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Inspection Report Service

TRU™ (Tree Radar Unit) Non-Invasive Tree Root Scans



In Association with:

sorbus
INTERNATIONAL LIMITED

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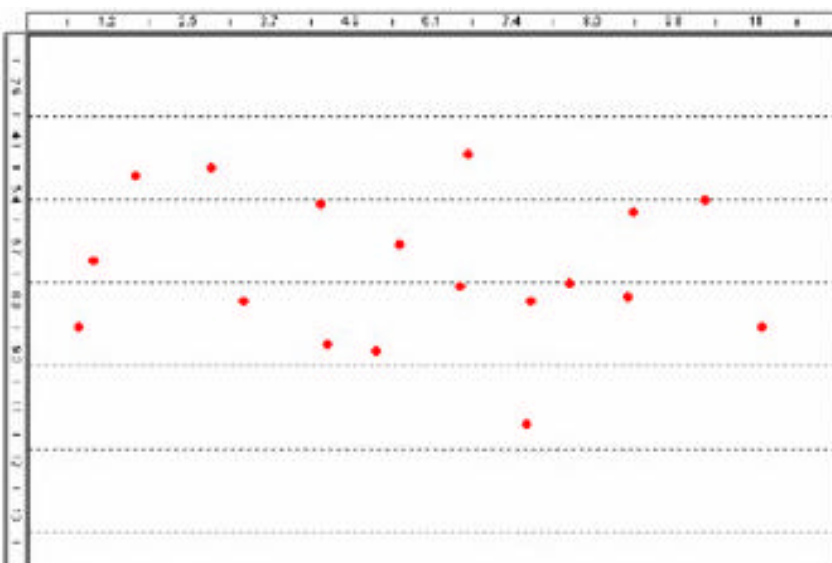
TRU™ (Tree Radar Unit)

Non-Invasive Inspection of Trunks and Roots

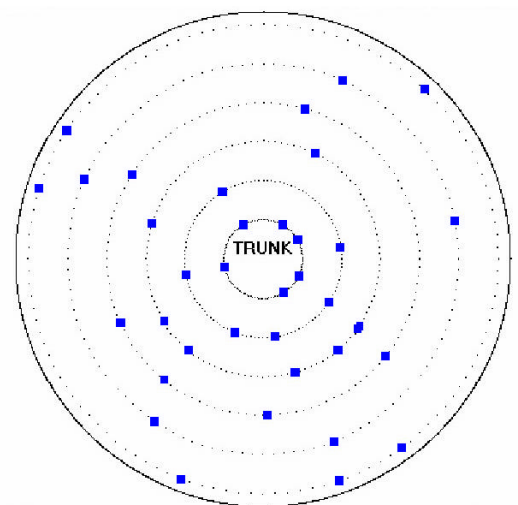
Root Inspection – "Virtual Excavator"



- Rapid, Non-Invasive Inspection of Subsurface Structural Roots
- Also detects buried pipes, cables, ducts, etc.
- Depth Penetration down to 1 Meter
- Minimal Setup & Scan Times – Typically 30 to 60 minutes for a Multi-Line Scan
- Scan either in Straight Lines Parallel to Tree or in Concentric Circular Lines around Tree
- Detection of Structural Roots as small as 0.5-inch (1.3-cm)
- Subsurface 2D image of Root Location and Depth for each Line Scanned – "Virtual Excavator"
- Top-Down 3D Image of Root Layout and Density
- Detect and Image Roots under Covered Soil such as Asphalt and Concrete
- Professional Analysis Report



Virtual Trench - 2D Planar Depth Image of Root Location (top scale, ft) and Depth (left scale, in) for One Scan Line



3D Top-Down Image of Root Layout and Density

DISCLAIMER

1. **Use at Customer's Risk.** TreeRadar endeavors to use equipment that generates useful information and, when provided, to prepare reports that will reflect its best judgment in light of the facts as it knows them, provided that you comply with all of your obligations to TreeRadar, but TreeRadar does not guarantee the outcome of its efforts or the structural integrity of any tree. Any report prepared by TreeRadar is used strictly at your sole risk. TreeRadar is not a certified arborist facility and its personnel are not certified arborists, and you are solely responsible for engaging the services of a certified arborist in interpreting any report or other information provided by TreeRadar.

2. **Disclaimer of Warranties.** You expressly understand and agree that:

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(b) TREERADAR SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES, INCLUDING BUT NOT LIMITED TO DAMAGES FOR GOODWILL, INJURY TO BODY OR PROPERTY, DEATH OR OTHER LOSSES (EVEN IF TREERADAR HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES) RESULTING FROM USE OF OR RELIANCE UPON TREERADAR'S SERVICES.

3. **Limitation of Damages.** Notwithstanding the above, TreeRadar's total liability for any damages shall be limited to the total fees paid by you to Treeradar for services over the preceding six (6) months. This is a comprehensive limitation of liability that applies to all damages of any kind, including (without limitation) compensatory, direct, indirect or consequential damages, loss of data, income or profit, loss of or damage to property and claims of third parties.

4. **Exclusions and Limitations.** SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OF CERTAIN WARRANTIES OR THE LIMITATION OR EXCLUSION OF LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES. ACCORDINGLY, SOME OF THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU.

5. **Dispute Resolution.** These terms shall be governed by and construed in accordance with the laws of the State of Maryland, excluding its choice of law provisions. You agree that any dispute between you and TreeRadar hereunder (other than as to payment of amounts owed) shall be submitted for binding arbitration before the American Arbitration Association conducted in accordance with its commercial dispute resolution rules in Washington, D.C., with the arbitrator's decision to be enforceable in any court of competent jurisdiction. Each party shall bear its own legal and other fees and expenses.

Note: TreeRadar and Sorbus personnel are not certified arborists. The results provided will describe what was found by the radar scans. They will not be a diagnosis. They should be used by a qualified professional, using traditional assessment criteria and instruments, to assess the tree risk potential.

An Introduction to Ground-Penetrating Radar (GPR).

- Ground-Penetrating Radar (GPR) has been in use for over 30 years
- It is used to locate objects underground, including engineering and environmental targets.
- When a GPR wave encounters a boundary between objects with different properties it will reflect, refract, and/or diffract from the boundary in a predictable manner.
- Use of GPR instrumentation for subsurface structural root mapping is a novel and recent application.
- Electromagnetic differences between tree roots and the surrounding soil provide the necessary contrast and reflection properties that are detected by GPR.

GPR measurement as a method of mapping tree roots has several advantages over other methods:

1. it is capable of scanning root systems of large trees under field conditions in a **short time**
2. it **does not** disturb the soils or damage the trees examined and causes no harm to the environment
3. being **non-invasive**, it allows repeated measurements that reveal long-term root system development,
4. it allows observation of root distribution beneath **hard surfaces** (concrete, asphalt, bricks), roads and buildings,
5. its accuracy is sufficient to resolve structural roots with diameters from **10mm upwards**.
6. it can characterize roots at both the individual tree and stand levels, facilitating correlations with tree-and stand-level measurements of physiological processes (e.g., sap flow and eddy correlation) in complex ecological studies.

Inspection Report Service (UK)

1. **Cost: £950 + vat**

This includes:

- **Travel to and from site within a 200 mile radius of our offices.**
- **Up to 10 scan files at your site.**
- **A full analysis report of the data collected.**

2. **Additional scans: £175 + vat per 5**

3. **Travel Expenses beyond 200 miles**

Mainland UK – Overnight expenses for 1 operative at £120 per night

4. **Information required on booking**

- a. Location of survey**
- b. Reason for survey**
- c. Images or site plan**

5. **On day of survey please ensure survey area is clear of all debris.**

6. **Delivery of report:**

- **The full report can take up to 7 days to complete dependant on current workloads but are generally returned within 3 -5 days.**
- **Please note that analysis data will only be released after payment being received in full by Sorbus Internationa Ltd.**

Inspection Report Service (Overseas)

Please contact us for a quotation on TRU surveys overseas based on the terms and conditions stated above.

Sorbus International Limited

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Inspection Report

TRU™ (Tree Radar Unit) Non-Invasive Tree Scans

inspection site:

Woburn Abbey Estate

prepared for:

Sorbus International Ltd.
Brook Lane Westbury
Wiltshire

scan date:

31 March 2008

inspection performed:

Subsurface Structural Root Scans



In Association with:



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TRU™ Scan Analysis Results

Overview

A root inspection was performed at **Woburn Abbey Estate** by Sorbus personnel on 31 March 2008.

The root survey was conducted to identify the location and density of roots. Two Oak trees – designated Mature and Young – were chosen to compare the root distribution between the two age classes of tree. Based on the results, an air spade will be used to excavate relevant areas to compare the readings.

Root Inspection Procedure

A TRU inspection consists of two independent steps: (1) on-site data collection as described above, and (2) off-site data analysis using TreeRadar's proprietary TreeWin™ software program to analyze the data after the field data collection runs.

The data can be presented in two formats.

One is a "virtual trench / excavation" format in which a planar 2D view is generated that shows the predicted subsurface structural root location and depth as if a backhoe had excavated by digging a trench. This is shown in the figure above. The way to interpret the 2D planar view is to imagine a backhoe digging a trench that was, for example, 20ft (6m) long and 3ft (1m) deep. The backhoe's digging blade would sever all of the roots. After the trench was dug, imagine stepping down and kneeling in the trench and looking at either cut side. You would see the severed root endings. If you painted them blue to make them stand out from the excavated soil, you would be seeing a collection of blue "dots" that would show you where the roots were located along the excavated trench line and their respective depths below the surface.

The other presentation takes the ensemble of line scans and shows the view looking down from above, i.e., a top-down 3D root map. This top-down view is valuable for determining the spatial root layout and this is the key result from this inspection.

In the graphical reports that follow, each detected root is shown as an "x". The root maps – both 2D (virtual trench) and 3D top-down (virtual excavation) – are color coded into three colors: **red** = roots in the top 1/3 layer of the total depth analyzed, **green** = roots falling in the middle 1/3 depth zone, and **blue** = roots falling in the bottom 1/3 depth zone.

Results

A total of 12 scan lines were conducted – 6 for each tree – in semi-circular scans starting at a radius of 1m and indexing by 1m up to 6m distance. The scan layout is shown in the schematic in the first graphic figure.

Scans were conducted in a clockwise manner starting at 180-deg (6:00) and continuing up to 360-deg (12:00) for the Mature Oak, and starting at 0-deg (12:00) and continuing down

to 180-deg (6:00) for the Young Oak. A reference line bisecting the centers of the two stems was drawn and a Marker was created each time the scanning cart passed this line.

The next twelve figures present the results of the 12 2D “virtual trenches”, six each for each tree. Each scan was circular, so the virtual trenches represent the “unwrapped” circular scan into a line; this is why the scan distance increases for each larger radius scanned.

As described above, each colored dot represents a root detection whose X,Y coordinates can be found from the horizontal (X) axis representing distance along the scan, and the vertical (Y) axis representing depth.

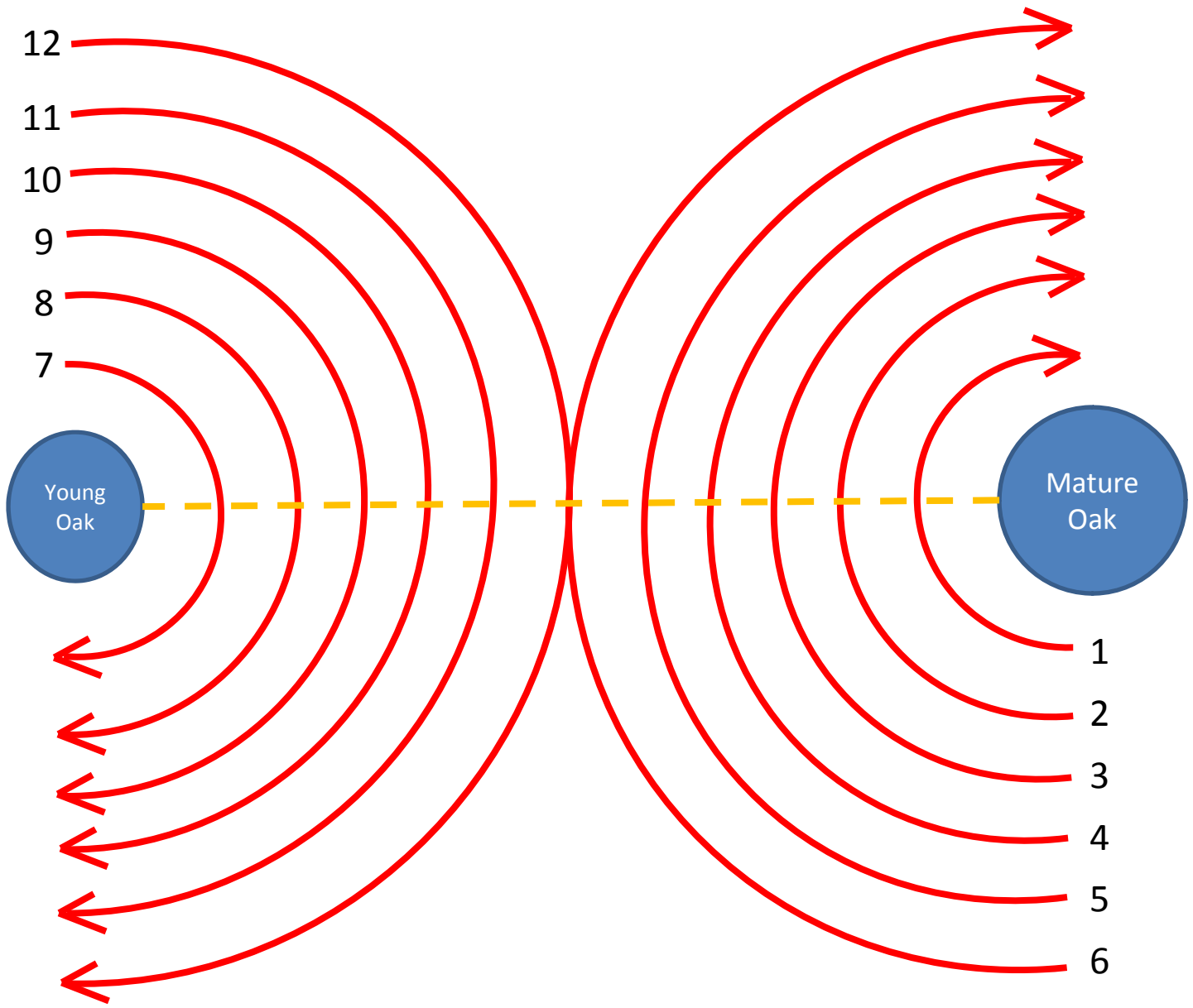
A comparison of detected root densities (units = roots/metre) for the six radii about each tree shows the Young Oak with a slightly higher root density than the Mature Oak for all radii:

Radius	Young Oak	Mature Oak
1m	4.6	2.9
2m	3.9	2.5
3m	2.8	1.7
4m	2.2	2.1
5m	2.2	2.0
6m	2.3	1.8
Average	3.0	2.2

The next four graphic figures show the 3D top-down map in depth color-coded format. The first figure shows the overall root layout and density for all 12 scan lines at the six different radial distances from each respective tree. The overall root depths are then divided into three equal depth zones and the fraction of roots falling within each of these depth zones is then presented.

The final two figures present the root morphology (where the 3D top-down map has the dots connected) and root density maps, respectively.

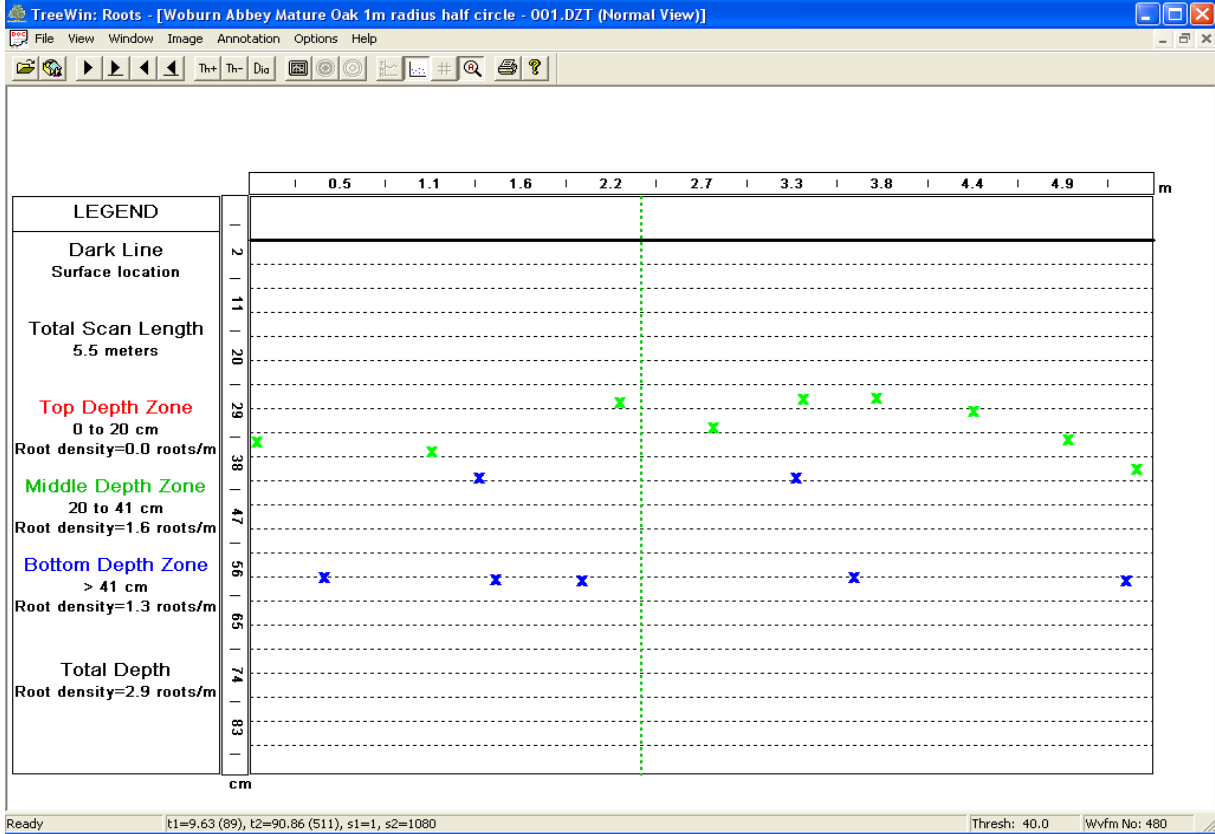
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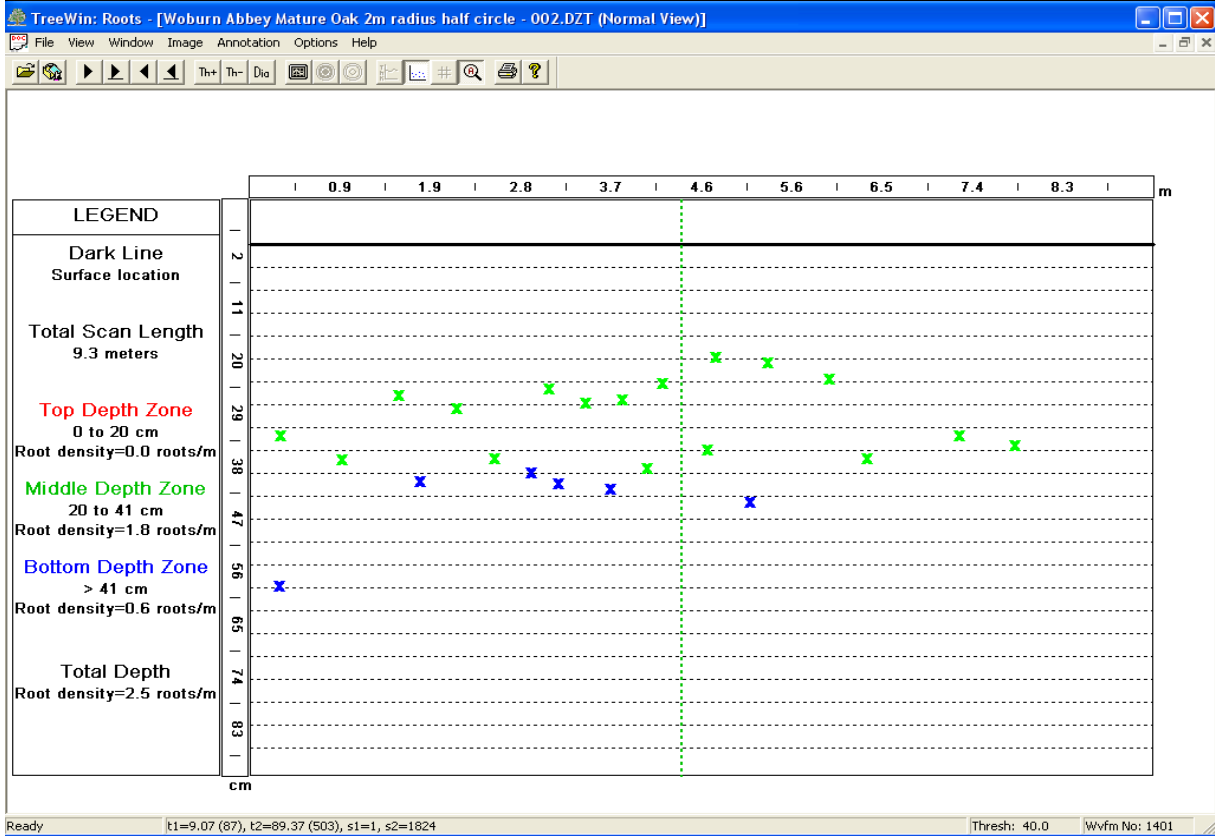
--- =Centre Line

12m

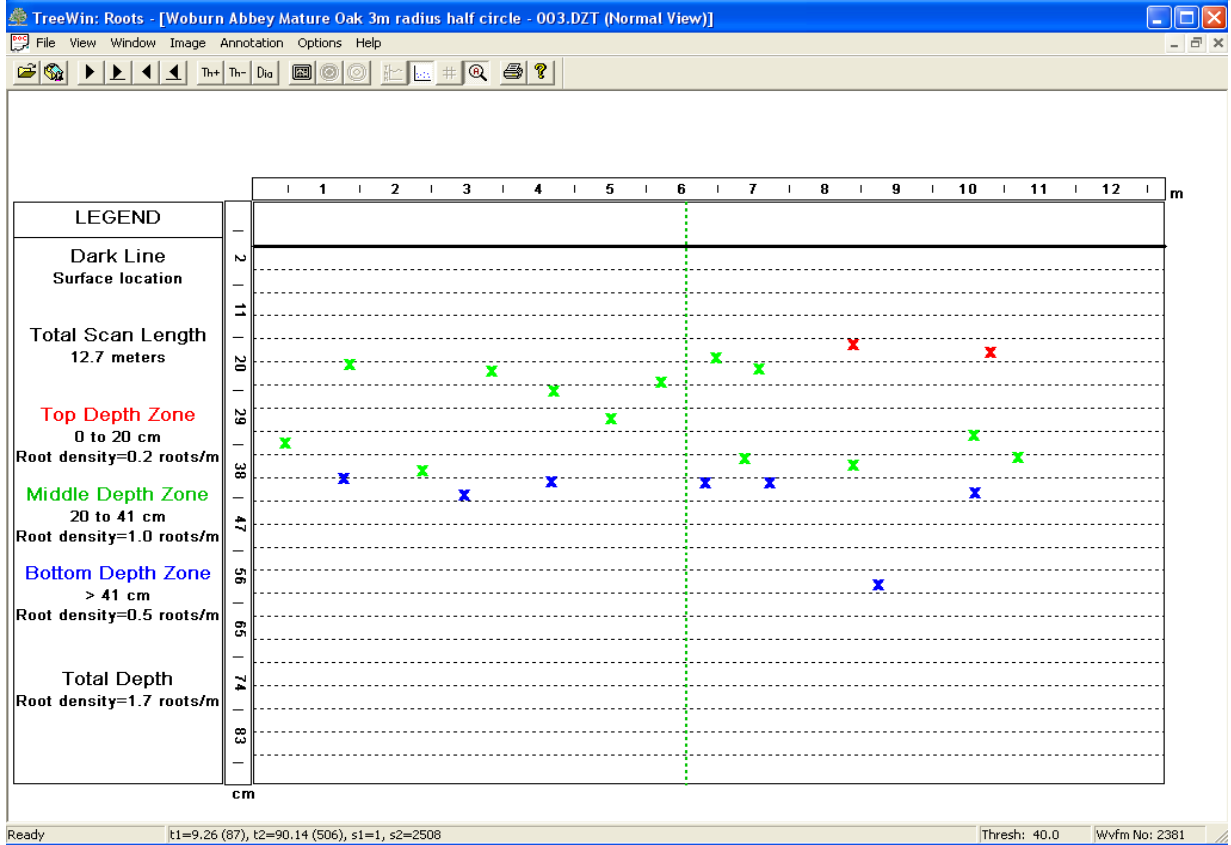
Woburn Abbey - Scan # 1 - Length = 5.5m - 31 Mar 08



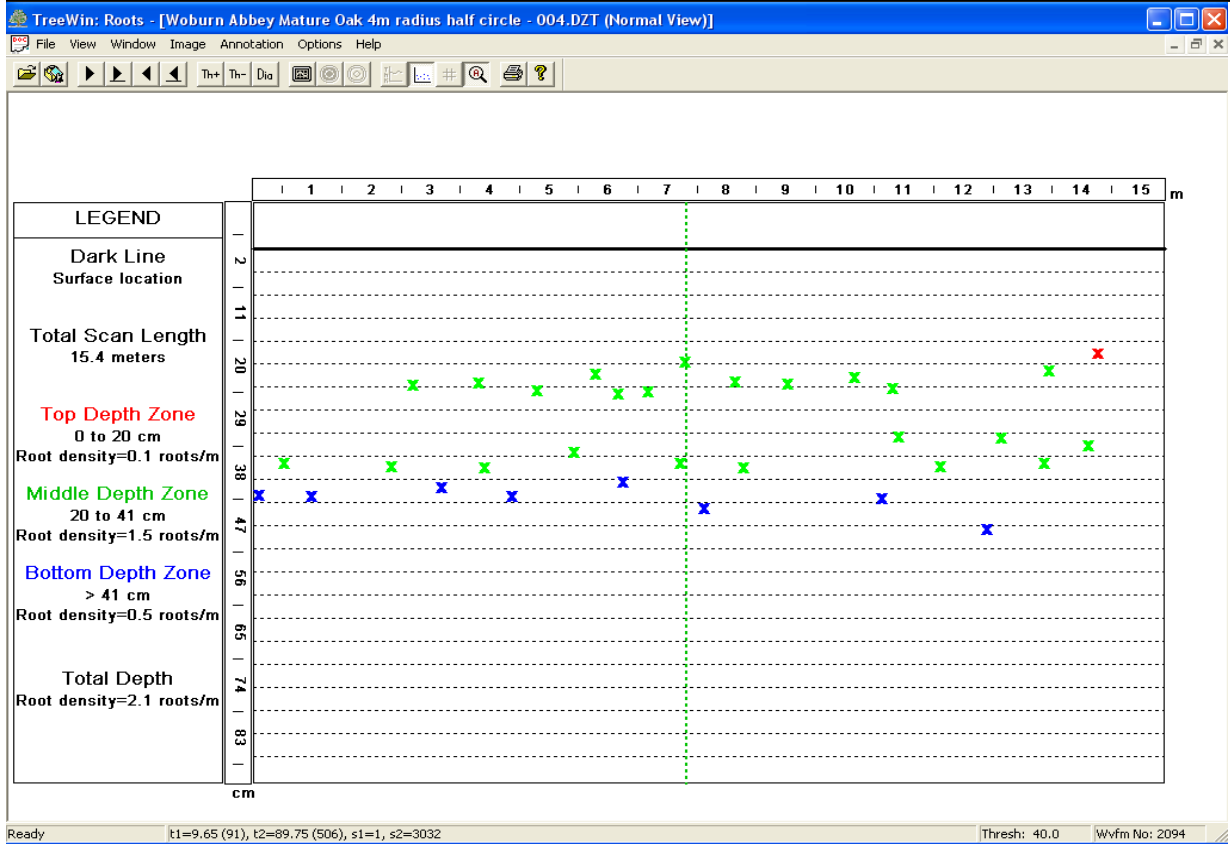
Woburn Abbey - Scan # 2 - Length = 9.3m - 31 Mar 08



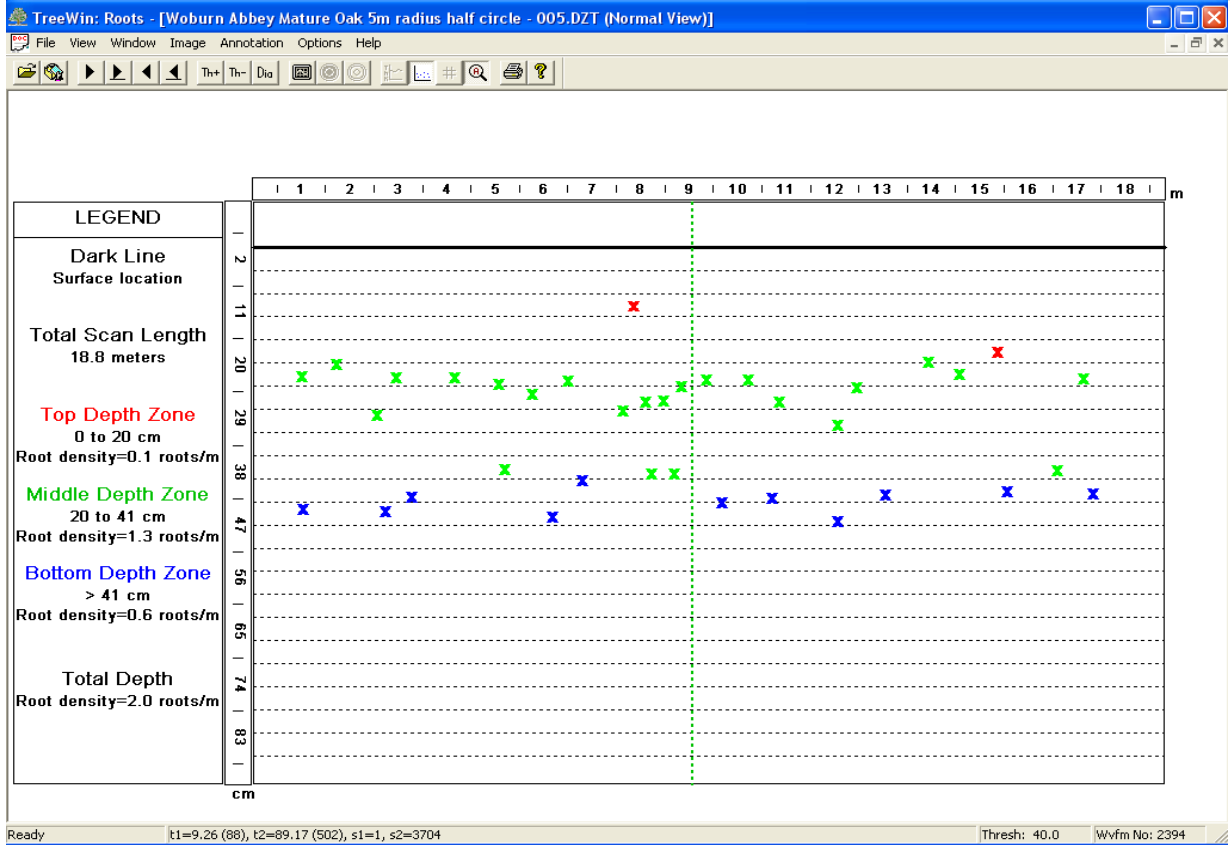
Woburn Abbey - Scan # 3 - Length = 12.7m - 31 Mar 08



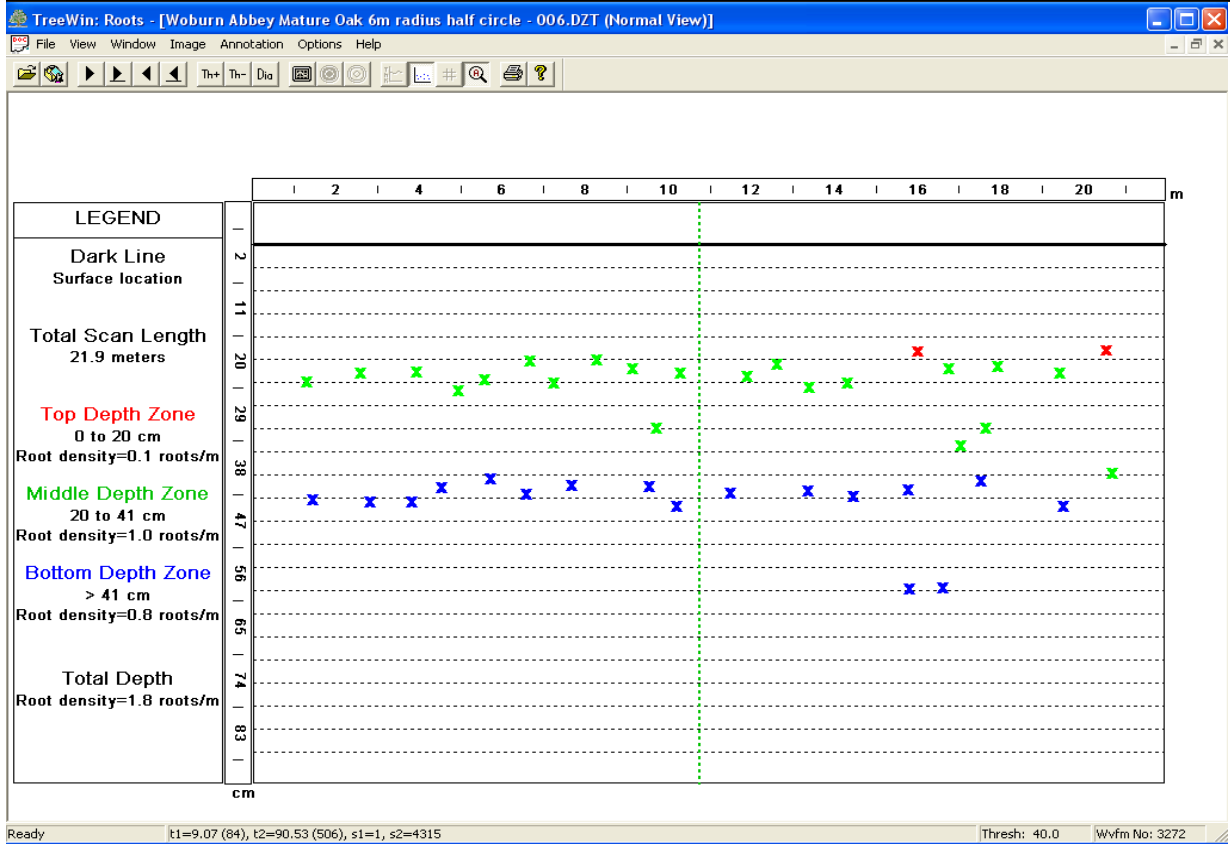
Woburn Abbey - Scan # 4 - Length = 15.4m - 31 Mar 08



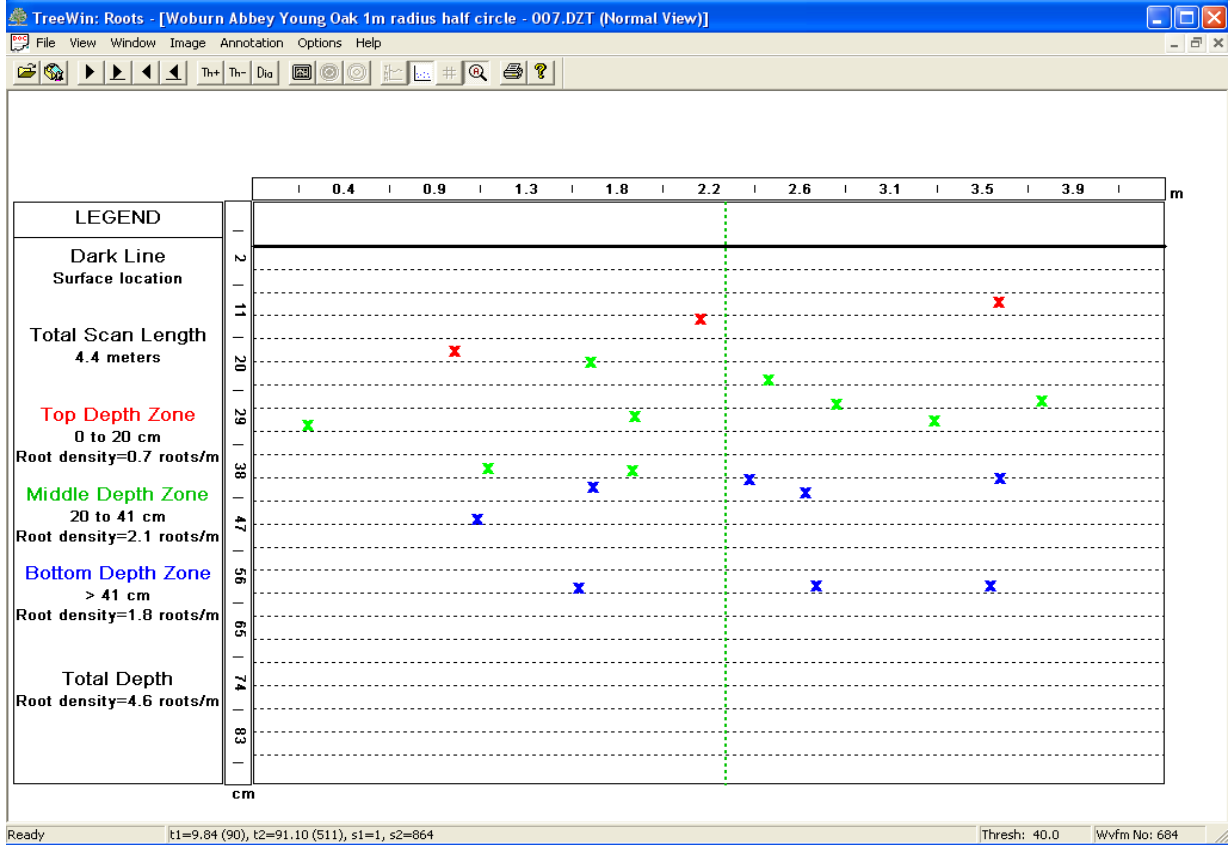
Woburn Abbey - Scan # 5 - Length = 18.8m - 31 Mar 08



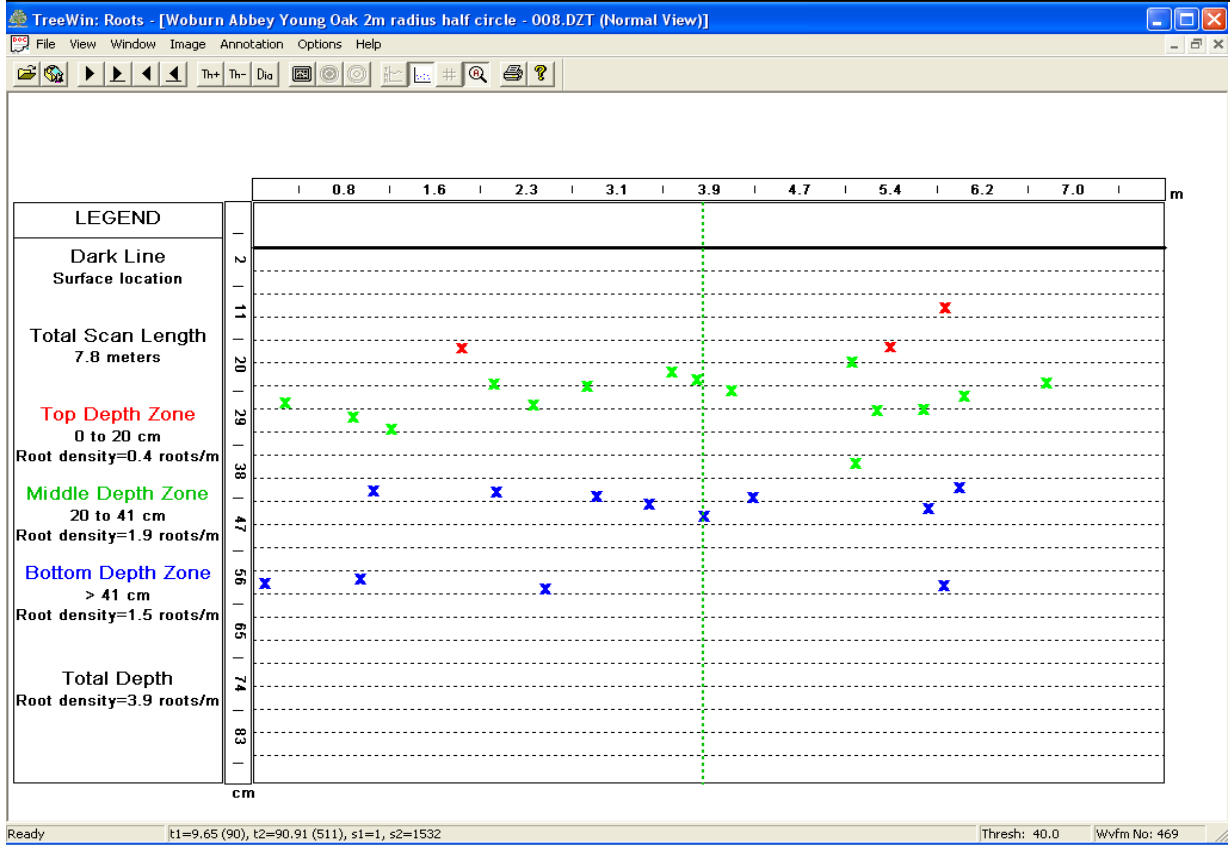
Woburn Abbey - Scan # 6 - Length = 21.9m - 31 Mar 08



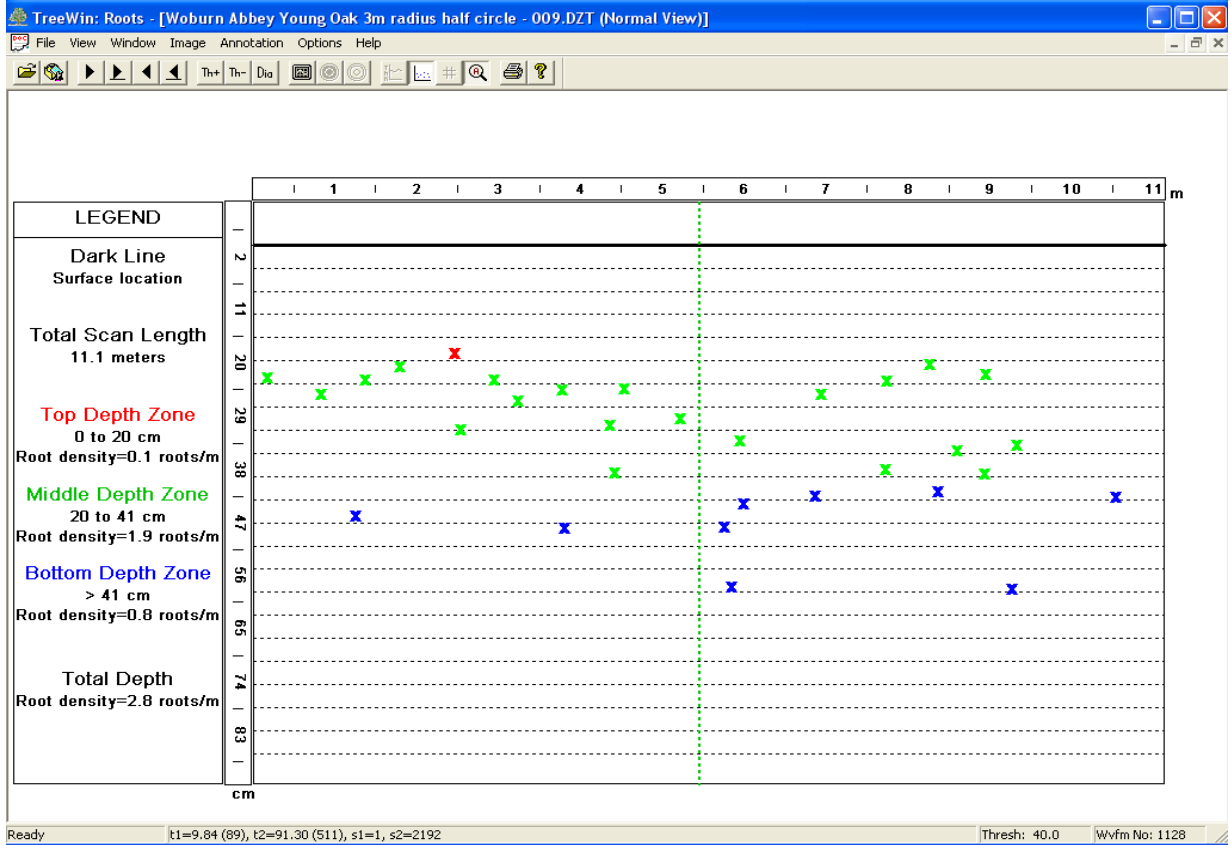
Woburn Abbey - Scan # 7 - Length = 4.4m - 31 Mar 08



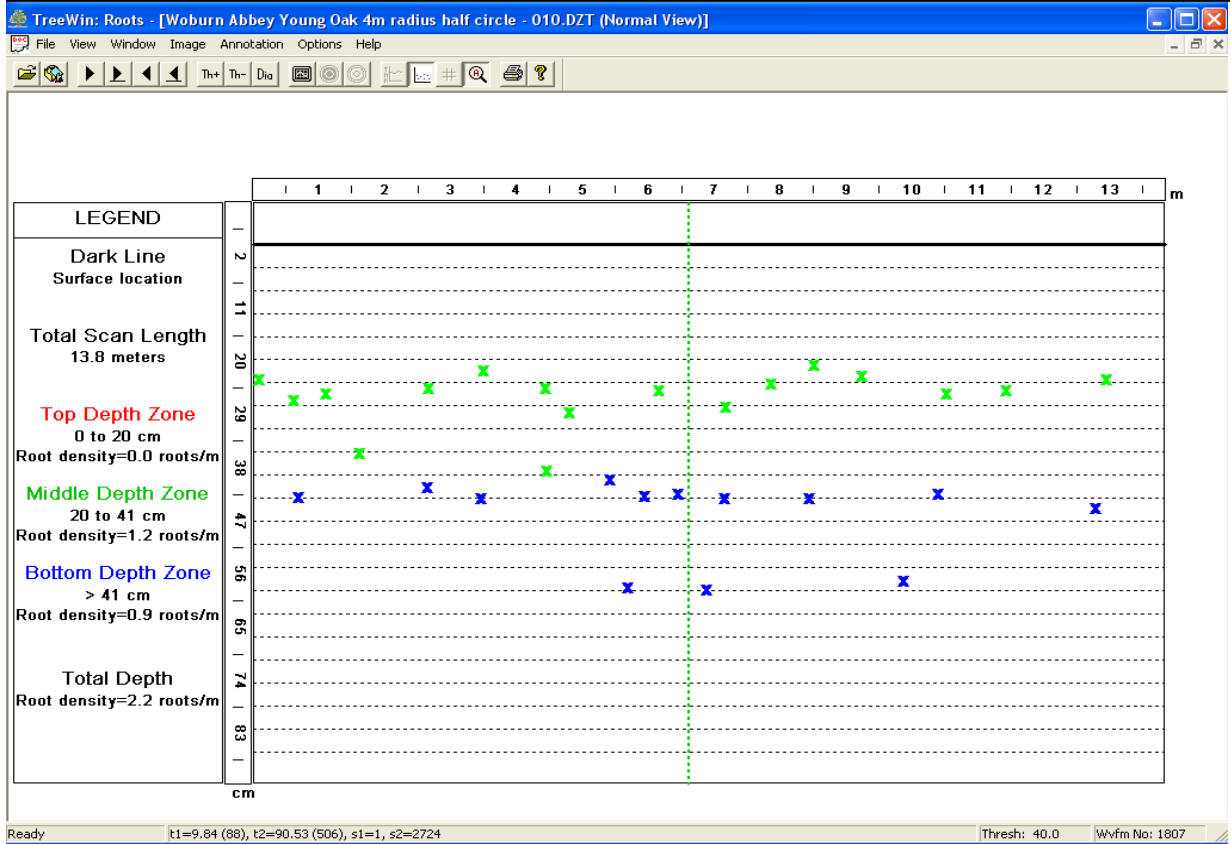
Woburn Abbey - Scan # 8 - Length = 7.8m - 31 Mar 08



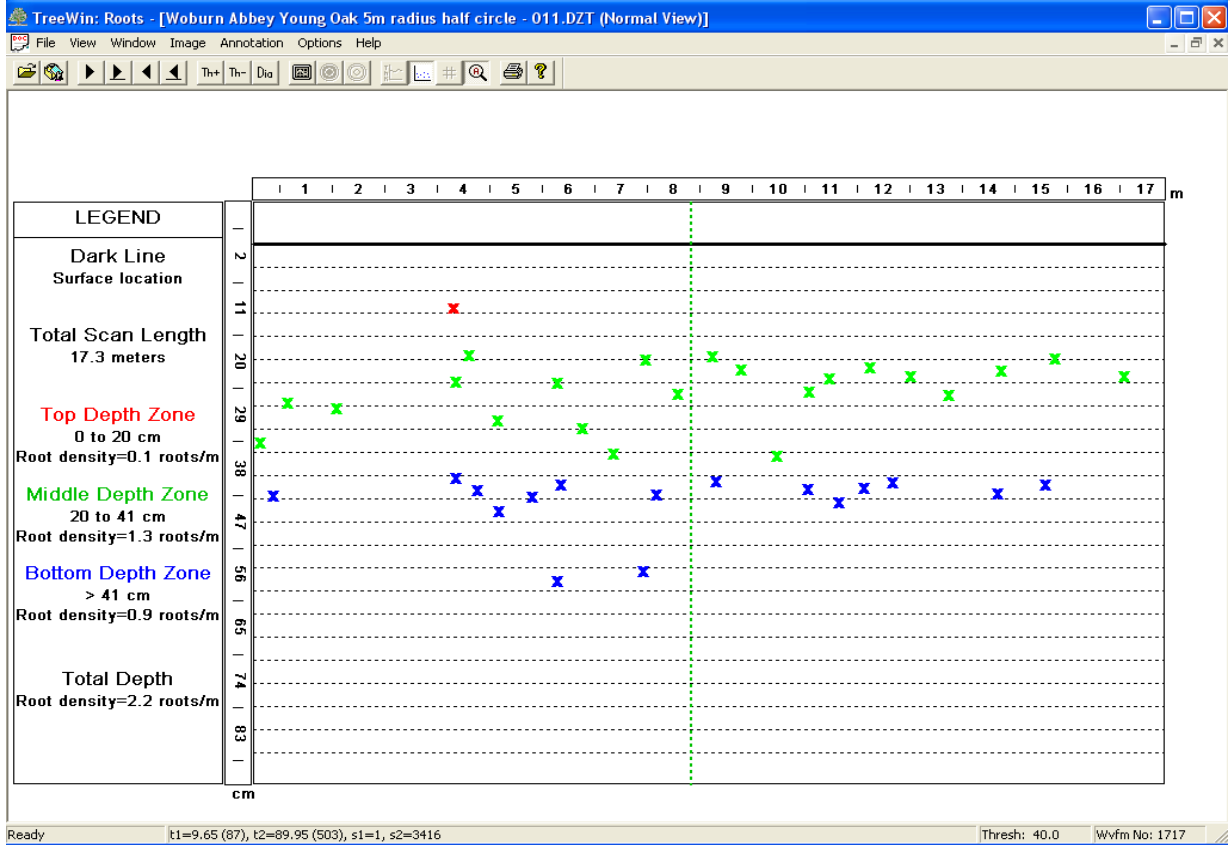
Woburn Abbey - Scan # 9 - Length = 11.1m - 31 Mar 08



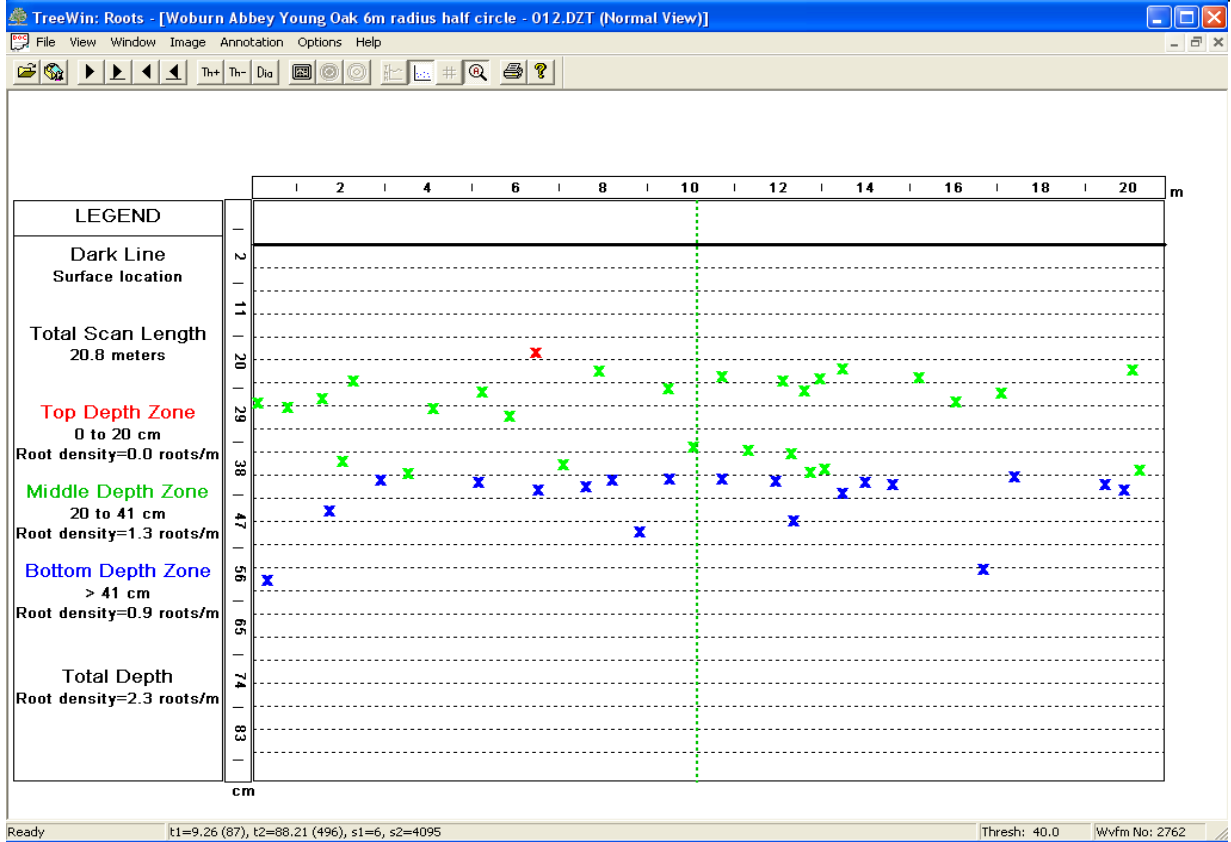
Woburn Abbey - Scan # 10 - Length = 13.8m - 31 Mar 08



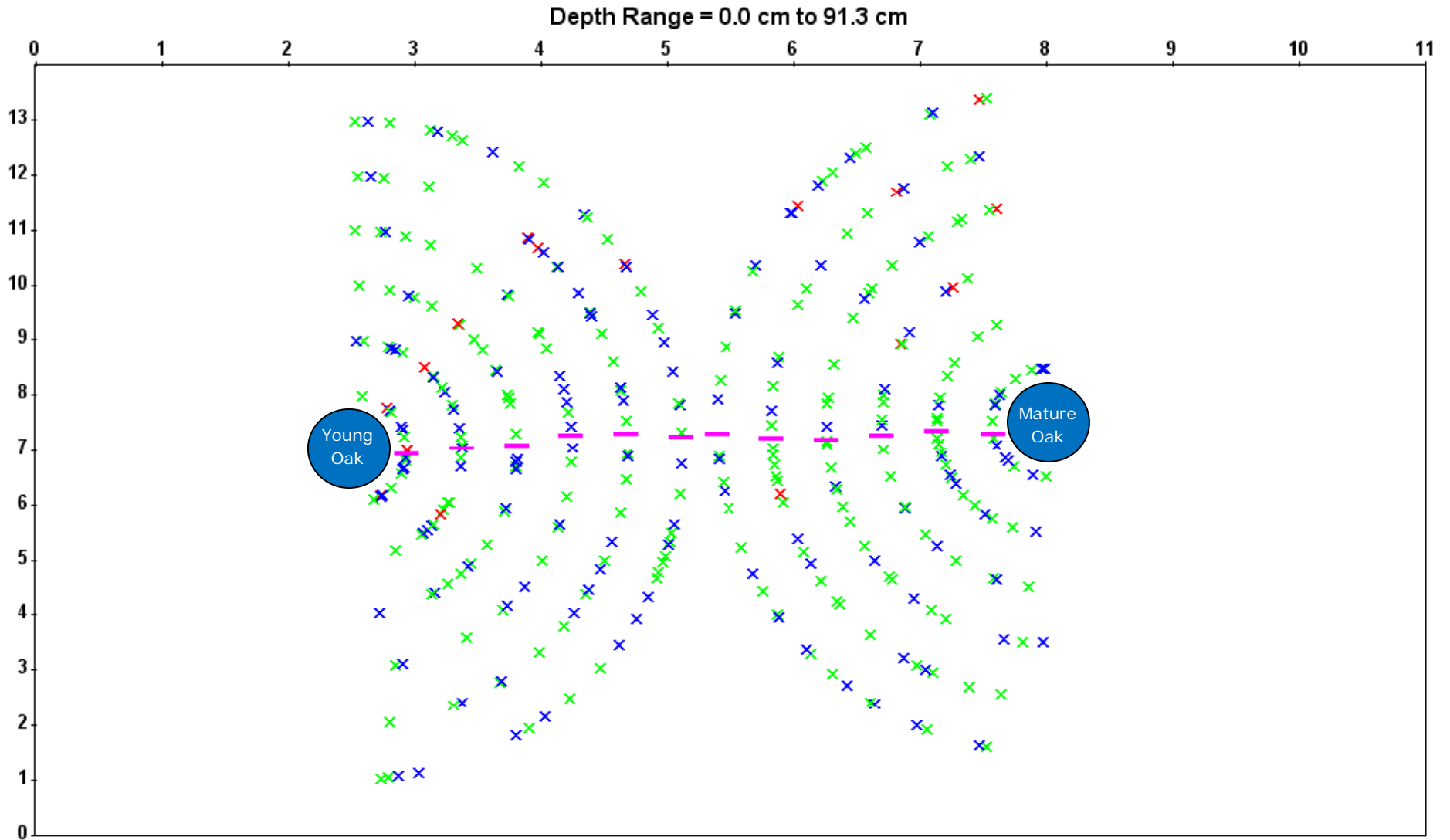
Woburn Abbey - Scan # 11 - Length = 17.3m - 31 Mar 08



Woburn Abbey - Scan # 12 - Length = 20.8m - 31 Mar 08

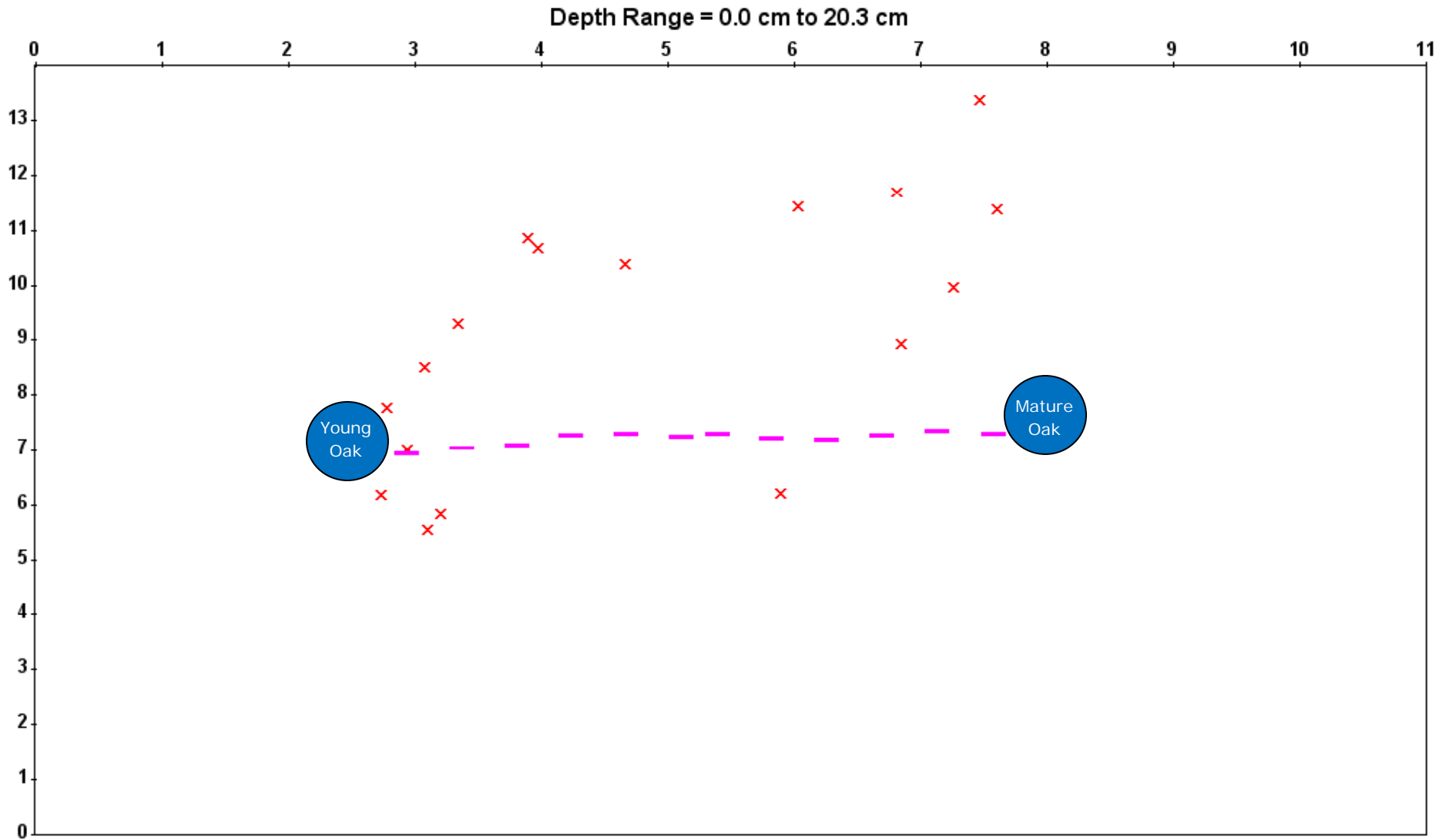


Woburn Abbey
Total Depth Range



Note: not to scale

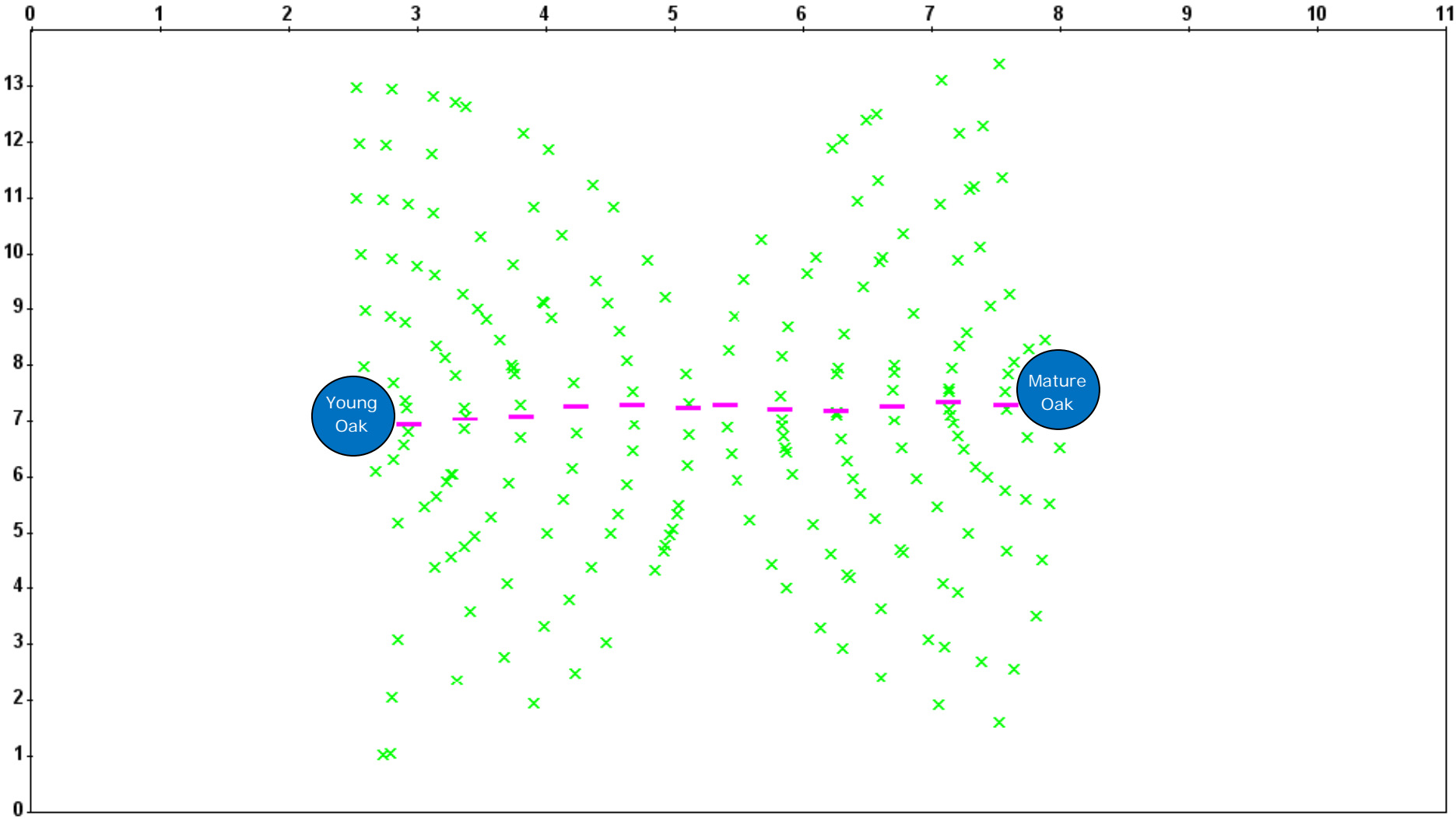
Woburn Abbey
Top 1/3 Depth Range



Note: not to scale

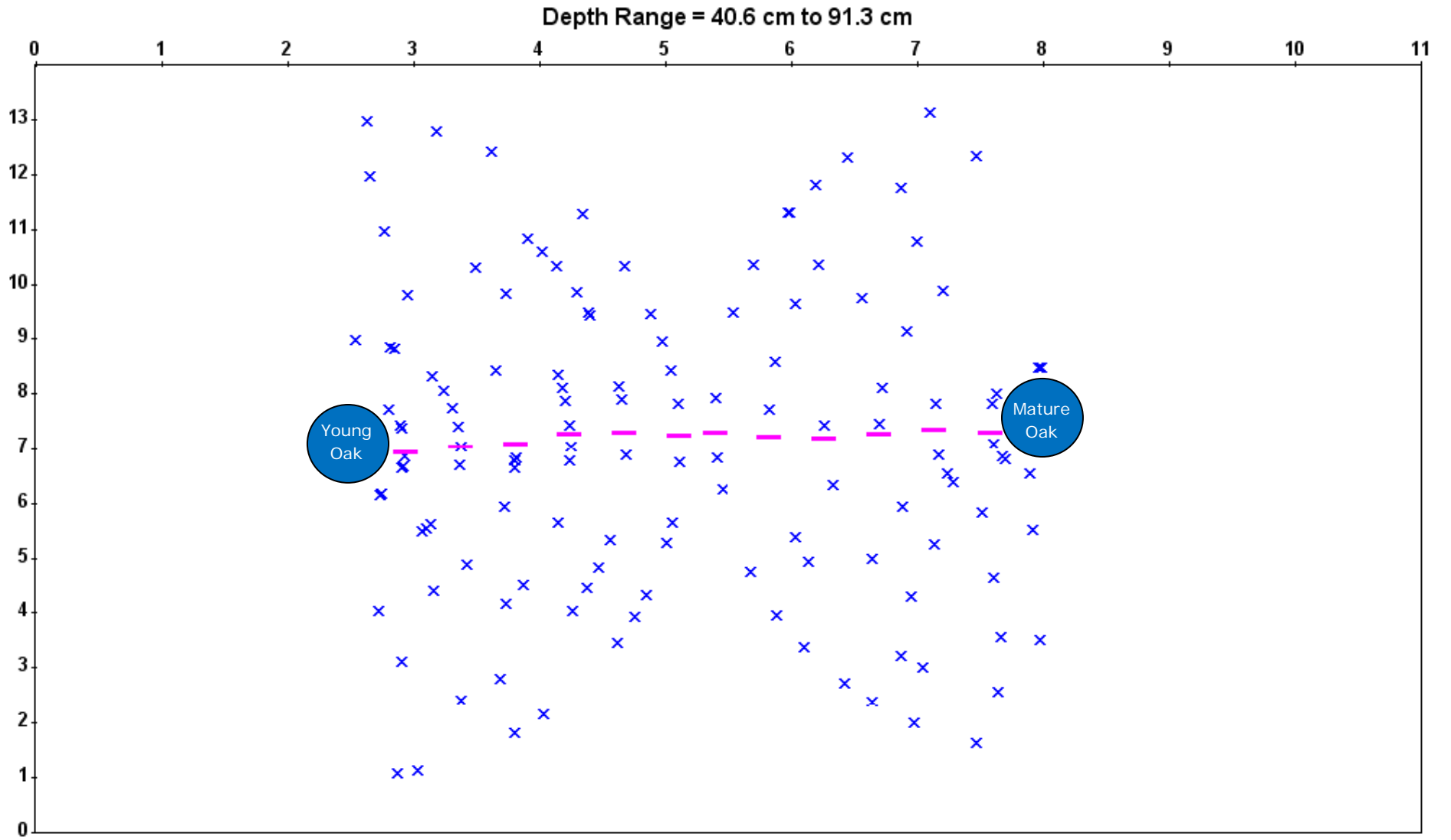
Woburn Abbey
Middle 1/3 Depth Range

Depth Range = 20.3 cm to 40.6 cm



Note: not to scale

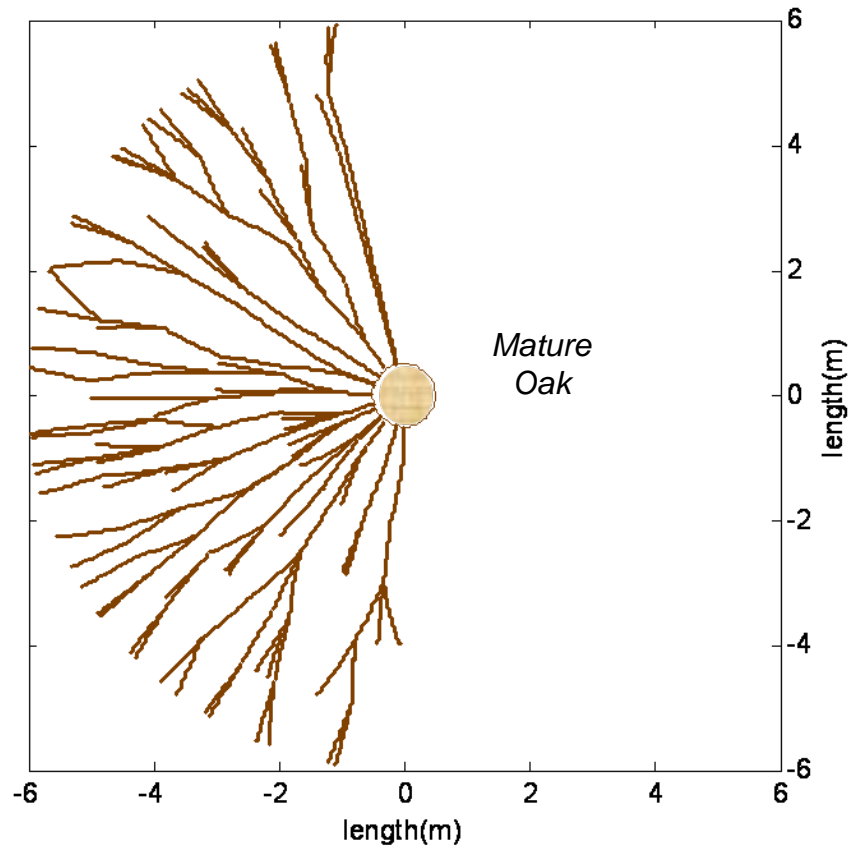
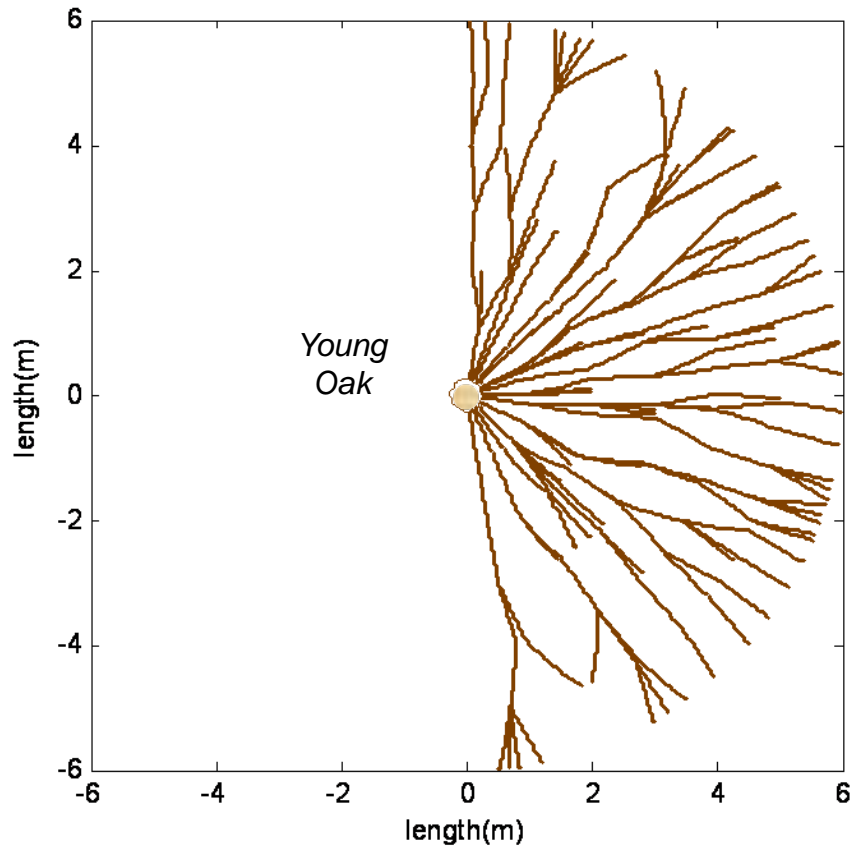
Woburn Abbey
Bottom 1/3 Depth Range



Note: not to scale

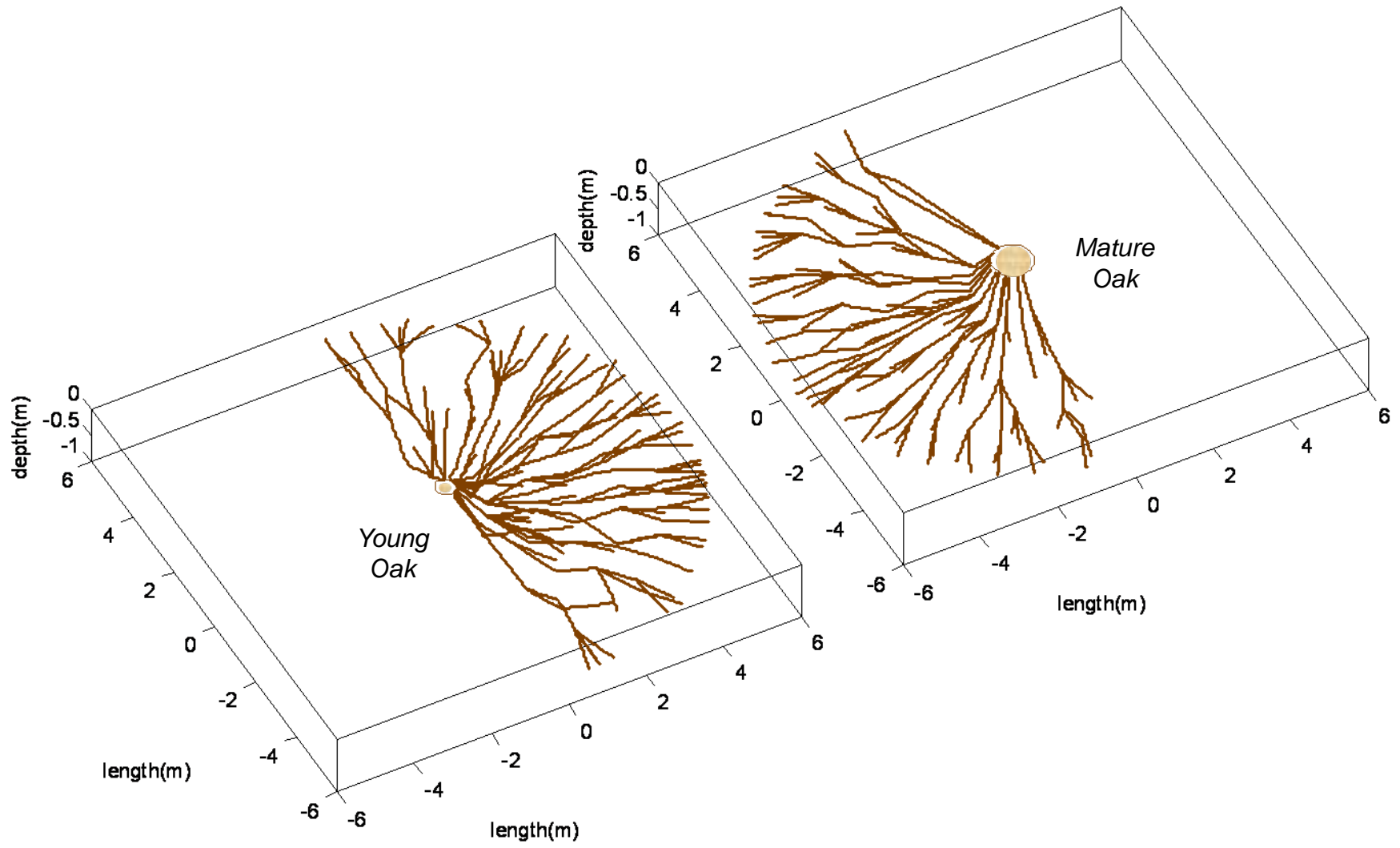
Woburn Abbey Root Morphology Map

Ground plan, front, and side views of 2 Oak



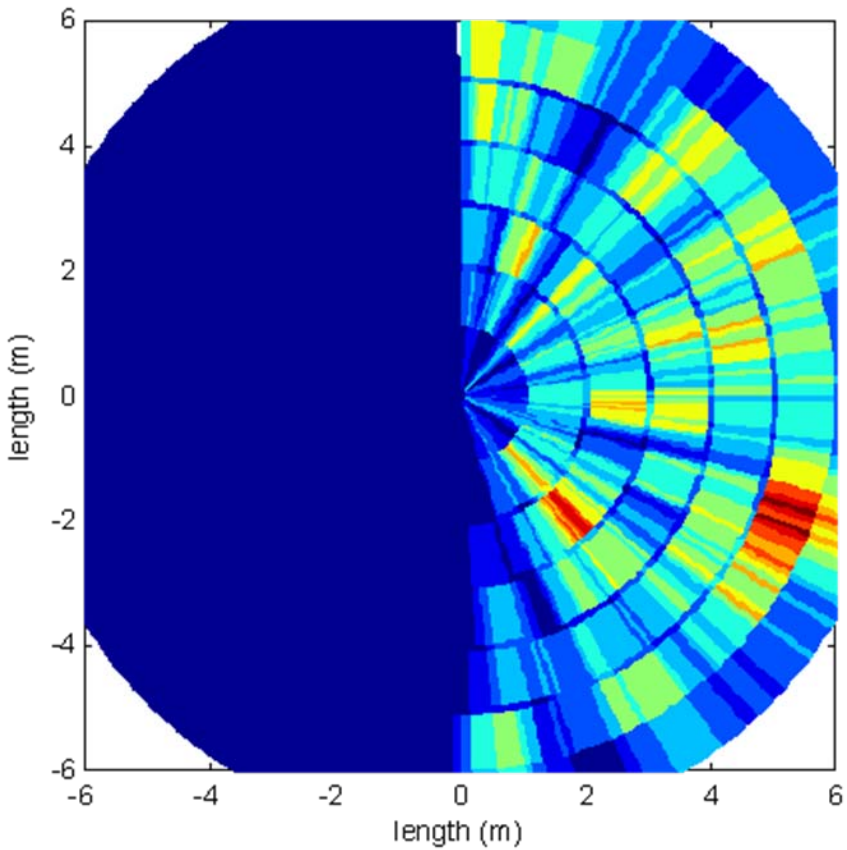
Woburn Abbey Root Morphology Map

3D view of 2 Oak



Woburn Abbey Root Surface Density Map

Young Oak



Mature Oak

