



LUDWIG SENSORS APPENDIX



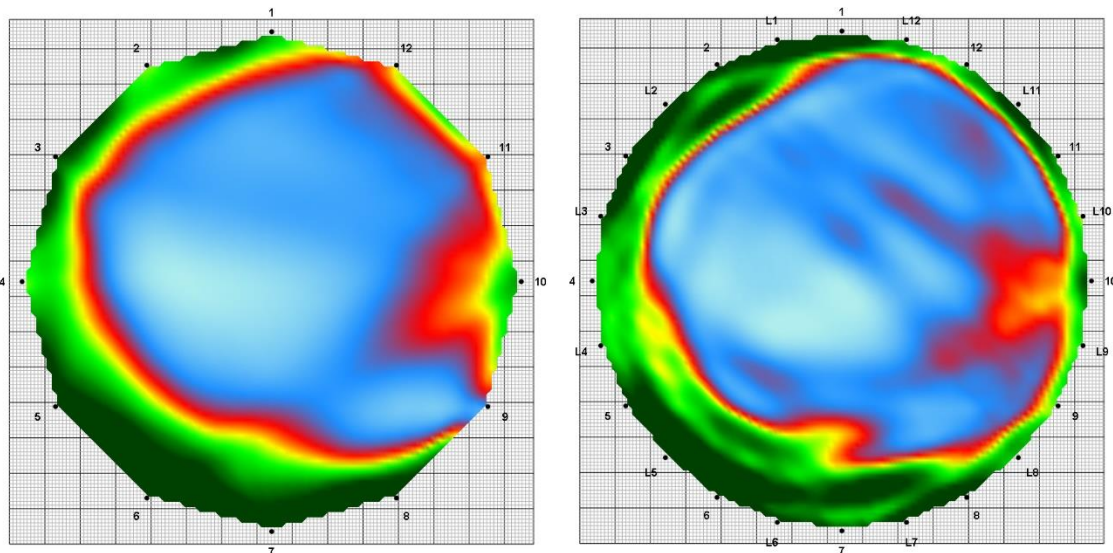
Introduction

Ludwig sensors

- make more detailed measurements
- let you enter more precise geometry
- provide tomograms closer to the real situation



This appendix is for the users of ArborSonic 3D who measure with Ludwig sensors. Ludwig “sensors” are nails without sensors. They can be hit like sensors, making them signal sources, but they can not receive any signal. (They are “deaf”, still making perfect sounds.) Using Ludwig sensors can show a more accurate picture of the selected layer (if the number of sensors was not changed).



Same measurement with sensors only and with Ludwig sensors as well.



On the geometry page, there is a checkbox under the number of sensors. If you check it, Ludwig sensors are added to geometry and they behave like extra sensors. Going on to Time data, normal sensors should be measured like during a usual measurement. After the sensors, the Ludwig sensors should be measured in order (L1, L2, L3...).

The tomogram is calculated by the program and can be used for biomechanical calculations or for reports and so on. The steps are detailed in the chapters of this appendix.

Accurate evaluation is possible only if the 'blind' sensors are the same in both shape and material to the ArborSonic3D sensors. In case of using any other nails or using less than 10 Ludwig sensors, the time data is misleading the tomogram is unreliable.

Hardware and set up

Ludwig sensors are special nails (both in shape and in material) with a 6 cm long spike and a rounded head. The maintenance, fixing and removing are almost the same as for the normal sensors. Ludwig sensors can be easily removed with the remover tool.

As Ludwig sensors are supplements only, they can NOT be used on their own, they have to be used together with normal sensors.

When measuring with Ludwig sensors, use the same number of Ludwig sensors as normal sensor. Always put one Ludwig sensor between 2 normal sensors (and one sensor between 2 Ludwig ones).

Hit the Ludwig sensors to the same depth as the normal ones are.



Geometries

- Check in the “Ludwig sensors” on the Geometry page
- If you use circular, elliptic or rectangular geometry, the software will show you where to place the Ludwig sensors. They will be L1, L2, L3,... on the geometry page

Sensor distances (cm)					
1	0,0	L1	15,5	2	30,7
		L2	45,0	3	58,3
		L3	70,6		

- Distances will start with 1 for the first sensor, then L1 for the first Ludwig sensor, 2 for the second sensor and L2 for the second Ludwig one, and so on.
- The Ludwig sensors are numbered as which sensor is on their left side (on the tree).
- Ln is always between sensor n and n+1. (Except the last one, which is between the last and the first sensors.)
- Otherwise you will need the usual data, circumference, major and minor axis (for ellipse), penetration depth, bark thickness, ...
- When using irregular geometry, you will have to measure the distances similarly like when you have normal sensors, just, of course, you will have to measure the Ludwig ones too. The software will tell you which distances to measure (if you turn the speakers on).

Sensor Geometry
Time Data

Layer name
Layer #4

Plane
Height 20 cm

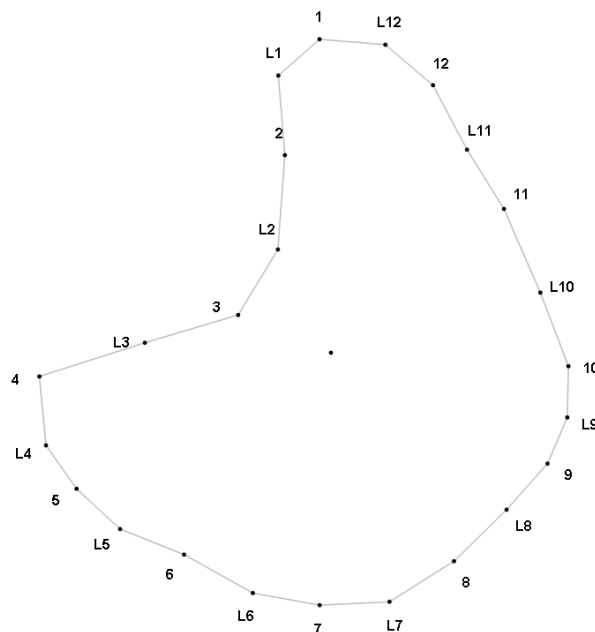
Sensor position data
Scheme Irregular
[Convert to Irregular](#)

Sensor count 12

Ludwig sensors

Valid spatial data

L1 - 1	15,5
2 - 1	28,7
L2 - 1	51,0
3 - 1	70,2
L3 - 1	86,3
4 - 1	107,5
L4 - 1	120,0
5 - 1	125,3
L5 - 1	129,8
6 - 1	131,0



An example for irregular geometry with 12 sensors and 12 Ludwig sensors

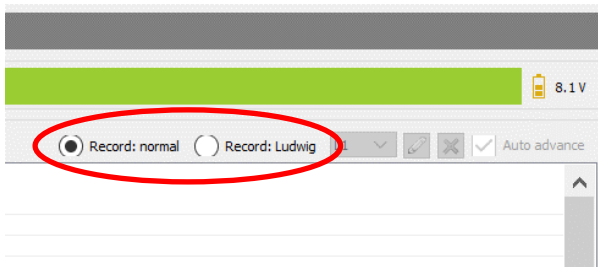
Measurement – switch between usual and Ludwig sensors

After setting the proper geometry, click to the “Time data” tab for executing the measurement. The measurement starts similarly to a usual measurement, the tomogram should be set up (Amplifier Boxes, linking cables, Battery Box), the proper COM port should be set and found. Turn the Battery Box on.

At the “Time data” tab there will be an extra row.

Time rows												
Remove bad rows	Remove selected rows		Remove all rows									
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12
	267	338	378	390	402	416	405	391	307	181	0	159
	267	338	377	390	402	415	404	390	306	179	0	158

First do the measurement using **only** the normal sensors, just as you usually would.



In the right top corner “Record: normal” should be chosen. (The program chooses it automatically.)

When all the sensors were hit (at least as many as the minimal row count in set – see in the subsequent chapter), you can switch to “Record: Ludwig”.

The software needs to be told, which Ludwig sensor you are going to hit next. The easiest way to do this, is to make sure that "Auto Advance" is checked. This way once you've made enough good hits on a Ludwig sensor, the software will automatically "advance" to the next Ludwig sensor. You will hear the name of the next Ludwig sensor to be hit, when this happens."

The Ludwig sensors should be hit in order, starting with L1. Hit the Ludwig sensors' heads similarly to the normal ones, with a loose wrist.

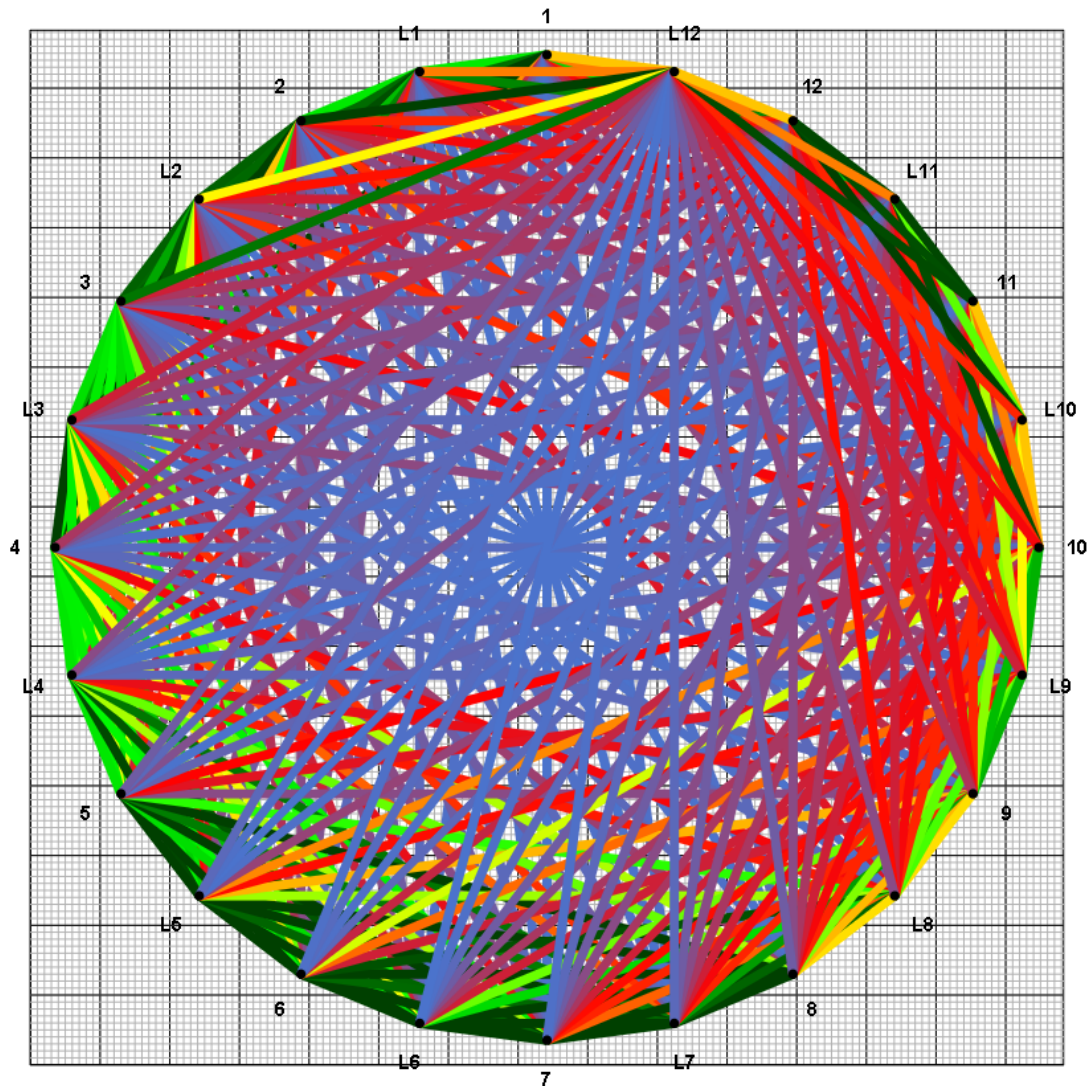


When you hit enough on the Ludwig sensors, the measurement is finished. (Turn off the Battery Box for saving battery.) All the areas next to the sensors' and Ludwig sensors' numbers will be green containing the number of correct hits.

If you hit a Ludwig sensor badly, you will hear the usual sound indicating this. If you however hit a normal sensor instead of a Ludwig one or reverse, the same sound will be played. (A normal hit can be turned into a Ludwig hit, and vica versa. See chapter: “Time data corrections – what to do with a bad hit?”.)

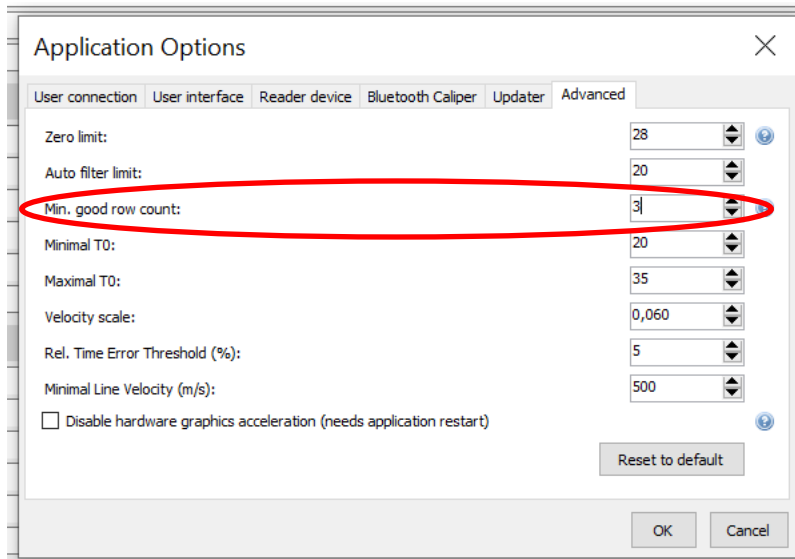
Tomogram

The tomogram(s) is calculated by the software and the only difference is that Ludwig sensors are shown as L1, L2 and so on. Otherwise the tomograms can be used as usual, the functions are the same.




The maximal number of sensors are 32 while the maximum number of Ludwig sensors are the same. Together the 32 sensors and 32 Ludwig sensors can make measurements via about a thousand “lines” like the ones you can check in graph view.

Software – Number of (required) hits

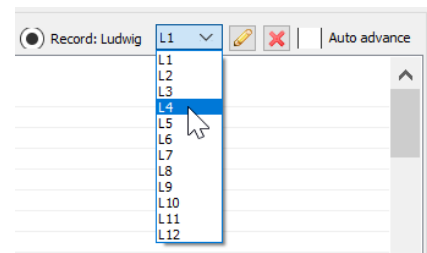


For both normal and Ludwig sensors, there is a minimum number of good hits required per sensor. When you reach this, the number in the column header turns green, and if this was a Ludwig sensor and Auto Advance is checked, you automatically advance to the next Ludwig sensor.

It is recommended to set this number between 3 and 6.


This can be set in Application Options, which is  button on the left top of the program window. Here the Advanced tab is used.

If you want to measure more with one Ludwig sensor, you can do it manually with unchecking “Auto advance” and setting the proper Ludwig sensor.




Time data corrections – what to do with a bad hit?

If a measurement is bad, you can delete the time data row as you normally would.

If the measurement itself is good, but it indicates the wrong Ludwig sensor being hit, you can reassign the Ludwig hit: select the correct Ludwig sensor that was hit from the combo box, select the time row to be fixed, and then click the  button.

You can do the same thing, to turn a normal sensor hit into a Ludwig sensor hit (in case you might forget to click "Record: Ludwig").

You can also turn a Ludwig sensor hit into a normal sensor hit, by selecting the affected time rows, and clicking the  button (in case you forgot to click "Record: normal").

Extra possibilities

If you are interested how the tomogram would look like if the measurement was done with normal sensors only, you can go to the Sensor Geometry page and uncheck the Ludwig sensors check-box.

This hides the Ludwig sensors, and you can see how the tomogram and biomechanical calculations would do without the Ludwig sensors. You can always check " Ludwig sensors" to bring the Ludwig sensors back. You do not lose any data, by hiding them.

Go to the Tomograms page to see the tomogram from the sensors only.