AN INTRODUCTION TO

DECAY DETECTION IN TREES USING

ELECTRICAL IMPEDENCE TOMOGRAPHY (EIT) AND

THE IML PD 400 MICRO DRILL

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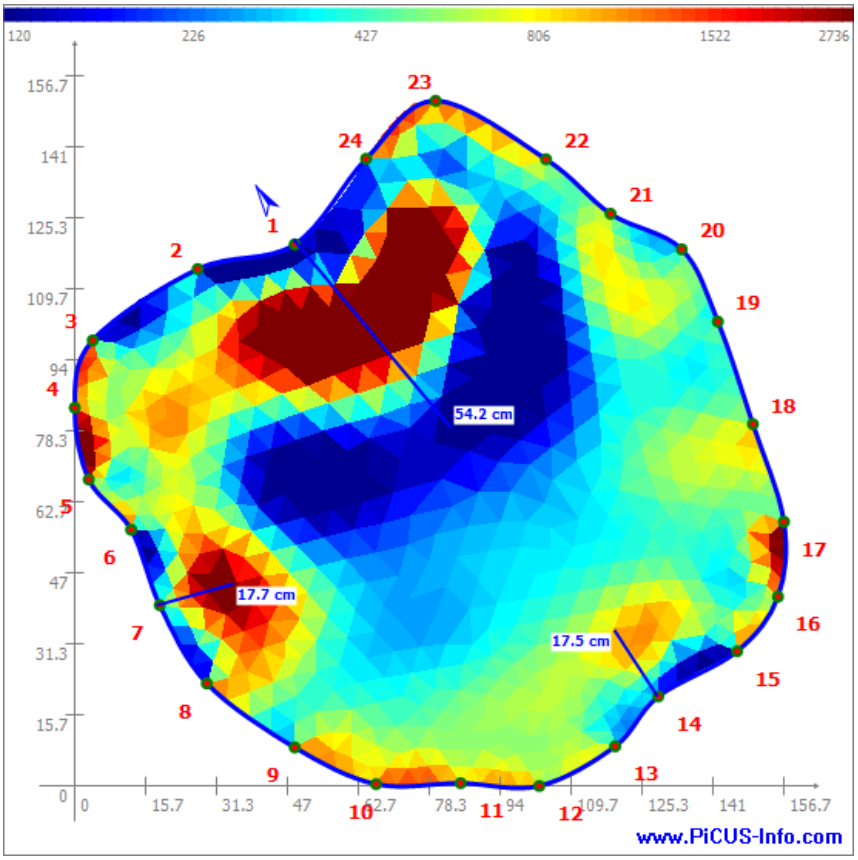
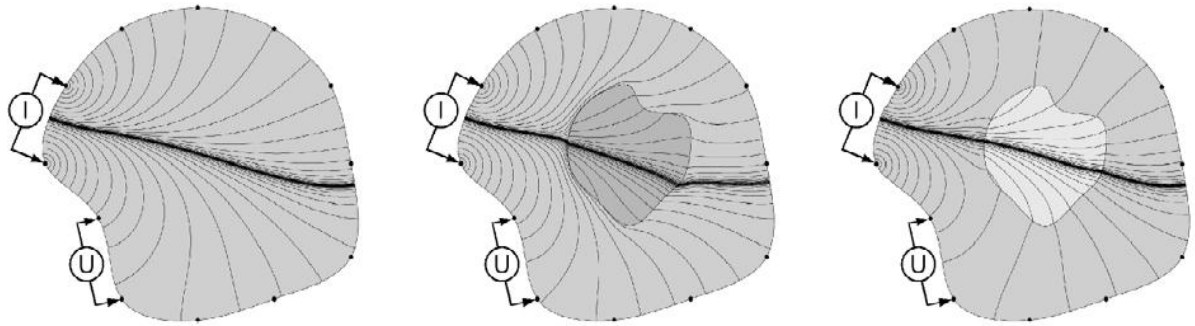


Theory of Operation (EIT)

Electrical resistivity or its reciprocal, electrical conductivity, is a physical property that allows arboriculturists to assess the structural properties of wood. Determining the spatial resistivity distribution in a non-destructive way is the task of the electrical resistivity tomograph.

Low resistivity may indicate increased moisture content, whereas hollowed structures also cause increased resistivity due to the changed direction of the electrical current. However, in order assess the health and stability of trees based upon EIT alone requires a lot of experience and should NOT be used in isolation.

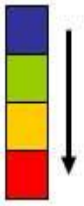
The measurements are taken using point-like electrodes (nails) set into the bark (phloem). The more measuring points used the more data is generated and therefore the more accurate the tomogram. A current (I) is applied across two of the measuring points, and then repeated around the stem across pairs of electrodes, the resulting electrical field then depends on the resistivity distribution and is measured by pairs of sequential electrodes to obtain a potential difference, (U - voltage).



“I” – current is applied and measured, “U” – Voltage is measured

The left diagram shows the electrical field in a uniform material. The field is distorted if the material is not uniform as in the centre and right sketch, e.g. decay or cavities.
When combined with the sonic tomograph, the EI tomographs offer advanced information about the structural condition of the tree. In many cases the result can be used to analyse the type of decay or help to distinguish between cavities and ‘wet’ diseased wood. Water transportation in the trunk can be analysed by scanning a tree at several levels.

Each tree species has a typical impedance (water/moisture) distribution. To properly analyse the tomographs, the operator should have a good working knowledge of how the subject tree species grows and how the water/moisture distribution may vary in different seasons.



The EI Tomographs use colour coding:
- Blue colours indicate areas of low impedance (high water content etc)
- Increasing impedance
- Red colours indicate areas of high impedance (lower water contents etc)

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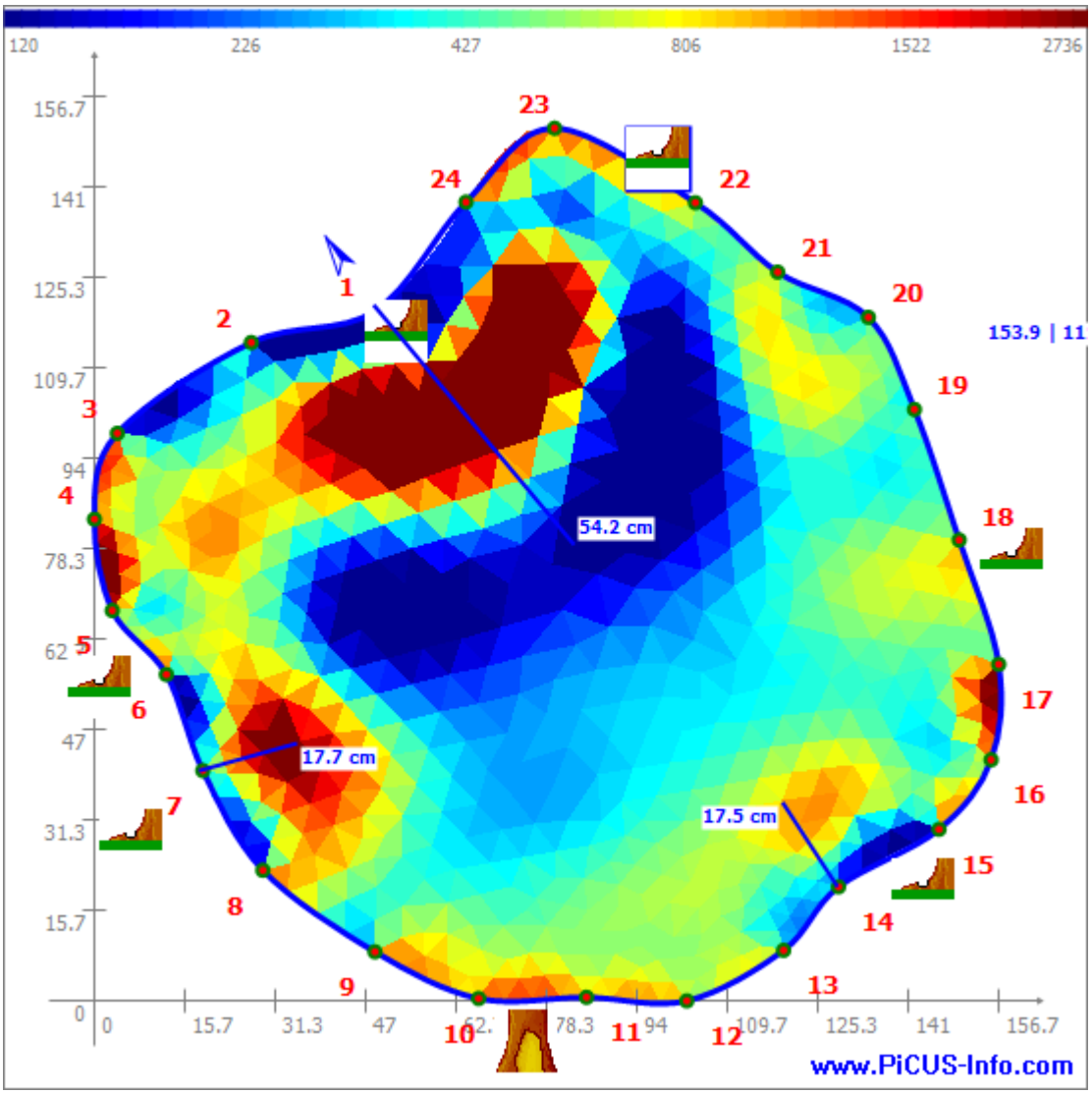
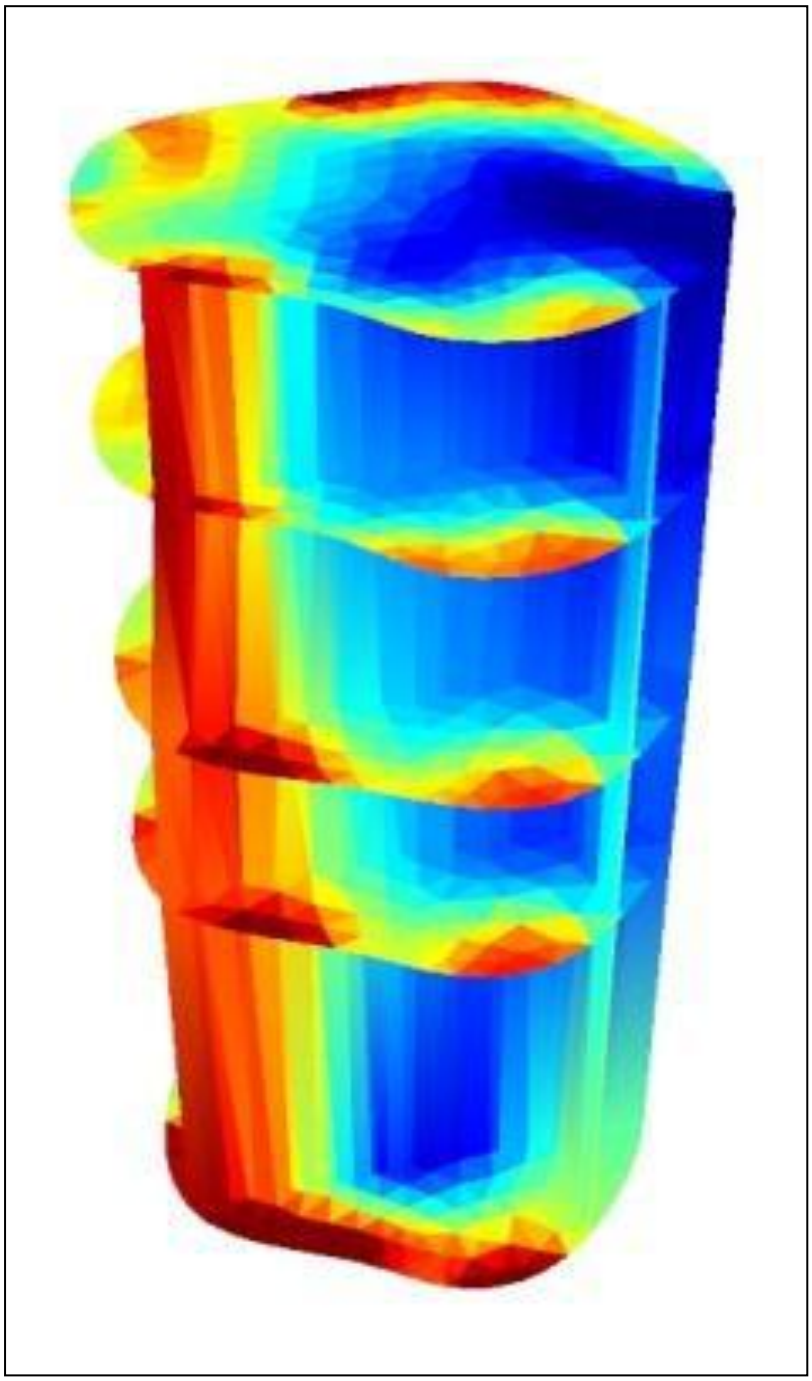


The instrument can also produce 3D images vertically below and above the measuring level, so we can now look at columns of decay, as seen in the example below.



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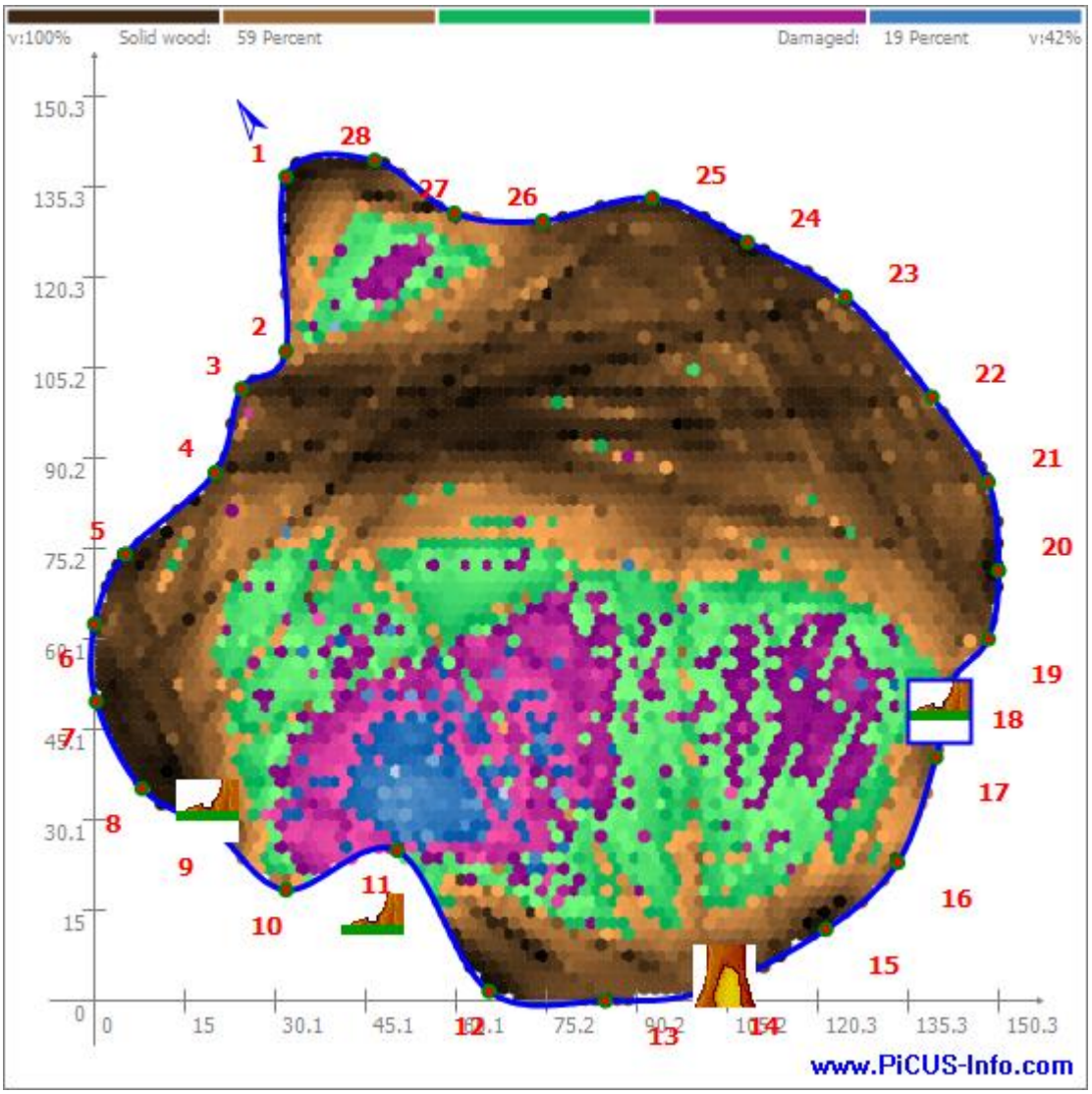


PD400 RESISTOGRAPH

The Resistograph is a mechanical drilling machine with a constant drive, which measures the drilling resistance and rotational speed along a needle, when inserted into the tree. The result is displayed on a digital panel and stored electronically at a scale of 1:1, measurement is in metric units.

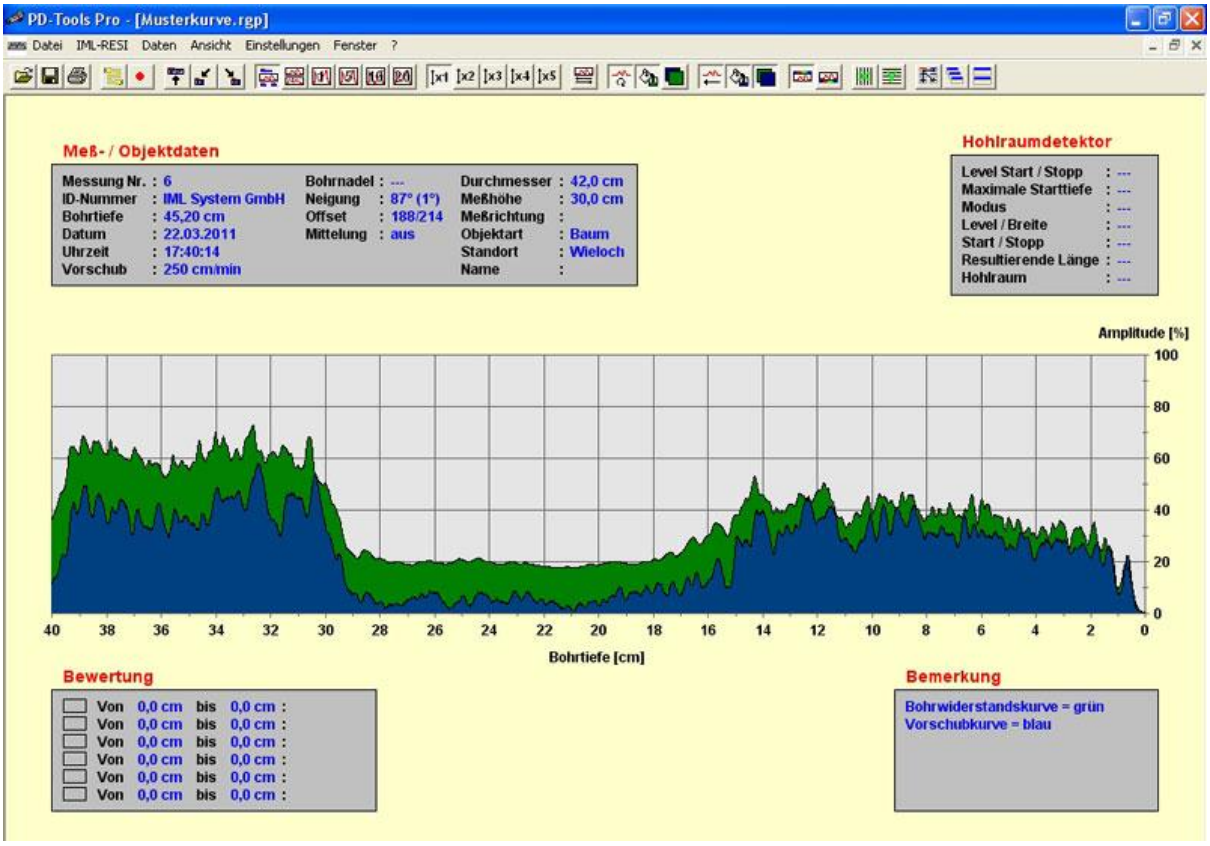
The drilling rate may be varied for hard or softwoods. The drilling resistance is correlated with the mechanical properties, and the defective areas that have developed within the tree may be detected and assessed.

Examples of defects detected by the Resistograph may be dysfunctional areas such as internal cracks, areas of decay and hollows. Remaining wall thickness may be determined to a depth of 400mm.

The instrument is adept at detecting the early stages of decay in white rots as well as detecting brown rots at an early stage.

The drilling needle is specially formed and the tip is only 3mm wide with a shaft diameter of 1.5mm, thereby keeping internal damage to a minimum and reducing the risk of further fungal infection.

Resistograph image showing a central area of decay from 14 to 30cm.



Further Reading:
Non-destructive monitoring of early stages of white rot by *Trametes versicolor* in *Fraxinus excelsior by,* Dirk Bieker, Rolf Kehr, GesineWeber, Steffen Rust. Annals of Forest Science 67 (2010) www.afs-journals.org

Non-Destructive Estimation of Sapwood and Heartwood Width in Scots Pine (*Pinus sylvestris* L.) by Dirk Bieker and Steffen Rust. Silva Fennica, 44(2) research articles, www.metla.fi/silvafennica

Manufacturers:
EIT. www.argus-electronic.de

IML (resistograph) www.IML.de