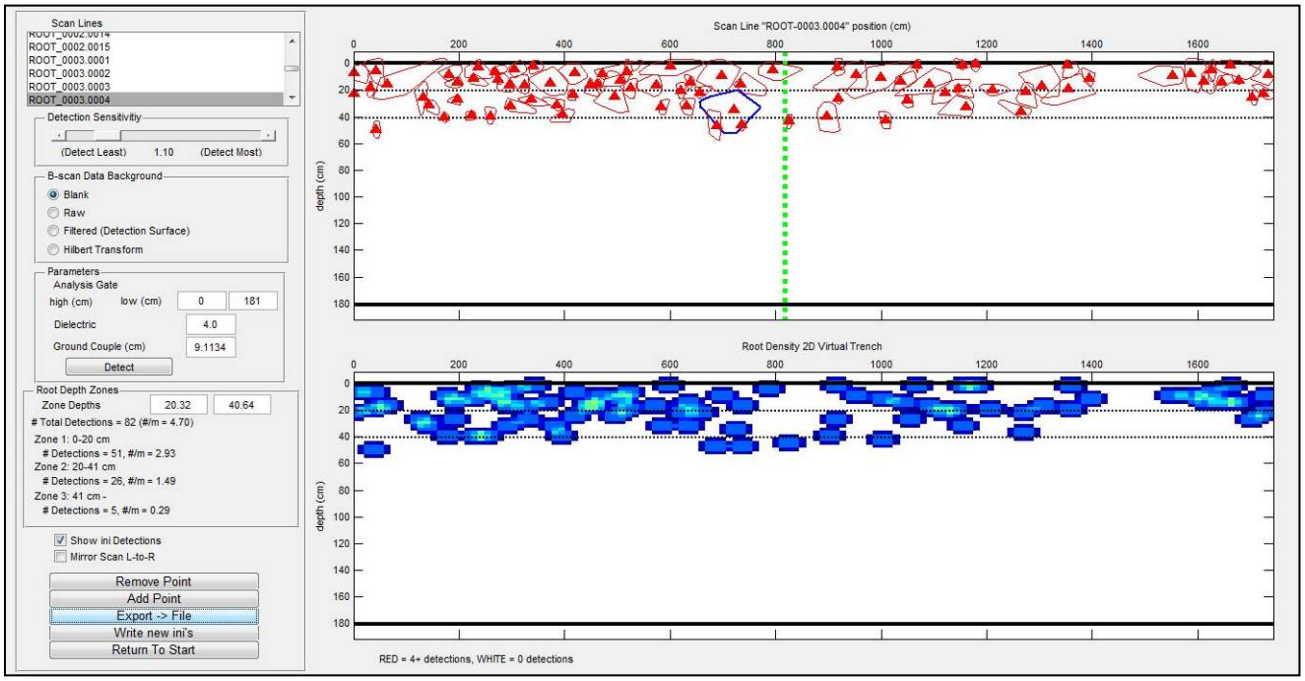

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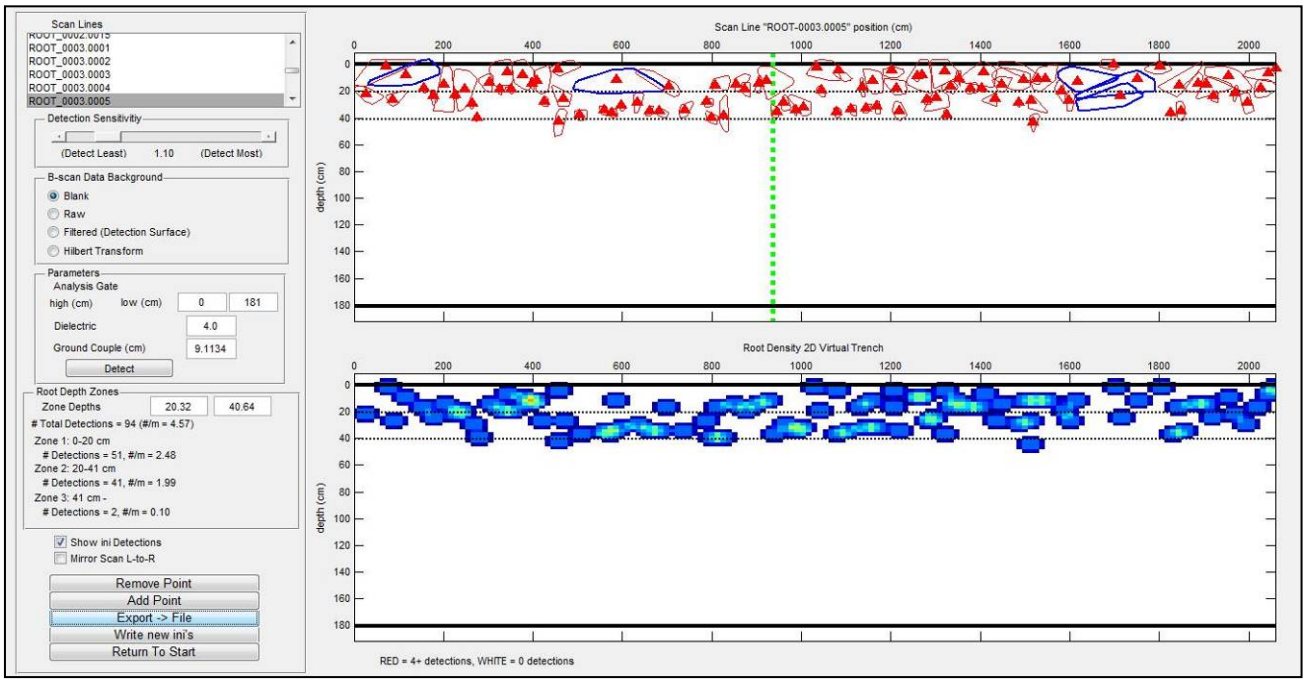
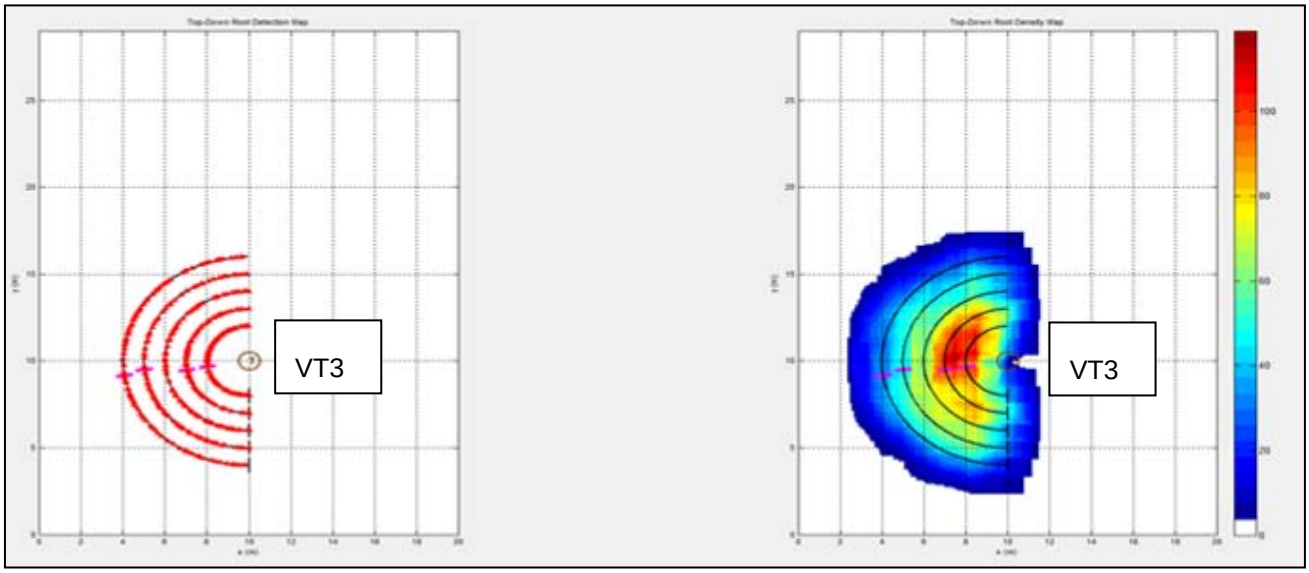
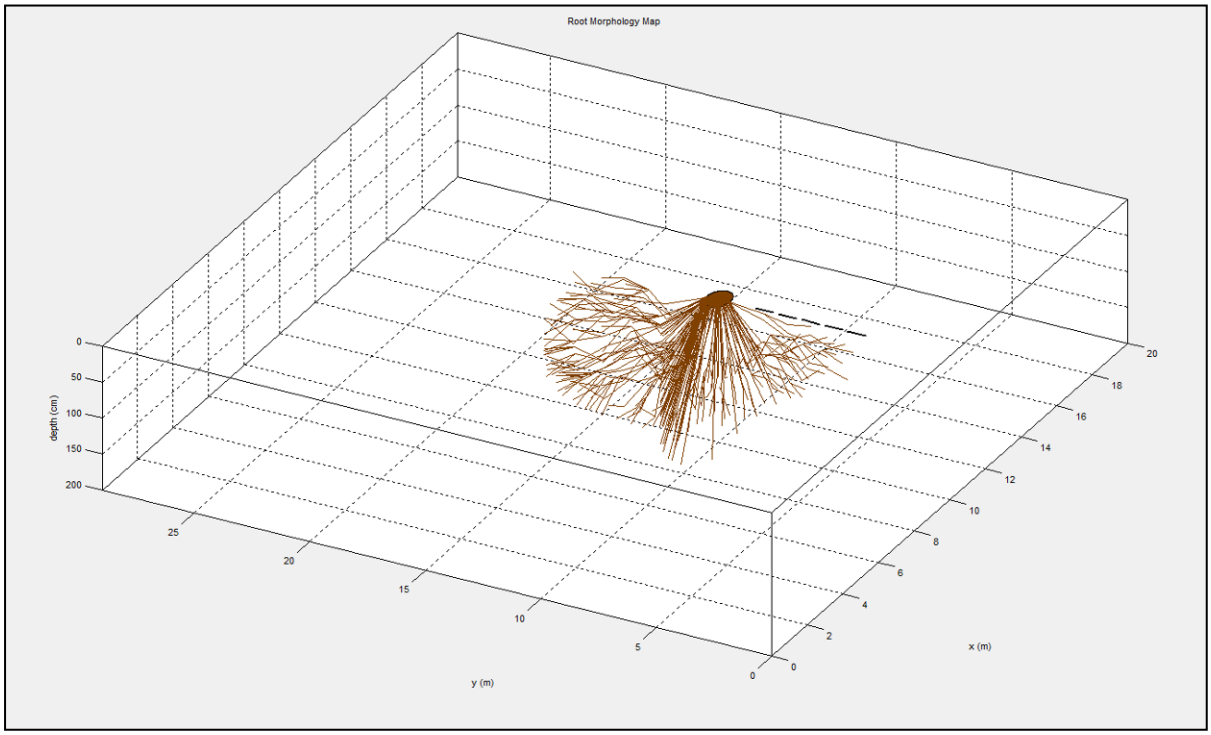




Top-down view of root detections

Rooting densities

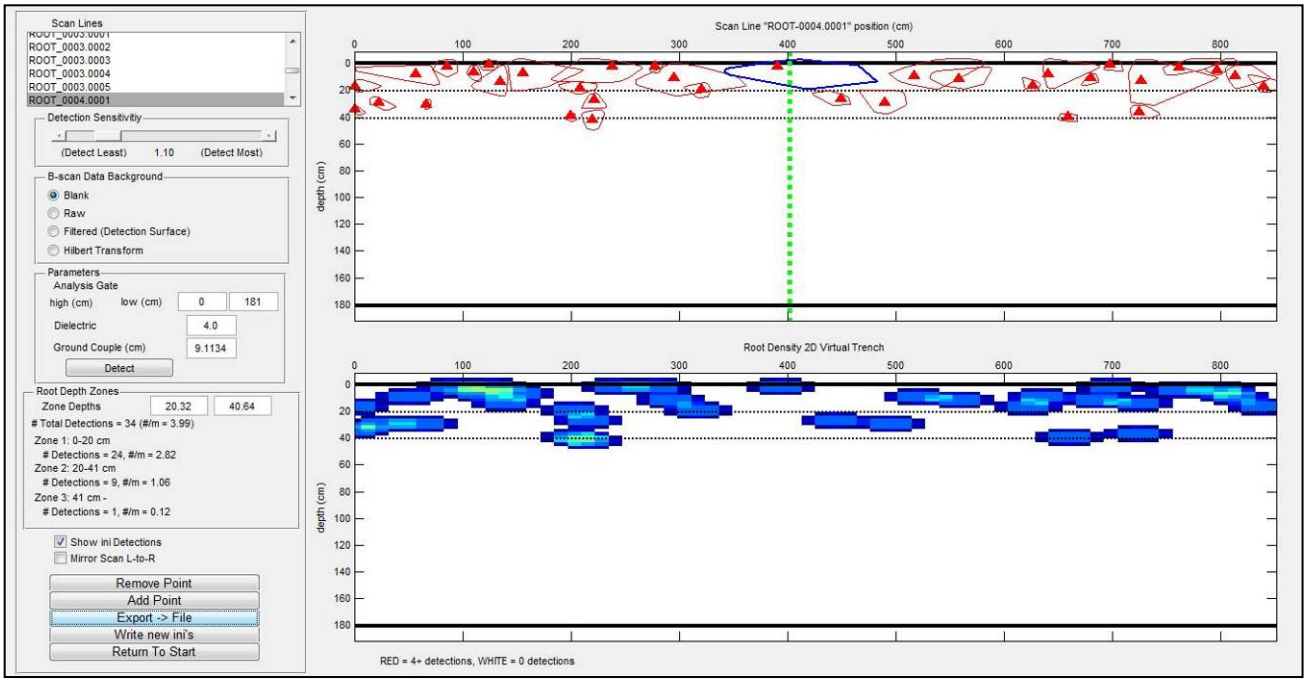


Root morphology in grass to rear of VT3

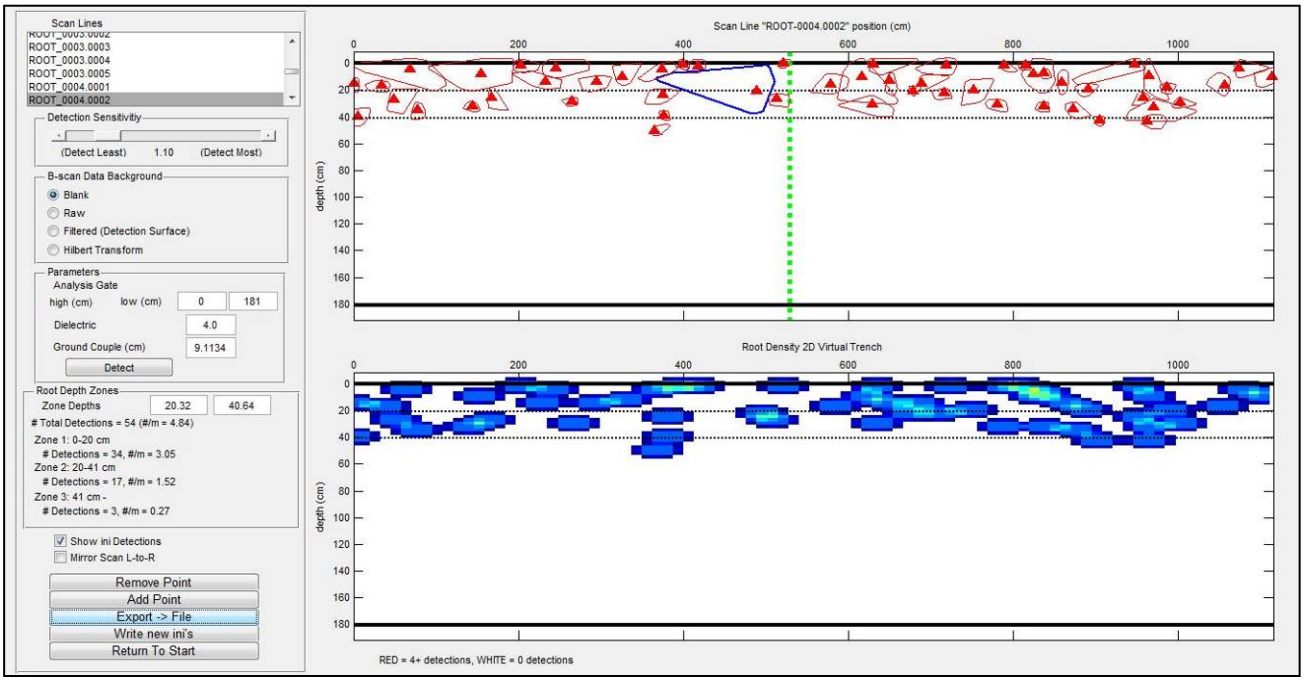
File 004 Scan 001-005

Please note, data is only analysed for the top 50cm of soil in scan lines 001-004

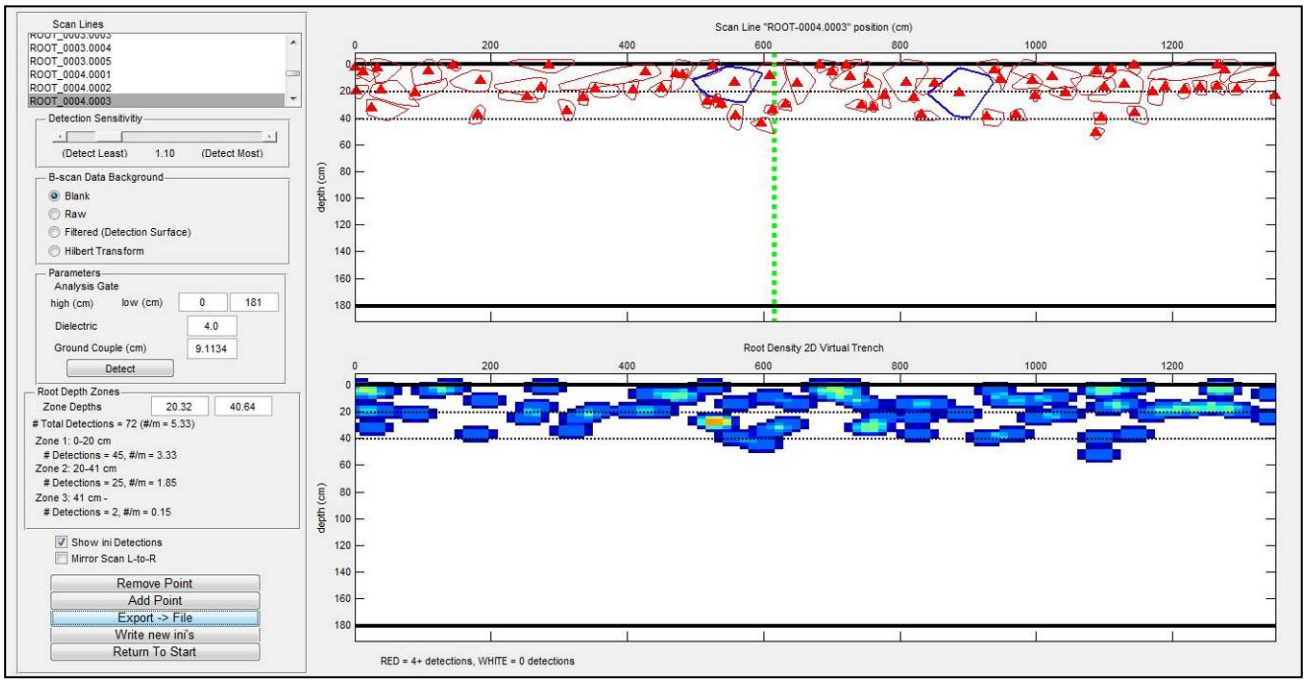
Scan 001



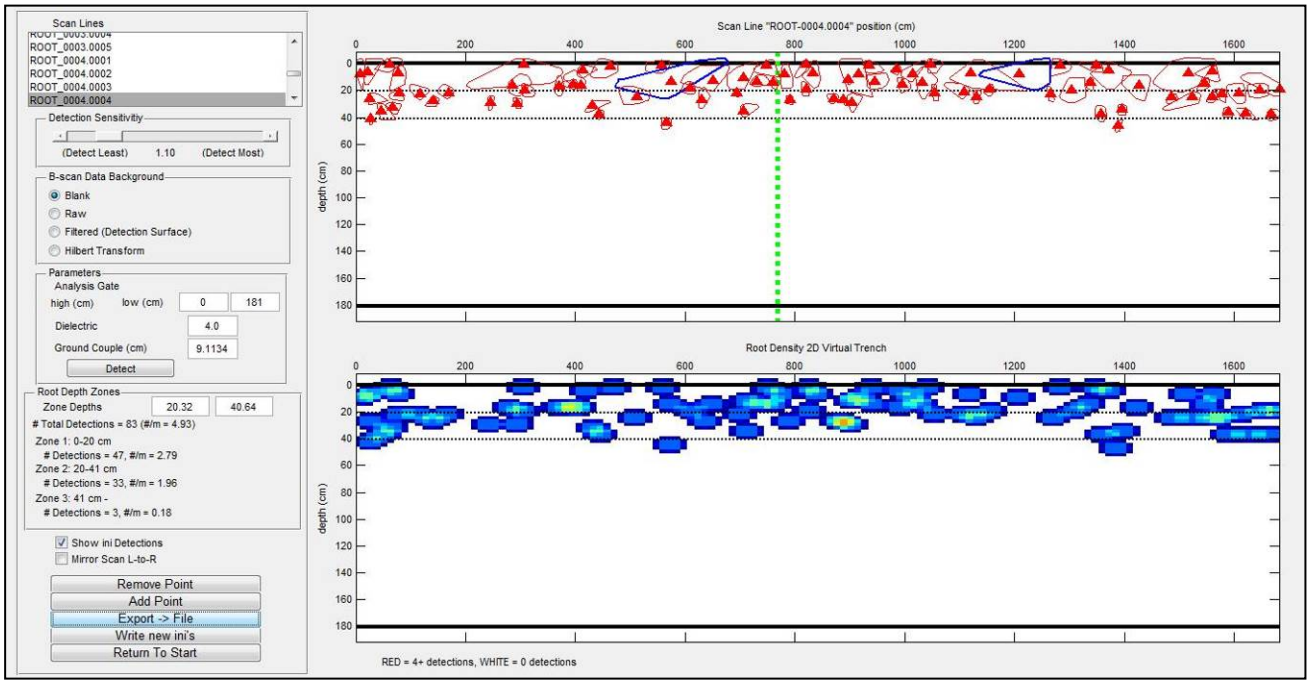
Scan 002



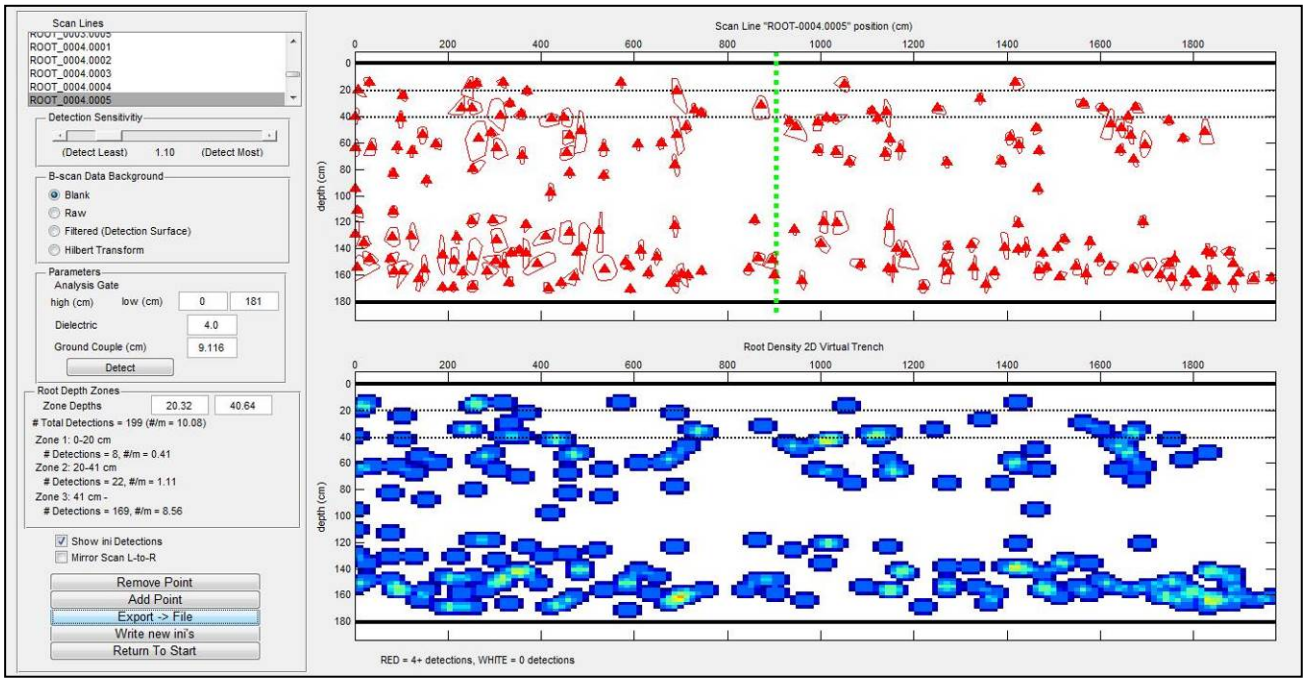
Scan 003

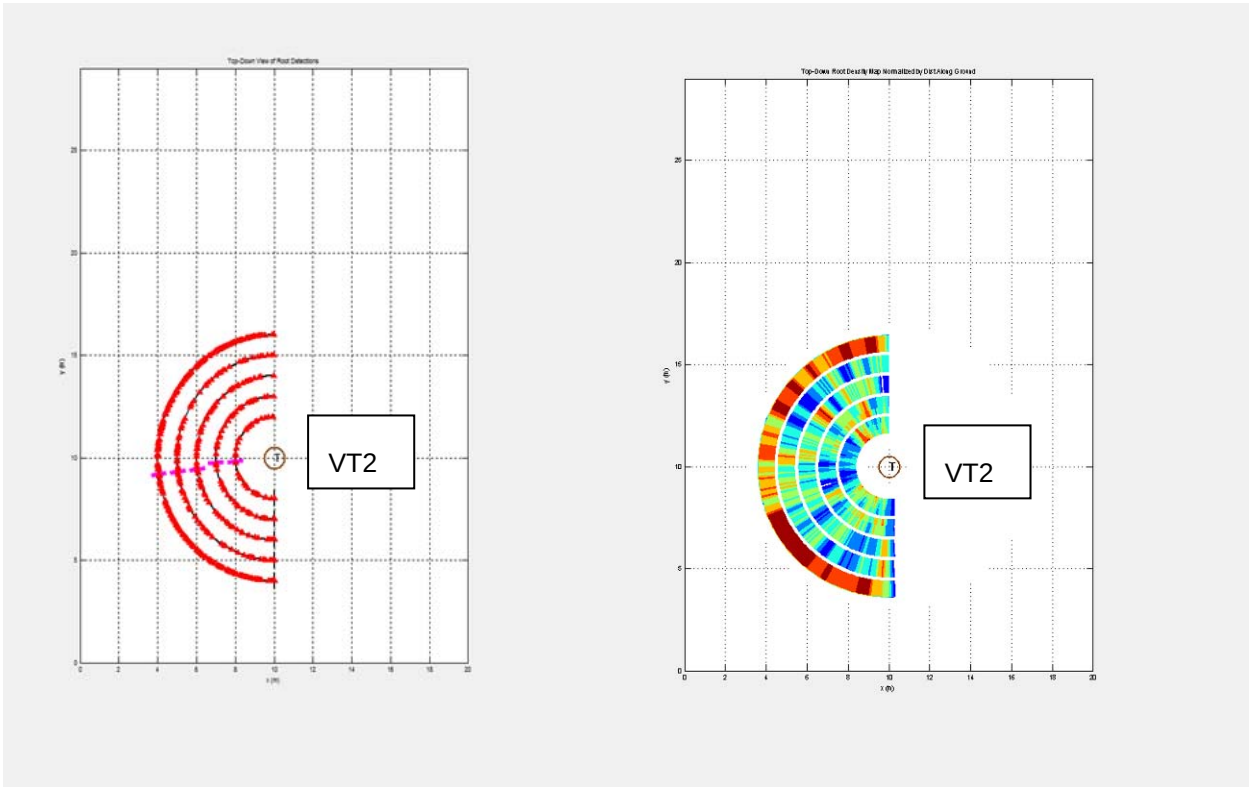


Scan 004



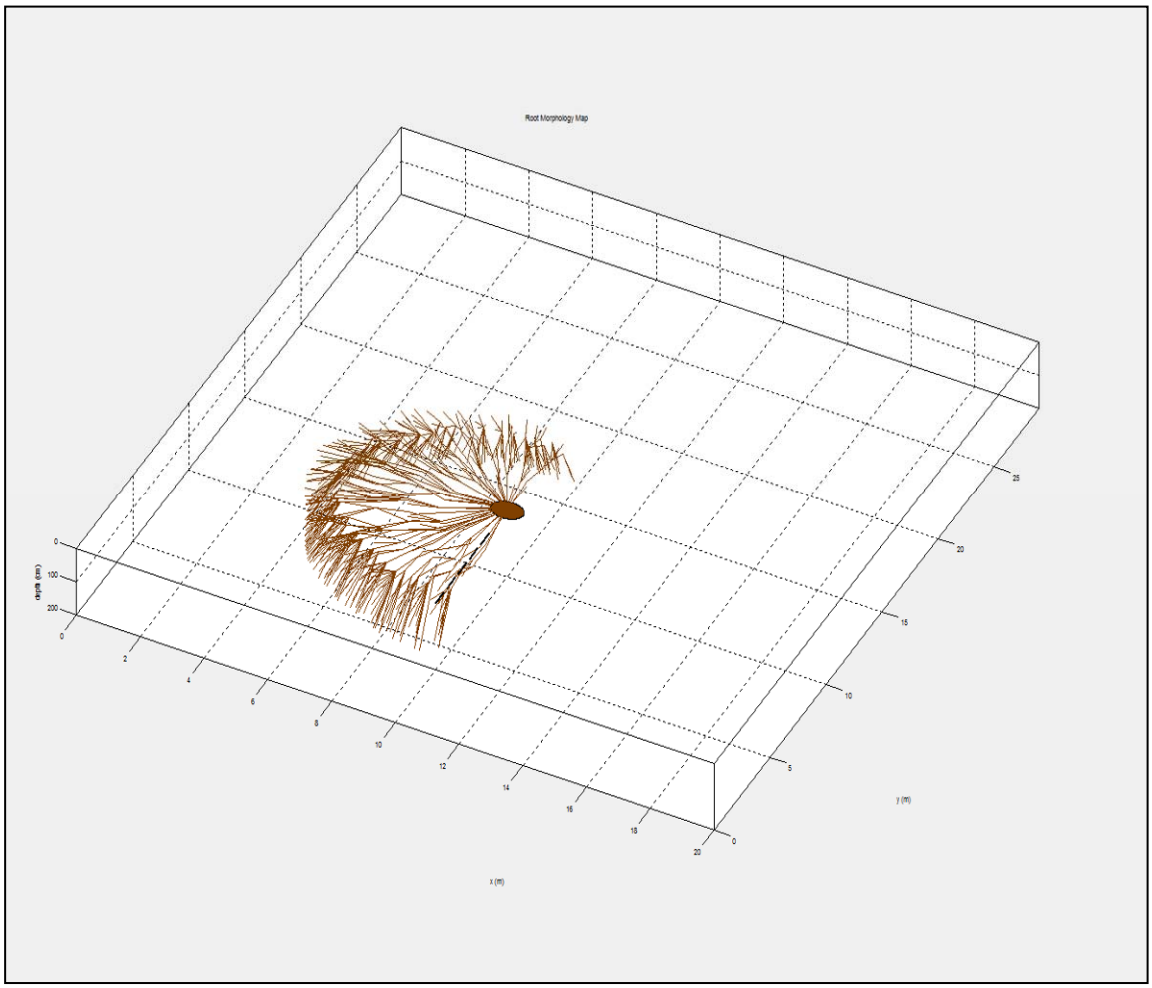
Scan 005





Top-down view of root detections

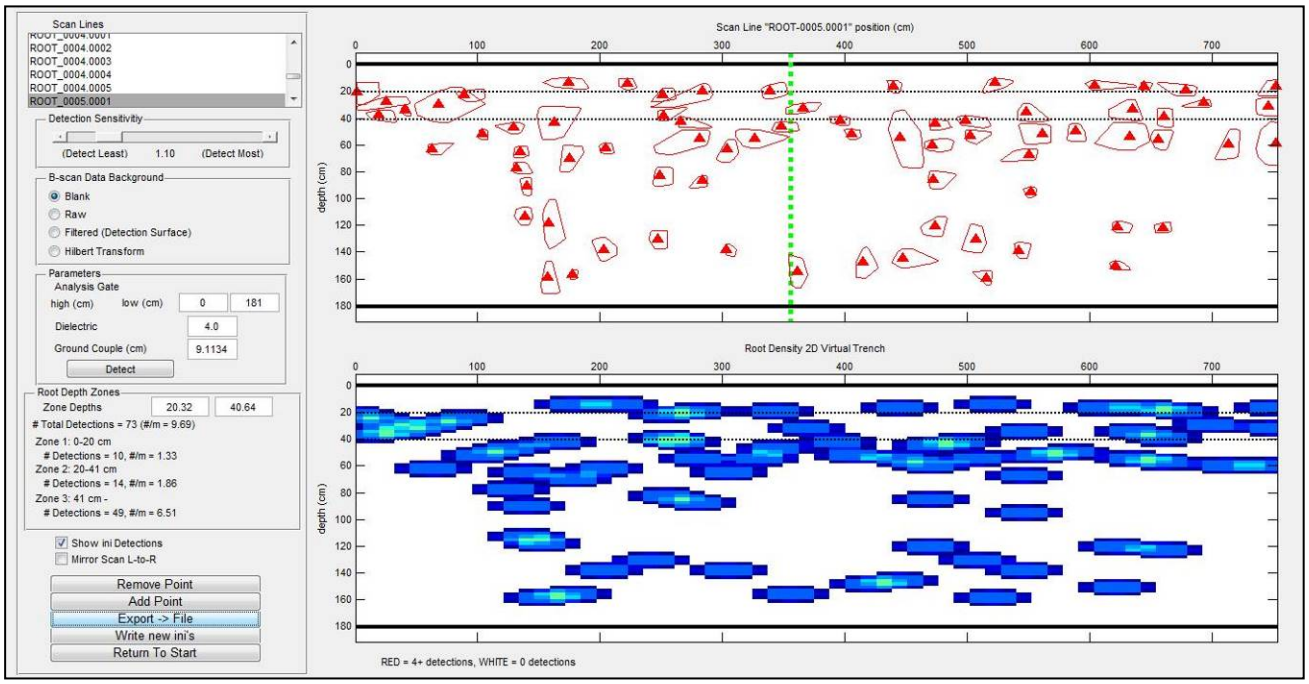
Rooting densities



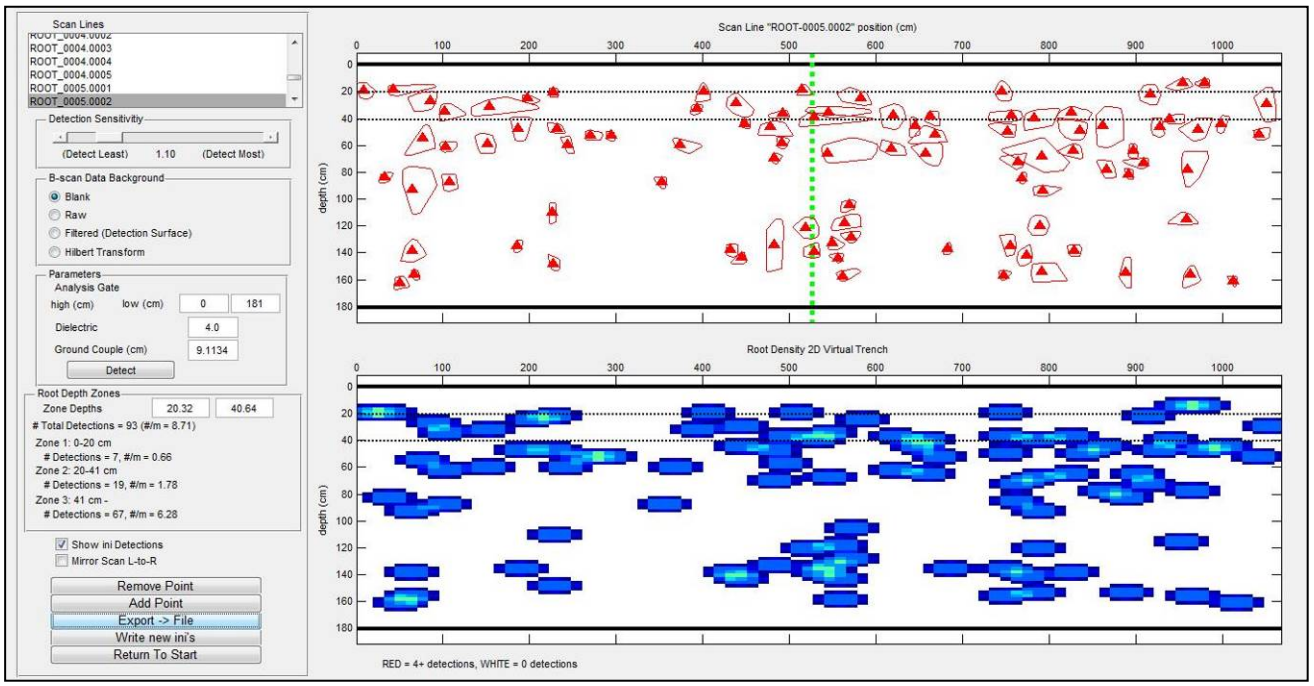
Root morphology in grass to rear of VT2

File 005 Scan 001-005

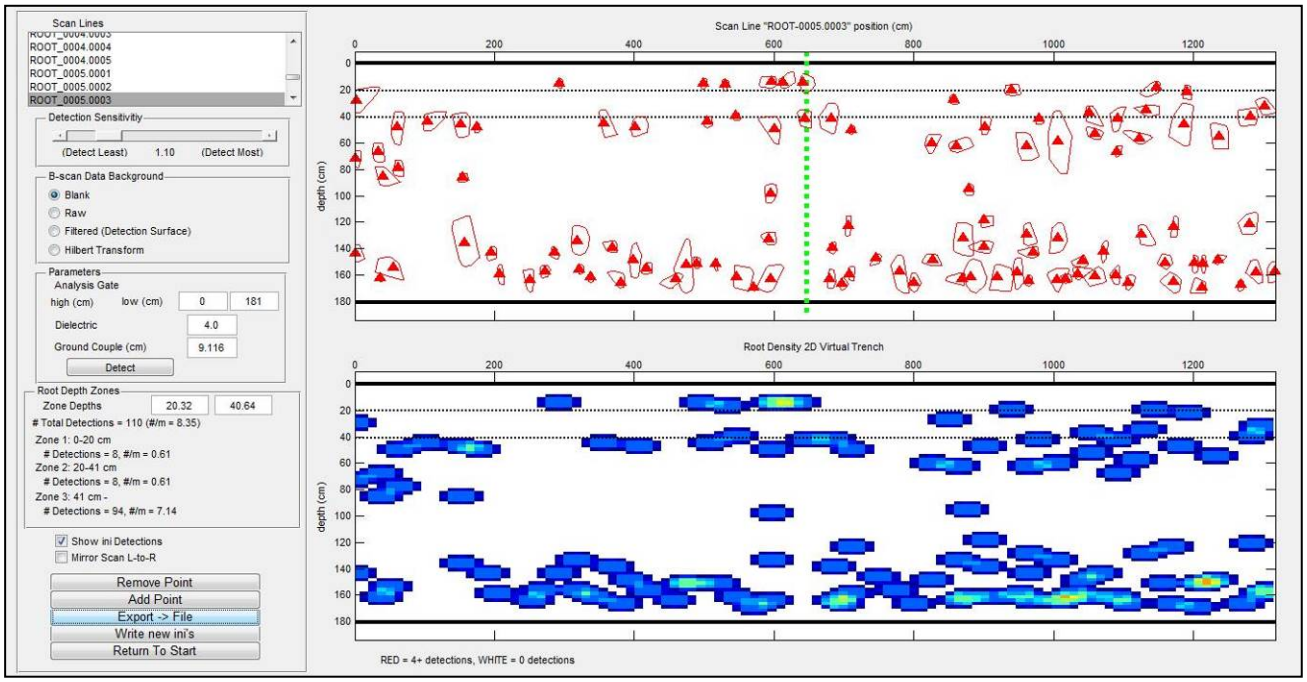
Scan 001



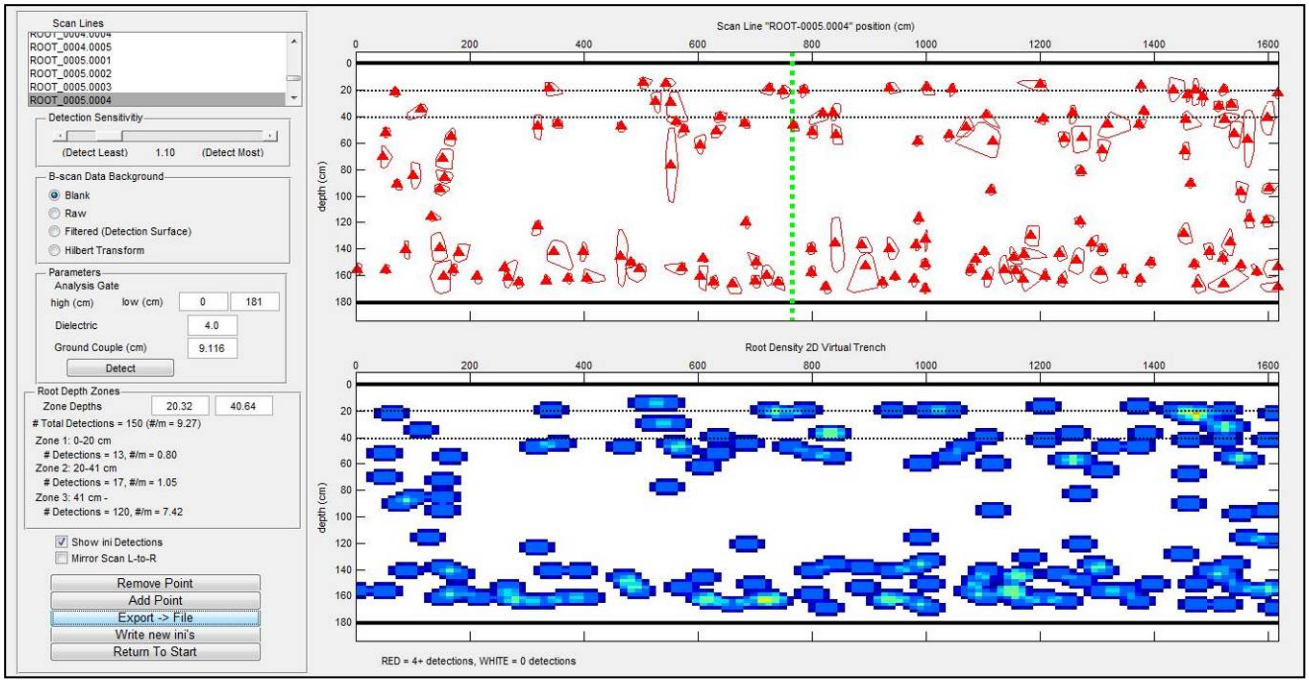
Scan 002



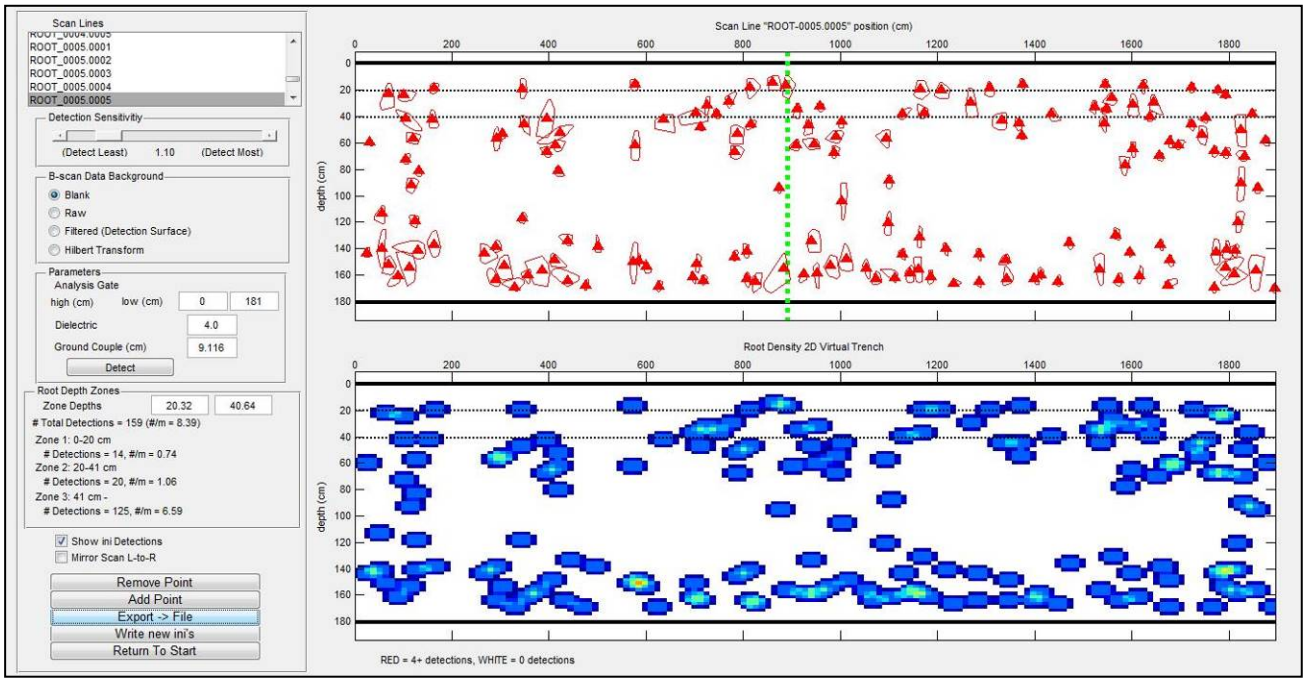
Scan 0003

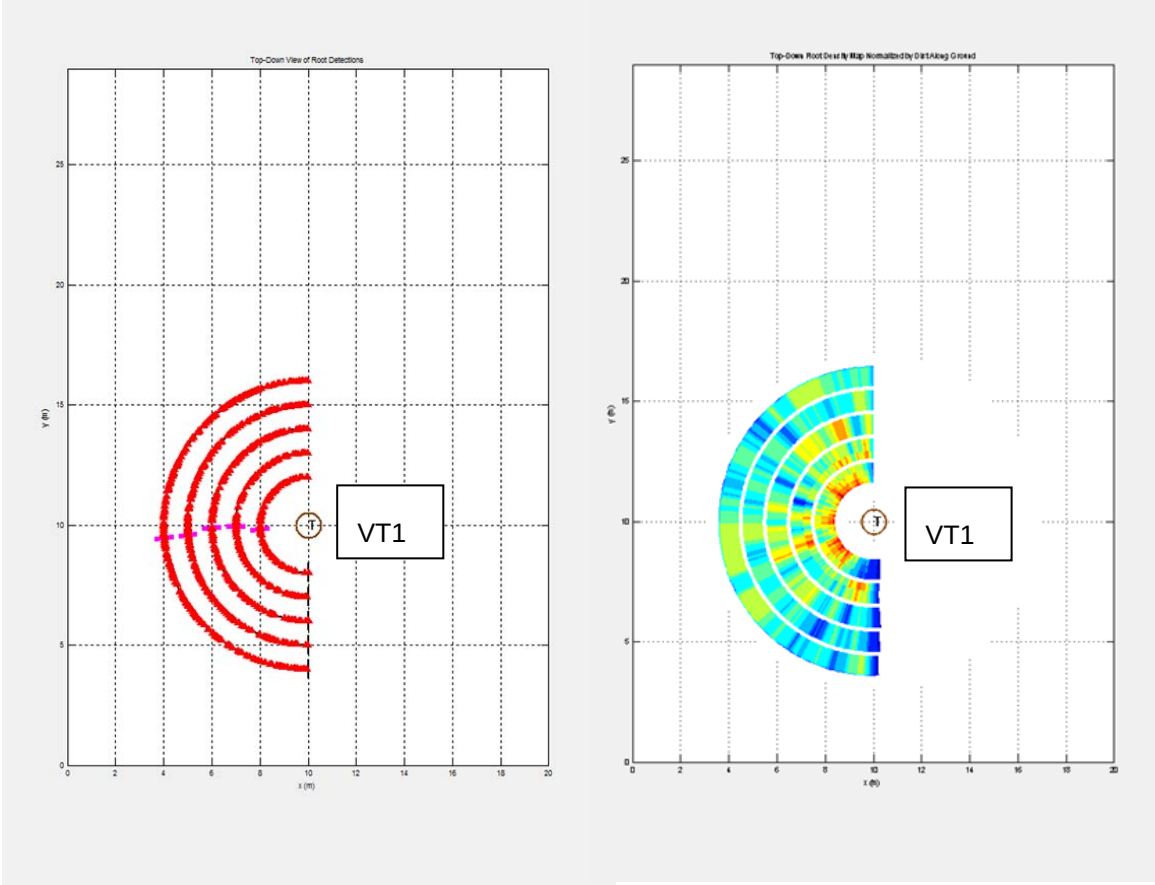


Scan 004



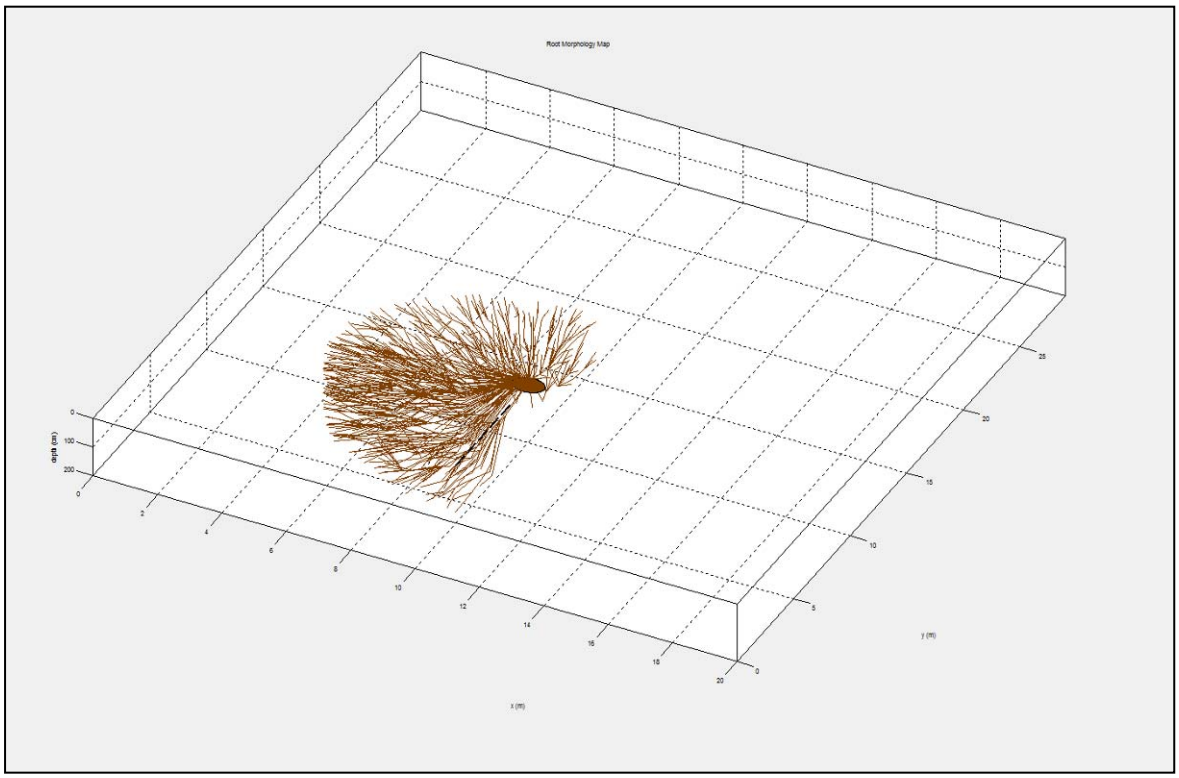
Scan 005





Top-down view of root detections

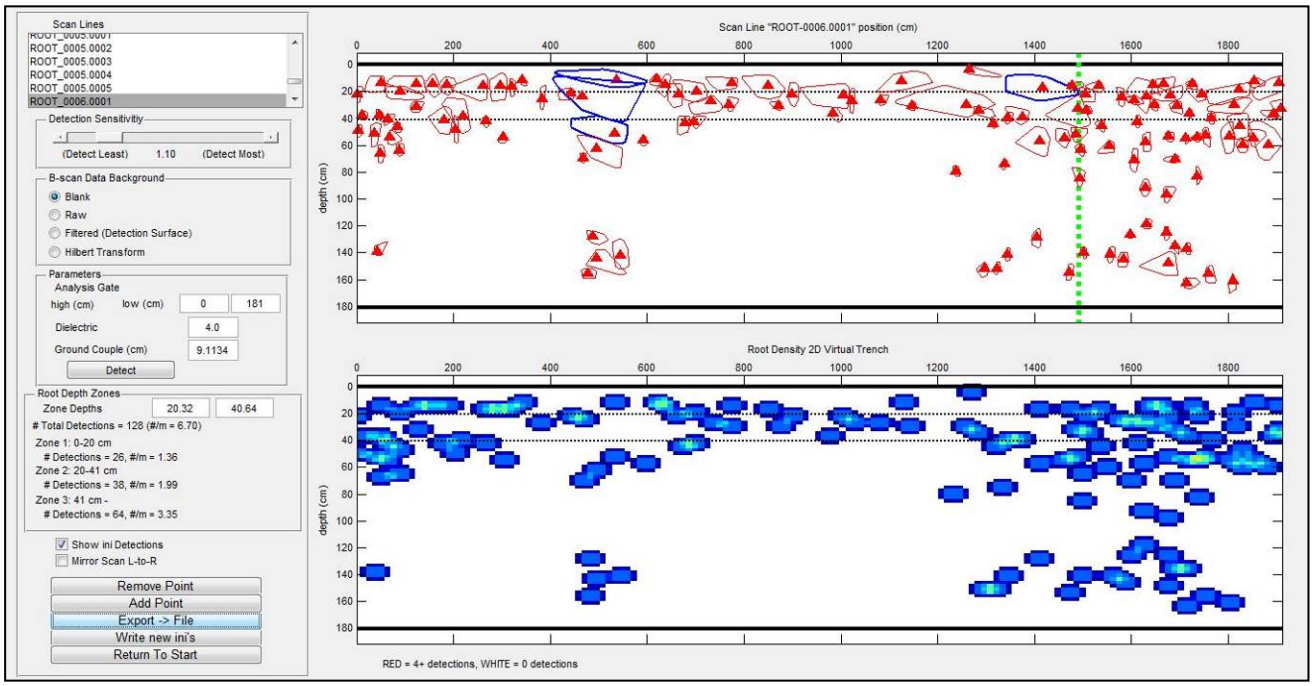
Rooting densities



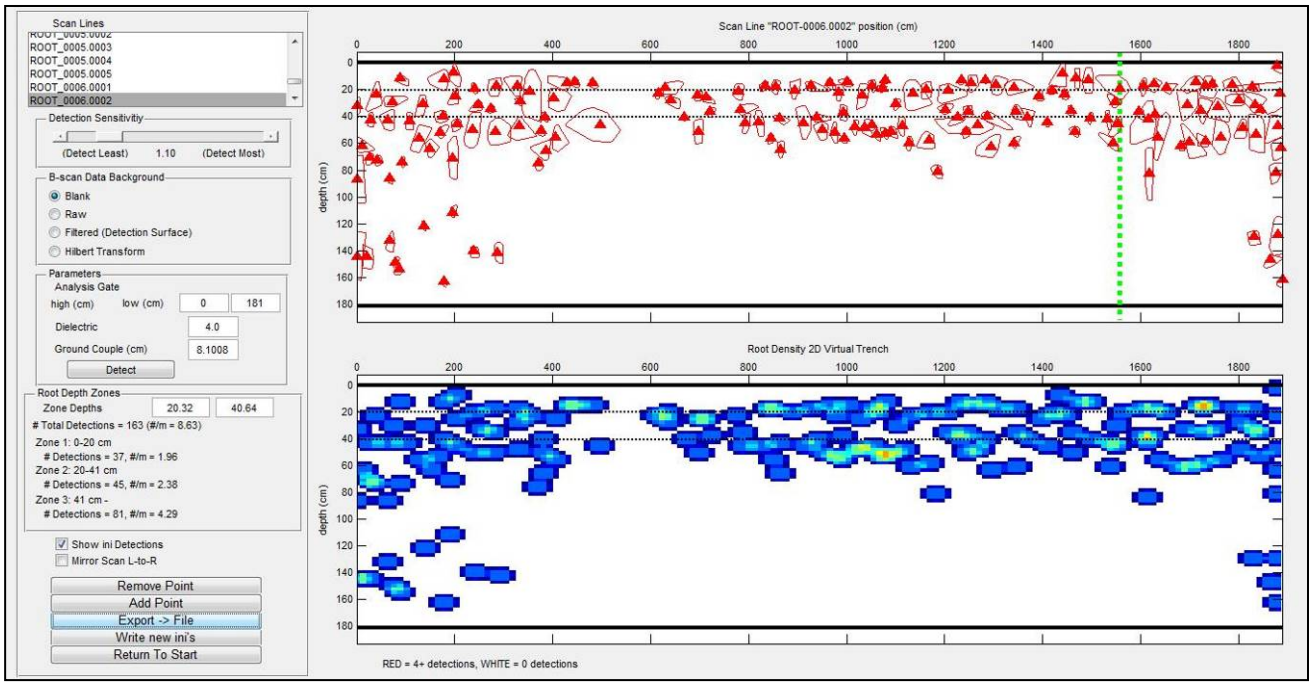
Root morphology in grass to rear of VT1

File 006 Scan 001-005

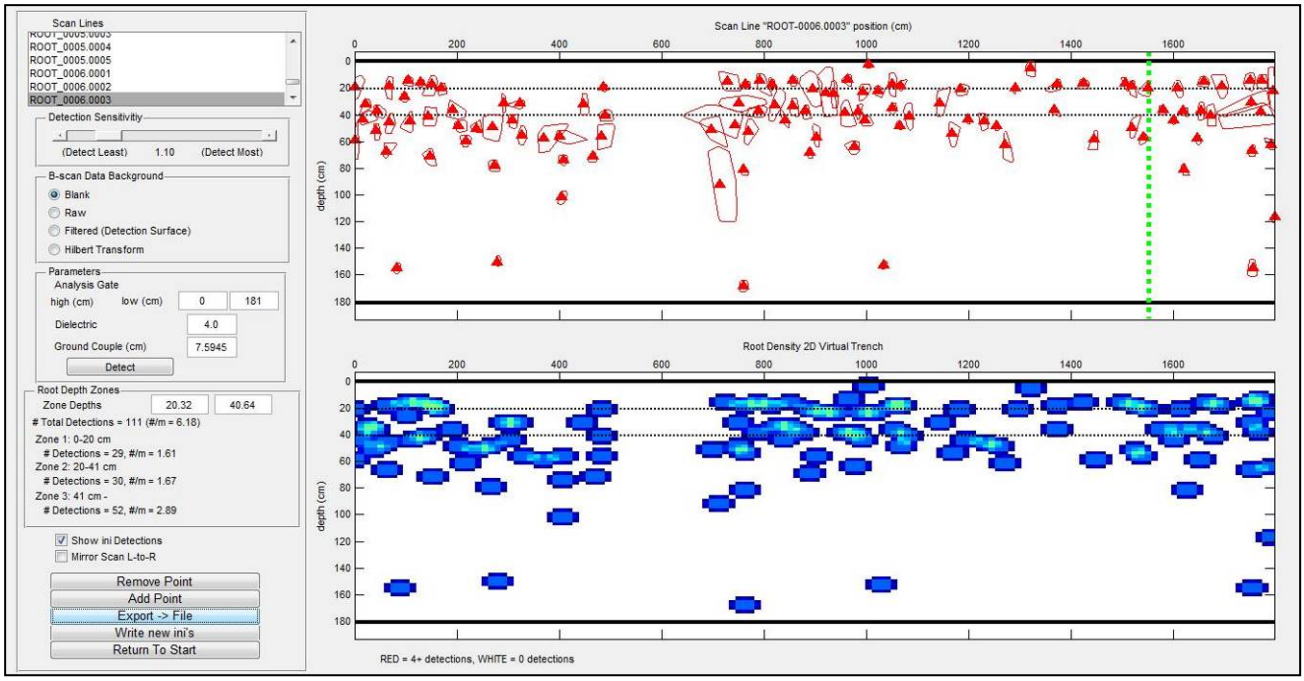
Scan 001



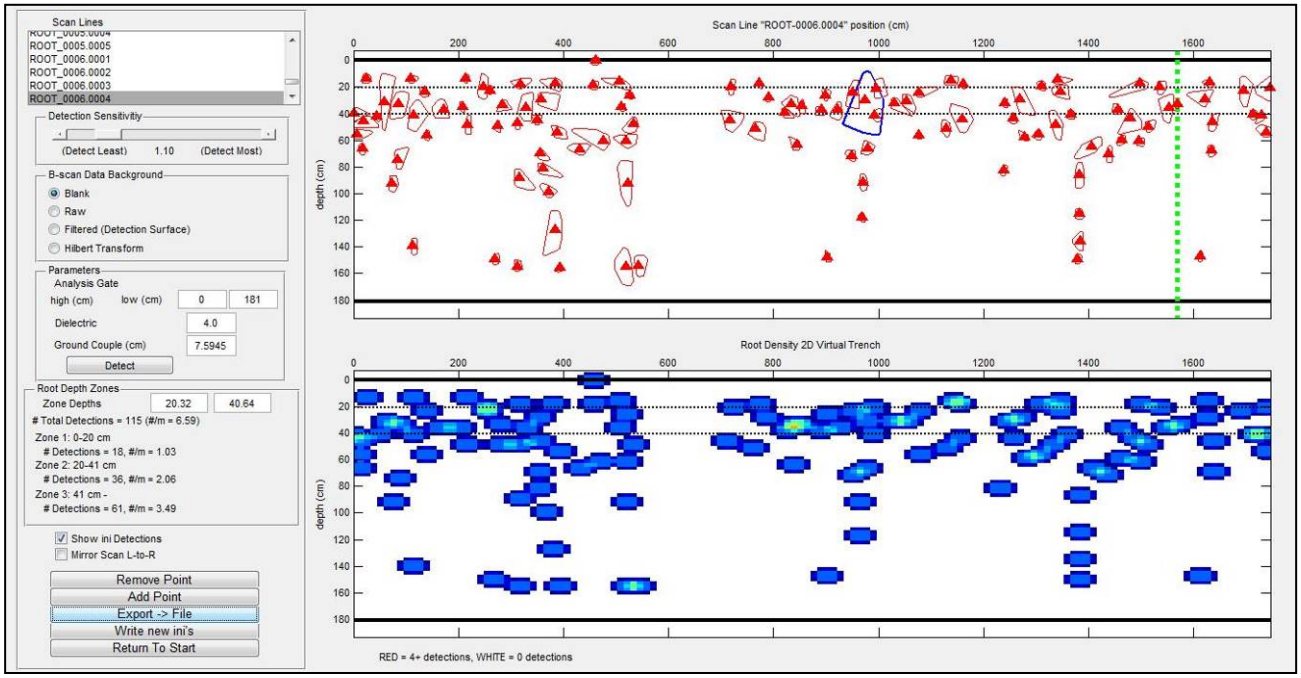
Scan 002



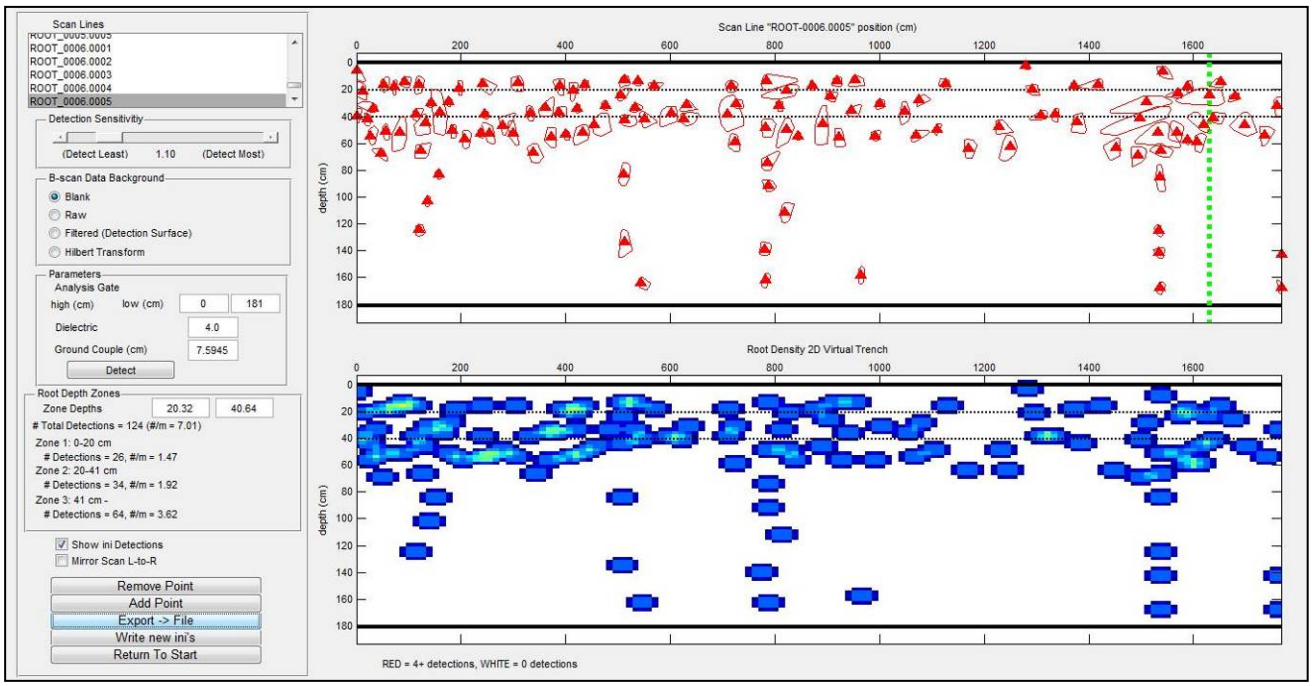
Scan 003

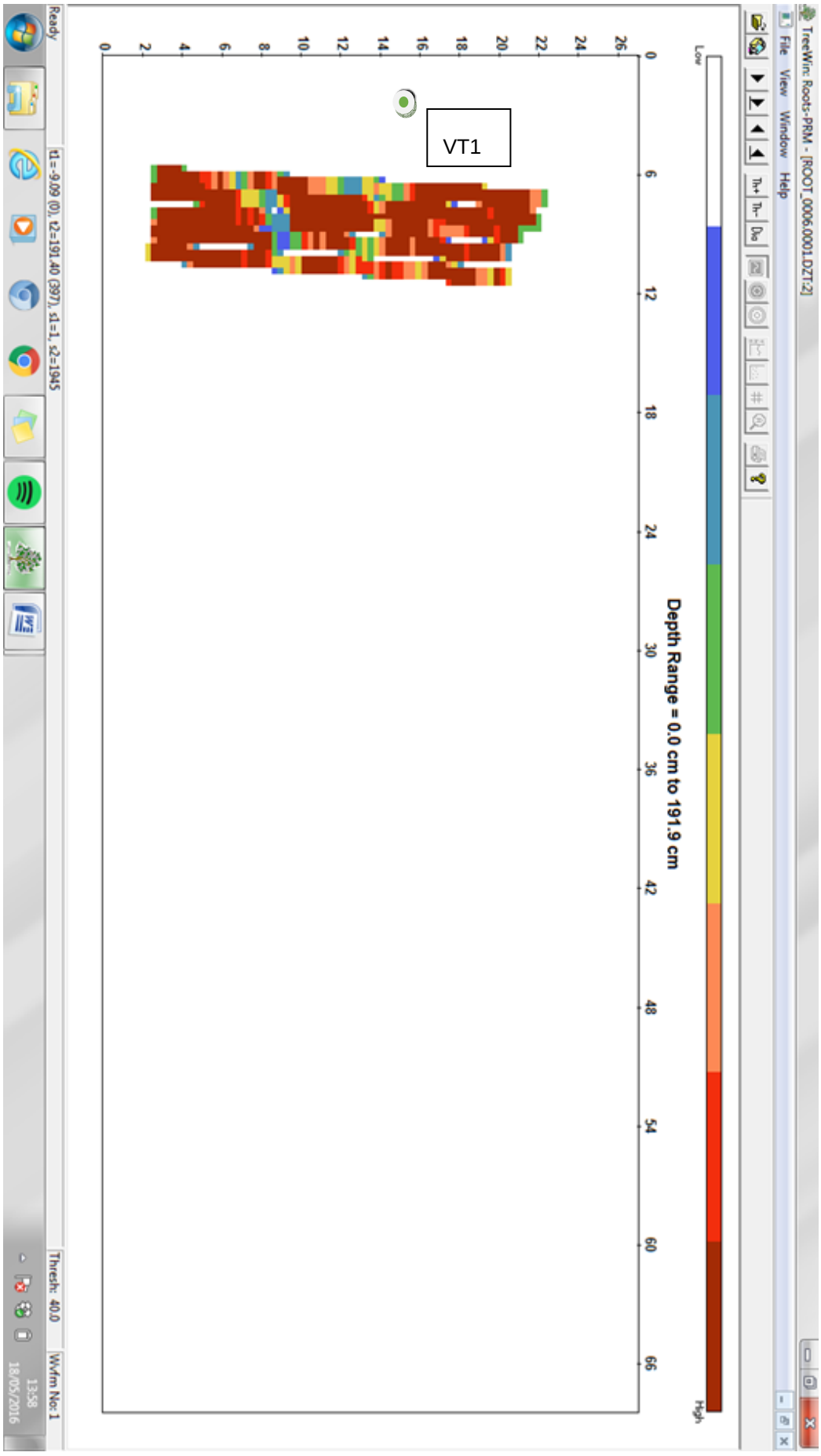


Scan 004



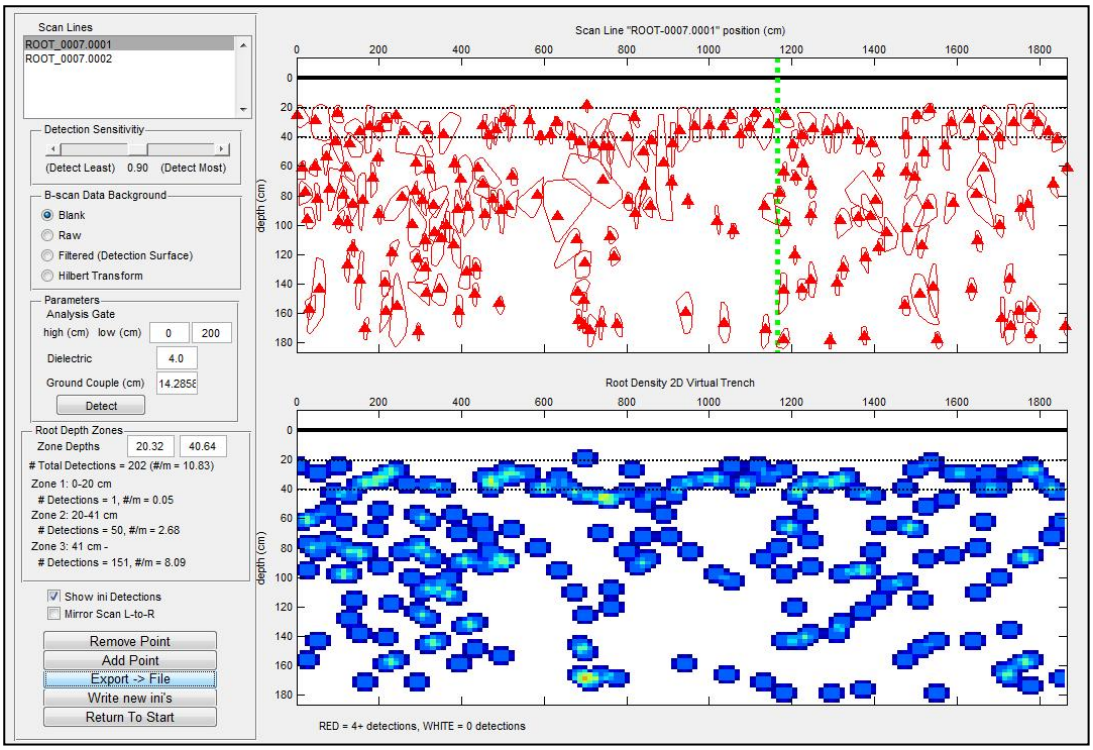
Scan 005



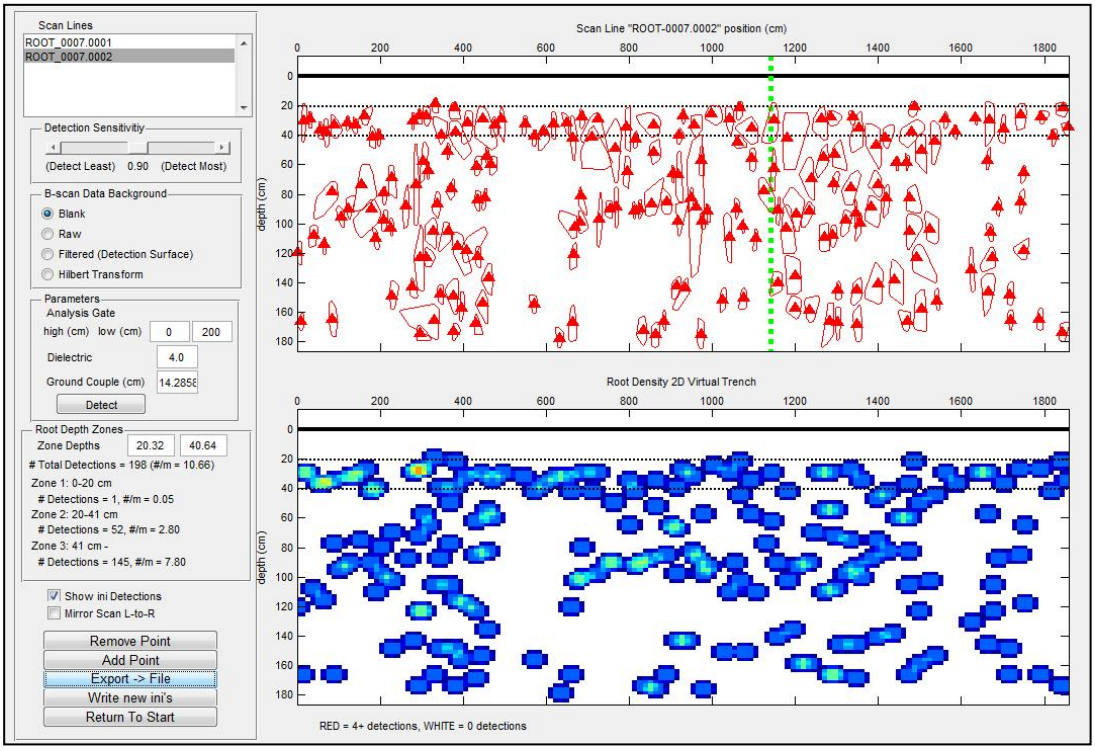

TreeWin: Roots-PRM - [ROOT_0006.0001.DZT:2]
File View Window Help
Low
High
Depth Range = 0.0 cm to 191.9 cm
VT1
Ready
t1=-9.09 (0), t2=191.40 (397), s1=1, s2=1945
Thresh: 40.0
Wvfm No: 1
13:58
18/05/2016

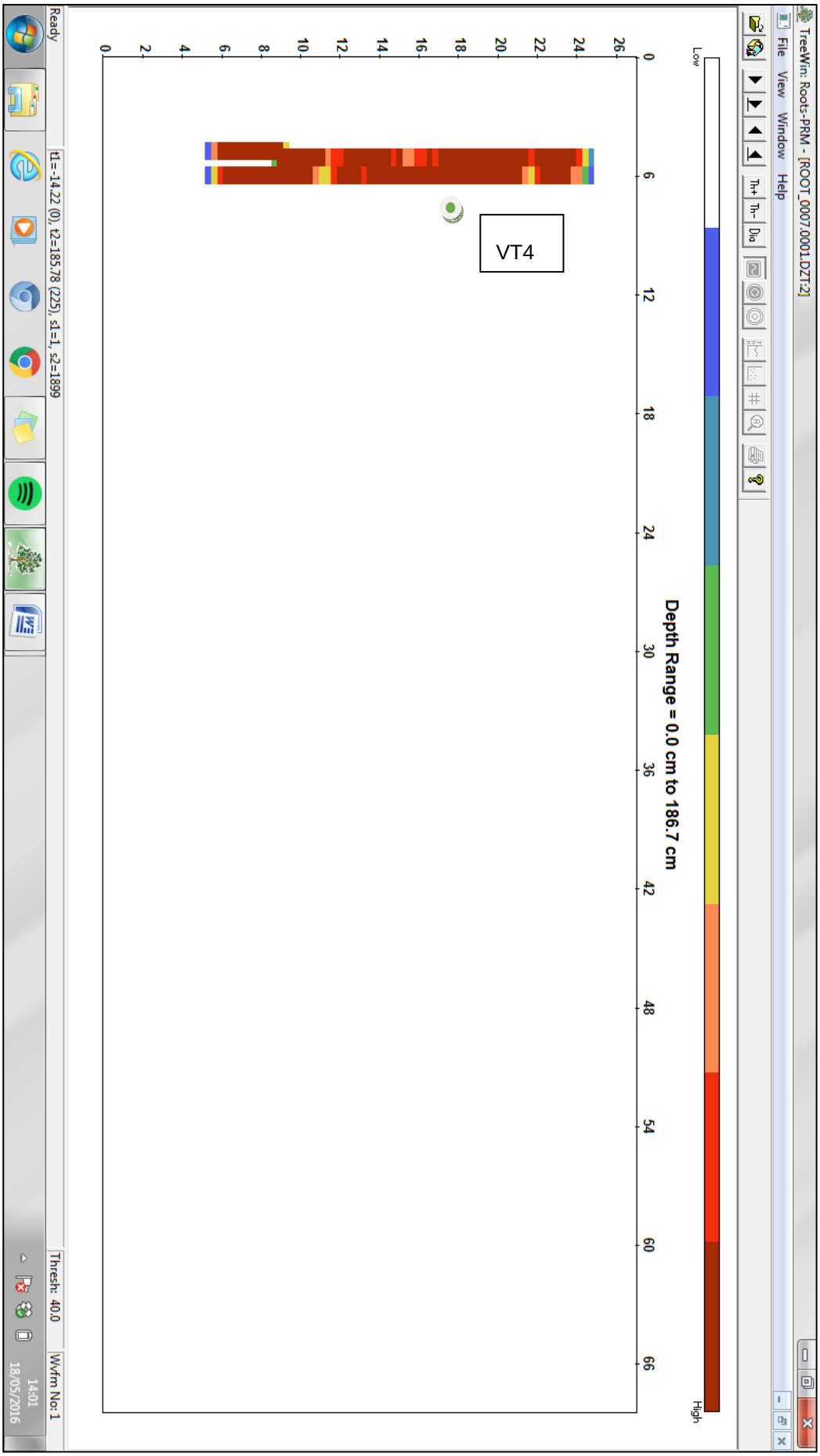
File 007 Scan 001 and 002

Scan 001



Scan 002




TreeWin: Roots-PRM - [ROOT_0007.0001.DZT:2]
File View Window Help
Low
High
Depth Range = 0.0 cm to 186.7 cm
VT4
Ready
t1=-14.22 (0), t2=185.78 (225), s1=1, s2=1899
Thresh: 40.0
Wvfm No: 1
14:01
18/05/2016

8. APPENDIX 4 - CAVEATS

1. The survey is concerned solely with TreeRadar issues.

2. As trees are a dynamic living organism this report is only valid for a period of 12 months.

3. All arboricultural issues, other than the root analysis by TreeRadar are outside the scope of this report.

4. The TreeRadar equipment only picks up roots with a diameter greater than 20mm. Finer roots will not be picked up.

5. The scanning conditions of some lines was poor due to ground vegetation and non-root reflectors, which may affect the accuracy of the scan results, but will still indicated the trend.