

# TuneLab Pro

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## What is TuneLab Pro ?

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TuneLab is software that helps you to tune pianos. This software comes in various forms – for a Windows laptop, iPhone, iPad, iPod Touch, and Android phones and tablets. Although these platforms are quite different, most of the features of TuneLab are implemented similarly in all versions. This manual describes TuneLab Pro for Windows laptops. There are separate manuals to describe TuneLab for these other platforms. See [www.tunelab-world.com](http://www.tunelab-world.com) for details.

### Visual Tuning

TuneLab is one of the class of devices or software programs called “Visual Tuning Aids” or “Electronic Tuning Devices”. These are devices or programs that provide a piano tuner with real-time guidance during tuning. The sound of a note as it is played is picked up by a microphone and analyzed. The results of the analysis are displayed in a visual pattern. In the case of TuneLab, there are two main visual patterns that are displayed - the **phase display** and the **spectrum display**. Both of these displays indicate if the pitch of a note should be raised or lowered, but each display has its own unique advantages. Having both displays visible simultaneously gives the piano tuner the best of both worlds.

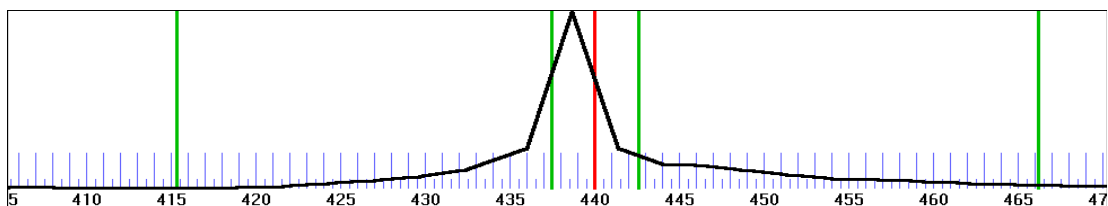
### Phase Display



The phase display is the horizontal band shown above. This display is used for fine tuning. The black squares move to the left if the note is flat and to the right if the note is sharp. The closer you get to the correct tuning, the slower the black squares will move. The goal is to make the black squares come as much to a stop as possible. If the piano string has any false beats, the black squares may appear to move in an irregular fashion, sometimes moving back and forth. When there is no note playing, or when the note being played is far from the correct pitch, the black squares will disappear or move randomly.

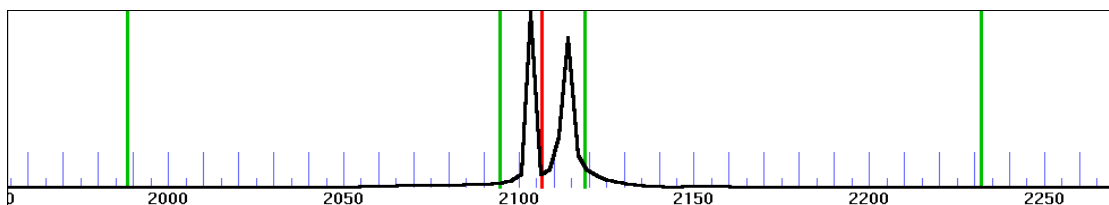
This display is called a phase display because it displays the phase of the sound from the microphone as compared to the phase of an internally generated reference pitch, as in a strobe tuner. The movement of the squares can be compared to listening to beats between a tuning fork and a note on the piano. For the bass and midrange, when a square makes one complete trip around the display, that corresponds to one complete beat that you would hear when comparing two tones. For higher notes the display is artificially slowed down in order to keep the speed of the display in a reasonable range.

## Spectrum Display



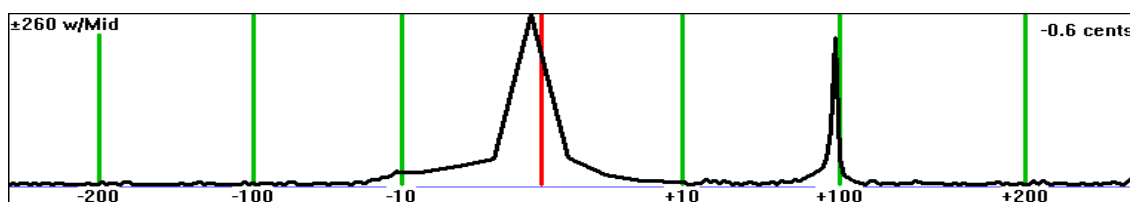
The spectrum display is the graph shown above zoomed-in to  $\pm 130$  cents around the desired pitch. Using the Edit Options menu, you can choose to make the traces thicker (as shown) for easier visibility, at the cost of a slight loss of resolution. This display shows how the sound energy is distributed across the frequency spectrum. If TuneLab is listening to a pure tone, the spectrum graph will show a single peak. The example seen here was made from a A-440 tuning fork that was a little flat. The red line in the center of the display marks the correct pitch. The green lines nearest the center mark the points that are 10 cents above and below the correct pitch. The green lines far from the center mark the points that are 100 cents above and below the correct pitch, i.e. the previous note and the next note in a chromatic scale. The object in tuning with the spectrum display is to tune the note until the peak of the graph is centered on the red line.

The spectrum display has several advantages over the phase display. One is that it shows where the pitch of the piano is, even when that pitch is far from the correct pitch. The other advantage is that the spectrum display can show several peaks at once. This is what you would get when playing a poorly tuned unison:



Here the piano note C7 is being played with one string tuned nine cents higher than the other two strings. By looking at individual peaks it is possible to tune notes in the high treble without mutes! You simply tune one of the strings and watch which peak moves. You can move that peak to the red line and then that string will be at the correct pitch. However, tuning this way is not as accurate as tuning by sounding one string at a time, because the multiple peaks tend to become blurred as they merge into one another.

The Spectrum Display can also be zoomed in on the center  $\pm 10$  cents in the center, while still showing  $\pm 130$  cents or  $\pm 260$  cents overall. When one of these “dual-zoom” modes is selected, the numbers at the bottom show offsets in cents rather than frequencies in Hz. Here is one such setting of the Spectrum Display showing two simultaneous notes - one at A6 and the other at A#6 (+100 cents higher than the target pitch):

















As shown in the upper right corner of the previous Spectrum display, if a tone is recognized close enough to the target pitch, there will be a numerical display of the tuning error in cents – in this case, -0.6 cents.

One advantage of the phase display is that it generally provides more resolution than the spectrum display, except in the highest octave where the resolutions are about the same. For this reason the spectrum display is used for rough tuning and the phase display is used for fine tuning. False beats can confuse the phase display though. So the spectrum display is preferred even for fine tuning in the high treble. In any case, both displays are available; so you can use whichever display seems to be giving the clearest indication.

## Toolbar

TuneLab Pro uses a toolbar for many functions. Here is the toolbar from TuneLab Pro:



-  **New Tuning File** - prepares for creation of a new tuning, and may start auto measure sequence
-  **Open Tuning File** - selects and loads an existing tuning file
-  **Save Tuning File** - saves the current tuning as a file so it can be recalled later
-  **Sound On/Off** - toggles the sound generation mode on and off
-  **Offsets** - manages overall offset and custom stretch values
-  **Lock Mode** - begins locking onto the note by automatically adjusting the offset (“.” also works.)
-   **Zoom Spectrum In/Out** - zooms through 6 different zoom levels (“-” and “+” also work.)
-  **Auto Note Switch, Both Direction** - enables auto note switching in both directions
-  **Auto Note Switch, One Direction** - enables auto note switching in just one direction
-  **Measure Inharmonicity** - measures inharmonicity (“M” also works.)
-  **Over-pull** - enables/disables over-pull (pitch raise) mode (function key “F2” also works.)
-  **Historical Temperaments** - selects optional non-equal temperaments
-  **Tuning Curve** - displays the tuning curve for adjustment or review (“T” also works.)

All these toolbar buttons have associated tooltips. To see a tooltip, merely move the mouse cursor so that it rests on one of these buttons. After a short pause a box will appear with a reminder about what that button does. If there is a keyboard key that performs the same function, the tooltip will tell you about it.

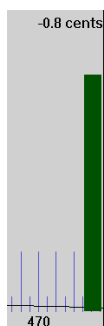
## Current Settings Display

In the middle of the main TuneLab display screen in large letters there is a display of the currently selected note. Above the phase display is a display of current settings. Usually most of these fields are blank; but here is an example with all the fields active:

MyKawai.tun		Offset = 0.60 ¢
Bremmer EBVT-3		Custom Stretch = 6.27 ¢
Using Fundamental	Current Settings:	Template Stretch = 0.79 ¢
Frequency = 556.474 Hz	Auto up	Temperament Offset = -1.08 ¢

Here is a description of each of these fields, reading down the left column and then the right column:

1. **Tuning File Name** - the name of the tuning file currently in use (“*MyKawai.tun*”)
2. **Temperament Name** - the name of the temperament file, if one is selected (“*Bremmer EBVT-3*”)
3. **Tuning Partial** - which partial (or fundamental) is used for tuning the current note
4. **Frequency** - the calculated frequency, taking into account all offsets (“*556.474*”)
5. **Offset** - the overall offset from standard A-440 pitch in cents (“*0.60*”)
6. **Custom Stretch** - the offset (if any) manually programmed for the current note only (“*6.27*”)
7. **Template Stretch** - the offset calculated from the tuning curve (“*0.79*”)
8. **Temperament Offset** - the offset from the optional historical temperament in effect (“*-1.08*”)
9. **Note Switching** - “*Auto up*” in this example, tells which form of hands-free note switching is in effect



## Microphone Level Indicator

To help verify that your microphone is working properly, TuneLab provides a display of the microphone level in the right edge of the spectrum display. When all is quiet, the level should be below 1%. When the microphone hears normal piano tuning the level should produce a level of at least 50%. If the reported level is nowhere near these levels, then check your microphone and check the multimedia settings in your computer’s Control Panel to see if some system volume control is improperly adjusted. The green bar shown here shows a mic level of about 80%.

## Tuning Curve Adjustment

By default the tuning curve is calculated automatically based on inharmonicity measurements. But if you want to override this default you can make some manual adjustments. See Chapter 3 for details.

## Partials

Each note is tuned according to its fundamental pitch or the pitch of one of its partials. The current settings box shows which partial is being used. The selection of partials comes from a table of partials. This table may be modified from the screen shown to the right. The table shows the partial number for each note from A0 to C8. Using the < and > buttons you

Partials:									
	Oct 0	Oct 1	Oct 2	Oct 3	Oct 4	Oct 5	Oct 6	Oct 7	Oct 8
C:		6	6	4	2	1	1	1	1
C#:		6	6	4	2	1	1	1	
D:		6	6	4	2	1	1	1	
D#:		6	6	4	2	1	1	1	
E:		6	6	4	2	1	1	1	
F:		6	4	2	2	1	1	1	
F#:		6	4	2	2	1	1	1	
G:		6	4	2	2	1	1	1	
G#:		6	4	2	2	1	1	1	
A:	6	6	4	2	1	1	1	1	
A#:	6	6	4	2	1	1	1	1	
B:	6	6	4	2	1	1	1	1	

< Duplicate > OK Help Cancel

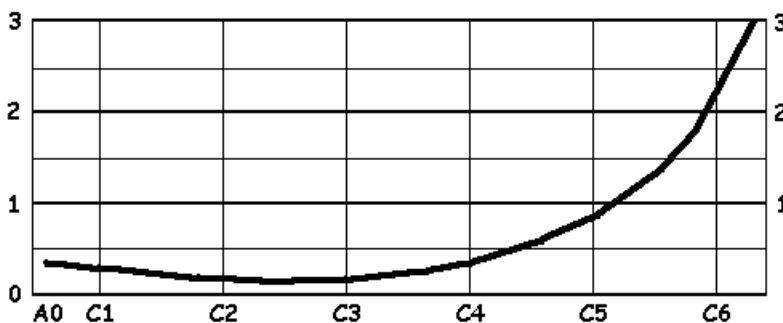
can lower or raise the partial for the highlighted note. You can highlight a different note by clicking on the partial number for that note. Since the same partials are generally used by a group of notes, the **Duplicate** button is provided to duplicate the highlighted partial into the next note and move the highlight. In this manner you can quickly set an entire section of notes to the same partial.

The table of partials is stored along with the tuning curve in the tuning file when you save a tuning. By modifying this table you can customize the partials used for tuning when that tuning file is loaded. Whenever you begin a new tuning, the table of partials is initialized from the special tuning file, **DEFAULT**, which is installed when you install TuneLab. If you want to make a change to the table of partials that will apply to all new tuning files that you create, you can explicitly load **DEFAULT** as a tuning file, edit the table of partials, then save the modified **DEFAULT**, which will replace the original **DEFAULT**. Partial numbers can also be changed on-the-fly using the function keys **F3** and **F4**. These on-the-fly changes are not stored in the table of partials and are canceled when a new note is selected, unless you have enabled “Persistent Partial Numbers” under Edit Options, in which case changes made on-the-fly are immediately incorporated into the current tuning file.

## Inharmonicity

Inharmonicity is the name given to the phenomenon whereby the partials of a piano string are not exact multiples of a fundamental frequency. TuneLab assumes that the partials are offset from their exact whole-number multiples of the fundamental by an amount that increases with the square of the partial number and is proportional to the inharmonicity constant for the given string. When TuneLab measures inharmonicity for a string, the pitches of all the partials of that string are analyzed and an inharmonicity constant is generated for that string. The inharmonicity constants are stored in the tuning file when a tuning is saved. You usually don’t need to be concerned with the actual values of the inharmonicity constants that you measure; but you can see and edit them from the **Edit** menu. In a well-scaled piano you can expect to see the lowest inharmonicity constants somewhere in octave 2. From there the inharmonicity constants

increase slightly as you move down to A0 and they increase substantially as you move up to C8, as shown below. TuneLab uses the specific samples that you collect to find a best-fit inharmonicity model for the entire scale. Using this model, TuneLab makes all the calculations regarding how partials relate to one another.



Typical Inharmonicity Values for a Kawai Grand

## Over-pull Mode

When raising or lowering the overall pitch of a piano by a significant amount, you will find that the notes that you tune first are changed by the time you are done tuning. This is due to the interaction of the string tensions, primarily through the bridge and soundboard and the flexing of the plate. When an entire section of notes is raised in pitch, the result is that the notes that were tuned first will tend to drop in pitch. Even the notes that you tuned last will drop somewhat due to the delayed settling of tension in the wire.

Over-pull tuning mode compensates for this change by setting tuning targets that are a calculated amount beyond the desired pitch. In this way the change that occurs will leave the notes right where you want them. In many cases using just one pass with over-pull tuning can take the place of tuning the piano twice. Over-pull mode accomplishes this goal using a process that has two phases. In the first phase you pre-measure the piano's pitch by playing a set of notes that TuneLab measures quickly. No tuning is done in this first phase. Then after the pre-measuring is done the second phase of over-pull mode lets you tune the piano. During this second phase TuneLab adds an over-pull offset onto each note to compensate for the expected drop in pitch after the tuning is done. These over-pull calculations are entirely automatic. The complete procedure for over-pull tuning is described more fully in Chapter 4.

## Calibration

TuneLab should be calibrated before you trust its absolute pitch. Without calibration, TuneLab assumes a nominal crystal oscillator frequency in your computer's sound system and makes all pitch calculations from that assumption. By doing a calibration you are compensating for whatever difference there may be between the nominal crystal oscillator frequency and the actual oscillator frequency in your particular computer, based on a comparison to a trusted pitch source. You can do a rough calibration using a tuning

fork, but your final calibration should be with some more precise source, such as the NIST phone service described later. The result of a calibration is a revision of the actual sample rate of the sound system, which is shown in the **About** box. Normally, calibration is done only once when TuneLab is first installed on your computer. See the chapter on calibration later in this manual for details on doing a calibration.

## Automatic Note Switching

Using the menu or the keyboard or the mouse you can enable different forms of automatic note switching. There is **auto up**, **auto down**, **auto both**, and **manual**. In manual mode the note TuneLab is listening for will not change unless you manually change it by using the arrow keys or clicking in the spectrum display. In the three automatic modes TuneLab listens for nearby notes and switches to them when you play them. **Auto both** will switch to any note within 300 cents of the current note, above or below the current note. **Auto up** will only switch to a note that is within 300 cents up from the current note. Similarly **auto down** will only switch in the downward direction. When measuring inharmonicity a special type of note switching takes over and switches through a pre-defined list of notes that you want to measure for a new tuning.

In TuneLab Pro, the different forms for automatic note switching can be enabled with the keyboard. Shift-Right-Arrow and Shift-Left-Arrow enable auto note switching in the indicated direction. Press both arrows at once to enable both directions. However the easiest way to turn auto note switching on or off is to click and drag from the Current Note display to the right or the left. Dragging to the left turns auto note switching off and dragging to the right turns it on.

## Historical Temperaments

By default, TuneLab assumes an equal tempered scale. If you would like to tune in some unequal temperament (not usual), you can select an historical temperament file to apply to your tuning. An historical temperament file contains a list of 12 offsets for each of the 12 notes of an octave. When an historical temperament is selected, one of these 12 offsets is used, depending on which note is selected. For any given note, the same offset is used in every octave. In addition, the temperament offset may be optionally normalized. This means that all 12 offsets will be shifted by the same amount before they are used. You can choose to have the offsets normalized so that the offset for A is always zero; you can choose to normalize so that the average offset is zero (to minimize the overall change from equal temperament); or you can choose to use the historical temperaments just as they are with no normalization. The temperament name and the temperament offset for the selected note appear in the Current Settings box shown previously. When you save a tuning the historical temperament values (and temperament name) are saved in the tuning file. See the chapter on special functions for information on making and using temperament files.

## Tuning Files

A tuning file is a file made by TuneLab and stored usually in **My Documents/TuneLab**. In this file are all the factors necessary to re-create a specific tuning. You can save the current tuning to a named file, or open an existing tuning file from the **File** menu. You can also save a tuning file by clicking on the diskette icon in the toolbar. If you want to organize your tuning files into several folders (like “Churches” and “Homes” or “Grands” and “Verticals”) under the one home folder, you can create these other folders as you save tuning files. When you save a tuning file, you will see a standard Windows “Save As..” dialog box. The appearance of that box will depend on which version of Windows you are running. But all versions offer some way to select different folders and to create new folders. Examine all the elements of your “Save As..” dialog box and you will find a way.

Here is what a tuning file contains:

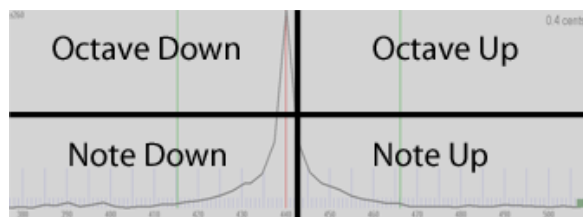
- The inharmonicity constants for all the notes that you measured.
- The adjustment settings of the tuning curve (the template).
- The name of the historical temperament (if any) and all 12 offsets from that temperament.
- The partial and custom offset (if any) for each of the 88 notes.
- The selection of bass and treble intervals in the tuning curve adjuster.
- The overall offset in effect at the time the tuning was saved.

## Sound Generation

Although the common use for TuneLab is in listening to notes and providing a visual tuning aid, you can also use TuneLab as a tone generator. When TuneLab is in sound generation mode, the spectrum display and phase display are disabled. The pitch of the sound generated in the speakers is the same as the pitch that would have indicated correct tuning in the listening mode. The pitch is generated for whichever partial is selected - not necessarily the fundamental. Sound generation using low pitches may not be audible due to the limitations in the frequency response of the speakers found in laptop computers.

Sound generation is generally used to aid in stringing operations where precision is not as important as in normal tuning. If you intend to use sound generation for precise tuning in TuneLab Pro, you should be aware of the fact that some laptops use two separate crystal oscillators in their sound output and sound input operation. Therefore a separate calibration may be needed for the sound generation mode. If this is the case with your laptop, you should do the separate output pitch calibration as described in the chapter on calibration. Even if your laptop has only one sound crystal, it does not hurt to do a separate calibration for the tone generation. If you don't plan on using TuneLab to generate precise tones, you don't need to do this special output calibration.

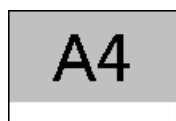
## Note Selection



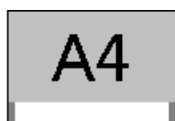
Using the mouse you can change notes by clicking in one of the four quadrants of the spectrum display. Clicking in the upper quadrants switches up or down an entire octave. Clicking in the lower quadrants switches up or down by a single note. You can also select a note using the keyboard by pressing the letter and then the octave number for the note on the keyboard. To select a sharp, use the right arrow key after selecting the natural, or use UPPER CASE letter to select the sharp directly. You can also select notes by using the right and left **Arrow keys** to move up and down the scale. You can change octaves with the **Page Up** and **Page Down** keys. During a normal tuning it is most convenient to switch notes automatically using **auto note switching**.

## Tuning Closeness Indicator

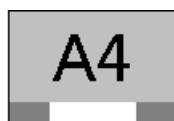
The current note display has a region on the bottom that indicates how close your tuning is to the target pitch. Here are some examples:



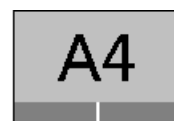
more than one  
cent off



slightly less than  
one cent off



half a cent off



nearly perfect

As these examples show, the gray bars start appearing when the tuning is within one cent of the target pitch; they close down and meet in the center at zero cents.

## Normal Tuning Procedure

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This chapter takes you step-by-step through an ordinary piano tuning (not a pitch-raise). We are also assuming that you have not tuned this piano before and saved a tuning file, because if you had, then you could skip the initial setup and just load that tuning file now and begin tuning.

### Initial Setup


Tuning with an electronic tuning aid can be done with just two mutes. First check the condition of the existing tuning to see if there are any major problems with the piano and to see if a pitch raise is necessary. Assuming that a pitch raise is not necessary, the next step is to measure the inharmonicity of the piano.

When TuneLab is started it will have a tuning file name such as “untitled-1”. If you have some other tuning file loaded as the current tuning you should clear out that tuning and start a new tuning by selecting the toolbar button shown here. This will clear out any old inharmonicity constants and reset the table of partials to the default. You are now ready to develop a new tuning. TuneLab will now switch to the first note in your “measure sequence” and start the inharmonicity measurement. Depending on your option settings the measurement may start immediately or you may have to click on the measure button first.

### Measuring Inharmonicity

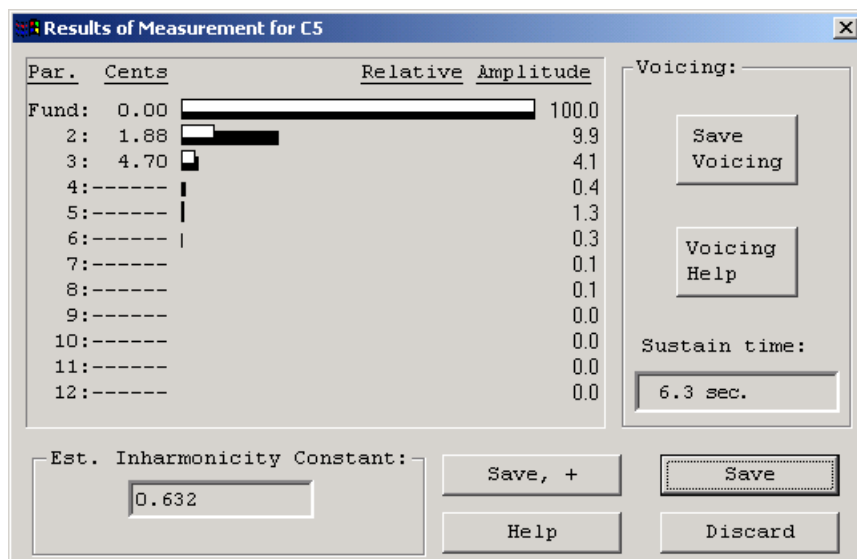
Start by measuring the inharmonicity of at least four notes and preferably six notes. The default measure sequence is the C notes from C1 to C6. If the piano is a spinet that is known to have a large break in the inharmonicity, you may want to consider using the Split Scale mode, as described in the Special Functions chapter. For now, we will assume that the piano is a well-scaled instrument that does not require Split Scale mode. We will measure the C notes from C1 to C6. If one of these notes is hard to measure accurately because of a serious false beat or lack of partials, then just measure some other nearby note instead. The graph in Chapter 1 shows typical inharmonicity measurements of a Kawai 6’8” grand. In any case, when you measure the inharmonicity of a note you should mute all but one string of the note. Measuring the inharmonicity of two or three strings sounding at once is not recommended.

To measure the inharmonicity of a note, select that note in TuneLab, as described in Chapter 1 under “**Note Selection**”. (That selection may have been done for you if you had set up an auto measure sequence in Edit Options.) Now that TuneLab is showing the note that you want to measure, if the measurement has not already been initiated by the auto measure sequence, begin a measurement by pressing **M** on the keyboard

or by clicking on the measure button:  This will cause a status box to appear showing “**Measuring, waiting for trigger**”. TuneLab will begin listening to the note as soon as you play it. The sudden rise in sound level is the trigger. If you do not play the note shortly after initiating a measurement it is quite likely that some extraneous noise may trigger the sampling period and you will get a false reading. If this happens, just wait for the calculation to finish and then discard the reading and start over. If the “**Auto Measure**” option has been enabled, then you do not need to switch notes or start each measurement because this will be done automatically for you.

When sampling for inharmonicity you should play the note that you want to measure and then watch the status box change from “**waiting for trigger**” to “**listening**”. This listening period is about six seconds for low notes and progressively shorter for higher notes. If the piano is in good condition the sustain period of the note should last to the end of the “listening” period. After the listening period TuneLab will calculate the inharmonicity and display a results box showing what was measured. In some notes with too-soft hammers, the partials are so weak or ill-defined that they cannot be measured. In that case it may be useful to pluck the string rather than strike it using the key. If you pluck the string, pluck it near the termination point to get a rich set of partials. This is generally needed only for very high notes.

The only value that is saved from the inharmonicity measurement is the inharmonicity constant. The graph in Chapter 1 shows the typical pattern of inharmonicity constants for a Kawai 6’8” grand (model 650). Other pianos may have more or less inharmonicity, but the pattern should be approximately the same. The graph stops at C6, but in almost every case, the actual inharmonicity continues in the same pattern of rising inharmonicity established by the lower octaves. So you can avoid measurements in the highest octaves and still have an accurate picture of the inharmonicity of the piano.



When a measurement is complete, TuneLab displays a box like the one shown to the left. Here we see that pitches were detected for the fundamental and partials 2 and 3. Some of partials 4-6 were detected, but they were too weak to be used for measuring inharmonicity. The offset column shows the offset in cents for the individual partials as compared to what they would be if there were no inharmonicity. Generally there is more inharmonic offset the higher you go in the partial series. The amplitude

column shows the relative strengths of the specific partials. TuneLab analyzes the pattern of partial offsets and calculates an inharmonicity constant for the string - in this case 0.632. If things look reasonable at this point then you would select **Save**, which will save the inharmonicity constant for the note C5. You can also select **Save, +** which will save the measurement and then begin another measurement of the same note so

that you may average several readings of one note. This is especially useful when using the auto-measure sequencing where **Save,+** will allow you to take additional readings of the same note without canceling the auto-measure sequence. In this box you can also view the partial amplitudes in graphical form using the horizontal bar graph, which is explained in Chapter 6 in the section on Voicing. If you measure inharmonicity again for the same note, the inharmonicity readings will be averaged.

## Adjusting the Tuning Curve

Now that the inharmonicity readings have been taken, TuneLab forms a model of the inharmonicity of all the notes of the scale. Using that model, TuneLab can predict how various intervals will sound. In automatic adjustment mode TuneLab uses that prediction to find an adjustment of the tuning curve that is optimized for the intervals you have selected. In manual or semi-automatic mode you can adjust the curve yourself. This tuning curve is sometimes called the template tuning curve because it follows a four-parameter template.

Subjective value judgments can play a role in how tuning curve adjustments are to be made. *Normally we recommend fully automatic adjustment mode, which you can select using the toolbar buttons at the top of the adjuster screen.* When the fully automatic mode is selected, you can cause the automatic adjustment to be made by pressing **U** on the keyboard, or clicking on any of the four **Auto** buttons below the tuning curve.

Refer to the picture of the tuning curve in Chapter 1. You get to this screen by pressing **T** on the keyboard or by clicking on the tuning curve icon in the toolbar. You are also taken to this screen automatically at the end of a sequence of inharmonicity measurements for a new tuning. Note the buttons that select between the three different ways of adjusting the tuning curve:



This button selects the totally manual method of adjusting the tuning curve. When this option is used, you must use the adjuster arrows to adjust all four aspects of the tuning curve, which are overall stretch in the treble and in the bass, and the shape of the bass and treble portions of the curve.

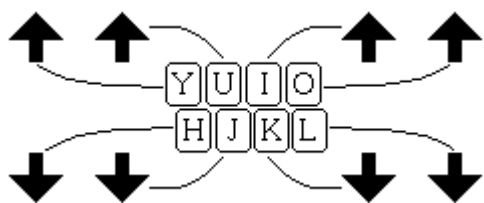


This button selects the semi-automatic method. The overall stretch in the treble and the bass are calculated automatically, but you must manually adjust the shape of the treble and the bass using the remaining adjuster arrows.



This button selects the fully automatic method. All four aspects of the tuning curve are adjusted automatically when you touch any of the adjuster arrows, which now will say “Auto” instead of showing a picture of an arrow.

If you do not choose the fully automatic method, you must adjust the curve by clicking and dragging up or down through the green bands in the graph background. The bands at the extreme left and right control the overall stretch in the bass and the treble. The inner bands control the shape of the bass or treble portion of the tuning curve without changing the overall stretch.



Although tuning curve adjustments can be carried out by clicking and dragging the mouse, for compatibility with older versions of TuneLab you can also use the keyboard for these actions. The mappings shown to the left are in effect. This mapping shows the inner two adjustment bands are mapped to U, I, J, and K. The outer two adjustment bands map to Y, O, H, and L (in fully

manual mode only). If you are using the fully automatic method of tuning curve adjustment, then you can skip the adjustment details.

In the course of doing an adjustment you may find that a portion of the tuning curve goes off the scale. If this happens and you want to see the whole curve, press the **Z** key (for “Zoom”). This will toggle the graphical limits between the original limits and the limits that exactly contain the current curve.

Now that you have become familiar with the mechanics of adjusting the tuning curve, it is time to adjust the tuning to match your tuning criteria. You may want the 6:3 octaves in the low bass to be as pure as possible and the 4:1 double octaves in the treble to be as pure as possible. Do that by selecting these intervals in the selection boxes located around the adjuster arrows. Open these drop-down selection boxes by clicking on the little triangle after the interval name. Scroll through the choices and tap or click on 6:3 in the left selection box and 4:1 in the right selection box. TuneLab will remember your preference and these intervals will always be selected for you when you start a new tuning. In addition, the interval selections for each tuning will be stored in the tuning file, so you can have different interval selections with each tuning file.

Now that you have the proper intervals selected, the deviation curve (the lower curve) shows you how your selected intervals will sound. The goal is to adjust the tuning curve until the deviation curve is as straight as possible at both ends. This is, in fact, what the fully automatic adjustment method does. You will notice that the right-hand adjuster buttons control the shape of the treble end of the tuning and hence the shape of the treble end of the deviation curve. If the deviation curve is bowed up in the middle, press the down adjuster arrow. If the deviation curve is bowed down in the middle, press the up adjuster arrow. Unless you are using the totally manual method, the ends of the deviation curve will always be at zero. Your goal in adjusting the shape is to get as much of the deviation curve as possible to lie close to zero.


When you adjust the shape of the bass end of the tuning curve you will notice that the deviation curve moves in the opposite direction as the tuning curve. This behavior is a consequence of the way the deviation curve is defined. If the bass end of the deviation curve is bowed up in the middle, press the up adjuster button. If the bass end of the deviation curve is bowed down in the middle, press the down adjuster button.

The Zoom function was mentioned earlier in relation to containing the tuning curve. The Zoom function also scales the graphical display of the deviation curve.

When you get the deviation curve to look something like the one shown in the picture in Chapter 1, you are done. Notice that the deviation curve does not hold very close to zero at the transition in the middle. That is normal and expected. As you move from the bass to the treble, your criterion for a good tuning gradually changes from making 6:3 octaves beatless to making 4:1 double octaves beatless. Midway through that

transition the 6:3 octaves will be a little narrow and the 4:1 double octaves will be a little wide. It is impossible to get both intervals to be beatless at once throughout the scale. You should find that in the vicinity of the transition you have other criteria for a good tuning (such as 4:2 single octaves) and those criteria will be satisfied quite well. The criteria for a good tuning that we suggested here are just a starting point. Some TuneLab users report getting better results by selecting 4:2 octaves in the treble. Feel free to experiment to find the settings that most closely correspond to your tuning style.

## **Saving the Tuning File**

After the tuning curve has been adjusted to your satisfaction, exit from the tuning curve adjuster by pressing **ESC** or click the **X** button. If you want to save this tuning file for later recall, now would be a good time to do so. Save the tuning file by clicking on the Save Tuning File button  in the toolbar and entering the name of the tuning file. Use a name that is short enough to fit in the space allotted in the current settings box but long enough to remind you which particular piano this is so that you can recognize it in a list of other tuning files. If you are tuning a lot of new pianos of the same brand, you may decide to keep one tuning file that you use for all pianos of a particular model. If you have the time, it is best to measure inharmonicity and adjust a tuning curve for each piano. However new pianos of the same model do not vary that much and for all but the most critical uses, a generic tuning may be acceptable. You can delete tuning files from the Open File box using the right mouse button. See Chapter 1 for information on organizing your tuning files into different folders. After saving a tuning file, you can enter comments about this tuning from the **View** menu. The comments will be placed into a text file with the same name as the tuning file.

## **Beginning to Tune**

Because aural tuning always starts by setting a temperament, aural tuning sequences start in the middle of the scale and work downwards and upwards from there. When tuning to a calculated TuneLab tuning file, you can tune in any order that you want. Although you may not be considering a pitch raise at this time, remember that you will get less interaction between notes if you tune from the low bass to the high treble in order. That is the recommended sequence.

If tuning the bass first, select A0. Play the A0 on the piano and watch for a peak on the spectrum display. The bass requires some special consideration. Because you are tuning to a high partial, it is quite easy for a wrong partial to masquerade as the correct partial if the note is seriously mis-tuned. When in doubt, use aural methods to verify that the note is at least in the ballpark before trusting the spectrum display or the phase display. If you do not see a very prominent peak in the spectrum display, it is not necessarily a cause for concern. The phase display will work even with partials that are almost too small to see in the spectrum display. Especially in the bass, feel free to select a different partial on the fly if you are having trouble getting a reasonable indication on the current partial. You can press Function keys **F3** or **F4** to change the partial. If you have enabled auto partial selection in Edit Options, TuneLab will search for a stronger partial as you tune and switch to that stronger partial automatically if one is found.

We recommend that for your very first tuning with TuneLab you leave auto note switching disabled. That way you will not be confused by unintentional note switches. Later on, you can enable auto note switching to speed up your tuning. For now you can manually switch notes by pressing the arrow keys.

When you finish the monochord section of the bass and come to the bichords, always mute one of the strings before tuning the other string in the unison. After one string is tuned, remove the mute and tune the unison aurally. There are times when machine tuning of the unisons is an advantage, but those instances are usually in the high treble. In the bass there are many partials that need to be balanced. Tuning these unisons aurally allows you to make the needed compromises to get the best-sounding unisons. Also, aural unison tuning is faster than using the machine.

Proceed up through the bi-chords and into the tri-chords. Here you can mute the outside two strings and tune the middle string. Then move the right mute over one note to expose the right-hand unison. Tune that unison aurally and then move the left-hand mute over one note. That will expose the left-hand unison and also re-mute the right-hand string. In case your right-hand unison was off at all, it is better to tune the left-hand unison to the middle string than to tune the left-hand unison to the combination of the middle and right-hand strings sounding at once. Also, having all three strings sound at once increases your chances of having to deal with false beats. So always tuning unison strings in pairs is recommended.

Continue tuning through the high treble. Here you may have some trouble with the phase display. Even though TuneLab has artificially slowed down the movement of the phase display in the high treble, false beats together with a short sustain can produce a confusing picture in the phase display. It is here that we recommend that you switch over to using the spectrum display. The resolution of the spectrum display is in terms of cycles per second, not in terms of cents. Therefore the cents-wise resolution of the spectrum display gets better and better the higher you go in frequency. You can see this by noting the jagged look of the spectrum display around A-440 in the picture in Chapter 1 as compared to the somewhat more precise look of the graph following that one which is based around C7 (at about 2100 Hz). Therefore, in the high treble we recommend just trying to get the peak to be centered on the central red line in the spectrum display.

## **Using Auto Note Switching**

You can use auto note switching to make tuning easier. To enable this feature hold the Shift key and press the appropriate Arrow keys. When auto note switching is enabled, TuneLab will be constantly listening for nearby notes; and when it hears one, it will switch to it. Auto note switching can be enabled for switching up, down, or in both directions. The range of auto note switching is up to 300 cents from the current note. If you use aural checks while tuning, be aware that auto note switching may occur while you are doing these checks. If an unintended auto note switch occurs, simply use the arrow keys to return to the correct note.

When higher treble notes are selected, auto note switching requires a “trigger”, which is a sudden rise in volume, such as you would get when playing a note after some silence. At other times, auto note switching is less demanding, and will switch when the pitch changes without a trigger event. If TuneLab doesn’t switch when you want it to, wait for some silence, and then play the note again.

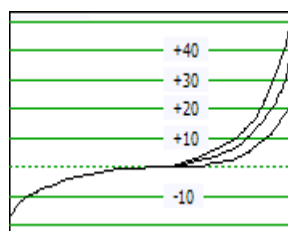
## The Tuning Curve

The tuning curve is the source of the “*Template Stretch*” offsets that appear on the main tuning screen. The tuning curve determines how much stretch there is in the bass and the treble. You do not need to look at the tuning curve if you are using a saved tuning file, or if you are using automatic tuning curve adjustment. But it is advisable to take a look at it when making a new tuning just to confirm that the automatic adjustment is reasonable. You will certainly need to look at it to make manual or semi-automatic adjustments. Also, you will need to visit the tuning curve adjuster if you want to change which intervals are used to adjust the bass and treble portions of the curve, as described later in this chapter.

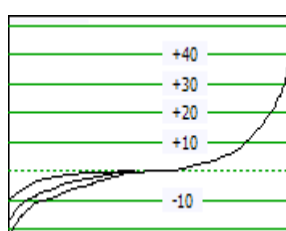
If the tuning curve adjuster is configured for automatic adjustment, then the tuning curve will be adjusted automatically after every inharmonicity measurement, using the bass and treble intervals you have selected. Therefore you can just start tuning after making the final inharmonicity measurement for a new tuning. The rest of this chapter will describe what aspects of the tuning curve can be adjusted and how to accomplish those adjustments.

### Tuning Curve Variations

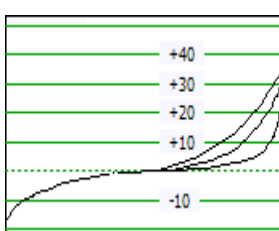
The tuning curve is adjustable in four different ways, as illustrated here:



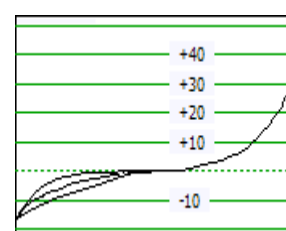
over-all treble stretch



over-all bass stretch



treble shape

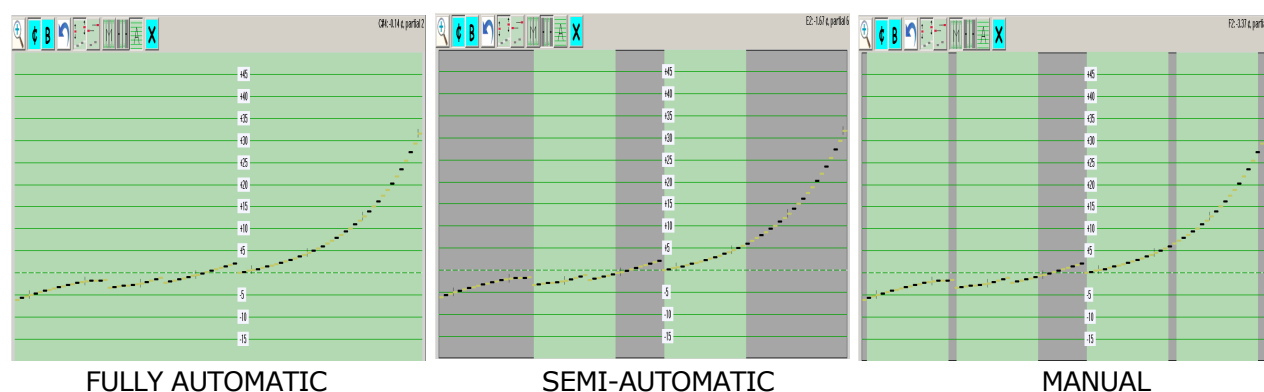


bass shape

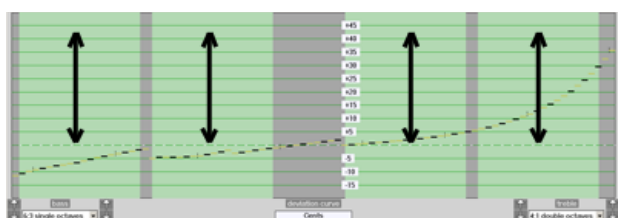
Each of these graphs shows the stretch for all the notes from A0 to C8. The first graph shows three variations of a tuning curve where the thing that is being adjusted is the overall stretch in the treble. The second graph shows three variations of a tuning curve where the thing that is being adjusted is the overall stretch in the bass. The third graph shows variations of the shape of the tuning curve in the treble. The overall stretch at C8 remains the same, but the way in which it gets there is different. One graph shows a stretch that gradually increases as you approach C8. Another shows a stretch that goes up very little at first,

and then abruptly goes up to the same value for C8 as before. And yet another variation is midway between these two extremes. Of course there are infinitely many such variations, but these few have been presented to illustrate the kind of variation we are talking about. And finally the fourth graph shows variations in the shape of the bass portion of the tuning curve.

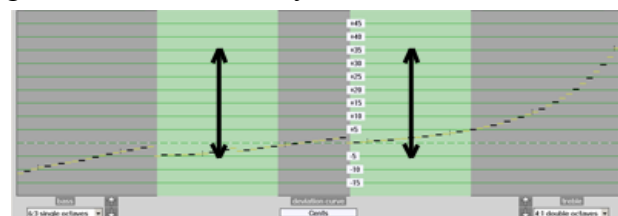
Every tuning curve generated by TuneLab is some combination of these four kinds of variations or adjustments. So it is not surprising that in manual adjustment mode, you have four different adjustments that you can make. Here is what the top part of the tuning curve adjustment screen looks like in each adjustment mode:



Notice that these graphs have breaks and do not appear continuous. These breaks represent places where the tuning switches to a different partial. The jumps in the tuning curve are necessary to compensate for the fact that different partials are being used. The jumps in the curve do not represent actual jumps in the tuning, which is in fact still continuous.



gives the most flexibility, but it is the most tedious,

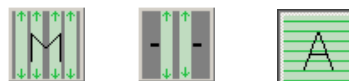


by clicking and dragging up or down in the appropriate green band. In the semi-automatic mode, TuneLab will adjust the overall stretch to make the deviation curve (described below) average near to zero at A0 and C8.

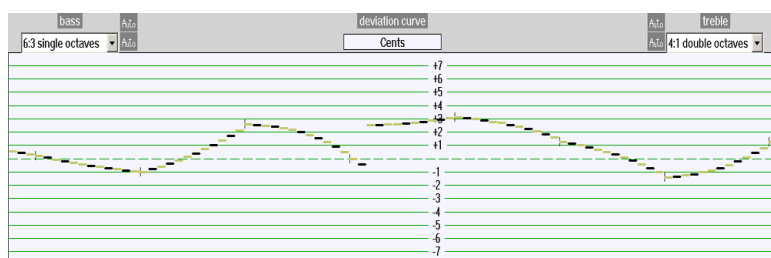
In the *manual* mode there are four green bands in the background. Clicking and dragging the mouse up or down in those bands will adjust one of the four aspects of the tuning curve. The left-most and right-most bands adjust the overall stretch in the bass and the treble. The middle two bands adjust the shape of the tuning curve in the bass and the treble. This kind of adjustment gives the most flexibility, but it is the most tedious, especially if you don't know what you want to do to the tuning curve. It is preserved for historical reasons, but is hardly ever used. In *semi-automatic* mode only the inner two adjustment bands are active. That is because the overall stretch in the bass and the treble is being adjusted automatically, so the outside green bands that control those adjustments are removed. As with full manual mode, you adjust the shape of the tuning curve

The *fully automatic* mode shows a solid green background. In this mode, just one click anywhere in that background will cause all four aspects of the tuning curve to be adjusted automatically. As with semi-automatic mode, TuneLab will adjust the tuning curve overall stretch to make the deviation curve read near zero at the low and high extremes of the scale. In addition it will adjust the shape of the tuning curve to make the deviation curve as flat as possible in the vicinity of the ends of the scale.

You can select between fully automatic, semi-automatic, and manual adjustment modes by clicking on one of the mode selection buttons shown here:



## Deviation Curve



In order to understand how the tuning curve is adjusted automatically or manually we first have to examine the deviation curve, which is the graph shown below the tuning curve. The deviation curve is divided into a left and a right portion. The left portion shows the effect of the tuning on the interval selected for the bass, and the right portion shows the effect on the interval selected for the treble. The bass and treble intervals are selected from the two drop-down boxes in the upper corners of the graph. This particular display indicates that the treble interval is the 4:1 double octave, and the bass interval is the 6:3 single octave.

the bass, and the right portion shows the effect on the interval selected for the treble. The bass and treble intervals are selected from the two drop-down boxes in the upper corners of the graph. This particular display indicates that the treble interval is the 4:1 double octave, and the bass interval is the 6:3 single octave.

Using the intervals shown (4:1 and 6:3), the left portion of the deviation curve would show how wide or narrow the 6:3 octaves are in the bass. A positive number of cents means wide and a negative number means narrow. In the bass portion, each interval is specified in the graph by the left-most note in that interval. So for example, the left-most portion of the deviation curve says how wide or narrow is the 6:3 octave formed by A0 and A1.

Similarly, the right portion of the deviation curve would show how wide or narrow the 4:1 double octaves are in the treble. In this case, each interval is specified by the right-most note of that interval. Therefore the right-most portion of the deviation curve says how wide or narrow is the 4:1 double octave formed by C6 and C8.

Common selections for bass and treble intervals will generally give these results:

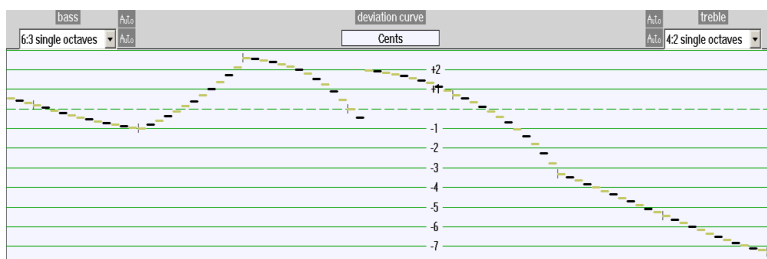
- 6:3 in the bass = low to moderate bass stretch
- 8:4 in the bass = higher bass stretch
- 4:1 in the treble = moderate treble stretch

- 4:2 in the treble = higher treble stretch
- 2:1 in the treble = low treble stretch

The graph shown above is the deviation curve for a particular piano and tuning curve. The selected intervals were 6:3 in the bass and 4:1 in the treble. It was adjusted in the fully automatic adjustment mode. As we said before, this causes the deviation curve to be near zero at the extreme ends of the scale and to be as flat as possible in the vicinity of those extremes. In this case we see that is so. Reading from that graph we can see that for this particular tuning of this particular piano:

- The 6:3 octave A0-A1 is wide by about 0.6 cents
- The 6:3 octave C#1-C#2 is nearly perfect
- The 6:3 octave F1-F2 is narrow by about 0.2 cents
- The 6:3 octave C3-C4 is about 2.6 cents wide
- The 6:3 octave C#4-C#5 is narrow by about 0.4 cents
- The 4:1 double octave D2-D4 is about 2.5 cents wide
- The 4:1 double octave G4-G6 is nearly perfect
- The 4:1 double octave C6-C8 is about 1.3 cents wide

To read the deviation curve properly, remember that every interval is composed of two notes and the deviation curve reports the condition of that interval on the graph. But the graph shows the condition of that interval for either the upper or lower note in the interval. In the treble section of the deviation curve the note chosen to represent the interval is the upper note, but in the bass section the note chosen to represent the interval is the lower note. So for every point on the graph, imagine an interval that extends from that point to the right or to the left depending on which half of the deviation curve you are in.

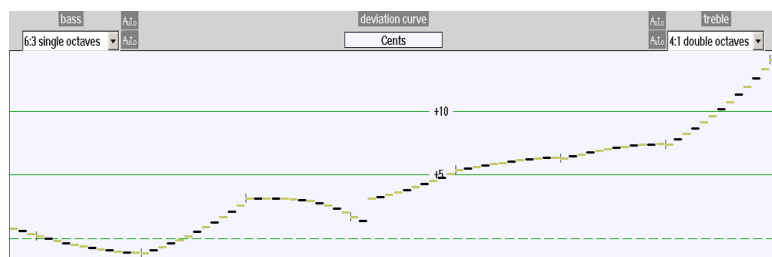


Now let's explore the deviation curve further. Without changing the tuning curve adjustment, we can select the 4:2 octave in the treble in place of the 4:1 double octave. If we did that, the deviation curve would become the graph as shown here on the left. The graph zoom has been

changed to contain the very low value at C8. When the 4:1 interval is changed to the 4:2 interval the tuning does not change. The tuning is still the same, but the deviation curve changed because it is now reporting a different interval in the treble. (Notice that the bass portion of the deviation curve remained the same, since it is still reporting the 6:3 interval.) But looking at the 4:2 interval we see that its tuning has a perfect 4:2 octave at D#4-D#5. This is actually quite good because the fourth octave is normally tuned with perfect 4:2 octaves when tuning aurally. But 4:2 octaves are not used for aural tuning in the high treble because the

partials involved are too weak to cause much of a beat. So we should not be upset at seeing such narrow 4:2 octaves being reported in the high end of the deviation curve.

Now suppose we force an automatic adjustment of the tuning curve based on this new interval selection (by clicking on the tuning curve when the background is all green). Then the deviation curve would look like the one shown below. As before, when we do an auto-adjust the selected intervals are forced to come out nearly beatless near A0 and C8. Adjusting with 4:2 in the treble generally produces more stretch than with 4:1 in the treble. In the example that generated these graphs, C8 was stretched by 31.64 cents when the 4:1 interval was selected for the adjustment. But C8 was stretched by 48.31 cents when the 4:2 interval was used as the basis of the adjustment instead.



Now that we have adjusted the tuning curve based on the 4:2 intervals, let's go back and see how the 4:1 interval would turn out with this adjustment. The graph shown here shows that the 4:1 interval would be generally much wider everywhere, especially in the high treble. Compare this graph to the one on the

previous page to see how well- behaved the 4:1 double octave was when it was used for the adjustment.

So what we see is that tuning is a compromise between competing intervals. Personal preference determines which intervals are most important at which parts of the scale. As you can see, there are many possible ways to adjust the tuning curve even if you use the fully automatic adjustment mode. And after an adjustment has been made, you can temporarily select a different interval just to see how that interval would work out with the current tuning curve adjustment. We recommend that at first you simply select 6:3 in the bass and 4:1 in the treble and do an adjustment in automatic mode and use it. If you prefer more stretch in the bass, use the 8:4 octave instead of the 6:3. If you want more stretch in the treble, use the 4:2 octave instead of the 4:1 double octave.

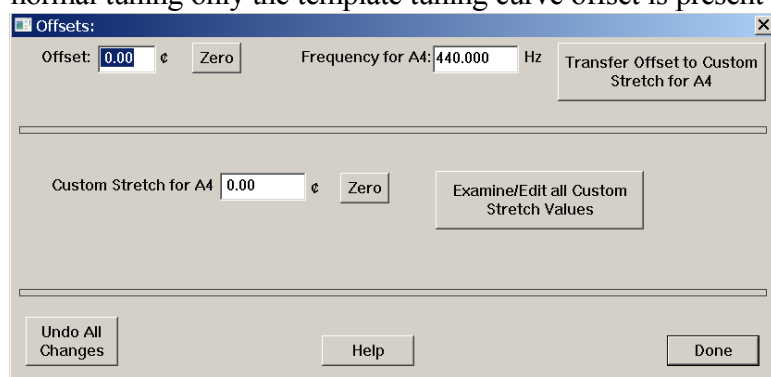
## Displaying Beats in the Deviation Curve

The deviation curve normally shows the condition of the selected intervals in cents. But you can also show beats. To switch between beats and cents use the beats or cents buttons shown here:



## All About Offsets

TuneLab uses various offsets. The offsets are all displayed in cents on the right side of the Current Settings box as shown in Chapter 1. TuneLab combines them to calculate the desired pitch for each note. In normal tuning only the template tuning curve offset is present and the other offsets are all zero. The **overall**



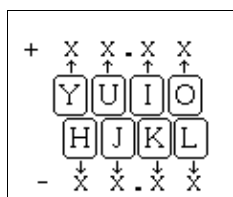
**offset** and the **custom stretch** offsets can be entered numerically using the **Enter Offsets** menu item, or by pressing **F6**. In the window shown here the entry in the upper left is the **overall offset** which affects all notes equally. This is the offset you would use to shift the entire scale to some non-standard pitch, like A-435. Instead of entering the offset in cents you can let TuneLab calculate the offset for

you by entering what pitch you would like for A4 (instead of 440). Just enter the desired pitch in the next box and TuneLab will make the offset be whatever is needed to achieve that pitch.

There are also optional **custom stretch** offsets for each note individually. Normally all these custom stretch values are zero. But for special uses you can establish a custom additional offset for any note. You can fill in the box shown above for the “Custom Stretch for..” for whatever note is currently selected. Or you can click on “**Examine/Edit all Custom Stretch Values**” and see and edit all 88 of these custom stretch values at once.

### Working with the Overall Offset

In addition to entering the overall offset numerically, you can also modify the offset with either the keyboard or the mouse. To use the mouse just click and drag right or left through the phase display. Dragging to the right raises the offset and dragging to the left lowers it.



For compatibility with older versions of TuneLab you can also use the keyboard to adjust the overall offset. Just observe the mapping shown to the left. You can adjust the offset using the keyboard keys **Y**, **U**, **I**, and **O** to raise the offset by +10, +1, +.1, and +.01. Similarly, the keyboard keys **H**, **J**, **K**, and **L** may be used to lower the offset by -10, -1, -.1, and -.01. The **Z** key will set this offset to zero. The overall offset can also be affected by Locking mode, which is described later in this chapter.

## Custom Stretch

This is an optional note-by-note offset and it is stored in the tuning file. It is rarely used, except when recording an aural tuning for the Tuning Exam. It can be used to make note-by-note corrections to the tuning curve. But if you find yourself making many such corrections, then you should consider readjusting the whole tuning curve instead. This custom stretch can be set by a transfer from the overall offset as described above. This offset is not displayed if it is zero.


## Template (Tuning Curve) Stretch

For each note, this offset comes from the tuning curve. It is calculated based on the adjustment of the whole tuning curve, taking into account the partial that is selected and the inharmonicity. It is normally calculated automatically, but it can also be manually adjusted by adjusting the entire tuning curve.

## Temperament Offset

This offset is shown only when an unequal (historical) temperament is selected. In that case, this offset shows the temperament offset for the current note, which is the same for all other notes of the same name in different octaves. The 12 temperament offsets are stored in the tuning file when it is saved with an unequal temperament selected.

## Locking Mode

Locking mode is entered by clicking on the Lock button  or by pressing the period (".") key. The left status box will appear indicating the Locking mode. To cancel locking mode, click on the Lock button again or press the **ESC** key. When Locking mode is active, the offset is automatically adjusted by TuneLab to make the phase display come to a complete stop. The adjustment starts by making large rapid changes in the offset, which gradually reduce to small slow changes after a few seconds. This behavior allows quick initial locking, followed by more precise offset trimming as the feedback is gradually reduced. At any time during the locking operation the feedback can be set to maximum by pressing the period key again. A form of Locking mode is also used whenever you perform a calibration as described in the chapter on calibration.

## Over-pull (Pitch Raise) Tuning Procedure


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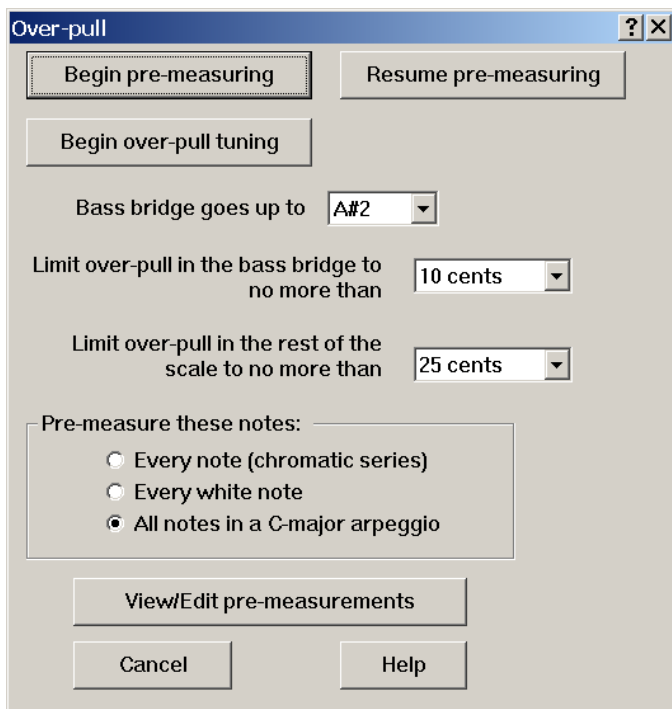
Over-pull tuning is most often used in pitch raising, although it could also be used for pitch-lowering. When large overall changes are made to the tuning of a piano, the notes that you tune tend to change pitch as you tune later notes. Over-pull tuning mode compensates for this change by setting the pitch targets a calculated amount beyond the desired pitch. In this way the settling that occurs as later notes are tuned will leave the notes closer to where you ultimately want them to be. In many cases using just one pass with over-pull tuning can take the place of tuning the piano twice. And even if you do use two passes, doing the first pass in over-pull mode will leave the piano closer to the correct pitch than if you hadn't used that mode, and thus the second pass will be easier.

### Measuring Inharmonicity Before an Over-pull

When over-pull mode is activated TuneLab will not let you measure inharmonicity. Therefore if you want to create a custom tuning for the piano as described in Chapter 2, you would have to measure the inharmonicity before enabling over-pull mode. For small pitch raises the normal inharmonicity measurements will be sufficient. However for larger pitch raises, the act of pulling the string up to pitch will change the inharmonicity of the strings. For such pitch raises it is not worthwhile to measure inharmonicity first. Just load the **Average** tuning file (which comes packaged with TuneLab), or a generic tuning file from a similar model piano. Then do a pitch-raise pass using that tuning. When you do the second pass, start over with a new tuning file and take fresh inharmonicity readings. Only the final pass would need to have custom inharmonicity measurements taken.

### Enabling Over-pull Mode

Over-pull has two phases. The first phase is **pre-measuring** the piano. No tuning is done in this phase. We simply let TuneLab hear a set of notes from the piano and gather some pitch information about those notes. In the second phase we do the actual tuning which includes over-pull offsets that TuneLab calculates from the data gathered in the first phase of over-pull. If your evaluation of the piano convinces you that the overall pitch change is large enough to need an over-pull, you can begin the process of over-pull tuning by **pre-measuring** the piano. This must be done before any tuning has been started, in order to get an accurate measure of how flat the piano was to start with. This will enable TuneLab to calculate an amount of over-pull appropriate to the particular piano. To start, stop, or change any parameters relating to over-pull, use the Over-pull Mode menu item, or click on the Over-pull toolbar button shown here, or press the  F2 function key. This will display the window shown below.



You can click on **Begin pre-measuring** to start the pre-measuring process from the beginning. Or you can click on **Resume pre-measuring** to start pre-measuring at the currently selected note, keeping all previous pre-measurement values. After the pre-measurements all have been taken you can click on **Begin over-pull tuning** to start the actual tuning with over-pull offsets calculated and added in for you based on the pre-measurements that were taken. As a general rule of thumb, the calculated over-pull offsets are about one quarter of the average pre-measurement value. So if the piano was 50 cents flat, over-pull tuning will set target pitches that are about 12 cents sharper than normal. This is only an approximation because TuneLab uses the entire set of pre-measurements in a proprietary manner to calculate the over-pull offsets. There are no user adjustments needed in this calculation.

The rest of the window has to do with options that you can use with the over-pull process. The first over-pull option is the location of the break between the bass bridge and the tenor bridge. The example here shows the quite unnaturally high transition point of C#4. Clicking on the selection will allow you to change it. TuneLab uses this information in the calculation of the over-pull offset, as well as to qualify the next options - the safety limits.

The next two options are safety limits. They set an overriding upper limit on how high the over-pull offset can go. For example, if the pre-measurements showed that the piano was about 180 cents flat, the calculated over-pull would have been about 45 cents sharp. But this is above the specified safety limit of 25 cents, so the over-pull offset was limited to 25 cents. You can set these safety limits to whatever you want by clicking on the setting. But you take all responsibility for what may happen with higher safety limits. TuneLab initially is installed with the most conservative limits in effect. If you want more permissive limits, then you will have to change them. When the TuneLab over-pull offset is being limited by a safety limit, that offset will be displayed with a pink background to let you know that you have hit a safety limit. If this is expected then just continue tuning. You will probably need to do an extra pass, but you would want to do that anyway to lessen the chance of breaking strings. On the other hand if you think the strings can take it, raise the safety limit to a higher value to cause this piano to be brought up to pitch more quickly.

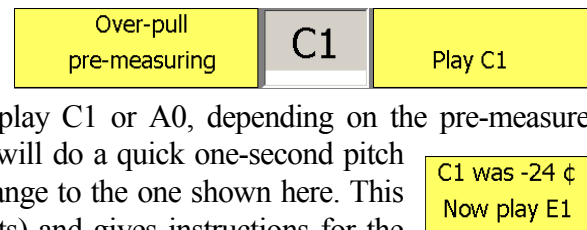
The last option is the pattern of pre-measurements. You can select **Every note (chromatic series)**, **Every white note**, or **All notes in a C-Major arpeggio**. Since TuneLab interpolates between the notes that you do pre-measure, it is not necessary to pre-measure every note.

You will also be able to delete pre-measurements that you decide are faulty. If you delete a pre-measurement, TuneLab will simply interpolate between the neighboring pre-measurements to calculate the over-pull offset. Sampling every note sometimes gives a more accurate picture of the pre-tuned state of the piano, but it also takes four times longer than sampling only the notes from a C-arpeggio. If you think the piano is close to being in tune with itself, then sampling only the C-arpeggio notes probably is sufficient, and that is in fact the default.

Sometimes something goes wrong with a pre-measurement. You might play the wrong note, or TuneLab might get triggered by some non-piano sound and make a faulty measurement. That is why each pre-measurement is displayed as it is taken. If you suspect that a faulty pre-measurement has been made then you either redo the set of pre-measurements from the beginning, or you can click on **View/Edit pre-measurements** and see if any pre-measurements appear unreasonable. If so, you can delete the faulty measurements and then proceed to tuning in over-pull mode. As before TuneLab will interpolate over the missing pre-measurements using the nearby good pre-measurements.

## Pre-measuring Process

When starting the pre-measurement process it is important to have some reasonable tuning loaded first. That is because the pre-measurements will evaluate the pitch of the piano by comparison to whatever tuning is currently loaded. However it is often sufficient to load the Average tuning, or some generic tuning from another piano to use in a pitch-raise, since it is difficult to customize a tuning while the piano is significantly flat. So if you have a reasonable tuning loaded, start the pre-measurements by clicking on the Over-pull button as described above and then on **Begin pre-measuring**. This will display the status boxes shown here, instructing you to play C1 or A0, depending on the pre-measure pattern you have selected. When you play C1, TuneLab will do a quick one-second pitch measurement for C1 and then the right status box will change to the one shown here. This shows the results of the pre-measurement of C1 (-24 cents) and gives instructions for the next note to play in the pre-measure sequence. So now you would play E1 and then TuneLab will automatically switch to E1 and make the pre-measurement. Note that this is not the same thing as auto note switching during ordinary tuning. During pre-measuring, TuneLab will switch to the next note whenever a moderately loud sound is heard. So it is up to you to ensure that TuneLab hears the note that it expects to hear. Normally you would run through all the notes in the pre-measure sequence in about half a minute. But if you and TuneLab should somehow get out of sync and you play a different note from the one that TuneLab is instructing you to play, the pre-measurements obtained that way will be invalid. If this happens there are several ways you can correct the situation. The easiest way is to start over and re-do all the pre-measurements from scratch. Or if you like, you can manually select a note and then select **Resume pre-measuring** from the Over-pull window. This will begin pre-measuring wherever you want. Or after the pre-measurements are done you can review the pre-measurements from the Over-pull window and manually delete those pre-measurements that you suspect are faulty. TuneLab will smoothly interpolate across any missing pre-measurements.



## Over-pull Tuning

After the last note in the pre-measure pattern has been measured, TuneLab automatically will switch to the tuning phase of Over-pull by switching to A0 and displaying status boxes like the ones shown here. The left status box indicates that we are now in the tuning phase and the right status box tells us how much over-pull is affecting the current note (A0 in this case). Comparing with the pre-measurement made for A0 previously, which was -24 cents, you can see that the over-pull amount is more than the rule-of-thumb one quarter of the pre-measured pitch. But that is because for this particular tuning the pre-measurements for notes after A0 were flatter than A0. In more extreme pitch-raises it is likely that you will hit your safety limits. If you should hit a safety limit, the over-pull amount will be limited by that safety limit and the right status box will indicate that it is limited by displaying the over-pull amount with a pink background as seen here. In this case 25 cents was previously set at the safety limit.

Over-pull tuning	A0	over-pull offset 9.4 ¢
---------------------	----	---------------------------

Over-pull tuning	G4	over-pull offset 25.0 ¢
---------------------	----	----------------------------

You can also switch to the tuning phase before all pre-measurements have been made. Just go to the over-pull window and click on **Begin over-pull tuning**.

You may now tune the piano normally, except that you should tune straight from A0 to C8, tuning unisons as you go, and each note will have an over-pull offset added on to it. You should tune unisons as you go because TuneLab assumes that you do that when it calculates the over-pull offset.

You can turn off over-pull mode by going to the Over-pull window again and clicking on **Stop using over-pull**.

## How Over-pull is Calculated

You do not need to understand the exact formula for over-pull to take advantage of over-pull mode. TuneLab performs the calculation automatically based on all the pre-measurements, and on the setting of the over-pull parameters. There is no longer any concept of an over-pull percentage, as found on earlier versions of TuneLab. Nor is there a running average of pre-measurements done during tuning. Instead, each individual pre-measurement contributes to each individual over-pull amount with a proprietary formula. This means you do not have to worry about pre-measurements while you are tuning, nor do you have to worry about auto note switching interfering with pre-measurements. If a note is too far off pitch to trigger auto note switching, just start tuning it near its correct pitch and TuneLab will switch to it when it comes into range of the correct pitch.

## Calibration Procedure

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Chapter 1 described the need for calibration. This chapter takes you through the process of actually doing a calibration. Normally you need to do a calibration only once when you first install TuneLab on your computer. The results of the calibration are stored permanently and used every time you run TuneLab.

### A Trusted Source of Pitch

To do a calibration you need to have a trusted source of pitch. The most accurate source of pitch that you can get is the National Institute of Standards and Technology (NIST). This agency of the U.S. government has a telephone service and shortwave radio service that disseminate standard time and frequency. The telephone service is free of charge (except for the usual phone charges – it is not a toll-free number), and the shortwave radio service may be heard on 2.5, 5, 10, 15, and 20 MHz, if you have a shortwave radio. Another source of accurate pitch is some other calibrated tuning device that can produce a tone. Finally you can check your calibration against high-quality electronic keyboard instruments that are normally set at the factory to exactly A-440 for A4. If you use this source be sure to check several keyboards to confirm consistency. **Do not try to use any tones from websites on the Internet for a calibration reference. The pitch from such sites is only as accurate as the sound card in your computer, which could be off by quite a bit.**

### NIST Broadcast (and Telephone) Schedule

The NIST standard frequency service is available by telephone by calling (303) 499-7111 in Colorado. This is a very popular number. What you hear when you call this number is exactly the same as what is being transmitted by the NIST shortwave radio stations as mentioned above. NIST reports that they get over two million calls per year. In order to use these services effectively, you need to know something about the schedule for this service. The following schedule is followed each hour. It shows what tones are present during each minute of the hour. When a tone is present, it is present for the first 45 seconds of the minute and it is silent for the last 15 seconds.

0: ---	10: ---	20: 500	30: ---	40: 500	50: ---
1: 600	11: 600	21: 600	31: 600	41: 600	51: ---
2: 440	12: 500	22: 500	32: 500	42: 500	52: 500
3: ---	13: 600	23: 600	33: 600	43: ---	53: 600
4: ---	14: ---	24: 500	34: 500	44: ---	54: 500
5: 600	15: ---	25: 600	35: 600	45: ---	55: 600
6: 500	16: ---	26: 500	36: 500	46: ---	56: 500
7: 600	17: 600	27: 600	37: 600	47: ---	57: 600
8: ---	18: ---	28: 500	38: 500	48: ---	58: 500
9: ---	19: 600	29: ---	39: 600	49: ---	59: ---

Although the 440 Hz tone in minute #2 is tempting, do not try to use it. That pitch is only present for 45 seconds each hour. The difficulty in calling at just the right time and the shortness of the tone make this choice inadvisable. Instead you can use the 500 Hz and 600 Hz tones. The telephone service will disconnect you after three minutes, so make sure that when you call you have everything set up and time your call so that you will be assured of at least three minutes of 500 Hz or 600 Hz tones. If you happen to be closer to Hawaii than to Colorado, you can receive WWVH by shortwave radio or by calling (808) 335-4363 in Hawaii. For more information on both of these sources, see the website:

[www.boulder.nist.gov/timefreq/stations/iform.html](http://www.boulder.nist.gov/timefreq/stations/iform.html)

## Using NIST Tones for Calibration

To use the NIST standard frequency service to do a calibration, start by selecting **Calibrate to External Reference** from the **File** menu. Then select **500 or 600 Hz NIST tones** as the reference source. Do not try to make the call to the NIST using Skype or any such Internet phone service. Use a landline or standard cellphone. Internet phone services can slightly distort the pitch of the sound. Position the receiver of the phone so it can be heard by your computer's microphone. Follow the on-screen instructions. TuneLab will automatically determine which tone is currently sounding (500 or 600) and lock to it. When TuneLab has heard enough it will display a message saying that calibration is done.

## Using Other References for Calibration

Besides the 500 and 600 Hz NIST tones, TuneLab offers other choices. If you have a precise 440 or 1760 Hz tone source, you can use that. 1760 Hz was chosen because it is the fourth harmonic of 440 Hz. Finally, there is a completely general choice where you can enter whatever frequency you like. But whatever frequency you enter, it must be the true frequency of the source that you intend to use for calibration. If you have a calibrated CyberFork (from Reyburn Piano Services) then you can use it as a calibration source by entering the exact pitch in Hz. The exact pitch of a CyberFork is offset from 440 by the amount written on the CyberFork. The offset on the CyberFork is in cents, so you first need to convert that to Hz. You can use TuneLab to do that by selecting A4 (440 Hz) and then adjusting the offset, as described in the chapter “All About Offsets”. Adjust the offset until it matches the offset written on the CyberFork, then read the frequency in Hz from the lower left of the current settings box. It should be near

440. For example, if the CyberFork says -0.56 cents, then the frequency of that CyberFork is 439.858 Hz. If you want to use that CyberFork to calibrate TuneLab, that is the exact frequency you should enter.

If you want to use a high-quality electronic keyboard instrument to calibrate TuneLab and if that instrument has selectable voices, select a flute or simple pipe organ voice without any vibrato. Play A4, assuming that the instrument has been trimmed at the factory to exactly A-440. If you are in doubt about the reliability of that pitch source then after calibrating, check the A4 of several other electronic keyboards. If they are all in general agreement, you can be fairly confident that you have performed a good calibration.

## **Stopping Calibration**

If a calibration is not completing automatically this usually means something is wrong with the setup or the sound being provided to the microphone. You can stop (abort) calibration at any time by pressing the ESC key or by clicking in the left status box that says “Calibrating..”.

## **Verifying Calibration**

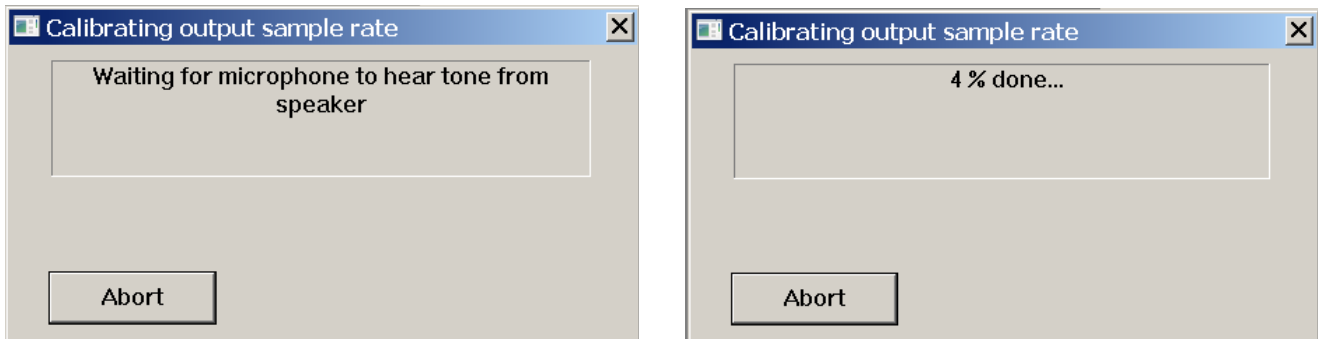
After a calibration is complete, you may wonder if it completed properly. You can check this in several ways. From the **Help** menu, select **About**. A box will appear that shows, among other things, the actual sample rate. This is the actual end product of doing a calibration. The actual sample rate is stored in your computer to be used every time you start up TuneLab. If you are curious as to how far off TuneLab would have been without calibration, compare the actual sample rate shown in the About box with the nominal sample, which is 22,050. Now that you have done a calibration, it will not matter that the actual sample rate is different from the nominal rate because TuneLab knows about the difference, and is taking it into account in all its calculations. Another way to check calibration is to go back to NIST or some other trusted source of known pitch. Select the note and offset that make the phase display stand still. If TuneLab is properly calibrated, the frequency display in the current settings box should be absolutely accurate and it should agree with the frequency of the trusted source.

## **Calibrating Sound Generation**

When you calibrate the listening mode as described above, TuneLab assumes that same calibration will apply to sound-generating mode too. That assumption is generally true. But in some computers the sound generating (the speaker) is based on a separate crystal oscillator from the one that runs the listening mode (the microphone). That means it is possible for the listening mode and the sound generating mode to require different calibrations. If you would like to ensure that generated tones are just as precise as the listening mode, you should calibrate the sound generating mode as well.

The calibration of the sound generating mode is based on the calibration of the listening mode as described above. What we do is generate a tone and have the microphone of that same computer listen to that tone. Then TuneLab will be able to determine a precise calibration for sound generating mode.

From the File menu select **Calibration / Calibrate Sound Gen from Listen Mode**. After clicking on **Start** you will see a window like the one shown on the left. At the same time you should hear a tone in the speaker. When



the microphone hears that tone, the message will switch to “**Initializing...**” and then to a message like the one on the right, showing a percentage done. This percentage will count up to 100% in about half a minute and then the calibration will be done. If the sound is interrupted or if there is excessive noise before the calibration can complete, the message may go back to “**Initializing..**” or even “**Waiting for microphone to hear tone from speaker.**” But if the tone is heard clearly by the microphone, the calibration will complete with a message telling you that it is completed successfully.

## Historical Temperaments

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TuneLab normally produces an equal temperament. But historically, equal temperament was not always the norm. Even today there is a strong interest in non-equal temperaments. With a non-equal temperament, different key signatures have different musical characteristics. It is said that the classical composers were aware of these differences and wrote their music to take advantage of these differences. A full treatment of historical temperaments and their musical characteristics and advantages and disadvantages is beyond the scope of this manual. But if you are interested, there is a lot of literature on this subject.

For our purposes an historical temperament is defined by a set of 12 offsets from equal temperament. These 12 offsets are repeated in every octave. TuneLab comes packaged with a set of historical temperaments that can be applied to any tuning file. If you know of an historical temperament that is not included with TuneLab, it is easy to add that temperament to your computer by entering the 12 offsets, as described below.

### Loading Temperament Files

To add an historical temperament to the current tuning, click on **Read Temperament File** in the File menu, or press the F5 function key. If you see a temperament that you want to use, just open it. If you have an historical temperament applied and would like to remove it from the current tuning, click on **Cancel temperament** in the File menu. This will return your tuning to Equal Temperament.

When an historical temperament has been added to the current tuning, you will see the name of that temperament just below the tuning file name on the main tuning page. Also you will see an offset for each note showing as **Temperament Offset xx.xx**. As you change notes, the temperament offset changes.

### Making Temperament Files

If you want to use a temperament that was not provided with TuneLab, you can create your own new temperament files from the File menu, **New..., Unequal Temperament File**. At this point you have two choices on how to make the temperament. One is “**..by manually entering offset**”. This will show you 12 boxes where you can enter the 12 offsets that define the temperament. The other choice is “**..from current Custom Stretch values**”. This choice is useful when you already have tuned a temperament aurally and captured that tuning by locking TuneLab to each note and transferring the offset into the Custom Stretch values. Then TuneLab asks you to decide which note will form the basis of the 12 offsets that you wish to capture, as shown below.

C	0.00
C#	0.00
D	0.00
D#	0.00
E	0.00
F	0.00
F#	0.00
G	0.00
G#	0.00
A	0.00
A#	0.00
B	0.00

Use Custom Stretch values starting with:

G4

Make temperament file

Cancel

When you select a starting note the Custom Stretch values for that note and the following 11 notes will fill the boxes on the left. You can still make manual changes to those values. To finish, you click on **Make temperament file** and give the temperament a name. This will store the 12 offsets that you entered into a file with the specified file name.

## Applying Temperaments

In addition to merely selecting a temperament you can also specify how it is to be applied to your tuning. You have three choices that you can make from the Edit menu under **Edit Options / Temperaments**: (1) Normalize so that the average offset is zero cents. (2) Normalize so that A is always at zero cents. (3) Leave the temperament offsets just as they are in the temperament file. The reason for normalization #1 is to minimize the overall impact on tuning stability when changing between equal temperament and an unequal temperament. Choice #2 may be useful if you want to ensure that the pitch of A does not change.

Finally you can rotate any temperament. From the File menu select **Rotate temperament starting note**. This will take the 12 offsets and rotate them so that the offset currently associated with C will instead be associated with the note that you select. This is useful if you want to apply an historical temperament, but you want to change which key signatures are “favored” by the given temperament.

## Special Functions

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### Split Scale Mode (especially Spinets)

Many spinets (and some small grands, like the Yamaha GH-1) are difficult to tune because they have a large jump in their inharmonicity - usually at the point where the scale makes the transition between wound strings and plain strings. TuneLab has a special facility just for such pianos. This facility is called the "Split Scale".

If you want to use the Split Scale, do this:

1. Take inharmonicity measurements of the two consecutive notes at the transition. (If the inharmonicity constants from these two measurements are not significantly different from each other, discard one of the readings and do not use Split Scale mode.)
2. Measure three other notes below the transition.
3. Measure three other notes above the transition.

This pattern of inharmonicity measurements tells TuneLab to use the Split Scale tuning curve, and it also tells TuneLab exactly where the transition is.

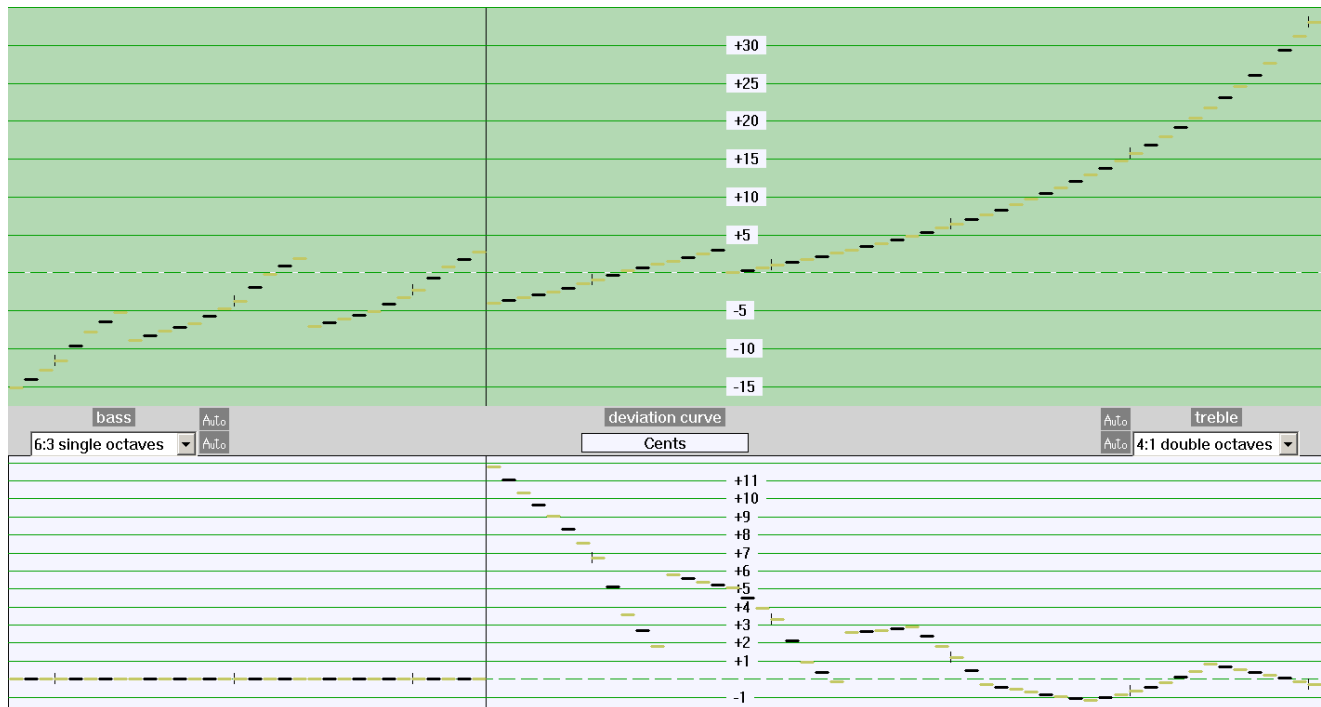
An alternate way to start a Split Scale tuning file is from the New menu. Select "New Split Scale Tuning File". TuneLab will then ask you for the location of the break where you expect the inharmonicity to jump (typically the break between wound strings and bare wire strings). Once TuneLab knows this, it will figure out which notes you should measure and sequence through those measurements automatically.

After you have measured inharmonicity as described above, you can invoke the tuning curve adjuster. The tuning curve adjuster shows when TuneLab is in Split Scale mode by placing a vertical line on the tuning curve and the deviation curve, as shown in the picture below. This vertical line shows the location of the break between the two parts of the split scale. If you do not see this vertical line in the tuning curve adjuster, TuneLab is not in Split Scale mode. If you expected to see Split Scale mode, review your list of inharmonicity readings to see if they follow the correct pattern for Split Scale.

For example, if you are tuning a piano that has a break at F#3/G3, you could invoke Split Scale mode by measuring inharmonicity at:

B0 G1 E2 F#3 G3 C4 A4 G5

When TuneLab is in Split Scale mode, the tuning curve adjustments have a direct effect on the portion of the tuning curve above the transition. We recommend that you select 4:1 double octaves in the treble side of the tuning curve adjuster, and 6:3 single octaves in the bass side. As with normal tuning you can let TuneLab calculate the tuning after inharmonicity measurements are made. But looking at the tuning curve is useful for confirming that the calculations went well.



In Split Scale mode, the usual model for the inharmonicity of the whole piano is broken up into two separate models - one for the portion of the scale below the transition and one for the portion above the transition. When you adjust the tuning curve, you will be adjusting directly only the portion of the tuning curve above the transition. The portion of the tuning curve below the transition will be adjusted automatically to give perfect 6:3 single octaves, if 6:3 octaves are what you selected for the bass. If you selected something else for the bass, then TuneLab will adjust the bass for 6:3 single octaves at the top of the bass and whatever you selected at the bottom of the bass. TuneLab will blend smoothly between these two intervals as you move down the scale in the bass. If you select 6:3 single octaves for the bass, then the deviation curve will show exactly zero cents for the entire left half of the curve. For adjusting the tuning curve in Split Scale mode, we recommend the fully automatic method of adjustment as shown in the previous picture. The image shown above is what a good tuning curve and deviation curve might look like in Split Scale mode. Note the vertical line which indicates Split Scale mode.

The large deviations in the middle of the deviation graph are to be expected. Pianos that need Split Scale mode tend to have high inharmonicity just above the break. Although 4:1 double octaves in this region may

be quite wide, 4:2 single octaves will be just about right. You can check the condition of 4:2 single octaves by temporarily switching to 4:2 in the treble. Make sure you switch back to 4:1 double octaves before making any further adjustments. After you have adjusted the tuning curve so that the deviation curve looks like the one above, focus mostly on the far right end of the curve and how it sticks close to zero, then exit from the tuning curve adjuster and tune the piano as usual.

## **Tuning Exam Mode**

From the Modes menu you can enter or leave Tuning Exam Mode. When this mode is active, the status box on the right side of the current note display is used to display the total offset, rounded to the nearest 0.1 cents, in keeping with the requirements of the PTG Tuning Exam. This display may be used to gather tuning offsets manually. Also, Tuning Exam Mode forces the use of the proper partials, as specified by the PTG Tuning Exam. In addition, there is a grading facility for comparing an examinee's tuning with a master tuning. See the separate document on using TuneLab in the Tuning Exam for details.

## **Measuring Voicing and Sustain Time**

As a by-product of measuring inharmonicity, TuneLab creates a picture of the relative amplitudes of the various partials that were measured. All the partial amplitudes are rated in proportion to the strongest partial, which is rated at 100. The voicing display is part of the inharmonicity result display shown in Chapter 2. In that display you will see two sets of horizontal bar graphs - one white and the other black. The white bars show the amplitudes for the current measurement. The black bars show the amplitudes for a previously saved measurement (using the “**Save**” pushbutton). In the case of the picture in Chapter 2, the previous measurement was made with a forté blow, and the current measurement was made with a much softer blow. This resulted in different relative amplitudes, especially for the second partial. Keep in mind the limitations in the use of this voicing measurement. The exact pattern of amplitudes depends greatly on the quality and the placement of the microphone, and on the strength of the hammer blow.

Another by-product of an inharmonicity measurement is the sustain time, which is described as the length of time that a note sounds before fading so much that it cannot be heard. Although this definition is imprecise and subjective, piano rebuilders often need some measure of sustain time to evaluate the quality of the bridge and soundboard. The calculated sustain time is shown along with the results of the inharmonicity measurement. To measure sustain time, follow the normal instructions for measuring inharmonicity. However, there are several precautions for measuring sustain time.

One precaution is to turn off automatic gain control on the microphone, if your laptop soundcard offers such an option. Normally, automatic gain control would be a good thing because it brings up the level of the sound as the note decays, thus giving TuneLab more signal to work with. But automatic gain control will make the notes appear to sustain much longer than they really do, so the calculation of sustain time will be invalid. If you do change automatic gain control settings, you will have to switch temporarily to sound generating mode and back to listening mode for the change to take effect.

Another precaution is to be aware of the sound level as you strike the note. If the level reaches 100% for too much of the phase of the inharmonicity measurement, then no sustain time will be reported. You can preview the sound level by looking at the mic level indicator on the main screen. Learn how hard you must strike the note to achieve an initial 100% level, or thereabouts. A brief period of 100% level is OK as long as the level drops below 100% shortly thereafter.

Finally, make sure that the correct note is selected when you measure sustain time. Although the sustain calculation is not pitch-sensitive, the total sampling time does depend on which note is selected. TuneLab assumes a shorter sustain for higher notes, as you can see by noting the differences in the inharmonicity sampling times.

## **Auto Partial Selection**

As stated in Chapter 1, the selection of which partial to use for each note can be modified by editing the table of partials as a whole, or by making individual on-the-fly changes. Sometimes individual bass strings are found to be weak in the pre-selected partial, making it difficult to tune them. You could manually try different partials, or you can let TuneLab change to a different partial by enabling the option for automatic partial selection. This option can be found under Edit Options. You specify a note below which automatic partial selection may occur, and how high a partial you will allow to be selected automatically. The default is to disable automatic partial selection completely. If you select a higher limiting note in your Options, then the lower notes will have automatic partial selection enabled.

When automatic partial selection is enabled for a note, the partial selection may change during the first few seconds after you switch to that note. TuneLab will not change partials unless it finds a qualified partial that is at least twice as strong as the currently selected partial. TuneLab will change partials only once for each note switch. If an automatic partial change does occur, that change is treated exactly the same as if you had made the change on the fly manually. In particular, if the Persistent Partial option is enabled, the change is incorporated immediately into the current tuning file.

## **Aural Temperament Tuning Sequences**

Normally TuneLab sequences from one note to the next in chromatic half-steps. But what if you want to follow a sequence like those that are used in aural tuning, perhaps as a training aid in learning aural tuning? For this purpose TuneLab provides aural temperament sequence control.

First, select an aural sequence file by going to the **File** menu and clicking on **Select Aural Tuning Sequence**. An aural sequence is specified by a file that lists the notes contained in the sequence in the order that they should be seen. The TuneLab installation contains one such file named “**4ths and 5ths.txt**”, but you can make others. The aural sequence files are simple text files and they reside in the **Aural Sequences** folder under the same folder where you keep your tuning files (usually **My Documents\TuneLab Pro**). Any text files that you create and place in this folder will be accessible as an aural sequence file. If you would like to add more aural temperament sequence files, use Notepad or some other text processor and

make a file that lists the notes you want to include in the sequence in the same format that is used by “**4ths and 5ths.txt**” and place the new file into the same **Aural Sequences** folder.

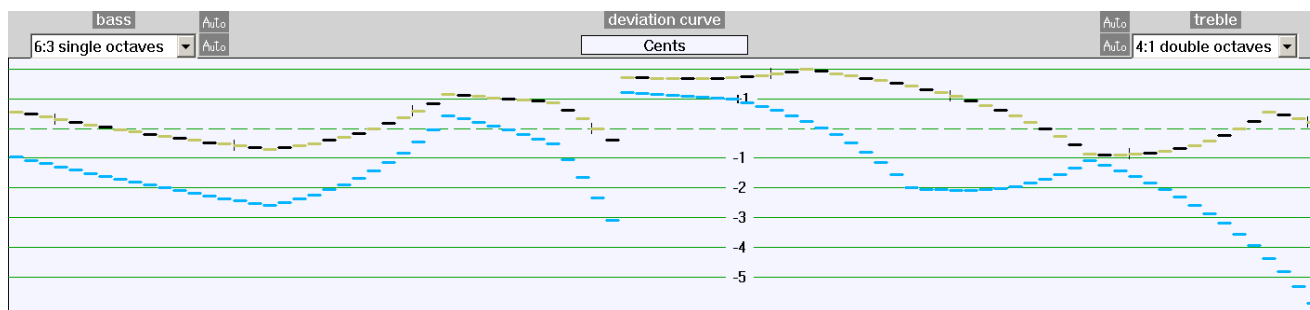
After you have made a selection, the note switching mode will show “**aural sequence**” instead of “**Auto up**”, or “**Manual note**”, etc., and the first note in the sequence will be selected automatically. Once TuneLab is in the **aural sequence** mode, you can switch to the next note in the sequence by pressing the **space bar**. You can go to the previous note in the sequence by pressing the **Backspace** key. There is no automatic (hands-free) note switching in **aural sequence** mode.

Once an aural sequence has been selected, you can change back to some other note switching mode and return to aural sequences again later by selecting aural sequence from the **Modes** menu, or by pressing **Cntl-A**. TuneLab remembers the last aural sequence file used so you don’t have to select it again.

## Using Alternate Intervals on the Deviation Curve Display

In Edit Options there is an option that defines an additional interval that can be displayed in the deviation curve for both the bass and the treble sections. By default, only the intervals you select in the selection boxes on the screen are displayed in black and green in the deviation curve. But if you specify an alternate interval, that interval will also be displayed with a light blue trace. The alternate intervals are not used in any automatic adjustments. They are displayed just for informational purposes.

The alternate intervals can be useful when adjusting the tuning curve if you want to ensure that two different intervals come out the way you want them. For example, suppose the regular interval selections are 6:3 single octaves for the bass and 4:1 double octave for the treble. Then suppose that we also define alternate intervals of 8:4 single octaves in the bass and 4:2 single octaves in the treble. The deviation curves might look like this:



Note how the 4:1 interval (shown in black and green) is about 1.8 cents wide at the middle of the scale and gradually becomes beatless in the high treble. However the 4:2 interval (shown in light blue) is beatless in the middle of the scale (at D#5) and becomes about 6 cents narrow at the very top of the scale.

This actually is a very desirable outcome. The 4:2 interval is more important in the middle of the scale, and the 4:1 interval generally is considered a better standard for judging the high treble. The two traces in the

deviation curve show a gradual transition from beatless 4:2 octaves in the middle and beatless 4:1 double octaves in the high treble.

In the bass, we see that while the 6:3 octaves (in black and green) are all fairly good, the 8:4 octaves (in blue) generally are narrow throughout the bass.

When alternate intervals are specified, the usual Zoom function (activated by the **Z** key) is modified slightly. Normally the Zoom function redraws the curves so that they are just contained in the display. A second consecutive Zoom will return to the original default zoom level. But if an alternate interval is specified, there are three stages in setting the zoom.

1. The first application of the Zoom function redraws the display to just contain the primary intervals in the deviation curve. The alternate intervals are allowed to run off the top or bottom of the graph.
2. The second application of the Zoom function redraws the display to just contain both the primary and alternate intervals. Nothing is allowed to run off the top or bottom of the display.
3. The third application of the Zoom function redraws the display with the original zoom settings, allowing the alternate intervals again to run off the top or bottom of the screen.

## Menu Items and Options

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Here is an item-by-item list of the menus used in TuneLab Pro.

### File

#### New

**New Tuning File** - clears out any existing tuning file data and loads from **DEFAULT**

**Split Scale Tuning File** - asks for the break, then starts new tuning file

#### Unequal Temperament File

**...by manually entering offsets** - If you know the 12 offsets that define an new unequal temperament, you can enter them here and make your own temperament file.

**...from Current Custom Stretch values** - If you have a piano that has been tuned aurally in an unequal temperament and you would like to make a file that duplicates that temperament, match at least one octave from that tuning using Custom Stretch values and then choose this menu item to use those Custom Stretch values to make an unequal temperament file.

**Open Tuning File** - lets you choose an existing tuning file to load

**Save Tuning File** - saves the current tuning data into the current tuning file name

**Save Tuning File As...** - saves the current tuning data and lets you choose a new file name

**Read Temperament File** - lets you choose an existing unequal temperament file, (or press **F5**)

**Rotate Temperament Starting Note** - lets you transpose a temperament so that it is based on some other note besides C

**Cancel Temperament** - returns the current tuning to equal temperament

**Select Aural Tuning Sequence** - lets you pick a file that defines the tuning sequence you want

#### Calibration

**Calibrate to External Reference** - TuneLab calibrates to a reference tone, such as the NIST tones or some other trusted source of pitch.

**Calibrate Sound Gen from Listen Mode** - Choose this item only if you need precise sound generation capability and have already done a basic calibration of TuneLab in the listening mode.

**Save Overpull Pre-measurements** - Use this function after you are done tuning a piano in overpull mode if you want a record of all the pre-measurements for off-line study.

**Exit** - Exit from TuneLab. TuneLab will prompt you if you need to save a tuning file first.

### Edit

**Edit Inharmonicity Constants** - Review and possibly edit the inharmonicity constants that resulted from inharmonicity measurements, (or press **Insert**) (Not generally needed)

**Edit Template Tuning Curve** – This item switches the screen to the tuning curve adjuster. You can also switch to the tuning curve adjuster by pressing the **T** key on the keyboard.

**Edit Partial**s – This item allows you to review and possibly change the table of partials currently in use. This table will be saved with the current tuning if you save the tuning file, (or press **P**)

**Change Partial Lower** - overrides the tuning file and changes to a lower partial, (or press **F3**)

**Change Partial Higher** - overrides the tuning file and changes to a higher partial, (or press **F4**)

**Enter Offsets** - Allows you to enter the Overall Offset or Custom Stretch offsets, (or press **F6**)

**Transfer Offset to Custom Stretch** - If you have adjusted the offset for the current note and would like to make that offset a permanent feature of the tuning for the current note only, use this menu item, (or press **F9**)

**Edit Options** - allows the setting of various options, listed later

## View

### Zoom Spectrum Display

**Wide View** - shows many partials at once, (or press “-”)

**+/- 260 cents** - shows  $\pm 260$  cents around the current note and partial, (or press “+” or “-”)

**+/- 130 cents** - shows  $\pm 130$  cents around the current note and partial, (or press “+” or “-”)

**+/- 50 cents** - shows  $\pm 50$  cents around the current note and partial, (or press “+” or “-”)

**+/- 260 cents with Middle Zoom** - shows  $\pm 260$  cents with an expanded display of  $\pm 10$  cents

**+/- 130 cents with Middle Zoom** - shows  $\pm 130$  cents with an expanded display of  $\pm 10$  cents

**Exam Scoring** - If you have matched an examinee’s tuning by transferring all his/her offsets to Custom Stretch values, use this function to compare the resulting tuning with a previously saved master tuning which was also recorded using the Custom Stretch values.

**Comments for this tuning** - Lets you save comments attached to the current tuning file

## Modes

**Generate Sound Output** - switches to making tones instead of listening to them, (or press **S**)

**Listen to Sound Input** - switches back to listening instead of generating tones, (or press **S**)

### Note Switching

**Manual only** - change notes manually (Shift down arrow)

**Auto up** - enables auto note switching to higher notes (Shift right arrow)

**Auto down** - enables auto note switching to lower notes (Shift left arrow)

**Auto both directions** - enables auto switching in either direction (Shift left and right arrows)

**Auto Measure** - enables auto sequencing through defined notes to measure for a new tuning

**Aural Tuning Sequence** - enables following an aural tuning sequence that was previously selected from the File menu (Cntl-A)

**Over-pull Mode** - Manage all the phases of Over-pull tuning, (or press **F2**)

**Locking Mode** – This item enables the mode where TuneLab automatically adjusts the offset to match the tone that it hears. See the chapter on “All About Offsets” for more information.

### Tuning Exam

**Detuning** - adds detuning offset for test prep

**Capture** - displays offsets rounded to 0.1 cents and makes it easy to record them as Custom Stretch values for saving into a master tuning or examinee tuning file

**Stop** - turns off detuning or capture modes and goes back to normal

**Record A4 Fundamental for RPT Exam** – assumes overall offset is the A4 error

## Help

**Help Topics** - invokes the complete help file for reference

**Tutorial** - invokes a special help file that leads you through a step-by-step tutorial

**About this version** - gives information about this version of the program

**Enter License Information** - lets you convert the free trial version to the paid version

## Options (in Edit Options box)

### Spectrum Display

**Use wide traces in spectrum graph** - makes traces three pixels wide instead of one pixel

**Font Size for tuning error display in spectrum graph** – to make this number easier to read

### Phase Display

**Speed Factor** - scales the speed of the phase display for all notes

**Switch to Cents at...** - This item specifies the note at which the speed of the phase display switches to cents. Below this note, the speed of the phase display is based on beats. One beat of pitch error means one complete cycle of the phase display (if Speed Factor is set to 1). Above the specified note, the phase display speed represents the pitch error in cents. The higher you put this changeover point, the faster the phase display will be for the higher notes.

### Inharmonicity

**Start Measuring Inharmonicity Immediately** – used for new tunings to avoid having to click on the Measure button to start each measurement

**Measure Sequence** - allows you to redefine which notes are to be measured for inharmonicity in a new tuning

### Partials

**Make partial changes persistent** – This option remembers in the tuning file any changes made to the selected partial using the F3/F4 keys. If this option is not checked, all such changes are temporary, and the partial selections in the tuning file stay as they are.

**Auto Partial Selection** – This option specifies which notes, if any, should use automatic partial selection. This option is for the lowest bass notes. See Chapter 8 for details. The default is for no auto partial selection. The highest partial that may be used can also be specified.

**Create sound with partials and inharmonicity** – Instead of the normal operation of creating tones with a single partial, this option causes tone generation to be a complex combination of partials.

**Edit table of partials** - allows you to edit the partials used in tuning, either for the current tuning or for newly-generated tunings

### Temperaments

**Normalize Historical Temperaments** – This option allows the selection of three types of normalization: none (as is), normalize so that A=0, and normalize so that the average offset=0. The

normalization shifts all 12 offsets for tuning but does not change the original offsets in the tuning file or the temperament file.

## **Files**

**Treating Offsets between sessions and tuning files** - allows you to specify if the overall offset will be saved and restored from tuning files or between times when the TuneLab program is started up

**Always start TuneLab with the tuning file that was last used** - Normally when TuneLab is started up, the tuning in effect is a no-stretch “untitled” tuning. When this option is selected, TuneLab remembers the tuning file in effect when it is shut down and automatically loads that tuning file when it is started up again.

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