Manual

InTune

Version 4.0

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Contents:

Introduction

General information

InTune is designed for sound analysis and editing in terms of pitch, dynamics, timing and noise. The main purpose of the program is correction of freshly recorded musical material, particularly vocal, woodwind or brass instrument recordings, which are highly susceptible to impurity in tune. Apart from that, InTune can be used to remove noise, edit dynamics and timing or analyse the frequency spectrum of any sound file. The program works with the standard Windows™ sound file format RIFF WAVE (WAV file name extension), referred to subsequently as WAV files. The only WAV files accepted are 16 to 32 bits non-compressed and mono files. If you are working with a different file format, convert it to the format mentioned above, using utilities which usually come with your hard disk recording system. The whole program consists of two files:
Intune.exe - the program itself
Intune.pdf – the manual file

The files should be placed in the same subdirectory. When InTune starts first time it writes Intune.ini file. This file is created to keep program settings and last windows sizes and positions. If this file is corrupted you can have problems to open windows. In this case simply delete Intune.ini and restart the program.
Another file type this program uses has the extension SAS (Sound Attributes Set) which is originally created by InTune as a product of sound file analysis. By default, the files are saved to the same subdirectory (folder) as the source WAV files, though the user may, of course, choose to save it anywhere on the disk. An additional temporary WAV files are created when the user chooses *Play Corrected* option from the SAS Range menu (CorrectedTemp.wav) or presses *Generate* button from *Wave Synthesis* dialogue box (GeneratedTemp.wav).

New in version 4

1. Now it is possible to record sound with sampling rate up to 384 000 samples per second and bit depth up to 32 per sample from within the program.
2. Help file in *.chm format is not longer provided.

How InTune works

Noise removal

The noise removal process used by InTune is based on the Fast Fourier Transform. User defined section of the WAV file (assumed to be noise) needs to be transformed into frequency representation known as a noise spectrum. The program assumes that this spectrum is a representation of unwanted signals within the file. In order to remove that noise, InTune performs subtraction of defined noise spectrum from the spectrum of the whole sound file. The resulting product of this process is converted into standard WAV format and saved as a new file.
InTune Help

See also How to remove noise?

Amplitude correction

The amplitude correction of the sound is defined in SAS file. Based on the above definition InTune makes necessary calculations (using double precision numbers to preserve accuracy) to create new WAV file.
See also How to Edit SAS?

Pitch correction

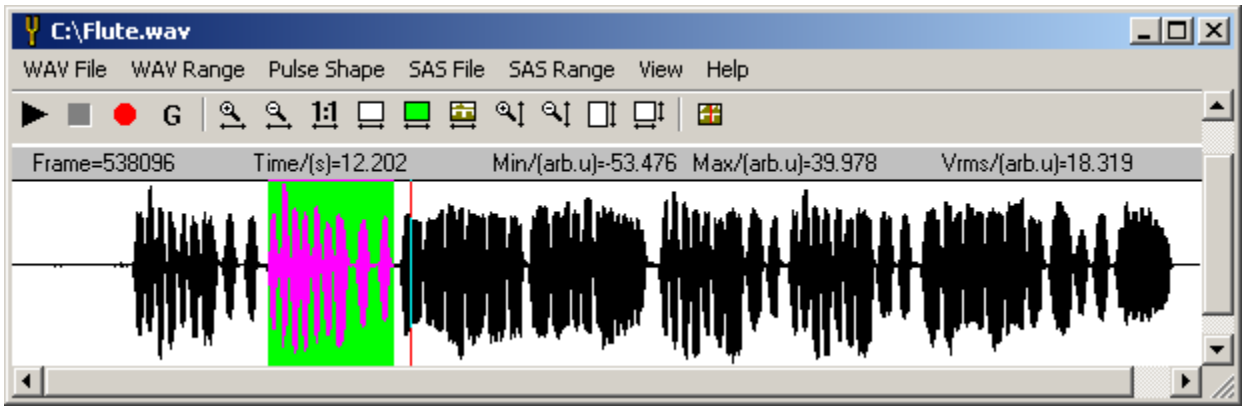
Similarly to the amplitude correction, the pitch correction is also defined by the user in SAS file. According to corrected and original pitch, InTune builds the sound file with a higher or lower frequency to achieve the desired pitch.
See also How to Edit SAS?

Time correction

Pitch correction alters the time of the corrected chunk of music. When the pitch is increased, the time of the chunk shortens and vice versa. The time correction feature of this program rectifies this. When the timing of the original and the corrected chunks differs by more than one period of the current analysed note then this period is cut off or pasted in the waveform. In some cases, when the wave is not periodic in nature, using this option can produce small distortions. To avoid that, time correction may be disabled locally for this specific chunk. Disabling time correction when pitch corrections are small and don't change the audible timing of the piece of music is a good idea. Additional time corrections can be created deliberately by the use of time-links. The time-link algorithm is designed for making small correction rather then huge time compression or expansion.
See also How to edit SAS?

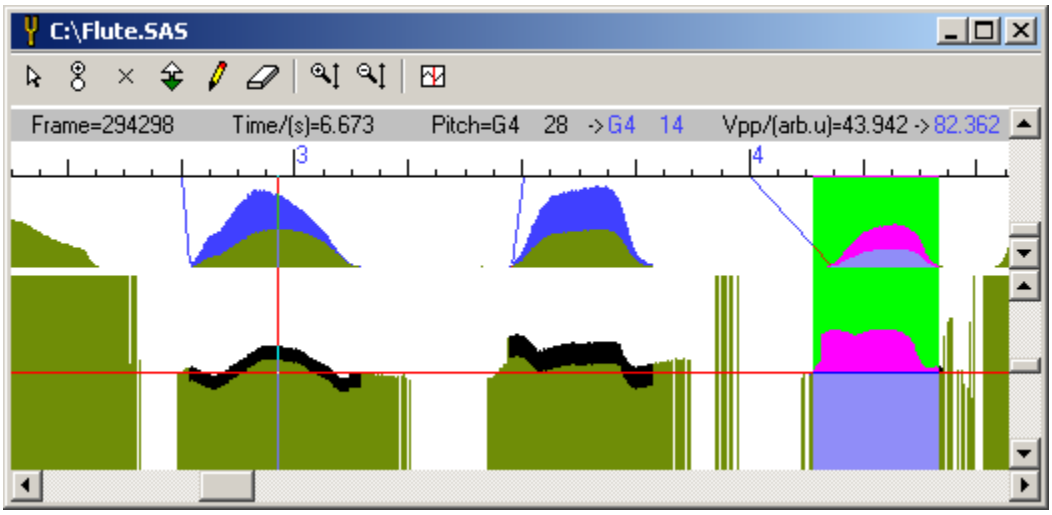
Windows

WAV window



The main window has the menu used for all windows in the program. Below the menu bar you will find a toolbar containing some of the most often used commands. Some of these commands are also accessible from the menu. Below the toolbar there is another bar displaying information about the WAV file at the current position indicated by a vertical red line. Use the left mouse button to change the current position. Position is displayed in both number of the frame (sample) and time (seconds) units. Other displayed information is the minimum and maximum value for the WAV chunk represented by one pixel on the horizontal axis. If horizontal display scale is one sample per point, both *Min* and *Max* values are equal. Closing the WAV window terminates the program. If you need the program running in the background (for example when the program is building a SAS file) use the minimise button instead.

SAS window



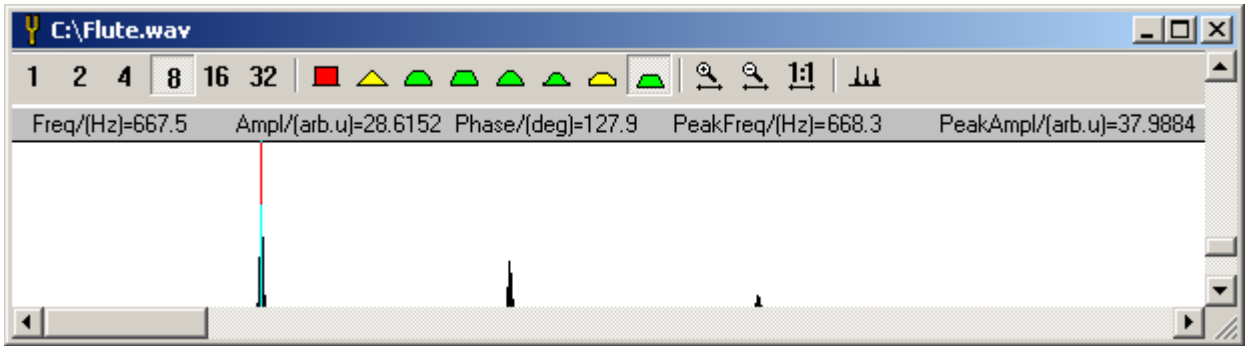
This window is divided into two main parts: the upper part displays amplitude and the lower shows the pitch. The user can adjust window split using the mouse. The SAS window has one horizontal and two vertical scroll bars. The horizontal scroll bar is used conventionally for moving the view along SAS file. The upper vertical scroll bar changes the scale of the amplitude display. The lower

is used for scrolling the pitch display. The vertical scale for the pitch display is constant and equals one cent per point. The horizontal red line in the middle of the pitch display represents a perfect tune in uniformly tempered scale (A4 = 440 Hz). Additional yellow lines are placed in 100 cent steps below and above the red line. Vertical scroll bar arrows shift the pitch display one semi-tone (100 cents), while a click on the scroll bar between thumb and arrow (page scroll) scrolls the tune display by one octave (12 semi-tones). Current SAS position is indicated by a vertical red line and can be changed like in any window in this program by pressing the left mouse button. The tune display is scrolled to the best view of original or corrected (if **Shift** key is pressed) pitch after releasing the button.
The information about the SAS file at the current position is displayed in the information bar, just below the toolbar.
"Frame:" and "Time:" has the same meaning as in the WAV window.
"Pitch:" displays the note and its offset from perfect pitch at the current position.
"Vpp:" displays the amplitude, which is the difference between maximum and minimum value in analysed sound chunk.
Original and corrected values are separated by small arrow. Black colour signify original values and blue corrected.
The ruler located below the information bar, is used mainly to create time-links used in the time correction procedure. It displays time in musical units (bars and beats). These units as well as the origin of the ruler can be set-up in the Settings dialogue box. The bar ruler is just a guide, the real reference for Time Links is the time.
The whole display is a superimposition of :

1. the original data displayed in black
2. the corrected data displayed in blue.
3. the selected range displayed in green.

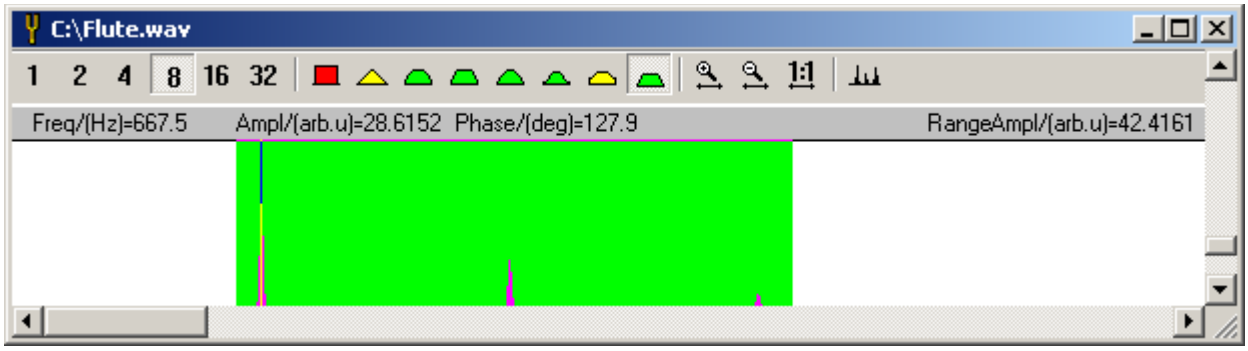
In the initial state the original and corrected data are identical and blue colour over the black produce khaki, but, depending on the graphical adapter card and display driver installed on your computer, the colours may be different to those described in this document. If SAS range is selected, the blue colour, indicating correction becomes red, and black indicating original values, changes to dark purple.
See also: How to edit SAS , How to correct WAV.

FFT window



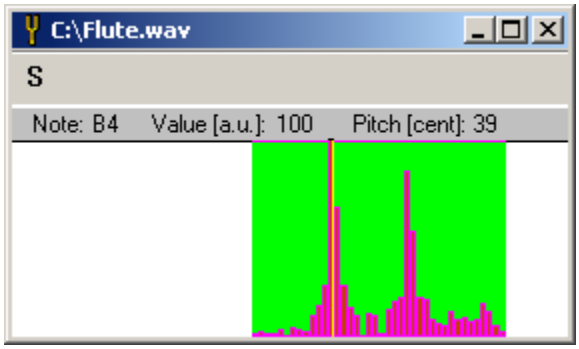
This window displays the frequency spectrum calculated for chosen number of samples following the actual WAV position. A vertical red line indicates the actual frequency on which corresponding information is displayed on the information bar. Use the left mouse button to change its position. FFT window content is updated automatically when the user changes current WAV position using mouse.

The vertical scroll bar is used for changing FFT display scale. The horizontal scroll bar moves visible frequency range over the spectrum.



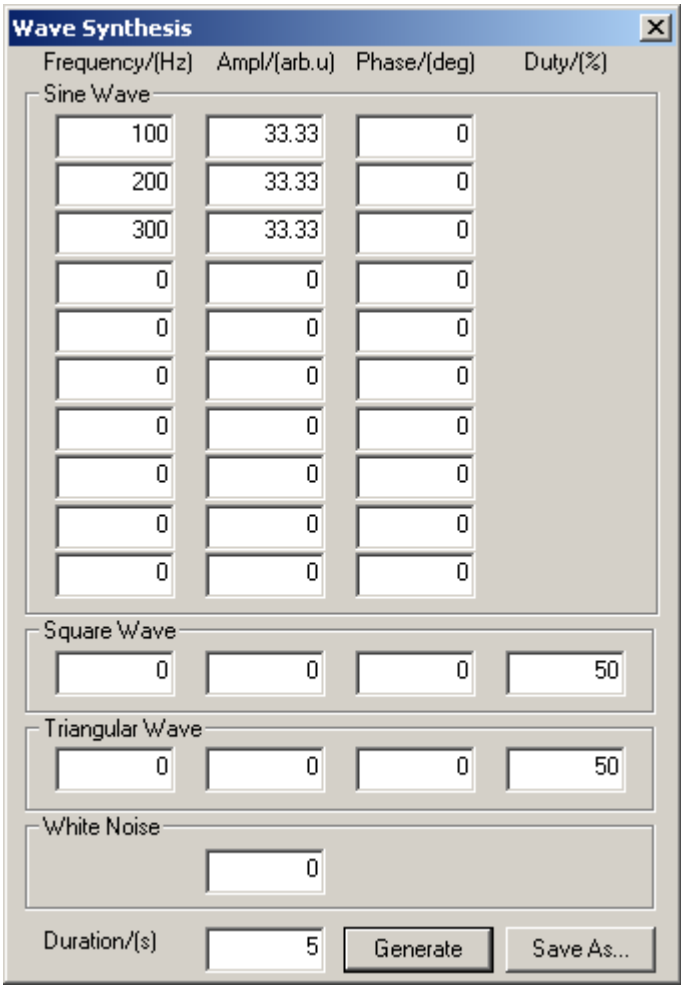
If a range of frequency is selected, an information about its power by the means of *Range Ampl* is also displayed. The Range 'Amplitude' and the 'Peak Amplitude' are calculated the same way. The only difference is that in the case of 'Peak Amplitude' the range is determined automatically. In both cases 'Amplitude' means amplitude of the sine-wave signal which has the same power as this contained in the selected range of frequency. There is a simple dependence between 'Range Amplitude' and 'Root Mean Squared Voltage' (*Vrms*): $Range\ Ampl = \sqrt{2}\, Vrms$.

MFT window



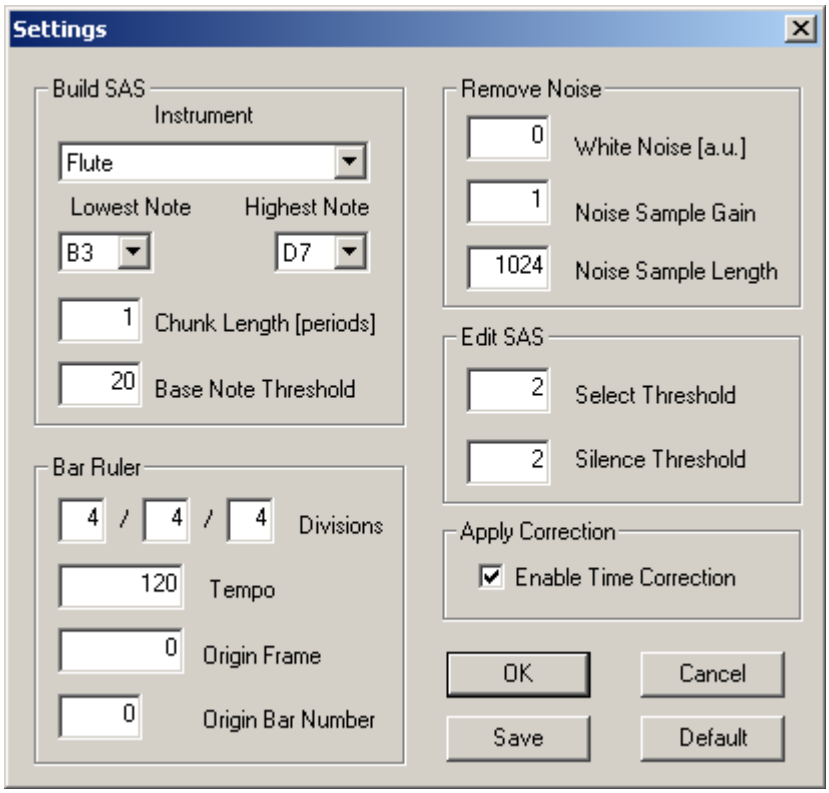
This window has a similar function as the FFT window. It displays sound components using a musical scale in the frequency domain rather than the linear as FFT does. The name of an actual note indicated by a vertical red (or blue on the green background) line is displayed on the information bar.
If there is a peak (local maximum), pitch information is also displayed (offset from perfect pitch in uniformly tempered scale). Use the left mouse button to change the note. The range of analysed notes is indicated by a green background. To change this range place indicator at new position and use **L** or **R** keys to set left and right limits respectively. You can also use the Settings dialogue box to set range by choosing the instrument which produced the sound being analysed or simply press the left mouse button while holding the **Ctrl** key, then drag the mouse pointer left or right like you usually select range in other windows.

Wave Synthesis dialogue box



This dialogue box lets you to generate a WAV file using up to ten sine wave components by defining their frequency, amplitude and starting phase. Also you can add a square or triangular wave (defining additionally duty parameter) and white noise (only the amplitude can be defined) components to produce a more complex signal. If the sum of the all amplitudes is greater than 100 arb.u it will be normalised to 100 arb.u. to avoid signal clipping. The generated WAV file will be in mono 16 bits per sample and 48000 samples per second mode.
Generate button calculates desired signal and saves it as GeneratedTemp.wav file. Thereafter this file is opened in WAV window.
Save As... button does the same as *Generate* but additionally gives you opportunity to save generated file under a different name.

Settings dialogue box



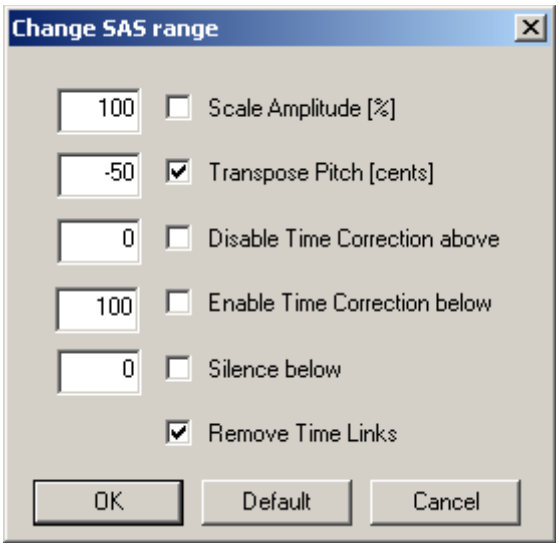
There are several controls compiled in 5 groups:
The first group **Build SAS** defines the range of notes and length of the chunk used to analyse the WAV file. You can specify one of many listed instruments or set your own range using *Lowest Note* and *Highest Note* list boxes. This may also be done by setting the range in the MFT window, using the left mouse button to specify note and **L** or **R** keys to set up *Lowest Note* or *Highest Note*. Setting the range of notes in the Settings dialogue box also automatically applies to the MFT window. The next edit box in this group sets the length of the chunk (in terms of lowest note periods) used to build the SAS file. The lowest setting is 1 period and gives you the best resolution of the SAS file but also the longest time for analysis. The last edit box in this group is used to set *Base Note Threshold*. This value tells InTune how to distinguish the true (base) note from its harmonics and depends on the tone colour of the particular instrument recorded. The default setting of 20 is usually adequate. Should it need to be changed (you will know it does, if the pitch graph produced in the SAS file is not 'smooth', but jumps usually one octave up and down), read and perform the step by step instructions to determine this value provided in Find Base Note Threshold.
The next group, **Bar Ruler**, lets you specify the settings of the bar ruler in the SAS window. The first three edit boxes labelled *Divisions* specify as follows:
First, the number of main units per bar (beats).
Second, specifies the main unit itself (e.g. 4 specifies a crochet, 8 a quaver).
These first two values correspond to the time signature of the musical score.
The third one specifies the number of unit subdivisions.
The next edit box labelled *Tempo* specifies the tempo in crochets per minute.
The next two edit boxes, labelled *Origin Frame* and *Bar Number*, let you specify where the Bar ruler starts in the WAV file, and the number of the bar corresponding to that position.

The **Remove Noise** group contains three edit boxes for setting the parameters used to remove noise from WAV file. Bigger values correspond to higher noise reduction but also involves bigger distortion of the signal. See also How to remove noise.
The next group, **Edit SAS**, has two edit boxes:

1. *Select Threshold*, for setting threshold level used to select automatically SAS range and
2. *Silence Threshold* for setting threshold level used with Silence command from SAS File menu.

The last group, **Apply Correction**, lets you specify global setting for time correction when the edited SAS file is applied to the WAV. If this setting is ON (tick in the check box), it can be overwritten locally by time correction disable in SAS file. If it is OFF, local disable or enable settings in the SAS file, and all time-links are ignored.

Global Edit dialogue box



There are 6 options which can be activated independently:

1. **Scale Amplitude** - enables global changes to the SAS amplitude. Fill corresponding edit box with the required value. Default scale 100% produces corrected amplitude equal to the original one. InTune takes care to avoid clipping if scaling factor is too big, but it does this locally (like freehand editing) and it can produce sound changes similar to the compressor (loud but flat dynamics).
2. **Transpose Pitch** - enables pitch changes. Value of 0 in the edit box clears any pitch correction over the selected range. Maximum changes are 1 octave (1200 cents). Positive value shifts pitch up and negative down. For better results is recommended to use smaller values and if necessary correct WAV file in few steps.
3. **Disable Time Correction** - if original amplitude is bigger than the value set by user time correction at this point will be disabled. Set value to 0 if you like to disable time correction for all points in the range.
4. **Enable Time Correction** - enables time correction for those points which original sound amplitude is smaller than the set value. The value of 100 enables time correction for all points in the range. If user activates both Disable and Enable Time Correction check boxes both will be performed in that order. The next two examples try to clarify that situation.
    - Example 1:
      Disable Time Correction value = 70

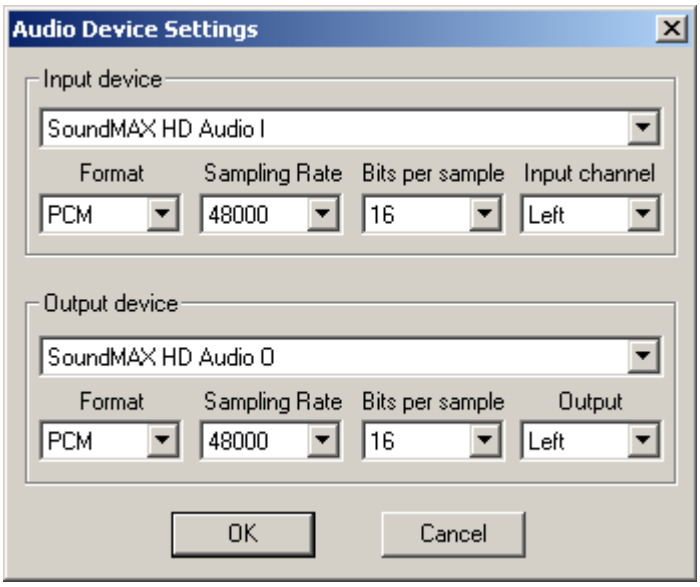
Enable Time Correction value = 10
Points with Vpp less than 10 will have time correction enable.
Points with Vpp between 10 and 70 will be not affected.
Points with Vpp bigger than 70 will have time correction disabled.

- Example 2:
  Disable Time Correction value = 0
  Enable Time Correction value = 10
  Firstly all points in the range will have disabled time correction and then points with Vpp smaller than 10 will be enabled.

5. **Silence** - changes to zero any amplitude below the level set in the edit box. It does exactly the same as Silence from the SAS File menu, but limited to the selected range.
6. **Remove Time Links** - removes any Time Link even if just one end of it is in selected range.

To avoid any accidental editing all check boxes are cleared when the dialogue box is invoked. Changes to the object which check box is selected are applied when **OK** button is pressed. **Cancel** exits operation without changes. **Default** button loads factory settings to the edit boxes.

Audio Device Settings



This dialogue box lets you select input and output audio device which you like to use. Usually if your sound interface comes with its dedicated sound control panel you should use it as well to choose desired settings. To access sound hardware InTune uses Windows Audio WaveIn and WaveOut interface. This is not always best supported by some drivers. In such a case you should use other recording software which comes with your hardware to record sound and then open created file in InTune. Free software “Audacity” is also very good for recording.

Menu

WAV File

1. **Open** - opens a WAV file, checking its format. Only 16 to 32 bits mono non-compressed sound files are supported. Previously opened WAV file (if any) is automatically closed. The WAV file (as well as SAS) can be also opened by using 'drag and drop' method. In this case InTune will recognise file type (WAV or SAS) automatically. You can 'drag and drop' WAV and SAS files simultaneously in any opened InTune window or program icon.
2. **Close** - closes WAV file without opening the new one.
3. **Remove Noise** - removes noise from current WAV file and saves the result as a new file. As a rule, you cannot overwrite the previously opened WAV file. The *Remove Noise* command is active only if the *Noise=* command from the *WAV Range* menu was executed previously. See also How to remove noise?
4. **Correct** - applies all corrections you made in the SAS file to the opened WAV file, and saves the result as a new WAV file. The program checks if the SAS file which you edit corresponds to the opened WAV file. The Correct menu item is active if checked files match each other. See also How to edit SAS file?
5. **Play** (Shortcut **P**) - starts playing opened WAV file from the current position. To see the actual song position, press the space bar. To monitor progress, hold the space bar down. This command has also shortcut button in the WAV window toolbar. See also How to play sound?
6. **Record** - starts recording WAV file. Small dialogue box allows to change a sampling rate and a maximum recording time. You can stop recording at any time by choosing Stop command from WAV File menu or pressing a stop button from a tool-bar.
7. **Stop** - stops playing or recording a WAV file. Also can be accessed from a tool-bar.
8. **Generate** - opens Wave Synthesis dialogue box which one can use to generate a waveform formed by up to ten sine, one square and triangular waves. Parameters such as frequency, amplitude, phase and also duty cycle for square and triangular waves can be specified in edit boxes. A certain amount of the white noise can also be specified in the generated waveform. If the sum of all amplitudes is grater than 100, all the amplitudes will be normalised to avoid any clipping effects. This command is also accessible from a tool-bar.
9. **Sync to SAS** (Shortcut **S**) - adjusts WAV window horizontal scale and position of the display to match that in SAS window. This command can be also executed from a tool-bar.
10. **Exit** - ends the program.

WAV Range

1. **Set Left** (shortcut **L** while the WAV window is active) - sets the beginning of WAV range at current WAV position.
2. **Set Right** (shortcut **R** while WAV window is active) - sets end of WAV range at current WAV position.
3. **Save As** - use this command for saving the selected range as a new WAV file.
4. **Noise=** - designates selected range as a sample of noise. This command is valid only if the selected range is longer or equal to *Noise Sample Length* value from a Settings dialogue box.
5. **Noise+** - adds selected range to the existing sample of the noise.
6. **Play** (shortcut **F7**) - plays selected range of the WAV file.

7. **Play Corrected** (shortcut **F8**) - corrects if needed (SAS file or WAV range has been changed) and plays temporary corrected range of the WAV file.

Pulse Shape

This menu is only used to produce an averaged pulse shape, which can be loaded to the Pulse Recorder and Analyser (PRA) program. Ensure that sample rate is set to the same value as in PRA application.

1. **Shape+** - adds 16 samples surrounding the current sample (8 samples before the current sample, the current sample itself, and 7 samples after the current sample) to the pulse shape. Preferred position of the current sample is a top of the pulse. Repeat this command a few times with different not distorted pulses. Shortcut **F9**.
2. **Save Shape** - saves pulse shape to a file, which can be later loaded into PRA program. Shortcut **F10**.

SAS File

1. **Open** - loads SAS file and opens SAS window for editing. If there is any SAS file opened it will be automatically closed. The SAS file (as well as WAV) can be also opened by using 'drag and drop' method. In this case InTune will recognise file type (WAV or SAS) automatically. You can 'drag and drop' WAV and SAS files simultaneously in any opened InTune window or program icon.
2. **Close** - closes opened SAS file and SAS window.
3. **Build** - begins analysis of the WAV file, and the building of a SAS file. This process is the most time consuming of InTune capabilities, but necessary for correcting the WAV file as all changes made must be first applied to the SAS file and then to the WAV file using the SAS file as a 'prescription'.
4. **Save As** - use this command to save copy of currently opened SAS file under different name.
5. **Silence** - automatically sets corrected amplitude to zero in regions, where original sound amplitude is smaller then Silence threshold level set in the Settings dialogue box . This additionally reduces noise level in your record in silent parts. This function is working on the whole SAS file. To make silence only on the selected part use Global Edit from SAS Range menu.
6. **Global Clear** - clears any correction made in SAS file, leaving it in its original state.
7. **Set Ruler Origin** (shortcut **O**) - invoking this option will set the current SAS position as the origin of the Bar ruler, this value is passed to the Settings dialogue box , and is saved with the SAS file.
8. **Edit Mode** - this option lets you choose one of the six possible editing modes:
    - *Set Time-link* (shortcut **F1**) - used to create a time-link in the SAS file.
    - *Delete Time-link* (shortcut **F2**) - used to delete a time-link.
    - *In Range* (shortcut **F3**) - used for 'moving' amplitude or pitch shape in the selected region.
    - *Freehand* (shortcut **F4**) - used for freehand 'drawing' of amplitude or pitch envelopes.
    - *Erase* (shortcut **F5**) - used to delete changes made using freehand or in range editing (does not remove time-links).
    - *Normal* (shortcut **Esc**) - changes edit mode to default which can be used to select the range and to move the position indicator.

    Selecting the range can be done in any above listed mode by dragging the mouse cursor

while holding the **Ctrl** key and left mouse button pressed. Any of the above edit modes can be changed as well from SAS Window toolbar or from a popup menu after click a right mouse button over a SAS Window.

9. **Sync to WAV** (shortcut **W**) - scrolls SAS display to make current WAV position central in the SAS window. This command is also accessible from a SAS Window toolbar.

SAS Range

1. **Find** (shortcut **F**) - automatically selects range in the SAS file containing current SAS file cursor position. The beginning and the end of the selected range is defined by the Select threshold level from the Settings dialogue box and is limited to the displayed part of the SAS file. This command is useful if notes in the recording are well separated.
2. **Set Left** (shortcut **L** while SAS window active) - sets beginning of SAS range at the current SAS position.
3. **Set Right** (shortcut **R** while SAS window active) - sets end of SAS range at the current SAS position.
4. **Select All** (shortcut **A**) - selects the whole SAS file.
5. **Time Correct Disable** (shortcut **D**) - sets selected SAS range as a region where time correction is disabled. This is useful if time correction produces distortion in particular regions.
6. **Time Correct Enable** (shortcut **E**) - sets selected SAS range as a region where time correction is enabled (default). Applying time correction in this region is defined by global setting in the Settings dialogue box.
7. **Global Edit...** - displays Change SAS range dialogue box for making changes in the whole selected range. Editing the SAS range by using mouse is limited to the visible part of the SAS file.

View

1. **Settings...** - opens the dialogue box which lets you specify all the settings in the program. See Settings dialogue box for more detailed information.
2. **SAS** - shows the SAS file window. Active if SAS file is opened.
3. **FFT** - calculates and displays, in the FFT window, the frequency spectrum of the wave using a chosen number of samples (1024, 2048, 4096, 8192, 16384 or 32768) . The current wave position is a centre of the analysed region. Calculation uses the Fast Fourier Transform algorithm and one of the 8 data windowing methods. This command is active only if WAV file is opened. FFT window is updated when a user click and release left mouse button over the WAV display or hit one of the FFT Window tool-bar buttons. Analysed region of the WAV file is then automatically selected.
4. **MFT** (shortcut **M**.) - calculates and displays, in the MFT window, sound components in a musical form based on a uniformly tempered scale (unlike FFT's linear frequency scale). The base frequency for an A4 note is 440 Hz. MFT stands for Musical Fourier Transform and uses an algorithm designed by the program's author. MFT is the main method used for creating a SAS file from a given WAV file. Active only if WAV file is opened. MFT window is updated when user click and release left mouse button over the WAV display or hit the **M** shortcut key.

Help

1. **About...** - displays information about InTune program.

Toolbars

WAV toolbar

This toolbar has three groups of buttons. The first group has four buttons used for playing and creating WAV file:

1. Play button starts playing opened WAV file beginning from the current position.
2. Stop button stops playing or recording WAV file.
3. Starts recording sound. The input source and the volume can be adjusted using Windows mixer program.
4. G Generate button opens Wave Synthesis dialogue box which can create WAV file by mixing some of the simple components as sine, square or triangular waves and white noise. This option is included for an educational purpose.

The next group of 10 buttons is used to change horizontal and vertical scale of the display:

1. Stretch time button is used to decrease horizontal scale twice. It's action is limited to a maximum time resolution 1 sample per pixel.
2. Squeeze time button increases horizontal scale twice. The maximum scale is achieved when a whole WAV file fits into the window.
3. 1:1 This button stretches time scale to the maximum 1 sample (time frame) per pixel.
4. This button changes horizontal scale to fit the whole WAV file into the window. Vertical scale of the display is not affected.
5. Fit range button changes horizontal scale to fit selected part of the WAV file to the window.
6. This button adjust horizontal scale to be equal that in SAS file. It is active only if SAS file is opened and is created from a opened WAV file.
7. Vertical stretch button decreases vertical scale twice. This action is limited by magnification corresponds to 1 pixel per sample value resolution.
8. Vertical squeeze button increases vertical scale twice. It stops the action if the picture fits vertically to window.
9. Vertical fit to window button changes vertical display scale to make all values to be displayed without clipping.
10. This button fits the whole picture to be visible in the window by adjusting horizontal as well as vertical display scale.

The third group of buttons has just one button:

1. Sync to SAS button is changing current WAV position and time scale to be the same as in the SAS window.

SAS toolbar

There are three groups of buttons in this toolbar.

The first group has 6 buttons used to change edit mode:

1. **Normal.** Shortcut **Esc**. Used to select the range (**Ctrl** pressed) and to move the position indicator without changing SAS file.
2. **Set Time Link.** Shortcut **F1**. Used to create a time-link in the SAS file.
3. **Erase Time Link.** Shortcut **F2**. Used to delete a time-link.
4. **In Range.** Shortcut **F3**. Used for 'moving' amplitude or pitch shape in the selected region.

5. **Freehand.** Shortcut **F4**.Used for freehand 'drawing' of amplitude or pitch envelopes.
6. **Erase.** Shortcut **F5**. Used to delete changes made using freehand or in range editing (does not remove time-links).

The second group has two buttons:

1. **Stretch Pitch Display.** Shortcut ↑. Increases vertical scale of the pitch view.
2. **Squeeze Pitch Display.** Shortcut ↓. Decreases vertical scale of the pitch view.

The third group has just one button:

1. **Synchronise SAS to WAV.** Shortcut **W** . Scrolls SAS display to make current WAV position central in the SAS window.

FFT toolbar

This toolbar has three groups of buttons.

The first group has six buttons used to adjust the number of samples used by FFT transform.

1. 1 1024 samples
2. 2 2048 samples
3. 4 4096 samples
4. 8 8192 samples
5. 16 16384 samples
6. 32 32768 samples

The forward and inverse Fourier Transforms are defined as follow:

$$X_k = \sum_{l=0}^{N-1} x_l e^{i2\pi kl}$$

$$x_k = \frac{1}{N} \sum_{l=0}^{N-1} X_l e^{-i2\pi kl}$$

N is a number of samples,
x is a complex number which real part is a value of sample and imaginary part equals zero,
X is a complex number which module (absolute value) is displayed in the FFT window as an amplitude. A phase is an angle which tan function equals to an imaginary divided by a real part of *X*.

$$\phi = \arctan\left(\frac{\Im(X)}{\Re(X)}\right)$$

The next group has eight buttons to choose data windowing method used by FFT.

1. Square window:

$$Square(x, T) = \begin{cases} 1 & if \ \frac{|x|}{T} \leqslant 1 \\ 0 & else \end{cases}$$

2. Triangular Barlett window:

$$Barlett(x,T)=\begin{pmatrix} 1-\frac{|x|}{T}\ if\ \frac{|x|}{T}\le 1 \\ 0\ \ else \end{pmatrix}$$

3. Parabolic Welch window:

$$Welch(x,T)=\begin{pmatrix} 1-\frac{x^2}{T^2}\ if\ \frac{|x|}{T}\le 1 \\ 0\ \ else \end{pmatrix}$$

4. Parzen combined polynomial window:

$$Parzen(x,T)=\begin{pmatrix} 1-6\frac{x^2}{T^2}\left(1-\frac{|x|}{T}\right)\ if\ \frac{|x|}{T}\le 0.5 \\ 2\left(1-\frac{|x|}{T}\right)^3\ if\ 0.5<\frac{|x|}{T}\le 1 \\ 0\ \ else \end{pmatrix}$$

5. Lanczos window:

$$Lanczos(x,T)=\begin{pmatrix} \frac{\sin\left(\pi\frac{x}{T}\right)}{\pi\frac{x}{T}}\ if\ 0<\frac{|x|}{T}\le 1 \\ 1\ if\ x=0 \\ 0\ \ else \end{pmatrix}$$

6. Hann cosine bell window:

$$Hann(x,T)=\begin{pmatrix} 0.5+0.5\cos\left(\pi\frac{x}{T}\right)\ if\ \frac{|x|}{T}\le 1 \\ 0\ \ else \end{pmatrix}$$

7. Hamming window:

$$Hamming(x,T)=\begin{pmatrix} 0.54+0.46\cos\left(\pi\frac{x}{T}\right)\ if\ \frac{|x|}{T}\le 1 \\ 0\ \ else \end{pmatrix}$$

8. Blackman window:

$$Blackman(x,T)=\begin{pmatrix} 0.42+0.5\cos\left(\pi\frac{x}{T}\right)+0.08\cos\left(2\pi\frac{x}{T}\right)\ if\ \frac{|x|}{T}\le 1 \\ 0\ \ else \end{pmatrix}$$

where ***x*** is a data value, ***T*** is a parameter defining non zero function's domain (-T, +T).

Next group has three buttons used to change horizontal scale (frequency) in the FFT display:

1. Shortcut → . Stretches spectrum display twice.
2. Shortcut ←. Squeezes spectrum twice. This action is limited to the scale where each frequency bin has a width of one pixel.
3. 1:1 Sets spectrum horizontal scale to have each frequency represented by one pixel.

The last group has only one button:

1. This button is useful for exporting results from FFT window to another application like "OpenOffice Calc" or "QtiPlot" for further analysis. It saves the frequency and the amplitude of the tagged peaks as an ASCII text file which can be imported to a spreadsheet. If no peaks are tagged, all peaks which amplitude excels *Silence Threshold* are automatically selected. To tag a peak set an indicator in FFT window at desired frequency and hit a **T** key. To undo all tagged frequency hit a **U** key when the FFT window is active.

MFT toolbar

This toolbar has just one command button S that shows Settings dialogue box.

How to …

Correct WAV

To make a correction on your WAV file follow these steps:

1. Choose Open command from the WAV File menu. Open the WAV file which you want to correct.
2. Open the Settings dialogue box from the View menu. Set parameters in *Build SAS group* in the Settings dialogue box. Click the OK button to accept the changes you have made.
3. Choose the *Build* command from the SAS File menu. Select file name for the SAS file and click OK button. InTune begins analysing the WAV file and moves the position indicator along the window to show progress. All menu options are then disabled, but you can still interrupt the process by pressing the **Esc** key or you can minimise the WAV window to perform in the background. At the end of this operation, WAV and other visible windows will be restored.
4. Choose *Open* from the SAS File menu. Select the file created in step 3.
5. Edit amplitude and pitch corrections in the SAS window. See also How to edit SAS .
6. Choose *Correct* from the WAV File menu. Select name for corrected WAV file, different to the currently opened WAV and press OK.
7. Choose *Open* from the WAV File menu. Select the file created in step 6.

Press **P** key to play the freshly corrected piece and enjoy it.

Edit SAS

Amplitude Edit

There are three ways to edit amplitude:

1. To draw a new sound envelope select *Freehand Edit Mode* (shortcut **F4**) from the SAS File menu or press button and then press the left mouse button in the amplitude part of the SAS window. The mouse pointer becomes a pen and you can use it to 'draw' the new amplitude envelope. If a mouse button was pressed while **Shift** key was held down, the beginning position will be pinned down and corrected values will form a straight line from that point to the current mouse position. InTune sees that your new signal is not clipped and limits the corrected amplitude accordingly.
2. To change the shape of the amplitude envelope in the selected range use *In Range Edit Mode* from the SAS File menu (shortcut **F3**) or press button. The mouse pointer changes to north-south arrows. Click and drag the correction envelope up or down. Depending on the initial position (when the mouse click occurs) of the cursor in the selected range, the envelope will either rise uniformly if the mouse cursor is centred (located somewhere in the central third of the window), or affect only one side of the selection keeping the opposite end pinned down. InTune does not allow the amplitude to rise above the clipping gain.
3. To undo any local changes you made select *Erase Edit Mode* from the SAS File menu (shortcut **F5**) or click on button. The mouse pointer changes to the eraser. Point the mouse cursor over the upper part of the SAS window. While holding down the left mouse button move the mouse pointer left and right over the range to be affected.

Pitch Edit

There are also three ways to edit the pitch correction envelope:

1. To draw a new pitch envelope, choose *Freehand Edit Mode*, then press and hold the left mouse button in the pitch part of SAS window. The mouse pointer becomes a pen during this operation. The new pitch envelope is created in the same way as the amplitude. Hold a **Shift** key when pressing left mouse button to enable linear changes of the corrected pitch.
2. To raise or lower the overall pitch without affecting sound effects like vibrato or glissando, select the range to be changed and switch to *In Range Edit Mode*. Press the left mouse button and drag up or down to raise or lower the pitch envelope. The mouse pointer becomes a pair of north-south pointing arrows. Depending on the position of the mouse pointer within the selected range the edit will affect either the entire range uniformly if the mouse is centred, or change only one side of the range, just like in the case of amplitude envelope corrections. The procedure may be repeated to achieve a large pitch change. Hold a **Shift** key when pressing left mouse button to enable smooth 'cosine bell' shaped changes of the corrected pitch.
3. To undo any local changes made, select *Erase Edit Mode* . The mouse pointer changes to an eraser. Press and hold left mouse button over the lower part of the SAS Window while moving the mouse pointer left and right over the range to be affected.

Time Correction Edit

Select the range to be affected and choose *Time Correct Disable* or *Time Correct Enable* from the SAS Range menu (shortcuts **D** and **E** respectively).
To create a time-link, choose *Set Time-link Edit Mode* from the SAS File menu (shortcut **F1**) or click on  button. Place the indicator on the position to be corrected (source) . To set the target end of the time link, the cursor should be placed on the desired position (destination) on the Bar ruler. Created time-link is represented by the line connecting source and destination position. The sound file will now have its envelope stretched and compressed to accommodate the time-link.
A time-link is deleted by choosing *Delete Time Link Edit Mode* from the SAS File menu or by click on  button. The mouse pointer becomes a small x cross. Clicking the left mouse button while pointing to the time-link line deletes it.

Global Editing

The *Global Clear* command from SAS File menu is used to reset the SAS file to the uncorrected status.
The *Silence* command from SAS File menu sets zero for amplitudes lower than the *Silence Threshold* in the Settings dialogue box. *Global Edit* command from SAS Range menu gives you more options to apply changes to any part (or whole file after selecting all) of the SAS file. See Global Edit dialogue box for details.

Play sound

There are a few methods to play the WAV file:

1. Choose *Play* (shortcut **P**) from the WAV File menu or press ▶ button to start playing from the current WAV file position.
2. Choose *Play* (shortcut **F7**) from the WAV Range menu. The selected part of the WAV file will be played.
3. Choose *Play Corrected* (shortcut **F8**) from the WAV Range menu to play the temporary corrected WAV file corresponding to the selected part of the SAS file.

Hitting the **Space** bar shows the currently played position.
Depressed **Enter** key or ■ button stops playback.

Record sound

Before recording use a Windows program SNDVOL32.EXE or other sound mixer program which comes with your sound card software to choose source of the signal and to adjust its volume. To start recording choose *Record* from a WAV File menu or click button. You will see a dialogue box that lets you set a name for the recording file. Click the **Save** button to start recording or **Cancel** to suspend the operation. Recording can be stopped manually by pressing **Enter** key or click ■ button. The freshly recorded file will be automatically opened. If you prefer to use other sound recording program remember to set recording mode to mono (1 channel) 16 to 32 bits per sample and sampling rate greater or equal 22050 samples per second.

Remove noise

Noise removal from the WAV file works as follows:

1. Select range of the WAV file which is to be the representation of the noise in the record: the silent part at the beginning or the end of the file is a good candidate.
2. Choose *Noise=* from the WAV Range menu to obtain a frequency spectrum of the selected region.

Steps 3) 4) and 5) are not necessary but recommended:

3. Select another range which can represent the noise.
4. Choose *Noise+* from WAV Range menu to calculate the frequency spectrum of the selected region and add it to the one previously taken.
5. Repeat steps 3) and 4) as many times as are feasible. The more noise samples are taken, the better the noise representation and the more thorough the noise suppression will be ones step 7 is implemented.
6. Set values for *White Noise* and *Noise Sample Gain* in the *Remove Noise* group of the Settings dialogue box. The *White Noise* can be ignored if the noise representation taken in steps 1) - 5) is good (taken from at least one second of the record). Leaving the *Noise Sample Gain* parameter equal to one is OK in this case. If the noise sample is short, setting *White Noise* around 1 or *Noise Sample Gain* around 2 is a good baseline for compensation. If the record contains no silent parts, select at least a one second range in step 1) (regardless if it is silent or not), then set *Noise Sample Gain* to zero and *White Noise* to around 2. To find more precisely white noise level use an FFT window. Choose *Hann* windowing method. Select the part of the spectrum which appears as white noise (uniform frequency distribution) and read a *Range Ampl* value. Use this value as a *White Noise Level*. The higher the values for *Noise Sample Gain* and *White Noise Level*, the more of the signal is treated as the noise and subtracted from the original record. This can have some seriously

unpredictable effects. *White Noise* value of 100 is the biggest possible and in this case all the sound will be removed.

7. Choose *Remove Noise* from the WAV File menu. Type the name for the new WAV file in the Select Output File dialogue box and click OK. InTune will then process the WAV file.

Select range

There are two methods to select a range in each of the four windows (WAV, SAS, FFT and MFT) used by InTune.

1. With the mouse pointer in the selected window and the **Ctrl** key held, press the left mouse button and drag the pointer left or right to make the selection.
2. Set the position indicator (red vertical line) by pressing the left mouse button at the beginning or the end of the region to be selected and press **L** (left) or **R** (right) key accordingly. If the R position is to the left of the L position nothing is selected.

Additional methods for specific windows are:

1. In the WAV window - choose *Set Left* or *Set Right* from the WAV Range menu to set left or right boundaries of the selected range.
2. In the SAS window - choose *Set Left* or *Set Right* from SAS Range menu to set left or right boundaries of the selected range or *Find* to set both at the same time automatically using *Select Threshold* value from the Setting dialogue box. This is a fast method, useful when notes in the record are well separated. Use **F** as a shortcut to the Find command. Use *Select All* to select the whole SAS file as a range.

Find Base Note Threshold

To determine *Base Note Threshold* follow these steps:

1. Open the WAV file that you want to be analysed.
2. In the Settings dialogue box, choose instrument used in WAV file.
3. Set cursor at the position which indicate well-defined sound.
4. Choose *MFT* from the View menu.
5. The highest peak in MFT window has assigned 100.
6. Find the base note. The highest peak may represent a base note or its harmonic. If it is not a base note, the base note will be represented by one of the peaks on the left side. Choose the one you know that you played in your recording and read its value as a percentage of the highest peak by placing the indicator bar on it.
7. On the left side of the base note peak (that found in 6) find the highest one and read its value. This peak will represent highest level of interference from the noise or other sounds (e.g. previously played note). If there isn't a peak found assign 0.
8. The base note threshold will be the average of the two read values.
9. Repeat steps 3 to 8 as many times as you like, choosing different notes in the WAV file.
10. Estimate the average base note threshold, from that found in step 9 and type its value into *Base Note Threshold* edit box in the Settings dialogue box. Click OK button to accept new value for building new SAS file.

Contact InTune author

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http://sydney.edu.au/science/physics/~marek/intune/