Sound Capture

Recording, visualization and recognition of sound

1. Why?

When we want to register sound during the lessons physics or science and to make sound visible then we can use simple or sophisticated aperture. (Oscilloscope, mixing panel, microphone, loudspeaker...). Those who can use a computer in the class with some freeware which is on the cd and a headset can have the same results and even more…

2. Materials and software

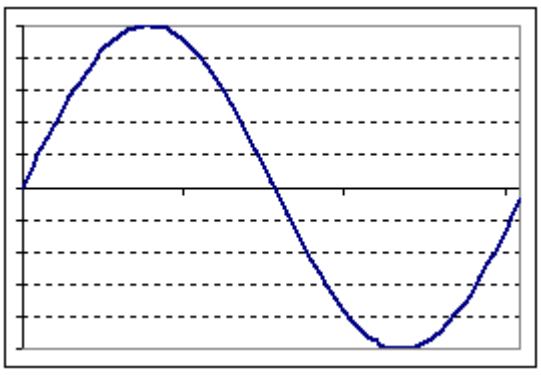
- Computer or laptop with a good soundcard
- Headset or microphone
- Tuning forks (For example. 440 Hz, 1700 Hz) and hammer
- sound recordings (on the cd, or eventually making it yourself)
- Software:
    - BIP Electronics Lab Oscilloscope - 3.0
    - Audacity
    - Visual Analyser 8.10

3. How to start

If you are doing experiments in which you want to record a signal (voltage) for a long time you can use an oscilloscope. If you don't have this apparatus at your disposal then you can use a computer with a sound card. The computer must link the AD/DA-conversion (Analogue to Digital and vice versa). Analogue signals (sound) come in via the microphone entrance or the line-in. These signals are digitalized by the soundcard (= sampling). Most of the sound cards can sample without problems with a frequency of 44.1 kHz.

Analogue and digital:

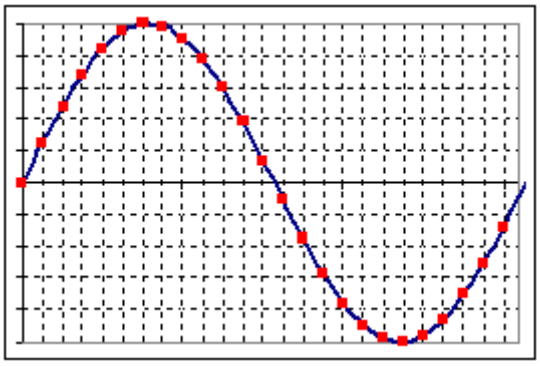
With an analogue signal the signals can have continue every different value. With a digital signal the value is discrete and the changes are with jumps.



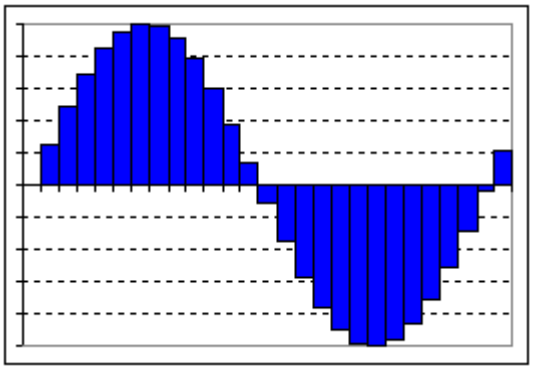
Analoog signaal

The signal which comes in via the cable and the sound card/PC is analogue and has to be converted in a discrete signal. We give that the name of a digital signal but it is as a matter of fact an analogue signal with digits and it needs to be converted with an AD-converter. On the sound card is in-

stalled such a Analogue-Digital-Converter (ADC) for recording and a Digital-Analogue-Converter (DAC) for playing sound samples.



Sampling



Digitaal signaal

How to connect

With the soundcard we must choose the right entrance. We have the choice between Line-In and the Microphone-entrance. On the left picture it is very clear but on the right picture it is not so obvious. Some symbols are used. Please check the manual to see what they mean.

Mostly they use a color code to mark the different entrances.

- Line-in-jack = blue
- Microphone -jack = red or pink
- Line-out-jack front / loudspeaker out -jack = green (for passive loudspeakers (most common))
- Line-out-jack back = black (for active loudspeakers) or white or not there!!

Which entrance is best? The microphone entrance or the line-in-entrance? That depends of the signal we want to measure.
Rules:

- maximum input for the microphone: 200 mV peek
- maximum input for the line-in : 2 V peek

For safety you can use the line –in entrance if you want to measure other signals the sound signals. If you only want to measure sound signals then simply take the microphone entrance.

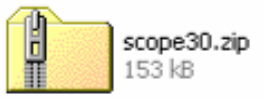
4. Use of Lab Oscilloscope - 3.0

4.1. Getting the software

The freeware program BIP Electronics Lab Oscilloscope – 3.0 can be downloaded for free from the BIP Electronics website.

Use this link: http://www.electronics-lab.com/downloads/pc/002/index.html

You get a zipped file with the name ***scope30.zip*** on your computer that you have to unzip first.



After unzipping you become a map ***scope30*** in which are the following data?

- README.TXT (information about the author)
- SCOPE.CFG (the chose installation)
- SCOPE.HLP (a very useful help-file, also available from within the program)
- SCOPE.EXE (the program itself)

Tip: It can be useful to start the program from the desktop page itself. Therefore make an icon

- Select the icon of the program **SCOPE.EXE**
- Use the right mouse button on the icon and select the icon by double clicking
- Select the icon of the coupling

4.2. Installation of the hardware

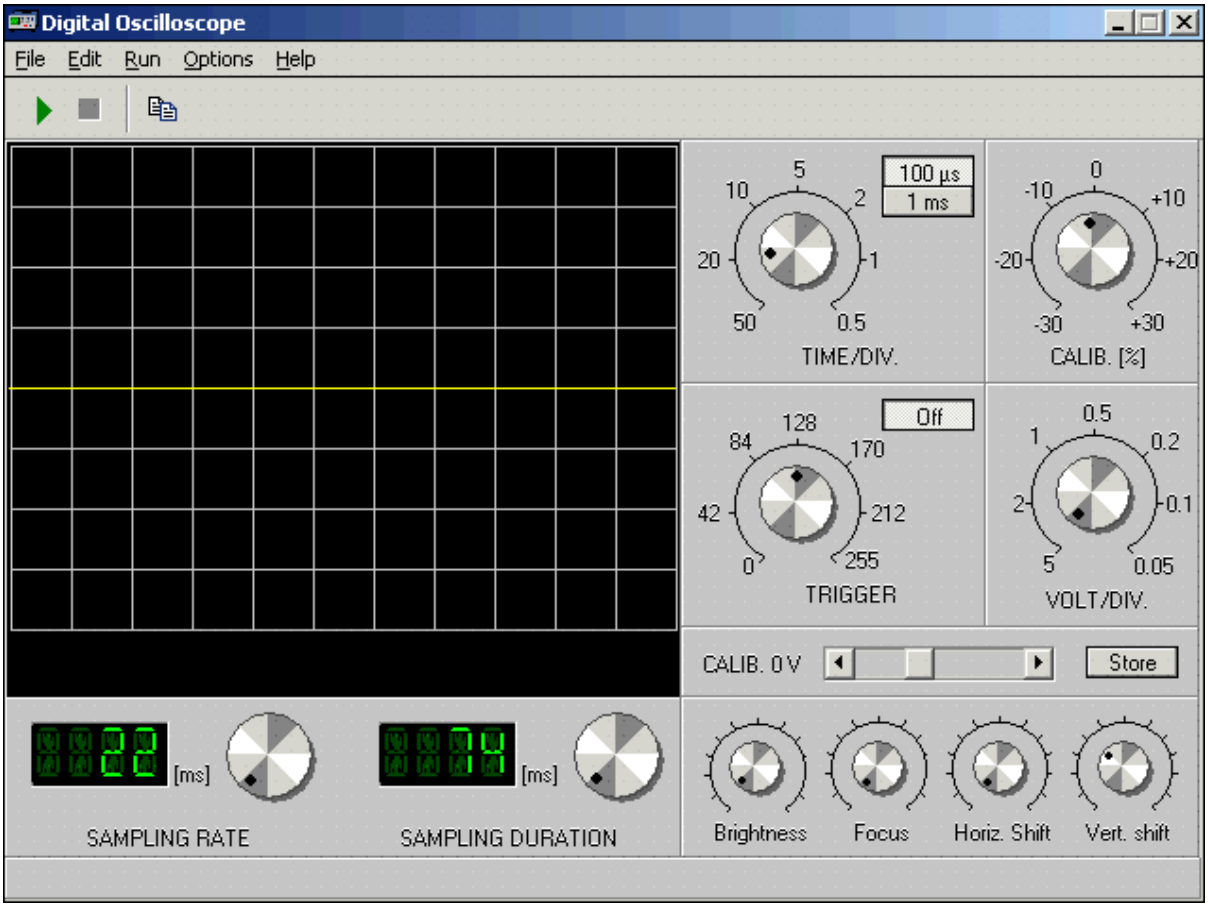
Connect the headset (earphone and microphone) with the computer. The black jack-plug must in the ***Line-out***. The pink or red jack must in the **Line-in**.

Only use the microphone of the headset or a standalone microphone, then you only have to connect this one and you can hear sound via the loudspeakers of the computer or laptop. This is very good in a classroom but very bad when you are using an investigation lesson for students on different computers.

4.3. Use of the program Digital Oscilloscope

Start the program by clicking on the icon SCOPE.EXE.

You have the following screen



What are the possibilities?

1. Making a sound wave visible (using it as a normal oscilloscope)

   This can at the following manner:
   - Connect the microphone properly
   - A usable ‘sampling rate’ and ‘sampling duration’
   - Go for play (the green triangle)
   - Look at the patterns on the screen
   - Stopping is by clicking on the green square

   SAMPLING RATE en SAMPLING DURATION

   With the Sampling Rate-boot on the period is set in (in milliseconds) and then a peace of input is sampled. The 1000 means that the input signal is sampled every 1000 ms.

With the Sampling Duration-button you install the length of the sampling fragment. A signal of 500 means that the input signal is sampled continuously during 500 milliseconds.

Note if you take a Sampling Duration which is equal or more then the Sampling Rate, then the (sound) signal is continuing sampled and is seen on the screen graphically

2. How to change the picture:

   - TIME/DIV
     the TIME/DIV button can be used to change or alter the time base of the oscilloscope. When this button is at 5 and the scale at 100 µs then every part of the raster (in horizontal direction) is for a time duration of 500 µs en the full raster gives a reach of 5000 µs (5 ms). If the scale is at 1 ms, then one part of the raster is 5 ms en the complete raster gives 50 ms.

   - VOLT/DIV
     to change the amplitude scale you use the Volt/div. button. Best is to install a high amplitude so that you can see it properly on the screen. The button can also be used once you have stopped the sound registration.

   - Horiz.Shift
     this turn button is used to have a horizontal movement on the screen. This is very useful when with stopping picture you want to give the left side of the raster (for t = 0) the golf no amplitude or a maximum amplitude.

   - Vert.Shift
     this turn button can be used to have a vertical movement on the screen. In this way you can place the picture symmetric to the time axe.

   - Focus
     With this button you can make the line thicker and therefore more visible. From a distance.

3. Some other functions:

   - In the menu: click ***Edit*** and then ***Copy*** (alternative: copy-icons or Ctrl+V): you can save the picture on the scope on the computer. In a word program you can put that in the text.

   - In the menu: click ***File*** and then ***save***: you can save the scope picture as a bitmap-file (BMP) on the hard disk. This picture can be used later as an illustration.

   - In that menu: click ***Options*** and then ***picture…***: you can raster on the screen if you want or if you don't want.

   -

- Remarks

- The Scope-program use the soundcard of the computer to measure signals. As a consequence the quality of the results depends on the quality of the soundcard. As for the sample frequencies the Scope-program uses automaticately the highest frequency. For most computers is this maximal 44 kHz but this program can also be used for computers with 11 kHz maximum.

- More possibilities for the program are found in the help function this cab be opened by clicking ***Help*** in the menu and then on ***contents F1***.

Exercises:

1. To look at sound pictures:
   - Connect a microphone to the computer, start Scope and start the recording
   - Look at the picture of different sounds:
     - Tuning fork of 440 Hz, 1700 Hz, …
     - Noise
     - Own voice: ie-sound, oo-sound, uu-sound, aa-sound, eu-sound…
     - Several whispering tones

2. A simple measurement:
   - Record a tone of a tuning fork en stop the recording. The picture stays visible on the monitor.
   - Put the picture symmetric to time axe.
   - Move the picture so that on the left the amplitude (for t = 0) equals null.
   - Move the mouse (it's a cross now) over the raster. You can read the time now on the time axe.
   - If you are positioning the cursor after 1 period then you can read the frequency (in kHz) approximatively. Example (2, 28 ms (0,438 kHz)) for a tone van 440 Hz.
   - If you put the cursor at the top of a golf pattern then you can also red the amplitude at that moment (ex. 0,83 V)

5. Use of the program Visual Analyser

5.1. Installation of the software

The freeware program Visual Analyser can be downloaded for free on the website from BIP Electronics.

Use this link: http://www.electronics-lab.com/downloads/pc/index_2.html

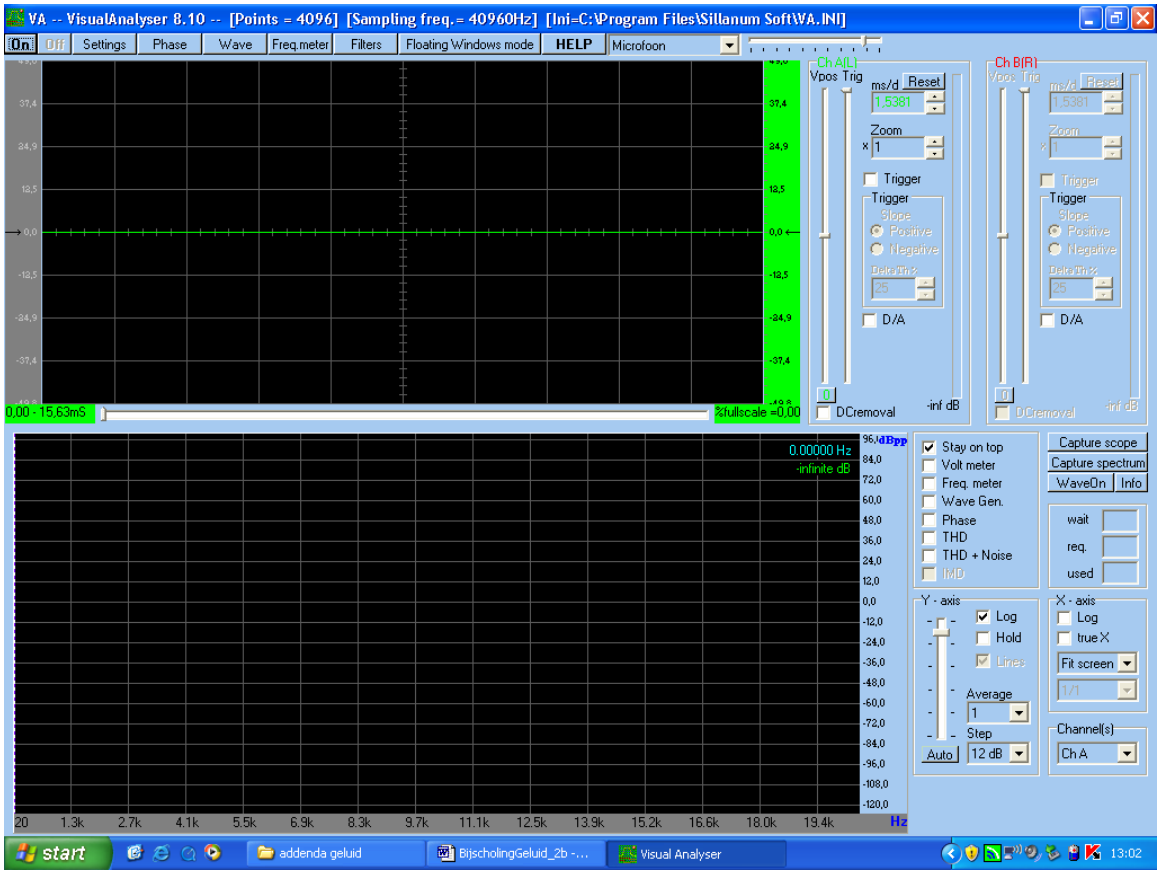
You can use a 'setup launcher' downloader and an 'iso-file'. Once this is done you can double click on the icon of the setup launcher (**VA810set.exe)** to start the installation procedure. This goes as a normal Windows-program. An icon is placed on the computer desk.

cd iso versie vd exe_file

5.2. Use of the program Visual Analyser

Start the program via the icon or by double-clicking on the program-icon or on the name ***VA.exe*** in the map C:\Program Files\Sillanum Soft.

You will have the following screen:



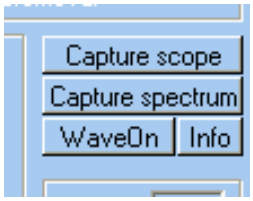
Visual Analyser is a multifunctional program to make sound waves visible, produce them and to make some measurements.

1. Making a sound wave visible (as on a normal scope)
   That can be done on the following manner:
   - Be sure the microphone is connected on the right way. Eventually you must adjust the right apparatus on the screen menu. Choose for microphone and put the record level high with the position button.

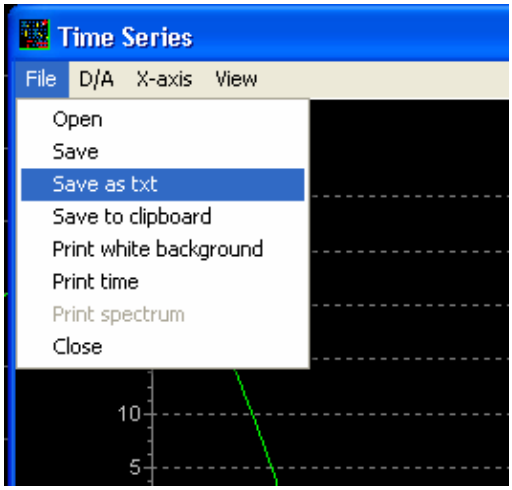
   - Click on the **On-button** left on the screen.
   - When you are recording in the microphone or record any sound then you can see it immediately on the screen. Above you get the ***scope-picture and at the bottom the sound spectrum***.
   - Look at the screen patterns.
   - Stop the sound recording by clicking on the **Off-button**.

   Remark: If you want to use the picture in a text then you can capture the visual of the screen by using PrtScr and import it in a Word (more info: see at point 6. Audacity).

   You can also capture the picture screen as a file with the buttons **'Capture scope' and 'Capture spectrum'**. A click on these buttons records sounds for about a 100 ms (this is adaptable in the settings (=Settings) of the Capture scope/spectrum).



   You have a new screen with the produced sound wave. With the mouse or with **zoom in or out buttons for x- and y-axes** you can zoom in.



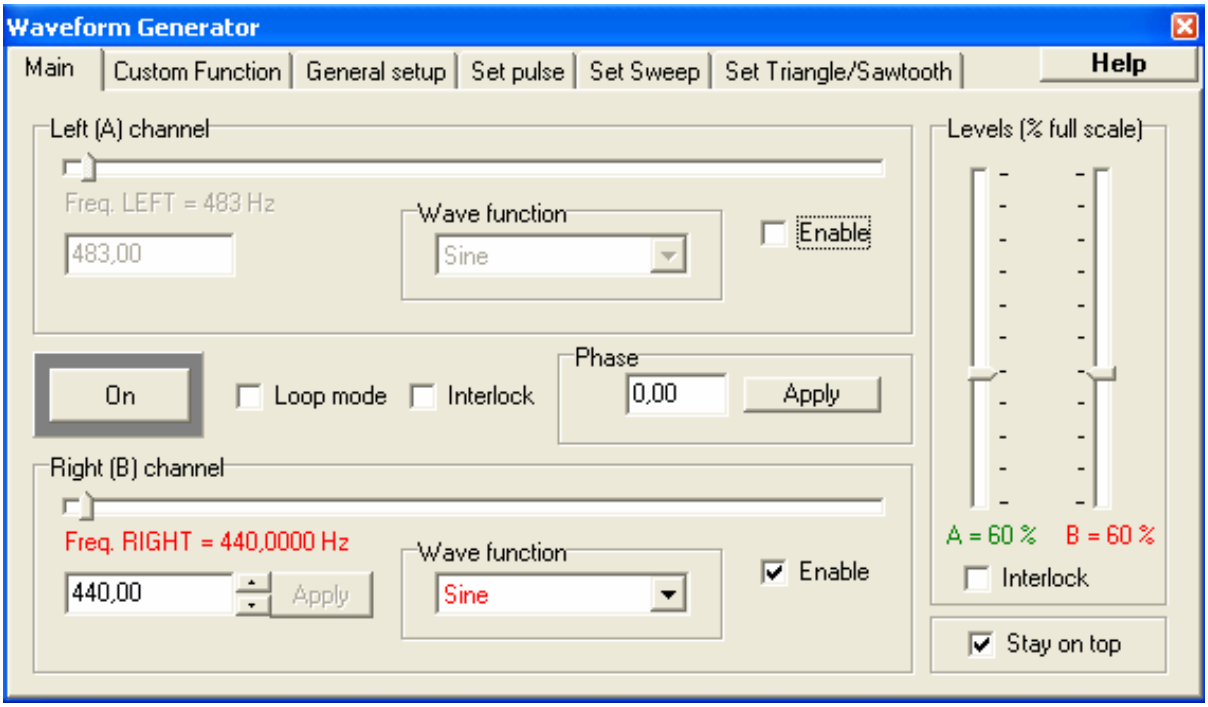
   In a **screen menu** you can capture the and save the recorded picture It is very interesting to choose for '**Save as txt**'. You the have a text in which the time and the amplitude is coupled to a picture (Windows metafile with extension wmf). This you can import in a text.

2. Production of a sound wave

That can be done as follows:

- Make sure the speakers are connected on the right way.
- Click on the **Wave-button** on the left of the screen
- You get a new screen in which you can install the frequency of the wanted tones. That can be done in big steps and in small steps with the **button regulator** and then refining with the triangles next to the frequency window.

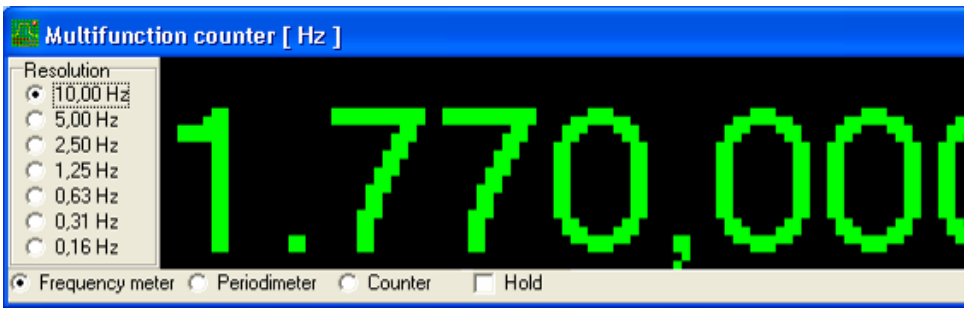
- Once you have the wanted frequency then you click on the **On-button** to produce the wanted sound.
- If you install left and right different frequencies then you have alternatings.
- You can also see the produced tone if you look at the scope program in VA .



3. Measuring frequencies

That can be done in the following manner:

- Click on the button Freq. meter. The following screen appears:



- Produce a sound (a tone from a Tuning fork) for the microphone en de frequency appears on the screen. You can have an idea of the justice of the measurement under ‘Resolution’.
- You can also measure the period.

What to do:

1. Look at sound pictures:
   - Connect a microphone on to a computer and start VA.
   - Look at the picture of different sounds:
     - Tuning fork of 440 Hz, 1700 Hz, …
     - Whisperings
     - Own voice: ie-sound, oo-sound, uu-sound, aa-sound, eu-sound…
     - Different whispering tones

2. A simple measurement:
   - Keep a trilling tuning fork for the microphone and look at the picture of the wave.
   - Capture this picture, zoom in and place it in a Word document.
   - Measure the frequency of the produced sound.

3. Sinus generator:
   - Use this option to produce some tones.
   - Example: go to 440 Hz.
   - Control the right frequency by putting a Tuning fork with wood reflection before the microphone, the sinus generator is out and the listen if you hear the Tuning fork. Normally this must go as resonance is occurring.

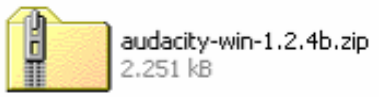
6. Use of the program Audacity

6.1. Installation of the software

The freeware program Audacity can be downloaded from the Audacity website.

Use this link: http://audacity.sourceforge.net/

You get a 'zip' file with the name ***audacity-win-1.2.4b.zip*** on your computer that you have to unzip first.



Remark: this software is updated regularly so that it is possible that you can download a more recent version. Don't use beta-versions as they are not complete safe to use with students.

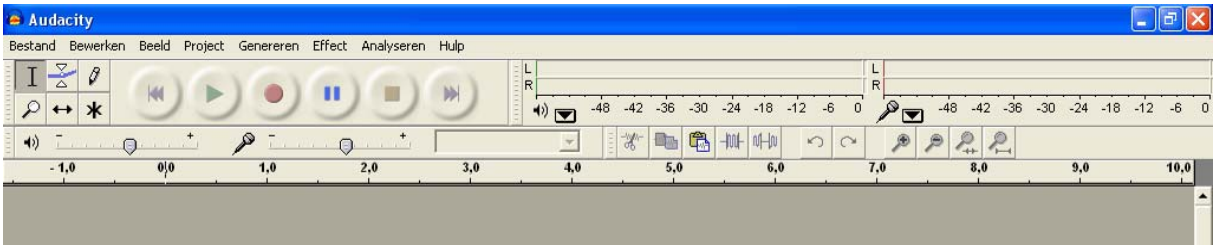
After unpacking this zip-file you have a map called ***audacity*** in which you find the file ***audacity-win-1.2.4b.exe.***

Double -click on the icon to start the installation procedure. This happens as any other windows program an icon is placed on the desktop during unloading.

6.2. Use of the program Audacity

Start the program with double clicking on the icon or on the program menu. On by clicking on the 'Audacity' program icon or on the name ***audacity.exe***. This map is on the C directory in the map 'Program files'.

You get the following screen:



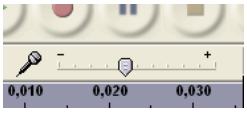
Audacity is a very multifunctional program for sound recordings, importing sounds; make sound visible and a lot more. The aim is not to illustrate all the possibilities of the program Therefore you can use the Help-function. This is available within the menu, First on ***Help*** and then on **Contents…**

The program Audacity has the following possibilities:

1. Sound recording

   That can be done as follows:
   - Make sure a microphone is connected in the right way
   - Do control if the program gets a signal of the microphone (see picture)

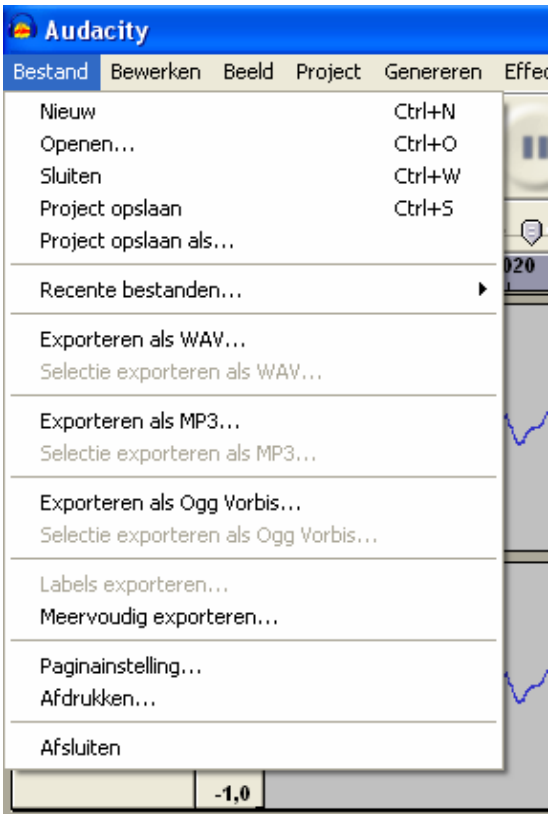
   - Push the record-button (with the red color)
   - Speak as the recording goes.
   - Stop the recording with the stop-button (with orange color with rectangular)
   - the recording level can be adjusted



   - You can also use the pause button(two rectangular)

2. saving a recording

   As follows:
   - Click in the menu on ***Bestand*** and choose for the wanted format.
   - You can save the record as a project (only opening in Audacity)
   - You can save the program as a WAV-file and /or as a MP3-file. Use the right option ***Exporter as WAV…*** or ***Export as MP3…***



3. Importing a sound recording

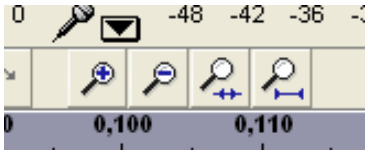
As follows:

- Click in the menu on ***Bestand*** and choose for Opening***…***
- You are in the menu where you can look for the right recording on DVD, CD or USB-stick (in WAV- or MP3-format)

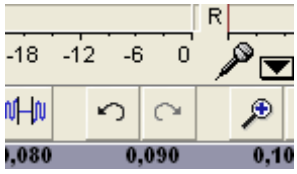
4. Setting the picture

- By clicking in the menu on ***Beeld*** you can put the picture on a full screen. You can do that bij clicking on ***Verticaal passen***

- You can also zoom in for a fragment of the sound recording. This can also be done with the Beeld-menu, but the ***zoom buttons*** are more practical, just under the menu.

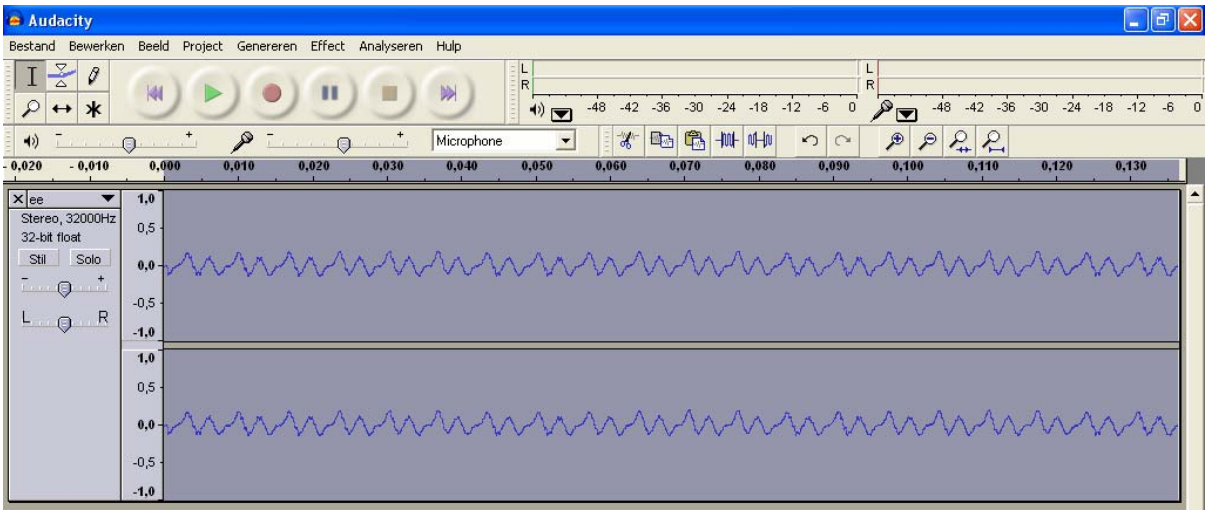


- Using ***recordings history can be very interesting.*** You can delete some other recordings that you don't want anymore. You can find this option under ***Beeld, Geschiedenis…*** Therefore also exist buttons under the menu (figure).

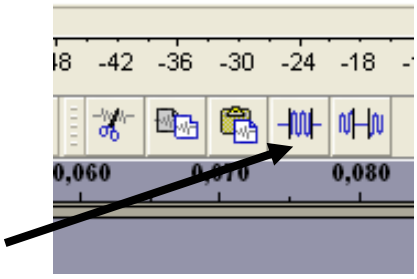


5. Working with recordings

- With Audacity you can isolate peaces of sound and the save them as a new sound. For instance the sound of an "ee" isolated from a spoken text.



- You can become such a picture by zooming in o, a sound recording and putting the rest aside. You listen to the recorded fragment and then you cut it away by using the indicated button.



- If you want to set the time at null again then you choose in the menu for ***Project***, then ***Sporen uitlijnen…*** and at last Op ***Nulpunt outline***.

6. Making a print copy and import it in a word document.

   When you are making a text in which you want to place a figure which shows what there is to see when editing a text then you can use two methods.

   1) Capture the screen picture with the PrtScr -button and open afterwards a program such as Draw or even better: Adobe Photoshop. Open a new document and paste the 'screen view'. Afterwards you can work on the image and import it in Word.
   2) Even faster you can after clicking on the PrtScr-button you can immediately insert the countenance of the board in your word document.
      If you click with the right mouse button then you can work on the picture with ***Werkbalk afbeelding weergeven***.

Click on  so that you can cut out the good figure by going over the 'four' sides.

<u>What to do</u>:

1. Recording and saving a sound fragment
   - Connect the microphone to the computer, start Audacity and start the recording.
   - Record different sounds
     - Tuning fork 440 Hz, 1700 Hz, …
     - Low noise
     - Own voice: ie-sound, oo-sound, uu-sound, aa-sound, eu-sound…
     - Different whispering sound, music instrument sounds
   - Save this as a WAV- or as a MP3-bestand.

2. Looking at recordings and working with them
   - Open a recorded sound and look at the graphics.

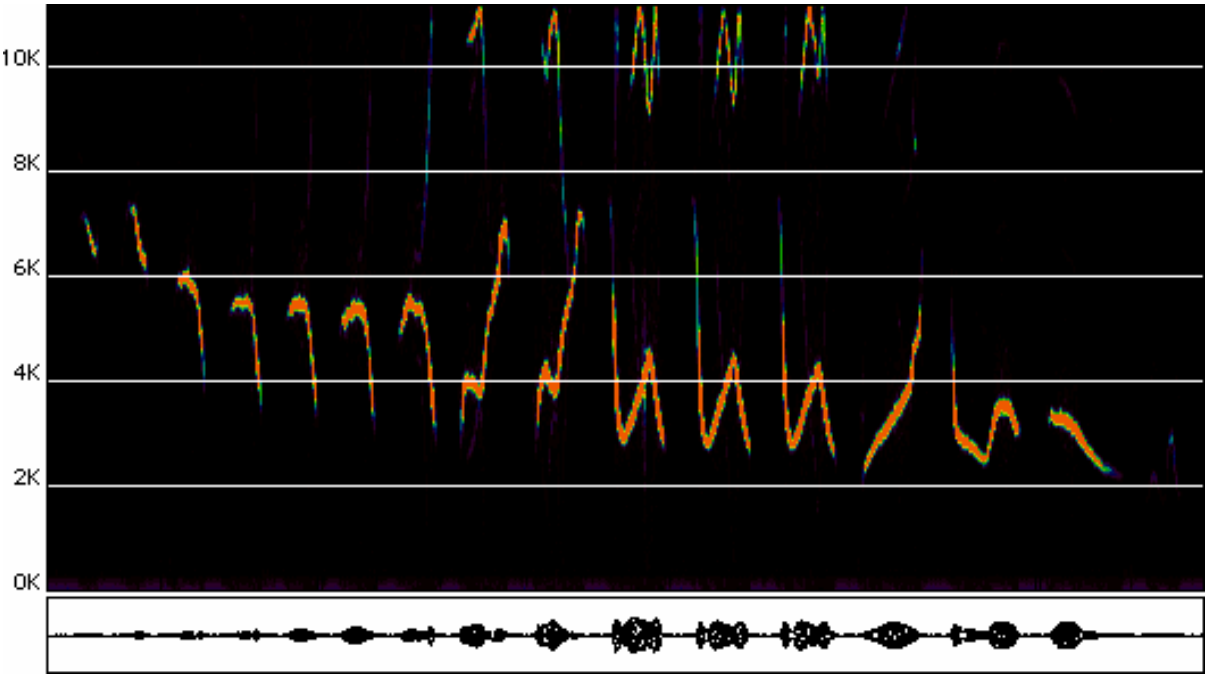
- Play the sound and choose one sound and remember where the sound is.
- Select this part from a recording and cut the rest.
- Repeat these two last steps till you see a graphic picture from this sound on the screen.
- Save this minimal sound fragment.
- Make sure that this picture is clear to appropriate it vertical.
- Make a Word-doc in which you place this picture/ figure.

3. ‘Natural sounds’
   - On the cd you can find some recordings from birds. You can compare the singing of two birds such as the fitis and the tjiftjaf. These two insect eaters are very alike and can’t be seen by experts. Their song is completely different, so that the birds recognize their own species. When coupling these two birds you would have non fertile family.
   - Look for one peace of very special bird, isolate it and look at it and see the difference...

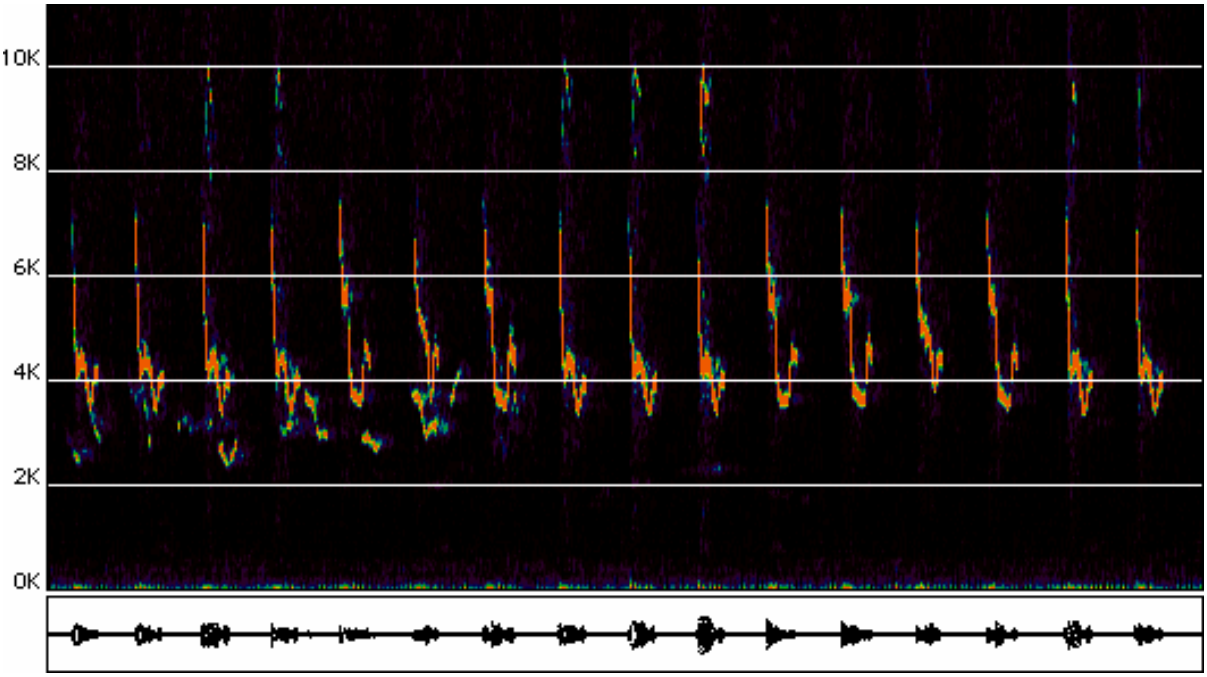
Extra information:

Some sonograms from fitis and tjiftjaf.

Fitis (Phylloscopus trochilus):

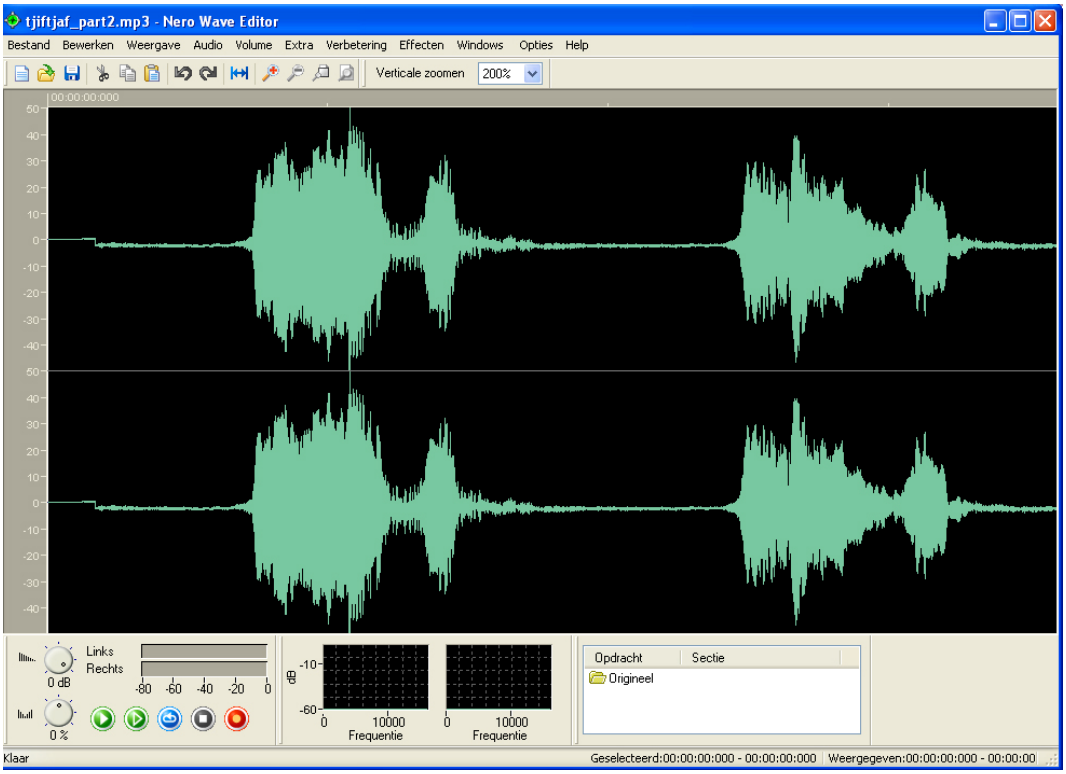


Tjiftjaf (Phylloscopus collybita):

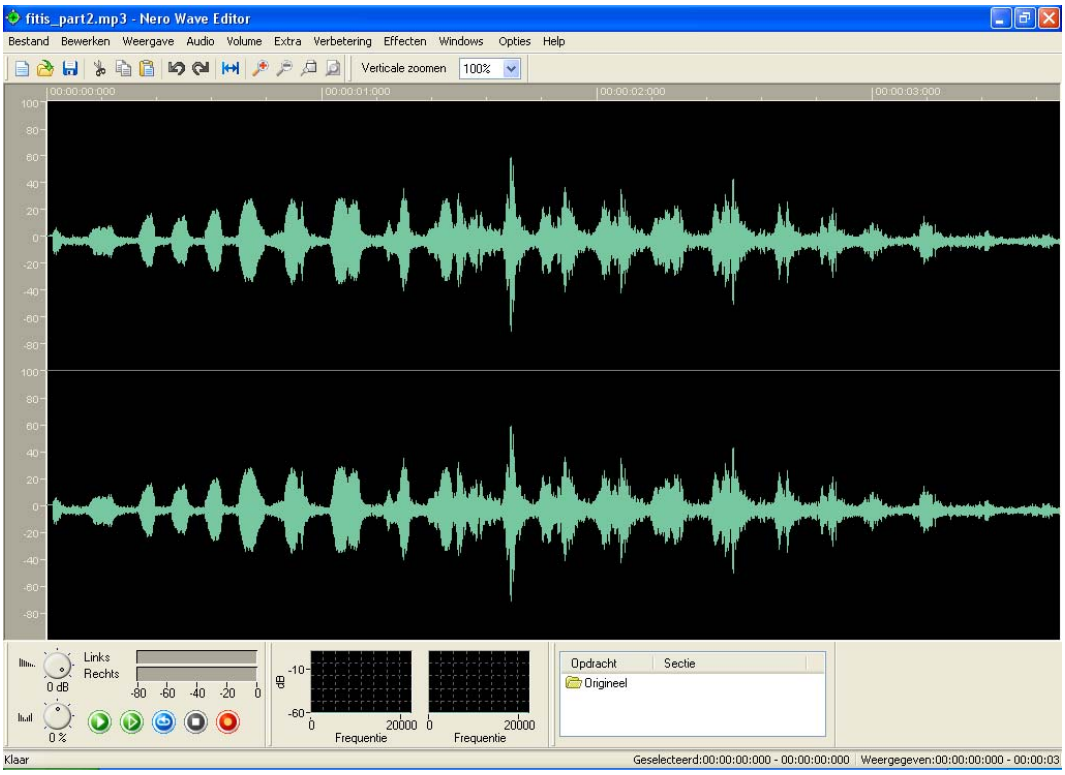


You can also work on these bird sounds recordings with Nero Wave Editor (a tool within the well known Nero-program to make backups of DVD's and cd's) and that gave the following oscilloscope picture:

Fitis (Phylloscopus trochilus):



Tjiftjaf (Phylloscopus collybita):



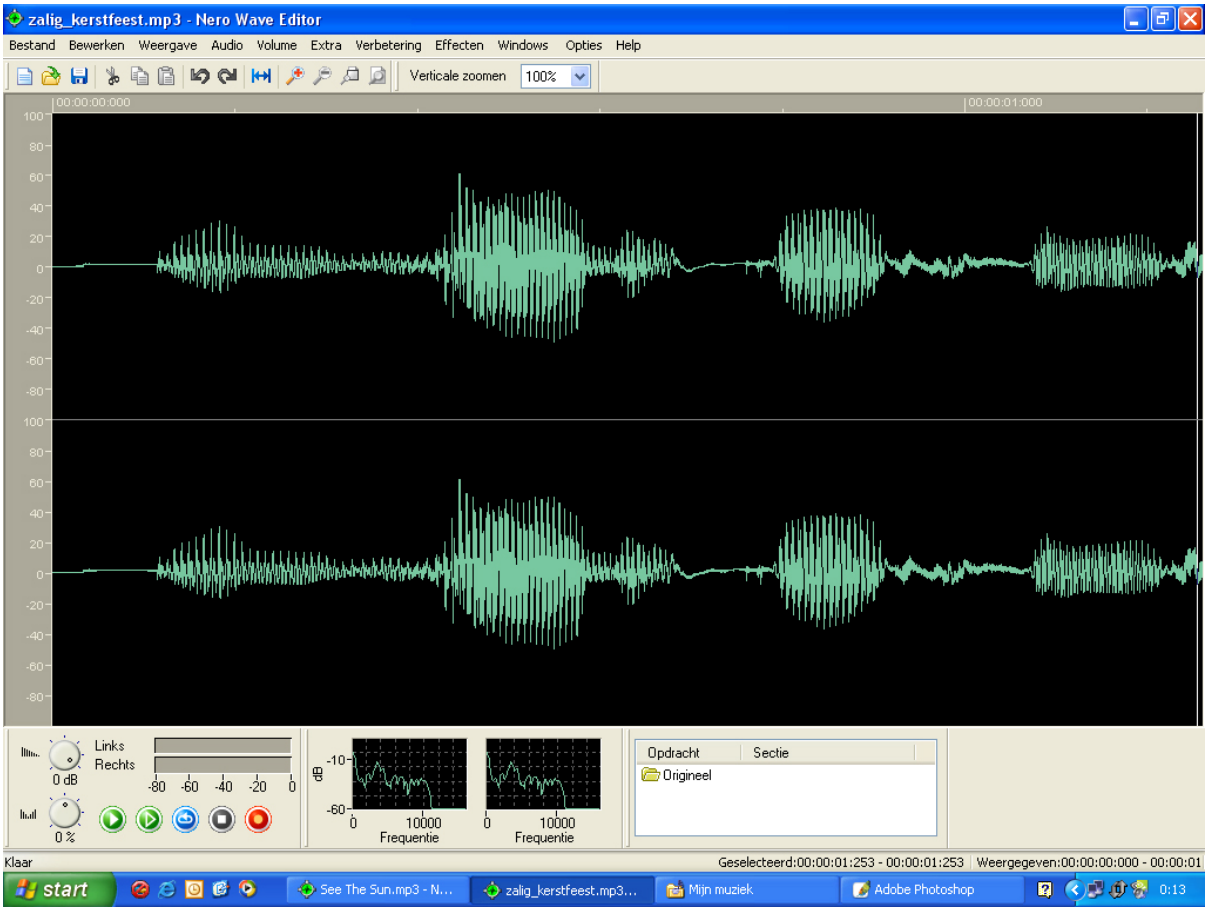
Analogue pictures you can become by importing bird sounds in the program Audacity. Just try it.

Addendum:

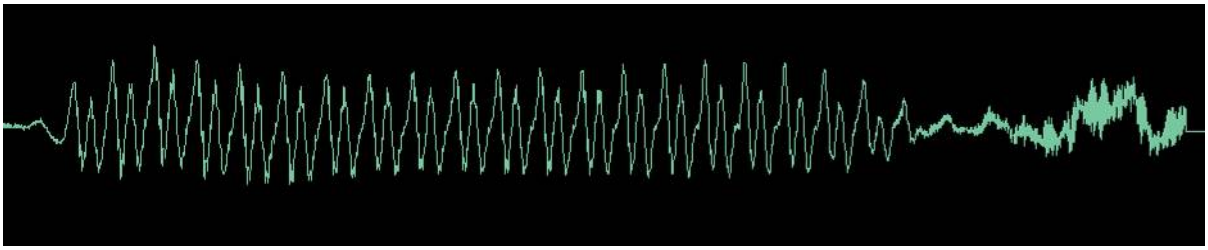
Another possibility to record with the microphone is using the program **'geluidsrecorder'** . This is standard on every computer under ***'bureauaccessoires > entertainment > geluidsrecorder'***. The result is a WAV-file.

This WAV-file you can work with in programs such as Nero Wave Editor or Audacity

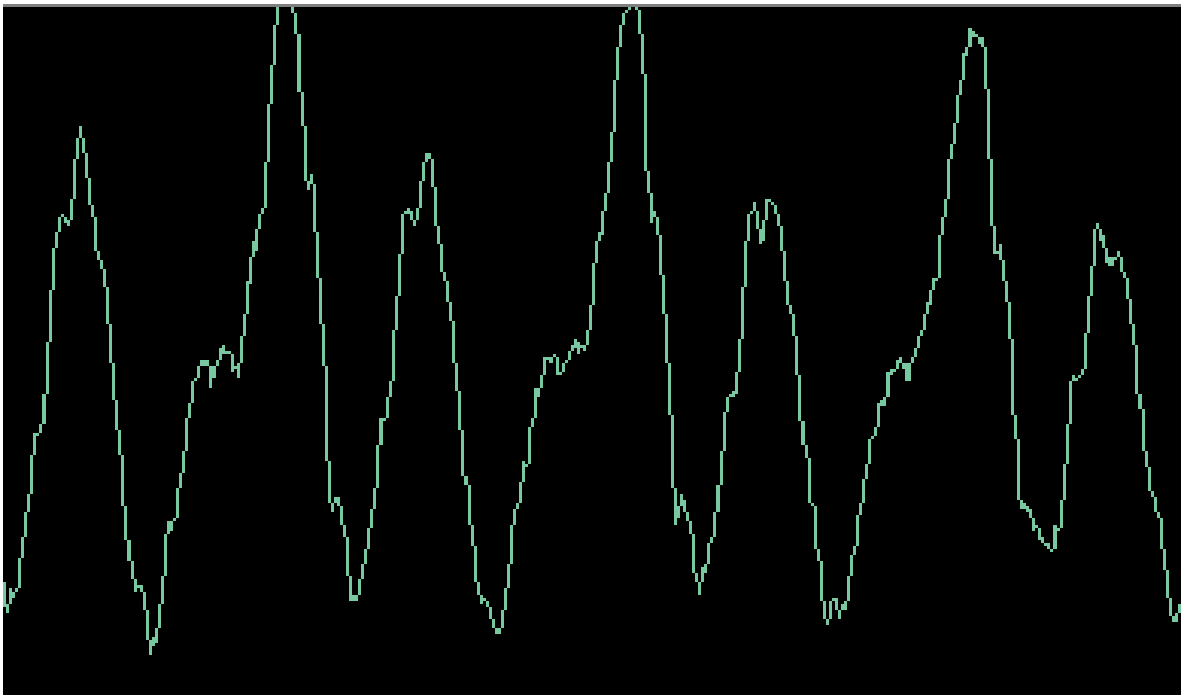
Example the spoken text 'zalig kerstfeest'.



Last peace from the sound 'eest'. This gives the following picture:



Zooming in gives the ee-sound:



Enjoy the working with sound capture!

Marc Schoonackers and Marc Debusschere

Further information at the website

http://users.skynet.be/sofysica (dutch language)

e-mail adress marc.debusschere@skynet.be