PiCUS
Tree Inspection Equipment

Tree Pulling Test
Sonic Tomography
Dynamic Sway Motion
Electric Impedance Tomography

www.argus-electronic.de
Description of Tree Inspection Equipment of

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1. Products of argus electronic for Tree Decay Detection

The development of tree inspection instruments in our company started in 1997 by designing the PiCUS Sonic Tomograph in a cooperation of argus electronic gmbh and the Institut für Gehölze & Landschaft Dr. Gustke GmbH. The worldwide launch of the PiCUS Sonic Tomograph was in 1999. It is now working in 27 countries on five continents.

Ever since this time we are improving our technologies and develop new instruments to cover a wider range of tree inspection tasks. Today our company offers a whole product family for the detection of decay and defects in trees:

**PiCUS® Sonic Tomograph.** The PiCUS Sonic Tomograph investigates the tree by using sonic waves. The instrument measures the time of flight of the sonic signals that have been generated by a hammer. By using accurate tree geometry information the software calculates the apparent sonic velocities and draws a “velocity” or “E-module” map of the tree. The velocity of sound in wood depends on the modulus of elasticity (MOE) and the density of the wood itself and therefore with the health of the wood. Full resolution tomograms can be recorded with as few as 6 to 8 sonic sensors by using the electronic hammer.

The PiCUS Sonic Tomograph has won the Technology Award 2000 of the German Federal State of Mecklenburg-Vorpommern.

**PiCUS : Treetronic® – Electrical Impedance (EI) Tomograph.** The Treetronic uses electric current/voltage to investigate the tree. The result of the measurement is a 2 dimensional map of the apparent electrical impedance of the tree. Chemical properties of the wood affect the resistivity; most of all: water content, the structure of the cells, ion concentration and others. The chemical properties are changed if decay etc. is in the tree. The Treetronic can detect very early stages of decay above and to some extend below ground.

**TreeKinetic** - There are two major types of tree failure: uprooting and breaking. A static pulling test can be used to estimate the uprooting and breaking safety of a tree. The TreeKinetic system is designed to collect data during static tree pulling tests. It can also be used to record the sway motion of trees in winds.

**PiCUS Calliper.** The PiCUS Calliper is an instrument to record the geometry of the tomography level quickly and accurately. This geometry data is needed for sonic and EI tomography inspections. It is particularly useful for testing large or irregularly shaped trees.
2. Frequently asked questions (FAQ)

1. What is the difference between Sonic Tomography and Electric Impedance Tomography?
   Sonic Tomography uses sonic waves to obtain “mechanical” information about the wood of the tree. Electric impedance tomography uses electric current to gain “chemical” information about the wood. In short, two different types of information are obtained by using these two different methods.

2. How many sonic sensors do I need?
   PiCUS technology distinguishes between sensors (the sonic sensor that receives and registers the sonic signals) and a measuring point (MP). The MP is a simple nail. By tapping on knocking on this nail, you create sonic waves. You attach the sensors to the nails and these receive the sonic signals and register them. The PiCUS system can also use MORE measuring points (nails) than sensors, which is important when you wish to inspect larger trees using only a limited number of sensors.
   The distance between measuring points should be between 15 and 40 cm. Very smooth and round trees will require fewer measuring points, whereas trees with buttress roots and very uneven circumferences will require more.

   It is most effective to place a sensor on at least half of the number of measuring points. This table shows the correlation of tree size to MP and sensors:

<table>
<thead>
<tr>
<th>Tree circumference [meter]</th>
<th>Number of measuring points</th>
<th>Number of sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>10 to 14</td>
<td>5 to 14, optimal 8</td>
</tr>
<tr>
<td>4 - 5</td>
<td>12 to 16</td>
<td>6 to 16, optimal 10</td>
</tr>
<tr>
<td>6</td>
<td>16 to 24</td>
<td>8 to 24, optimal 12</td>
</tr>
</tbody>
</table>

   MP distance between 15 and 50 cm.

   Experience shows that we can inspect nearly any tree using 8 to 12 sensors, placed on anywhere from 8 to up to 30 MP, and this includes the sensors needed for 3-D measurements.

   The largest tree we have ever tested was this sequoia sempervirens (a redwood in California), which was over 5 meters in diameter. To take the measurements, we placed 66 MP but only needed to use 16 sensors.

3. What are the limits of Sonic Tomography?
   Cracks in wood are real barriers for the sonic waves. They appear in the tomogram much larger than they really are and may thus lead to incorrect conclusions about the tree. To identify “star shaped” cracks, the PiCUS software contains a CrackDect Function. We
also recommended using other inspection methods, such as the Treetronic electric impedance tomography.

4. **What is the difference between Shigometer and Treetronic?**
Both Shigometer and Treetronic try to get the same information about the consistency of the wood (“what is the electric impedance?”), but the working principle is different. The Shigometer required you to drill a hole into the tree and it collected the information about the wood along the drill-line. This is a direct conductivity measurement, meaning two electrodes touch the wood in order to measure voltage and current.
The Treetronic uses a more accurate 4-electrode setup. Two electrodes are used to get the current into the tree; two other electrodes measure the drop of voltage at a different position. In doing so, the Treetronic can collect data of the entire cross section. In the strictest sense, this is data of a column of the tree.
The calculation of the Treetronic are also very different from those of the Shigometer. The results of the Treetronic measurements are recorded in an Electric Impedance Tomogramm (EIT). Interpreting an EIT requires experience and knowledge of the particular species of tree. An EIT can provide valuable additional information about the type of damage in a tree.
Example: When measuring a beech tree with *Meripilus giganteus*, the sonic tomograph will not be able to detect this fungus well because the wood in the stem is not affected by the fungus growth. The Treetronic would show very high conductivity which, in beech trees, is a clear indication for a fungus infection that increases moisture content. In this case, the Treetronic can also provide you with a look underneath the ground because of the 3-dimensional nature of the measurements. The sonic tomograph does not give you any information from below the ground level.

5. **How many probes do I need to use the Treetronic?**
The number of Treetronic channels or probes is 24. Electric impedance tomography requires more measuring points than sonic tomography in order to get good resolution. In many situations it is best simply to double the number of sonic measuring points in order to get a good electric impedance reading. For instance, if the sound tomogram was recorded with 10 measuring points, the electric impedance tomogram should have 20 probes. You can measure larger trees by combining up to 3 Treetronic instruments.

6. **How important is the exact geometry?**
Velocity calculations are based on the formula:

\[
\text{Velocity} = \frac{\text{distance}}{\text{time}}
\]

The more accurate the geometry of the measuring level is, the more accurate the tomograms will be. The PiCUS software offers you a number of functions to measure the geometry efficiently. The triangulation method is most accurate.

7. **Do I need the electronic calliper?**
The electronic calliper is a very efficient tool to measure the positions of the measuring points. In can help you record even complex geometries in a matter of minutes. Mechanical standard callipers can also be used.

8. **What is the difference between the PiCUS electronic hammer (PEH) and the PiCUS Radio Hammer (PRH)?**
The PEH is connected to the end of the module chain by a cable. The cable is attached to the hammer grip. The PRH is connected to the PiCUS system wirelessly. The PRH contains an accumulator battery which must be charged in order to operate the hammer. The PRH is more convenient to use because it is wireless, but the PRH radio system can
pick up interference from other electronic devices in the area. If this is a problem where you are working, you can also attach the PRH to the system with a cable.

9. **Do the instruments require annual servicing?**
   No. The sensors do not need to be calibrated regularly, but argus does offer check-up and maintenance services according to the regulations ISO9000 and others.

10. **Do I need training to operate the PiCUS unit?**
    Yes. Training on the instruments is highly recommended and will take 1 or 2 days.

11. **What are the recommended configurations for my PiCUS system?**
    With the electronic hammer, the number of sonic sensors is no longer that important. Combining sonic tomograms and electric impedance tomograms will give you much more information about most trees than simply using more measuring points. It is more useful to work with a “smaller” PiCUS AND the Treetronic, rather than a “larger” PiCUS (12 to 16 sensors) alone.

    **Minimal setup:**
    PiCUS Sonic Tomograph – 6 to 8 sensors
    PiCUS Standard software
    Mechanic calliper (such as Haglöf, etc.)

    **Standard setup:**
    PiCUS Sonic Tomograph – 8 to 10 sensors
    PiCUS Electronic Calliper
    PiCUS 3-D Expert software

    **Scientific / Expert Setup:**
    PiCUS Sonic Tomograph – 8 to 12 sensors
    PiCUS Expert software
    Treetronic - Electric Impedance Tomograph

12. **Do the tomograms show sapwood – heartwood of the trees?**
    Yes. Particularly the Treetronic shows you the sapwood / heartwood accurately in many situations. In trees with defects (decay or cavities), the sapwood – heartwood is more difficult to find.

13. **Can I see growth rings in the tomograms?**
    No. Growth rings are much too small to detect with this technology.

14. **Do the tomograms give me any information about the roots?**
    The sonic tomograms (SoT) do not give you any information about the roots. They only give information about the level of tomography. The electric impedance tomogram (EIT) produces an integral of the resistance of a certain section of the tree. The length of this section is approximately equal to the diameter of the tree itself. Thus the EIT can give you information about the roots when you measure near ground level, particularly about the decay in roots.

15. **Can I use the PiCUS for root mapping / detection?**
    Using the Sonic Tomograph instruments for root detection is limited. Under perfect conditions it could be possible to detect large roots near the tree under the surface.

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3. PiCUS Sonic Tomograph

3.1. Working principle

The PiCUS® Sonic Tomograph is an instrument to detect decay and cavities in standing trees non-invasively. The velocity of sound waves in wood depends on the modulus of elasticity and the density of the wood itself. The PiCUS unit tracks the speed of these waves. Most damage and disease causes fractures, cavities, or rot and reduces the wood’s elasticity and density. This sketch displays the basic working principle, in that sound waves cannot take a direct path through the wood (red dotted line) if there is a cavity between the transmitter and receiver.

The results of the sonic investigation are recorded in a Sonic Tomogram (SoT), which uses different colours to display the various properties of the wood:

- **Areas of high E-module/density**, where the fastest velocities can be found, are represented in (dark) browns – indicating healthy wood.
- The meaning of green varies according to the defect. It often describes the distance between healthy and damaged wood, but can also indicate early fungus infection.
- Violets and blues represent areas of slower sound velocities (meaning low E-modulus).

The colour scale (black-brown, green, violet-blue-white) is ranges from the fastest to the slowest velocity.

Taking sonic measurements with the PiCUS unit involves four basic steps:

1. Determine the level, number, and positions of measuring points and mount the equipment on the tree
2. Measure the geometry of the tree at the level you are working at
3. Take the sonic measurements
4. Calculate the tomogram
3.2. Determining the measuring level
To determine the measuring level, first conduct a thorough visual inspection of the tree and also a sound evaluation with the mallet. Look for external signs of internal defects, such as fungus growth, cracks, cavities, damaged bark, etc. Use all of your knowledge about trees and diseases and choose the measuring level according to your visual assessment of the tree.

3.3. Measuring the geometry of the tree at the measuring level
When calculating the tomogram, sound velocities are measured using set distances and time recorded between these points. This means that it is important to note the geometry of the measuring level (positions of nails) as accurately as possible.

There are several ways to enter the geometry of the tomography test level.

1. Simple circular geometry
2. Elliptical geometry
3. Free shape geometry - Triangulation

The PiCUS Calliper can efficiently carry out the triangulation measurements needed to calculate the exact positions of each measuring point. Using the electronic PiCUS calliper allows you to plot any tree shape quickly and accurately.

Tomogram / cross section photo of tree\(^1\) with butress roots
On the right: Electronic calliper in work and in transport positions.

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\(^1\) Recorded by Craig Hallam, ENSPEC, Australia
3.4. Taking sonic measurements

The standard way to measure sonic data is to place a sonic sensor on each measuring point (nail). This means that if there are 10 measuring points (nails) along the circumference, you would need to use 10 sonic sensors. The impulse is generated on each measuring point (nail) and recorded on the sensors at the other 9 points.

The electronic hammer (photo on the right) allows you to use fewer sonic sensors than measuring points. This enables you to use smaller PiCUS systems in a fully functional manner. This hammer is also helpful when working on large trees, where the number of measuring points required exceeds the number of sonic sensors you have. The measurements obtained will be very similar to standard values, but it may take you longer to conduct the measurements. The sketch shows different variations of the measuring procedure using fewer sensors than measuring points. As you can see, it is possible to conduct a “12 sensor” PiCUS test using only 6 sensors.

Black squares = Measuring points (nails), Blue points = placement of the sonic sensors
3.5. Calculating a Tomogram
A tomogram of a tree can be calculated on site using a number of functions for data analysis and presentation.
The PiCUS Sonic Tomograph is the first to use “relative velocity” reconstruction algorithms. Earlier devices relied on absolute sound velocities, which were measured in meters per second. However, absolute sonic velocities vary among species, among the trees of the same species and even within the same tree. Thus the calculation transforms all velocities you measure into “relative” velocities.

The picture on the left shows the PiCUS Q72 Expert software with both a Sonic Tomogram (on the left) and an Electric Impedance Tomogram (EIT, on the right). The EIT shows that the decay is at different stages: dark blue (1) indicates active decay. The green/yellow on the right (2) coupled with the slow sonic velocity (SoT) indicate dead decay. (3) is a cavity.

3.6. PiCUS CrackDect - Crack Detection with the PiCUS Sonic Tomograph
Cracks are severe sonic barriers for sonic waves. There are two main types of cracks:

- “Star-shaped cracks” run from the centre of the tree to the outer fibres
- “Ring cracks” run parallel to the circumference

Both types of cracks can lead to errors in your tomograms. The PiCUS system is now capable of identifying star-shaped cracks in many cases. The Q72 program checks for the presence of radial cracks and indicates their likely positions in the tomogram with yellow lines. The example shows a Platanus tree² with cracks and decay.

² City of Strasbourg, France
3.7. 3-D View of a Tree

The 3-D function is used to present all tomograms that have been recorded on a single tree in a three-dimensional graphic. This function is useful for presentation purposes because it helps people who have little or no training to get a better idea about the internal structure of the tree.

This Eucalypt tree\(^3\) was investigated at four levels in order to see if there was a connection between the two external fungus growths on the upper left and lower right.

3.8. Colours of the Tomogram

Earlier versions of the PiCUS program (1997-98) used a grey scale in tomograms, but it is much easier to determine the exact extent of the damaged area by viewing different velocities in specific colours.

Sonic velocities vary according to species, seasons, water contents, etc., sometimes even within the same tree. This makes it difficult to assign “sharp” or definite colour borders. To avoid this problem, the software calculates “relative velocities” which means all velocities recorded at a certain level are compared with one another other. This shows us where the sonic waves travel slower, compared to the “fastest” areas.

When analysing a tomogram you need to look at three main colour groups:

1. Browns (light brown to dark brown)
2. Greens
3. Violet-Blue-Whites

It is also possible to display the violet-blue-white areas using only violet. These examples show a tomogram in standard, violet-only (no blue), and in greys. These colour definitions are part of the PiCUS Expert Software.

\(^3\) Recorded by Craig Hallam, ENSPEC, Australia
3.9. Configuration of the PiCUS
The sketch shows different options of PiCUS Hardware.
3.10. Advantages of using the PiCUS

- Using tomograms of the same tree to track changes easily over a long period of time helps with **long term tree maintenance**.
- Can be used on nearly **any size of tree**. The lower limit for a tree diameter is approximately 30 cm.
- **Easy to understand tomograms**: The areas of different density are easy to identify with the PiCUS colour-coding. (“Your customers will love the images!..” say BTL, The Netherlands, PiCUS users since 2000.)
- **Detect Cracks easily**: The PiCUS CrackDect system is capable of detecting star-shaped cracks and prevents you from reaching wrong conclusions about a tree’s status.
- The PiCUS is **easy to operate**: If you have a sound knowledge of trees and some technical capabilities, you can easily learn to use the PiCUS unit.
- Works well **independent of noise levels**. PiCUS can eliminate surrounding noise with its technology and can even be operated near roads with heavy traffic and in strong winds.
- **Sensitive sonic sensors** on the PiCUS unit yield excellent results, even on larger and damaged trees.
- Sonic data is compiled with **relative calculations** to compensate for different wood densities of each species, enabling you to work on species not yet tested. Also the PiCUS calculation algorithms compensate for a wide range of force used in tapping on sensors.
- **Sensors are easy to mount**: PiCUS Sonic sensors are very small and can be easily mounted on nearly every position on the trunk - even in the narrow gaps between buttress roots. This is important for investigations performed near ground level. The sensors are lightweight and the nails do not need to go far into the wood – only through the bark. This is important for trees with thin barks.
- Advanced **software**: The PiCUS Software is easy to operate and offers you many functions for analysing and presenting the data. The PiCUS control software runs on Windows PCs and Pocket PCs.
- The comprehensive PiCUS **manual** guides users through all steps and problematic situations.
- **Precise geometry recording** of the tree at the measuring level: The PiCUS Software uses a triangulation method, which is the most accurate way to determine the exact positions of the sensors.
- The mechanic-electronic **PiCUS Calliper** is an efficient and accurate tool for recording the positions of measuring points.
- **Root-tree-allocation**: Using the PiCUS hardware can help you answer questions like “which root belongs to which tree?” This is especially useful at building sites where roots have been uncovered and need to be identified as belonging to one of the nearby trees.
- **High quality hardware**: The PiCUS hardware consists of highest quality components to ensure a long and trouble-free service life.
- The PiCUS Sonic Tomograph is the **only instrument** that offers our new **Fewer – Sensors – Than - Measuring – Point** (FSTMP) Technology.
3.11. PiCUS Application
Since launching the system in 1999, the PiCUS has become a success in 26 countries around the world. These photos show its use in different places.

PiCUS on Ivenacker Oaks (Germany)

PiCUS test 93.5 meters up on a California redwood (USA)

Cedar tree in the Presidio, CA (USA)

PiCUS in Shrine in Fukuoka (Japan)

PiCUS user meeting 2008, The Netherlands

Oil-palm testing (Malaysia)
4. PiCUS : Treetronic®

4.1. Treetronic® Theory

The PiCUS Treetronic® is an Electrical Impedance Tomograph. The instrument uses electric current/voltage to examine the tree. The resulting measurements are displayed in a two-dimensional map showing the apparent electrical impedance of the wood, called an Electrical Impedance Tomogram (EIT). The electric impedance - or resistance - of the wood is influenced most of all by the water content, cell structure and chemical elements which change according to the status of wood. The Treetronic can detect such changes by measuring how the heterogeneous wood “bends” the electrical field.

The sketch 4 on the left shows the electrical field in a homogeneous material. If the material is not homogeneous – as in the sketches on the right - the field is distorted.

Measuring these fields is simple because the wires of the Treetronic unit are connected to the same nails used for sonic measurements (see photo on the right). The measurement runs automatically.

The EI tomograms are coded with rainbow colours:

- Blues indicate areas of low impedance (high water content, etc.)
- Greens and yellows show increasing impedance
- Red colours indicate areas of high impedance (lower water content, etc.)

In order to analyse an EIT, the operator will need extensive knowledge about the specific type of tree species. Each species has its own typical impedance (water/moisture) distribution.

When used in combination with a Sonic Tomograph, an EI tomogram offers you more information about the tree. The EIT helps to analyse the type of damage, and it is often possible to distinguish between cavities and ‘wet’ diseased wood.

4 Graphic by T. Günther, C. Rücker
4.2. Combined analysis of SoT and EIT

When analysing both SoT and EIT it is often possible to

- distinguish between different types of damage (for instance crack/cavity vs. decay) in many cases
- detect early stages of decay
- get information about areas above or below the measuring level. This is interesting for analysing root decay problems.

The table shows some general conclusions that can be drawn from the SoT and EIT of a tree species that usually develop higher conductive (blue in EIT) sapwood/bark on the edge and lower conductive heartwood (red in EIT) in the centre:

The table helps to evaluate the centre of the tree

<table>
<thead>
<tr>
<th>SoT</th>
<th>EIT</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High (brown)</td>
<td>High (red)</td>
<td>Healthy</td>
</tr>
<tr>
<td>High (brown)</td>
<td>Low (blue)</td>
<td>Still safe, but early decay</td>
</tr>
<tr>
<td>Low (blue/violet)</td>
<td>High (red)</td>
<td>Cavity / dead decay</td>
</tr>
<tr>
<td>Low (blue/violet)</td>
<td>Low (blue)</td>
<td>Active decay</td>
</tr>
</tbody>
</table>

The next examples show the scans on two chestnut trees. Both trees were suspected of having the chestnut wet wood disease.

4.2.1. Chestnut Trees: decay or cavity?

The SoT of “Tree 1” shows heavy damage (1), the type of which is initially unknown. The blue colours in the EIT tomogram (2) indicate areas of low impedance; most likely due to high water content. The combination of low sonic velocities (in the SoT) and high conductivity (in the EIT) is typical for active fungus infections. In the case of this chestnut tree, the diagnosis would be “wet wood”.

“Tree 2” appears to be very dry inside, as shown by the red colours in the EIT (4). This clearly indicates that this tree is not infected by wet wood disease. The EIT indicates an area of very high impedance (4); the sonic tomogram indicates low density (3). This might be a cavity.
4.2.2. Maple Tree: crack or decay?
This maple tree had an old wound which might be causing decay. To find out, two inspections were made. The SoT shows a crack-like area of low sonic velocity (1). The EIT shows very low resistivity in the centre of the trunk (2). A sound maple tree is supposed to have a high conductive blue ring (3) on the edge and a less conductive red centre (4) as shown in the EIT on the right.

4.2.3. A beech tree with 3 trunks: decay or bark inclusion?
The bark one can expect to find between the three trunks\(^5\) of this tree make it difficult to evaluate the true size of the damage seen in the SoT. The EIT shows the likely positions of the bark (1). The size of the actual fungus infection (2) – shown as a blue area in the EIT - is obviously very small.

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\(^5\) Recorded by Frits Gielissen, The Netherlands

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4.2.4. Decay in roots – a beech tree with Kretschnaria deusta
The SoT of this beech shows a typical pattern for a fungus infection: the centre of the tree does NOT have the darkest colours (i.e. highest sonic velocity), but only lighter browns. The EIT clearly shows a high conductive centre (1), which is a clear indication for fungus activity. The EIT on the right shows the typical resistivity distribution in a healthy beech tree.

4.2.5. Decay in roots – a beech tree with Meripilus giganteus
The root system of this beech was infected with Meripilus Giganteus. A sonic scan taken at 20 cm above ground level did not show any defects. The EIT conducted at 20cm and 120cm indicates high conductivity in the centre of the trunk (1). Healthy beech trees are supposed to have less conductive centre which show as reds in EITs, as seen in the EIT in section Fehler! Verweisquelle konnte nicht gefunden werden. above.
5. “PiCUS World of Tomograms“ – International Tomography Data Base

We are creating an international sonic- and electric impedance tomogram data base at www.picus-info.com to enhance the exchange of information among all PiCUS users.
6. TreeQinetic® – Tree Pulling Test

The tree pulling test was developed by WESSOLLY and SINN at the University of Stuttgart in the mid 1980’s. It is used to assess a tree’s stability with regard to stem fracture and uprooting precisely and non-invasively. The tree pulling test is performed to get information about the breaking stability of the trunk and the stability of the roots.

In a pulling test, a load (substituting for the wind) is exerted on a tree using a winch and a steel cable. The reaction of the stressed tree under this defined load is measured with high resolution devices (elastometer and inclinometer), and the data obtained are compared with those of sound trees. The major components to be considered in such calculations are the wind-load (the surface of the load-bearing structure, tree height, etc.) and the material properties of green wood.

The TreeQinetic System is designed to collect data during tree pulling tests. The complete system consists of:

1. One **Forcemeter** that measures the pulling force.
2. At least one **Elastometer** that measures alterations in length of the marginal fibres at a resolution of 0.001 mm.
3. At least one **Inclinometer** that measures the inclination of the tree at a resolution of 0.01° or 0.005°.
4. Evaluation software **ArboStat**

Another option available is to use a **wind-speed** sensor to measure the swaying motion of a tree in winds (see section 7).

The PiCUS TreeQinetic system is capable of recording data from many sensors at the same time. The whole pulling process is recorded synchronously and the data are transmitted wirelessly to a PC and registered.

**Advantages:**
- Easy, wireless measurement and continuous data transmission
- Modern wind load analysis
- User can calculate results autonomously
- Easy-to-understand graphical results
- Direct information about the breaking stability of the stem
- Direct information about the stability of the root system
The photo on the left shows four elastometers mounted to a tree to record fibre reaction to a pulling force. The photo on the right shows a typical winch used to create the substitute wind load.

ArboStat – Evaluation software
The ArboStat evaluation software calculates the breaking stability of a trunk and the stability of its roots. To do this it uses a wind load analysis for the tree and the data of the pulling test. For the wind load analysis, the data of the tree’s height, stem diameter, crown shape, wind zone, etc. are entered (see right). The resulting (wind) load to which the tree is exposed is calculated.

The breaking stability can be calculated by using the wind load analysis and the data of the pulling test. The results are shown in a simple green-red graphic. The relation of green to red is calculated by the wind load analysis. The data points of all elastometers are included in this graphic. If all values are located in the green area, then the breaking and fracture stability of the stem is good.

The uprooting stability is calculated and presented in a similar way. The data of the inclinometers are drawn into another red-green graphic which is derived from the wind load analysis and the generalized tipping curve.

Graphic for breaking stability (left) and uprooting stability (right)

You will need a thorough introduction to the products in order to operate the measuring hardware and use the evaluation software.
7. Dynamic Sway Motion of Trees

One further option of the TQ system is the “dynamic wind sway motion logging” function. This requires a wind-meter (anemometer) to measure wind speed. At present we can only record the sway motion (inclination of root plate and strain of marginal fibres and wind speed). It is not yet possible to obtain direct stability information from this data.

Some situations where the information can be used are:

- Measuring many similar trees (for instance in row on a parkway) to find out which tree is moving differently. This may indicate root problems. When comparing the sway motion of many similar trees, we reduce the problems involved in knowing the “normal” motion.

- Measuring a tree before and after construction work in the area. If the sway motion is significantly higher after the work, we can assume that major roots have been damaged.

7.1. Hardware for TreeQinetic Dynamic Sway Motion Tests

The minimal hardware for sway motion testing consists of

- 1 inclinometer
- 1 anemometer with a 10 meter pole
- 1 communication Unit
- 1 case with charging unit, cables, and measuring software
8. Technical information of PiCUS and Treetronic

8.1. PC System Requirements
The PiCUS software requires the following PC hard and software:

PC Hardware: PC Pentium 4 or higher, 1 GHz or higher, 400 MB HD
PC Operating System: Microsoft Windows XP (SP2) / Vista / 7 (32/64 bit, all updates)
PC Screen resolution: 1024 x 768 (or higher)

If the 3-D presentation function is installed, a Direct X compatible graphic card and more processor power will be necessary.
PocketPC operation systems: Windows mobile 2005

8.2. Software
PiCUS Software language: English, German, French, Spanish, Italian
Voice help during measurement: English, German, French, Spanish and Italian
Manual:
Image format: Windows Bitmap Format, JPEG Format

8.3. Parameters
Dimensions of the unit: PiCUS Sonic Tomograph: 540 x 480 x 180 (B x T x H) [mm]
Treetronic: 500 x 400 x 200 [mm]

Weight of the unit: PiCUS Sonic Tomograph: approx 12 kg (10 modules)
Treetronic: approx 7 kg

9. Contact

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