TuneLab Piano Tuner
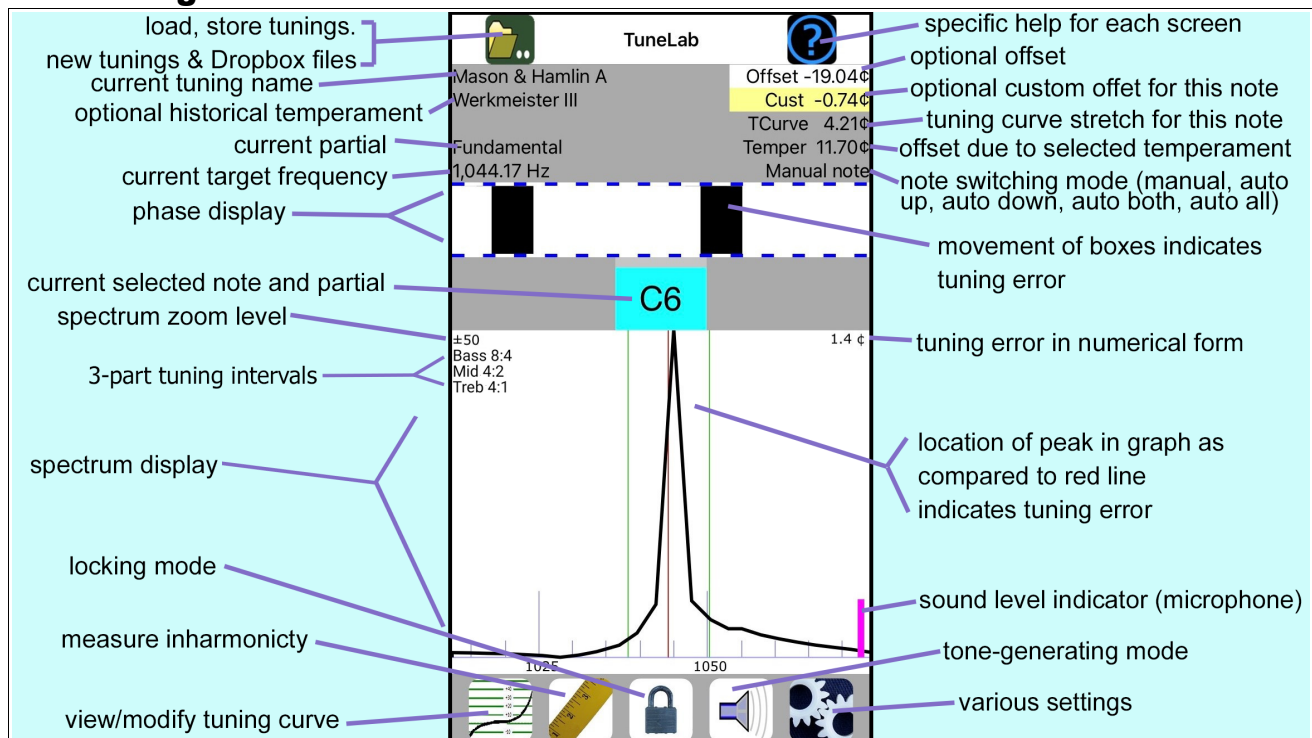
What is TuneLab Piano Tuner for iOS?

TuneLab is software that helps you to tune pianos. This form of the software runs on iOS devices (Apple iPhone, Pad, or iPod Touch) with iOS 9.0 or higher. It is available only through Apple's App Store. TuneLab is also available on Android smartphones, Android tablets, and Windows laptops. There are other manuals to describe these other forms of TuneLab, and they can be found on our web site at tunelab-world.com.

Visual Tuning

TuneLab is a software program that turns an iOS device into an Electronic Tuning Device, which provides a piano tuner with real-time visual 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 visual patterns. TuneLab displays two main visual patterns - the **phase display** and the **spectrum display**. Both of these displays indicate how the pitch of a note should be tuned, but each display has its own unique advantages. Having both displays visible simultaneously gives the piano tuner the best of both worlds.

Main Tuning Screen

load, store tunings.
new tunings & Dropbox files
current tuning name
optional historical temperament
current partial
current target frequency
phase display
current selected note and partial
spectrum zoom level
3-part tuning intervals
spectrum display
locking mode
measure inharmonicty
view/modify tuning curve

specific help for each screen
optional offset
optional custom offet for this note
tuning curve stretch for this note
offset due to selected temperament
note switching mode (manual, auto up, auto down, auto both, auto all)
movement of boxes indicates tuning error
tuning error in numerical form
location of peak in graph as compared to red line indicates tuning error
sound level indicator (microphone)
tone-generating mode
various settings

Phase Display

Referring to the picture of the main tuning screen on the previous page, the **phase display** is the horizontal band with the black squares. 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 the **phase display** because it displays the phase of the microphone sound as compared to the phase of an internally generated reference pitch. 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.
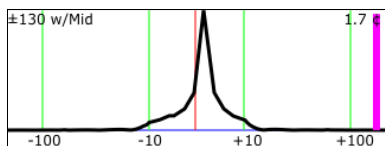
Spectrum Display

The **spectrum display** is the graph with the peak in the middle. As shown, the zoom set to ±50 cents around the desired pitch. This display can be configured for other zoom levels. This display shows how the sound energy is distributed across the frequency spectrum. If TuneLab is listening to a pure tone, then the spectrum graph will show a single peak, as shown here. This example was made from the note C6, and the display shows that it is 2.0 cents sharp. 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 objective 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. The picture here shows 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. In this display the zoom has been set to its most zoomed-in level, ±50 cents. By looking at individual peaks it is possible to do a rough tuning without mutes! You simply tune one of the strings and watch which peak moves, then move that peak to the central red line.
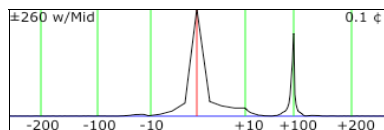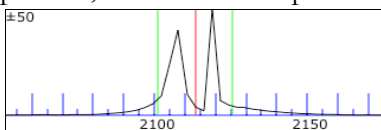

Switch to different zoom levels by using a two-fingered **pinch zoom** in the spectrum display. In addition to zoom levels of "**wide**", **±260 cents**, **±130 cents**, and **±50 cents,** the spectrum display can also be zoomed in on the center ±10 cents in the center of the display, while still showing ±130 cents or ±260 cents overall. When one of these "**dual-zoom**" modes is selected, the numbers at the bottom of the graph show offsets in cents rather than frequencies in Hz. The picture shown here is of one such setting of the spectrum display showing two simultaneous notes - one at A6 and the other at A#6.

There is also an option switch under **Settings** that makes the spectrum display appear thicker, as shown here. A thicker graph may be easier to see but it also is a bit less precise than the default thin graph. The thick option does not apply to the "**wide**" spectrum zoom setting.

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 of the two displays 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.

Command Buttons (main tuning screen)
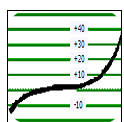
This button switches to the view of the **tuning curve** and the **deviation curve**. The tuning curve shows a graph of the stretch offset for all notes, and the deviation curve analyzes selected intervals for the bass and treble. On this page you can adjust the tuning curve to achieve an appropriate amount of stretch tuning for the particular piano. See "Adjusting the Tuning Curve" in chapter 2 for more information on the tuning curve.

This button starts a measurement of inharmonicity, which is needed when you create a new tuning. After pressing this button, play the selected note and hold it for up to six seconds. You should have all but one string muted so that TuneLab hears a single string. You need to measure at least four and preferably five or six notes in order to establish the inharmonicity pattern for the particular piano. After the measurements are made, you can adjust the tuning curve to match them.

This button turns on **locking mode**. In this mode, TuneLab listens to the sound from the microphone and tries to adjust the offset to match it. You can see the offset changing and you can see the phase display and the spectrum display indicating an in-tune condition. This is used for matching an offset to an existing tuning to measure an existing tuning or to establish a non-standard offset for a tuning. Be sure to turn off locking mode promptly when the sound stops, because otherwise TuneLab will continue to try to lock to noise, resulting in a random offset. The offset produced by locking mode can be reset to zero by touching the phase display with two fingers.
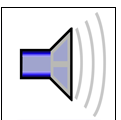
This button switches to sound-generating mode. In this mode TuneLab generates a tone in the speaker or headphones, rather than listening to the microphone. This is not generally used for tuning, but it can be useful for chipping after restringing a piano.

This is the **Settings** button, and it switches to a list of various settings and configuration actions, such as loading and saving tuning files, doing a calibration, configuring the spectrum display, and controlling auto note switching. Touching **and holding** the **Settings** button will take you directly to the particular Settings page you visited most recently.
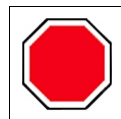
This image appears in place of a command button when a mode has been entered that needs to be able to end. This button will stop inharmonicity measurements, locking mode, sound-generation mode, calibration, and over-pull mode.

Loading and Saving Tuning Files

The picture of the main tuning screen shows a "Files" button, , in the upper left corner. This button presents a menu of functions relating to tuning files, which are described later in Chapter 8:

- **Load tuning file** – offers a list of previously saved tuning files that can be loaded.

- **Save current tuning as...** – saves the current tuning under a name that you specify.

- **New tuning** – prepares TuneLab for creating a news custom tuning by clearing inharmonicity measurements and any other tuning file data left over from the previous tuning.

- **Notations on current tuning** – presents a screen where you can enter text that is stored in the tuning file and may be viewed whenever that tuning file is loaded.

- **Dropbox Operations** – lets you upload and download your tuning files to and from cloud storage in Dropbox.

Selecting Notes
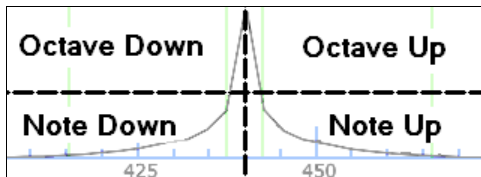
You can change the selected note one note at a time or one octave at a time by tapping on one of the four quadrants of the spectrum display.   The two upper quadrants change the octave and the two lower quadrants change the note. The picture on the left shows how the spectrum display is divided into quadrants.
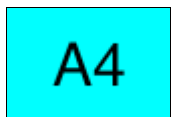
To directly select any note, first tap on the current note display as shown here on the left. That will bring up a note selection page as shown on the right. On this page you first select the octave by tapping on one of the buttons labeled "0" to "8", and then tapping on the desired note on the piano keyboard. Tap "Tuning" to return to the main tuning page, with the selections as they are shown.
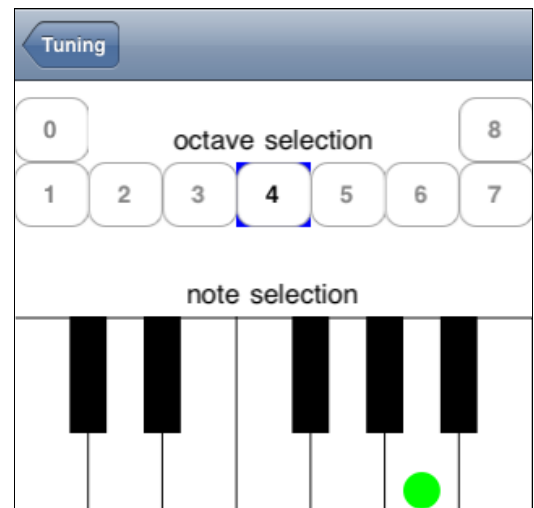
Note Selection Terminology

In this manual we refer to notes on the piano by note name and octave number. For example, A4 is the A above middle C. Each numbered octave runs from C up to the next higher B. So the lowest complete octave on a standard piano is octave 1, and it includes C1...B1. The notes below that are A0, A#0, and B0. The highest note on the piano is C8. Notes that are sharps or flats will always be designated as sharps. So, for example, we write A#4, not B♭4.

Automatic Note Switching

Selecting each note manually takes time and effort that can be avoided. By using automatic note switching, TuneLab will switch to the next note when it hears you play it. You can configure automatic note switching for "**Auto up**", "**Auto-down**", "**Auto-both**", and "**Auto-all**." "Auto-all" will switch from any note to any other note. The other modes are limited to notes within 300 cents of the current note. If you are tuning from low notes to high notes, then it may be an advantage to use "**Auto up**" note switching so that TuneLab will not follow you down the scale as you play notes you have already tuned for test purposes.
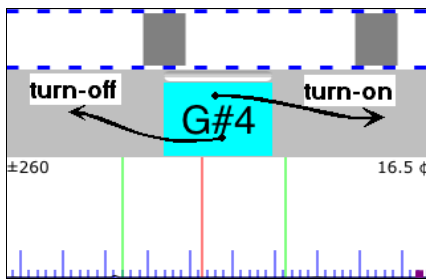

Automatic note switching can be turned on or off by swiping from the current note box to the space to the left (to turn it off) or to the right (to turn it on), as shown here. Start by touching your finger to the current note display (G#4 in this case) and then sliding it left or right to quickly turn off or turn on automatic note switching. To cycle through all four modes, do the turn-on swiping motion again after it is already on. Auto note switching can also be configured from the **Settings** page.

Tuning Curve

As described in Chapters 2 and 3, the procedure for generating a custom tuning for a particular piano involves measuring inharmonicity for a few notes. These measurements along with various settings determine the tuning. The default is for the tuning curve to be calculated automatically using **3-part tuning** (described later). But you can also use one of the classic adjusting modes – Manual, Automatic (using older 2-part tuning), and Semi-Automatic. The page shown to the right is where you can examine the tuning curve and change the settings or adjustments if you wish. It is actually composed of two graphs. The upper graph is the tuning curve itself. It gives the stretch offset for each note from A0 to C8 in cents. A typical piano tuning might be at -10 cents for A0 and +30 cents for C8.

Normally the tuning curve shows the offsets for the selected partials used in tuning. But you can double-tap the Zoom button to switch to a display of the offsets for "all fundamentals". This will show a smoother looking graph without the jumps where the selected partial changes.

The lower graph is called the deviation curve. It shows how the current tuning and the measured inharmonicity affect the two selected intervals shown in the button on the right. The button shown here specifies the 4:1 double octave for the treble and the 6:3 single octave for the bass.
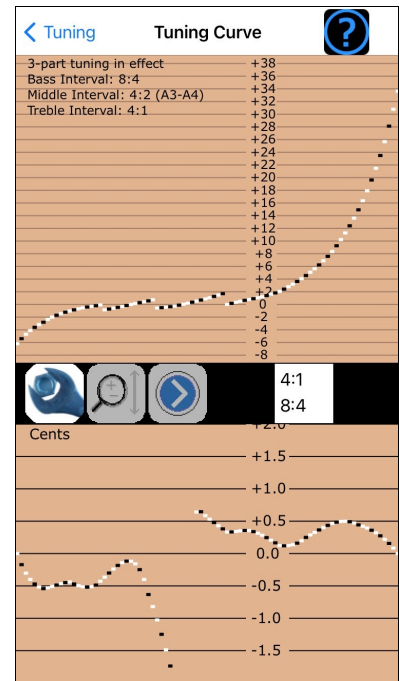
Both the tuning curve and the deviation curve can be zoomed and panned as needed.

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 for the current note. The selection of partials comes from a table of partials. This table may be modified from the screen shown here. The table shows the partial number for each note from A0 to B6. (C7 through C8 are assumed to be using the fundamental.) You can select any entry in the table by tapping on it. If the desired note is not visible, then you can scroll the table up or down. The selected entry is indicated by the green highlight. Once you have selected the entry you wish to modify, tap on the "**+**" or "**-**" buttons to raise or lower the highlighted partial number. Once a particular partial has been set to the desired value, you may want to use that same partial in some following notes. Tap the "**dup**" button to duplicate the partial value into the next note. 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. It is possible to customize the table of partials for each piano that you tune. Whenever you begin a new tuning, the table of partials is initialized to the default table of partials. If you want to make a change to the default table of partials that will apply to all new tuning files that you create, then you can tap on the "**store as default**" button to make that table the default.

Partials can also be changed for the current note while tuning by dragging your finger horizontally across the spectrum display on the main tuning page. Swipe from the left to the right to go to the next higher partial. Swipe from the right side to the left to go to the next lower partial. 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 Partials** under the **Settings**, in which case changes made on-the-fly are immediately incorporated into the current tuning file.

Inharmonicity

Inharmonicity is a measure of the relationship between the partials of a given string, and it is the key factor in determining the appropriate stretch for a custom tuning. 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 don't need to be concerned with the actual values of the inharmonicity constants that you measure; but you can see and selectively delete them using the screen shown on the right, which you can find in **Settings**. To delete a singe entry, just swipe horizontally through that entry. That will display a **Delete** button, as shown here for the A2 reading. There is also an overall **Delete** button at the top of the page. That button will delete **all** inharmonicity readings.

The following graph shows inharmonicity readings of a typical piano (A Kawai 6'8" grand).
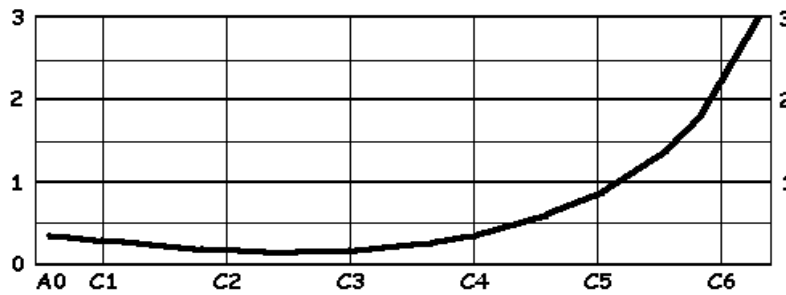
Typical Inharmonicity Values for a 6' 8" Kawai Grand

In a well-scaled piano you can expect to see the lowest inharmonicity constants somewhere around 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. TuneLab uses the specific inharmonicity samples that you collect to form an inharmonicity model for the entire scale. Using this model, TuneLab makes all the calculations regarding how partials relate to one another.

Over-pull Mode (see Chapter 5 for details)

When raising or lowering the overall pitch of a piano by a significant amount, you will find that the notes that you tune first will not stay where you put them 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 after you tune them. 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 ultimate desired pitch. By anticipating this drop in pitch the notes will end up closer to 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 by pre-measuring the pitch of the piano before you start tuning. This process is described in detail in the chapter on over-pull mode.

Calibration (see Chapter 6 for details)

Most modern iOS devices do not need calibration because the timing signals generated in those devices are within 0.1 cents of the ideal frequency. But if you wish to be sure TuneLab is calibrated you can use one of the several methods provided in the software to correct any small error in frequency in your hardware. **If you check TuneLab against a trusted standard and it agrees with that standard to your satisfaction, there is no need to perform a calibration.**

Without calibration, TuneLab assumes a nominal crystal oscillator frequency in your device's sound system and makes all pitch calculations from that assumption. By doing a calibration, TuneLab learns how to exactly compensate for any deviation from the ideal oscillator frequencies by comparing to a trusted pitch source. Do not use a tuning fork because your iOS device, even without calibration, is more accurate than a tuning fork. A better calibration can be achieved by using a more precise source, such NIST tones, or Internet Time Servers as described later. The result of a calibration is the determination of the actual sample rate of the sound system. If a calibration is deemed necessary it only needs to be done once when TuneLab is first installed on your

device. There are several methods provided for calibration, but the preferred method is Internet Calibration, as described in the chapter on Calibration.

Unequal (Historical) Temperaments

By default, TuneLab assumes an equal-tempered scale. If you would like to tune in some unequal temperament you can select an historical temperament to apply to your tuning. An historical temperament is defined by a list of 12 offsets - one 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. 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 historical temperaments for information on making and using temperament files.

Tuning Files

A tuning file is a file made by TuneLab on your phone. It is stored as part of the TuneLab application, and it is backed up by iTunes, just as iTunes backs up all your application data. You can organize your tuning files in folders if that makes more sense to you. Once you have saved a tuning file, that file can be loaded later to re-establish the exact same settings you used the first time. Here is what a tuning file contains:

- The inharmonicity constants for all the notes that you measured.
- The tuning curve, just the way you adjusted it.
- The name of the historical temperament (if any) and all 12 offsets from that temperament.
- The partials used for tuning and custom offset (if any) for each of the 88 notes.
- The selection of bass and treble intervals in the tuning curve editor.
- The 3-part tuning settings used for this tuning (if 3-part tuning is used)
- The main offset in effect at the time the tuning file was saved.
- Arbitrary textual notations that you can enter and view any time the tuning file is loaded.

Sound Generation

Although the most 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 pitch of the sound generated in the speaker or headphones 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 is generally used to aid in stringing operations rather than normal tuning.
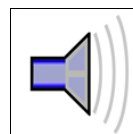
Tuning Closeness Indicator

Just above the current note display there is a progress indicator 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 |
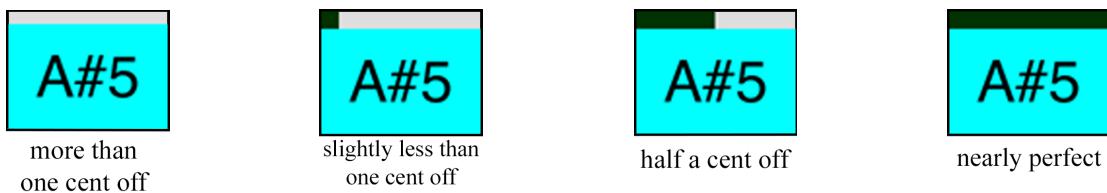
As these examples show, the progress indicator starts filling in with dark green when the tuning is within one cent of the target pitch; it fills completely when the tuning error goes to zero.

Microphone Level Indicator

To help verify that your microphone is working properly, and to help you control how loud sounds appear to TuneLab, there is a microphone level bar graph indicator at the right edge of the spectrum display as shown here. When the vertical bar reaches the top of the spectrum display, that corresponds to a mic level of 100%. If this indicator does not behave as expected, you may have a problem with your microphone. As a diagnostic feature, this bar alternates between two colors whenever a sudden rise in volume is detected by the software. This is called a "trigger." It is used to start an inharmonicity measurement or to an overpull pre-measurement.
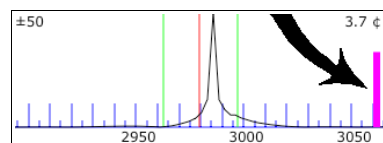
Normal Tuning Procedure

This chapter takes you step-by-step through an ordinary piano tuning (not a pitch-raise). We are assuming that you have not tuned this piano before and saved a tuning file. If you had saved a tuning file for this piano, then you could skip the initial setup and just load that tuning file now and begin tuning. Similarly, if you would like to try a simple tuning using one of the sample tuning files that came packaged with TuneLab, you can also skip this initial setup and just load the desired tuning file and start tuning, starting with "**Beginning to Tune**" below.

Initial Setup

Begin by selecting **New tuning** from the **Files** menu button on the main tuning screen. This will clear out all the tuning parameters that may have been in effect from the last piano you tuned. This includes inharmonicity measurements, tuning curve adjustments, and any custom offsets or pitch-raise pre-measurements. After selecting **New tuning** you should not see any tuning file name in the upper left of the screen.

Measuring Inharmonicity

When creating a new tuning, TuneLab needs to sample at least five notes for inharmonicity, and preferably more. You can measure whichever notes you want. For example let's assume you want to measure C1, C2, C3, C4, C5, and maybe C6. If you have an automatic measuring sequence defined, then these notes may be selected automatically when you start a new tuning. If you would like to change the automatic measuring sequence, go to **Edit Measure Sequence** in the **Settings**.

If a particular note is hard to measure accurately because of serious false beats or lack of partials, just measure some other nearby note instead. 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, first make sure the note you are about to play has been selected in TuneLab. Now that TuneLab is showing the note that you want to measure, tap on the measure button shown on the right. This will cause a yellow status box to appear:
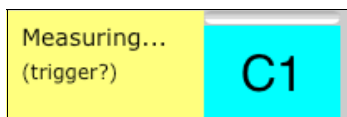
This means TuneLab is waiting for you to play C1. The sudden rise in sound level when you play the note is the trigger to begin the measurement. If you don't play the note shortly after initiating a measurement, it is quite likely that some extraneous noise may trigger the measurement period and you will get a false reading. If this happens, press the stop button (red stop sign) and start over. The stop button can also be used to cancel a measurement if you didn't really want it now. When you play the note and the trigger is recognized, the status box will change to green as shown below.
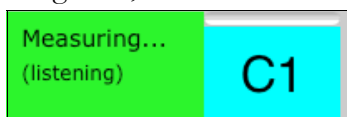
The listening period is about six seconds for low notes and progressively shorter for higher notes. If anything happens to interrupt or interfere with the note

during the listening period, cancel that measurement and try again. After the measurement is done, you will see a display like the following:

```
Tuning      IH. Results:

Partial  Offset  Amp.
   1:              0.0      For note:
   2:     0.51   100.0        C2
   3:     1.79    42.5
   4:     3.63    14.5
   5:     4.22    29.2
   6:     5.70    14.0
   7:              8.2
   8:              1.5
   9:    10.26    12.9
  10:    12.17    21.9
  11:              4.5
  12:              4.4
  13:    19.18    14.3
  14:              6.7      IH.Con =
  15:              2.0        0.170
  16:              0.6

  Save,+        Save        Discard
```

This page shows the results of the inharmonicity measurement for the note C2. Here we see that pitches were detected for partials 2, 3, 4, 5, 6, 9, 10, and 13. 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. These amplitudes are not used by TuneLab, but are presented for your interest. TuneLab analyzes the pattern of partial offsets and calculates an inharmonicity constant for the string - in this case 0.170. If things look reasonable at this point, you could tap on the **Save** button, which will save the inharmonicity constant for the note C2. Or you can select **Save,+** which will save the measurement and begin another measurement of the same note to form an average of several measurements.

This information is presented to you so you can confirm that a valid measurement has been taken. If you save an erroneous inharmonicity reading, you could throw off the accuracy of the tuning curve that you generate. The only item that is saved is the **IH.Con** (0.170 in this case). This inharmonicity constant is derived from the offsets shown.

```
Tuning      IH. Results:

Partial  Offset  Amp.
   1:              0.0      For note:
   2:     0.51   100.0        C2
   3:     1.08    49.3
   4:              9.0
   5:     3.91    23.7
   6:     5.07    12.4    Prior Avg.
   7:              4.0         =
   8:              1.9       0.170
   9:    10.10    14.5    Delete Prior
  10:    11.76    19.9
  11:              1.4
  12:              6.5
  13:    18.39    12.5
  14:              3.8      IH.Con =
  15:              1.6        0.169
  16:              0.5

  Save,+        Save        Discard
```

If you take several measurements of the same note, then you will see a results page like the one on the left. Here we see that the average of the prior readings is 0.170, and that the current reading is 0.169, which will be combined with the average thus far if you choose to **Save** it. If you decide that the current reading is the only one that you want to keep and you want to delete all prior readings for this note, tap on the **Delete Prior** button.

```
Tuning      IH. Results:

Partial  Offset  Amp.
   1:     0.00   100.0      For note:
   2:     1.72    47.5        C5
   3:     5.27    23.3
   4:    10.36     7.4
   5:              2.8
   6:              2.3
   7:              1.7
   8:              0.7
   9:              0.3
  10:              0.0
  11:              0.0
  12:              0.0
  13:              0.0
  14:              0.0      IH.Con =
  15:              0.0        0.798
  16:              0.0

  Save,+        Save        Discard
```

An example of inharmonicity results for a higher note is shown above and to the right. The higher notes have fewer partials that can be measured. Here we see four partials that produce an inharmonicity constant of 0.798. On some pianos the higher notes may not yield an inharmonicity constant at all. TuneLab needs the offset of at least two partials to calculate the inharmonicity. Sometimes higher notes with poor voicing have such weak partials, you don't get the needed two partials to measure inharmonicity. In that case you can either try a different note.

The measurement results screen shows a lot of data, but the most important measurement is the inharmonicity constant. The graph in Chapter 1 shows the typical pattern of inharmonicity constants from a Kawai 6'8" grand. Other pianos may have more or less inharmonicity, but the pattern should be approximately the same. Knowing the typical inharmonicity pattern will help to recognize and discard obviously bad readings.

After you tap on **Save** to save the inharmonicity measurement, and if an automatic measure sequence is defined, TuneLab will automatically switch to the next note in that sequence. You still will have to start the measurement by tapping on the measure button, but at least the note will be selected automatically. See **Edit Measure Sequence** in the **Settings** to select which notes you would like to measured for inharmonicity whenever a new tuning is started.

How the Stretch is Calculated

Now that the inharmonicity readings have been taken for several notes, TuneLab forms a model for the inharmonicity of all the notes of the scale - not just the notes that you measured. Using that model, TuneLab can predict how various intervals will sound. Using that model, the tuning curve will be adjusted to match the inharmonicity. There are two options for this calculation: the ***classic method*** and ***three-part tuning***, which was introduced in 2019 and is the recommended method and the default.

The ***classic*** calculation is based on the selection of a beatless interval for the low bass another interval for the high treble. The stretch for all notes in between is a gradual blend between these two extremes, using a four-parameter model for the tuning curve. ***Three-part tuning*** is based on three intervals (bass, middle, and treble) instead of two, and is based on a note-by-note calculation instead of a four-parameter model. See the next chapter for more information on how the tuning curve is calculated, and how to change the default settings.

Saving the Tuning File

After all inharmonicity measurements have been made, if you want to save this tuning file for later recall, now would be a good time to do so, although saving the tuning file is not necessary for tuning. Save the tuning file by using the **Save tuning as..** item in the **Files** menu. Assign a name to the file that 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 make and model, you may decide to keep only one tuning file that you use for all pianos of that same make and 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; for all but the most critical uses, a generic tuning may be acceptable.

Beginning to Tune - the Tuning Sequence

Now that you have a custom tuning for this piano and perhaps have saved the tuning file you can turn your attention to actually doing the tuning. Because aural tuning always starts by setting a temperament, an aural tuning sequences starts in the middle of the scale and works downwards and upwards from there. When using a calculated TuneLab tuning, you need not conform to this tuning sequence. You can tune notes in any order that you want. The most common sequence when tuning with an electronic tuning device is to start with A0 and go up from there.

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 mistuned. When in doubt, use aural methods to verify that the note is at least grossly at the correct pitch before trusting the spectrum display or the phase display. One way to confirm that you are tuning to the correct partial is temporarily to select a different partial. If several partials appear approximately in tune in the spectrum display, you probably have the partials identified correctly. 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 change to a different partial by swiping horizontally

through the spectrum display as shown here. Swipe from the left side to the right side to go to the next higher partial. Swipe from the right side to the left side to go to the next lower partial. If you have enabled auto partial selection in **Settings**, TuneLab will search for a stronger partial as you tune and switch partials automatically if one is found.
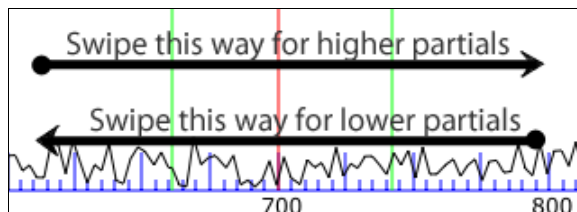
We recommend that for your very first tuning with TuneLab you leave auto note switching disabled. That way you will not be confused by unintentional note switches. Later on, you can enable auto note switching to speed up your tuning. For now you can manually switch notes by tapping a quadrant in the spectrum display as described in Chapter 1.

Using your Mutes - Tuning Unisons

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. 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 any electronic aid.

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.

Tuning the High Treble

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 direct your attention to the spectrum display. The resolution of the spectrum display is in term of cycles per second, not in terms of cents. Therefore the cents-wise resolution of the spectrum display gets better the higher you go in frequency. You can see this by noting the coarse 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. But if the Phase Display is not too disturbed by false beats then it is always preferable to use that.

Using Auto Note Switching

You can use auto note switching to make tuning easier. The quickest way to enable this feature is to swipe from the current note display ("A4" or whatever) to the right. You will also find auto note switching listed in Settings. There are four modes of auto note switching: auto up, auto down, auto both, and auto all. They work like this:

- **Auto up** will switch to a note that is higher than the current note by 1, 2, or 3 semitones (300 cents).
- **Auto down** will switch to a note that is lower than the current note by 1, 2, or 3 semitones (300 cents).
- **Auto both** will switch to a note that is 1, 2, or 3 semitones away from the current note in either direction.
- **Auto all** will switch from any note to any other 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 play the correct note again, or switch back to the correct note manually.

The Tuning Curve

The tuning curve is the source of the "***TCurve***" offsets that appear on the main tuning screen. The tuning curve determines how much stretch there is in various parts of the scale. It is advisable (though not absolutely necessary) to take a look at it when making a new tuning just to confirm that the stretch looks reasonable. Also, you will need to visit the tuning curve screen to select which calculation method is used adjust the stretch, as described later in this chapter.

If the tuning curve is configured for automatic calculation the tuning curve will be determined automatically after every inharmonicity measurement using the settings 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.

Three-part Tuning

The recommended default calculation method for the tuning curve is called "three-part tuning". You can turn three-part tuning on or off by tapping the adjustment wrench button on the tuning curve. (In certain cases you may need to tap it twice.) In three-part tuning, you can specify the type of intervals used at the bass, middle, and treble portions the scale as well as the exact location of the middle interval using the screen shown on the right. The tuning is calculated so that the very lowest bass interval is beatless, the very highest treble interval is beatless, and the interval specified by the remaining drop-down boxes is beatless, all using the partials specified in the interval selection. The tuning for the rest of the scale is designed to blend gradually from one criterion to the other. Furthermore, the tuning is calculated on a note-by-note basis, rather than by adjusting just four parameters, as in the classic stretch calculation (described later), which is still available for those who want it. Although classic tuning calculations have a manual adjustment option, the three-part tuning does not. The only adjustments you can make are those shown in the three-part tuning screen above.
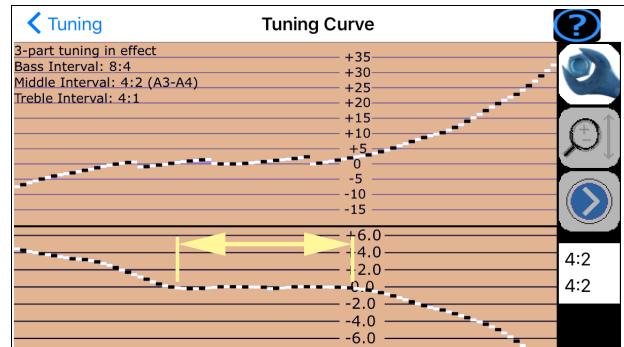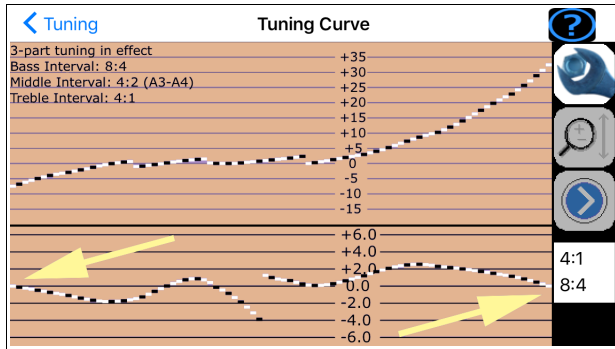

‹ Tuning Curve

| 3-part tuning setup	
Bass	8:4 octaves
Middle	4:2 octaves
Middle at:	A3-A4
Treble	4:1 dbl octaves
Make Default	Done

Note that the bass and treble selections in three-part tuning are separate and independent from the bass and treble settings in classic tuning curve calculations. However these bass and treble intervals are still useful in viewing the deviation curve (described later in this chapter) because the intervals displayed in the deviation curve are the ones selected for the classic tuning curve calculation, regardless of which intervals are specified in the three-part tuning. In the pictures below we see that when three-part tuning is in effect, the tuning curve is displayed with a bluish purple background and there is some text in the upper left describing the three-part tuning parameters. It also shows the bass and treble intervals for the classic tuning curve calculations, which in this case serve only to control what the deviation curve displays.

In the picture on the left where the bass and treble intervals shown in the classic intervals button have been set to the same bass and treble intervals as the three-part tuning, we see how the bass and treble intervals are beatless at the extreme ends of the scale. In the picture on the right both of the classic intervals selections have been set to 4:2 (which is the interval specified as the middle interval in three-part tuning). The deviation curve on the right shows that the 4:2 interval is beatless for a large portion of the middle of the scale.
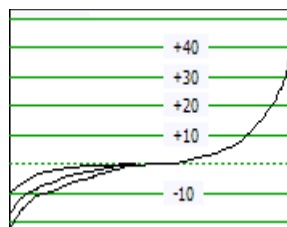

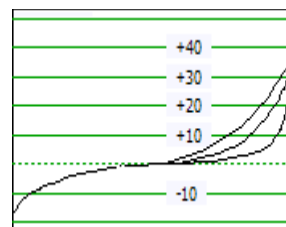## Tuning Curve Variations (Classic tuning curves only, not in 3-part tuning)

If three-part tuning is turned off the tuning is calculated in the "classic" manner automatically through four parameters, as illustrated here. These parameters can also be adjusted manually, but manual adjustment is not recommended.
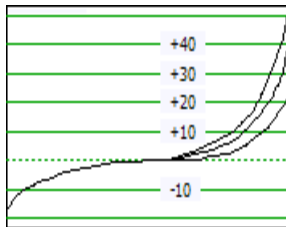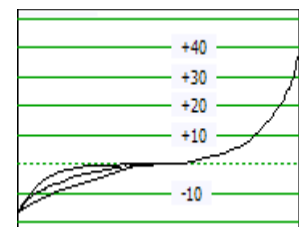

**over-all treble stretch**   **over-all bass stretch**   **treble shape**   **bass shape**

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 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 classic tuning curve generated by TuneLab is some combination of these four kinds of variations. And in manual adjustment mode, you can adjust these same four parameters. Here is what the top part of the tuning curve adjustment screens look like in each adjustment mode:

FULLY AUTOMATIC   SEMI-AUTOMATIC   MANUAL
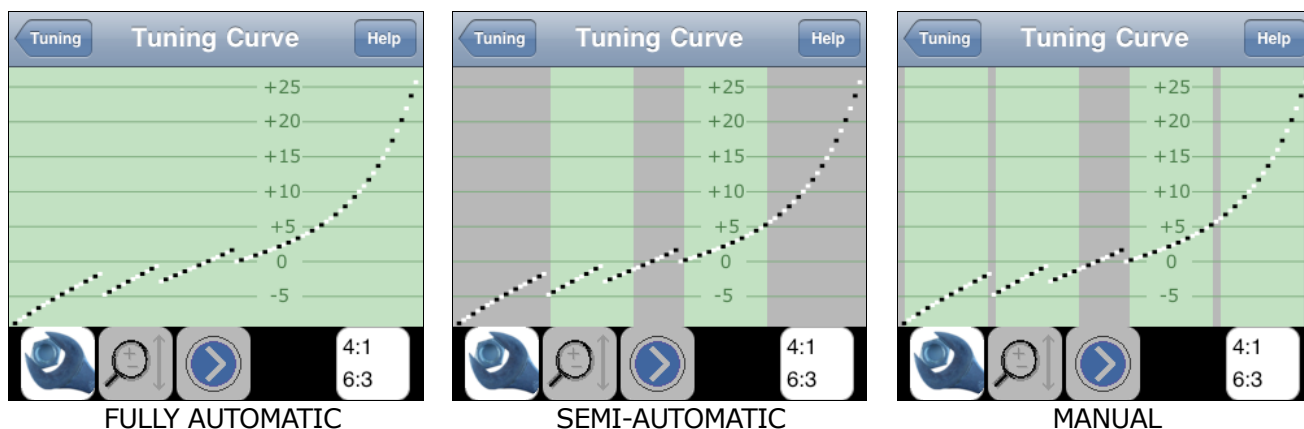
In the manual mode on the far right there are four green bands in the background. Swiping your finger up or down in those bands will adjust one of the four aspects of the tuning curve. The left-most and right-most bands adjust the overall stretch in the bass and the treble. The middle two bands adjust 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 by swiping 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) read zero at A0 and C8.

The fully automatic mode shows a solid green background. In this mode, just one tap 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 double-tapping the adjustment button shown on the right.

Note: *The tuning curve adjustment mode is automatically set to the fully automatic mode whenever you measure inharmonicity.*

Tuning Curve Display: Whether you use three-part tuning or the classic calculation method, the tuning curve displays the stretch for each note, based on the partial selected for that note. Because the partial selection for each note affect the stretch for that note, the tuning curve appears discontinuous at the points where the partial changes. This is necessary because of inharmonicity and does not represent any discontinuity in the actual tuning. Any custom offsets you may have defined will show up as red marks in the tuning curve graph, as shown here.
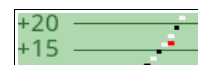
Deviation Curve
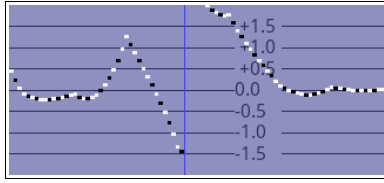
The deviation curve may be safely ignored most of the time. Its purpose is to display how much the intervals specified in the interval selection button (show here) deviate from being perfect (beatless). The curve is divided in the middle by a vertical line. The portion of the graph to the left of that line represents the base interval and the portion to the right represents the treble interval. The two intervals are specified by tapping on that button. When the deviation curve goes above zero, the interval is wide. When it goes below zero it is narrow. This particular display indicates that the treble interval is the 4:1 double octave, and the bass interval is the 6:3 single 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 to beats, swipe the deviation curve with a "Z-shaped" gesture, as shown here. Starting on the left side, drag your finger to the right, then to the left, then back to right and lift it off. This will switch the deviation to displaying beats instead of cents. It can also be used to switch back to cents. When beats are being displayed, the background of the deviation curve switches from the light blue shown here to a reddish color.
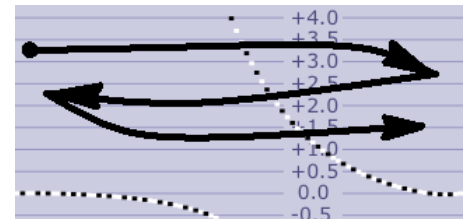
Common selections for bass and treble intervals will generally give these results:

● 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
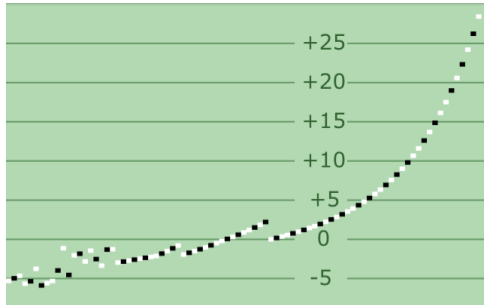
Mode Buttons

These buttons appear between the tuning curve and the deviation curve. The first button makes it possible to adjust the tuning curve setup parameter, such as manual, semi-automatic, and fully automatic, and 3-part adjustment mode.

The second button lets you pan the tuning curve graph up and down. It also enables a two-fingered pinch zoom on that graph. (Such zooming and panning is always enabled on the deviation curve.) Double-tap this button if you want to switch from displaying offsets for the selected tuning partials to displaying offsets for "all fundamentals". This will make the graph look smoother without the jumps where the selected partial changes, but it does not affect the tuning. The third button shows the details on individual notes in the tuning curve. After tapping on this button, you will see details about a single note. In this mode, you can touch anywhere in the tuning curve to select which note's details are reported. The fourth button lets you select different intervals for the bass and the treble, as described earlier.
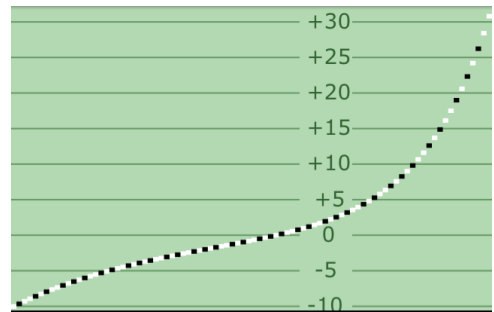
Displaying the Tuning Curve for all Fundamentals

As was noted earlier, the tuning curve is drawn for the partials that are used in tuning. This accurately reflects the **TCurve** stretch values that are shown on the main tuning page. But sometimes it is more useful to look at the tuning curve as it would be drawn if every note were tuned using the fundamental. For example, the picture on the left shows the tuning curve as it normally appears. In this case many of the normal partials for the notes in the low bass have been modified from the default values. Also the jumps at F3 and at A4 are where the default partial changes from the 4th to the 2nd and from the 2nd to the fundamental. In contrast to that graph, the picture on the right shows the tuning curve as it would be drawn if all notes were set to use the fundamental. Note that the the jumble in the low bass is gone as are the jumps at F3 and at A4. Switching the graph to display in this manner does not affect the tuning at all. The tuning will still use whatever partials you have selected for it. The main use for this display is in doing manual adjustments of the tuning curve to match custom offsets that would appear as red marks on the graph. Having all notes expressed in terms of the same partial makes it much easier to compare custom stretch marks with neighboring notes.

To enable the display of the tuning curve for all fundamentals, double-tap the zoom mode button shown here.

All About Offsets

TuneLab uses several kinds of offsets. The offsets are specified in terms of cents. The offsets in effect are all displayed on the right side of the Current Settings box, as shown here. TuneLab combines them to calculate the desired pitch for each note. In normal tuning, only the tuning curve offset (**TCurve**) is used and the other offsets are all zero and therefore are not shown.

|	
Offset	0.60¢
Cust	-4.00¢
TCurve	40.13¢
Temper	5.90¢
Manual note	

Main Offset

This offset is shown in the upper right corner on the main tuning page. When this offset is left at zero, A4 will be 440 Hz. If you want to tune to a non-standard reference (like A-442 or A-435), you can adjust the offset until you get the pitch that you want. You can change the offset by swiping your finger across the phase display. Swiping to the right increases the offset. Swiping to the left decreases it. The first time you adjust the offset you will get a message asking you to confirm that you want to adjust the offset. This is to prevent an accidental offset if you happen to brush the phase display. The phase display turns yellow to remind you that adjustment is enabled. Touch the phase display with two fingers at once to quickly reset the offset back to zero. The main offset can also be modified by **locking mode**, as described on the next page.

Custom Offset

This is a rarely-used optional note-by-note offset and it is stored in the tuning file. It is sometimes used to record an existing tuning that was done aurally, specifically in the PTG Tuning Exam. It can be used to make note-by-note corrections to the tuning curve. But if you find yourself making such corrections, then you should consider readjusting the whole tuning curve instead. This offset is not displayed if it is zero, and when present, it appears after the word "**Cust**".

You can transfer all or part of the main offset to the custom offset for the current note by tapping on the display of the main offset and using the menu shown here. You can also get this menu by swiping up and to the right from the current note display, as shown. To use a floating pitch, first set the offset to the floating pitch and then save it using the last menu item. After that, the "transfer" option will transfer only the excess above that floating pitch. You can also review, edit, or delete all the custom offsets at once by going to the **Custom offsets** item in **Settings.** For use in the PTG Tuning Exam, see the chapter on the Tuning Exam for a faster way to transfer the main offset into the custom offset for capturing an aural tuning.
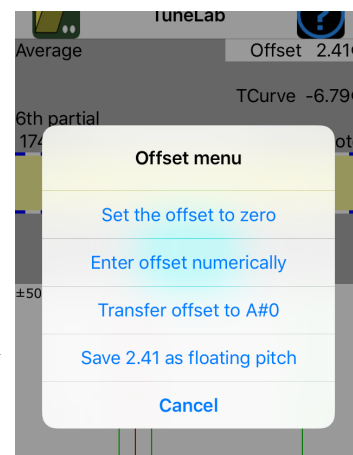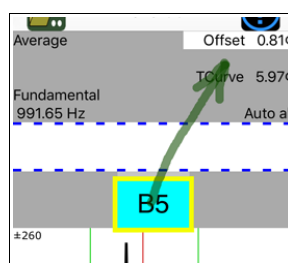
One possible purpose of custom offsets is to establish an aural tuning at several notes by locking on to each note that was tuned aurally, and then transferring the offset to the custom offset for that note. These

custom offsets will show up as red marks in the tuning curve display. There you can make adjustments to the tuning curve to make it agree with the aural tuning at the specified notes.

Tuning Curve Offset

This offset comes from the tuning curve for the current tuning. It is calculated based on the adjustment of the whole tuning curve, taking into account the selected note, the partial that is selected for that note, and the inharmonicity. The only way it can be adjusted is to adjust the tuning curve as a whole. The tuning curve offset is displayed after the word "**Tcurve**".

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 tapping on the lock button, shown here. Then TuneLab will show a status box on the left side of the page saying "**Locking**". When you are in locking mode, TuneLab listens to the sound in the microphone and tries to lock to it by automatically adjusting the offset. This function may be used to determine a non-standard reference to match an existing tuning. Make sure to turn off locking mode promptly when the sound is no longer available, or else TuneLab will continue trying to lock to random noise.

Storing Main Offset in Tuning Files

When a tuning file is saved while a non-zero main offset is in effect, this offset will be stored in the tuning file. But the stored offset will not be restored automatically when that same tuning file is loaded later. Instead you will see the following prompt when you load that tuning file:

> The selected tuning file was stored with an offset.
> Do you want to use that stored offset?

If you respond with "Yes", then the stored offset will be loaded. If you respond with "No", then the offset will not be loaded and the tuning will be based on the standard of A4 = 440 Hz.

Over-pull (Pitch Raise) Tuning Procedure

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 other notes. Over-pull tuning mode compensates for this change by setting the pitch target a calculated amount beyond the desired pitch. In this way the settling that occurs as later notes are tuned 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. 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 the Chapter 2, you would have to measure the inharmonicity and adjust the tuning curve 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

If your evaluation of the piano convinces you that the overall pitch change is large enough to need an over-pull, then 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.

Pre-measuring for Over-pull Mode

If an appropriate tuning file is already loaded, then go to **Settings** and select **Over-pull**. It is important to have some tuning file loaded when the pre-measurements are taken, because the pre-measurements are going to be interpreted with respect to whichever tuning file is currently loaded. If you had started a new tuning but had not taken any inharmonicity measurements yet, the tuning would be a no-stretch tuning and the pre-measurements would not accurately reflect how flat the piano was from what it should be.

On the over-pull page, tap on **Begin pre-measurements**. This will switch back to the main tuning page with two yellow status boxes showing. The right status box shows which note you should play, and how flat each note was as it is measured. Make sure to play each note only once and make sure you stay in sync with TuneLab. It is important that you play the note that TuneLab is expecting. If you get out of sync it is easiest to just start over from the beginning because the process is so short.

Here is what the display looks like when you first start the pre-measurement. TuneLab asks you to play the selected note. After you play the selected note and TuneLab has captured its pitch, TuneLab will switch to the next note to pre-measure and show a display like the next picture. Here you see the results of playing E2 (-58.6 cents). In addition, TuneLab is now instructing you to play G2. In this example we have configured the over-pull pre-measurement to sample just the notes of a C-major arpeggio. You can also configure it to sample all white notes or every note (chromatic scale). Sampling every note 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, sampling only the C-arpeggio notes is probably sufficient. If you need to pause the pre-measuring process just do a swipe gesture from the current note display to the left, just as if you were turning off auto note switching. The display will look like the one shown on the right. In this paused mode you can select different notes to review what their pre-measurements were and to make TuneLab back up and repeat an earlier pre-measurement that you think may be faulty. When you are ready to resume pre-measuring just do a swipe gesture from the current note to the right.
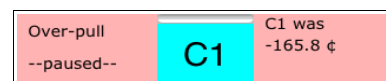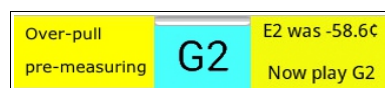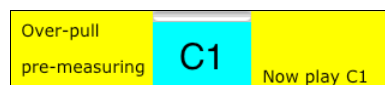
When you are done pre-measuring the piano, you can view and/or edit the pre-measurements from the over-pull settings page. When the list of pre-measurements is displayed, you can save this list permanently by e-mailing it to the address of your choice. Just tap the blue button with three white dots in the upper right and select the e-mail option.

Over-pull Tuning

After the last pre-measurement has been made, TuneLab automatically switches to tuning in over-pull mode by selecting A0. The display will look like this. The calculated over-pull offset is shown next to the current note display. In this example, the calculated over-pull would have been more than 20 cents, but it is being limited to 20 cents by the safety limits in effect. You can tell that from the color of the background. Whenever a safety limit is causing the over-pull offset to be limited, that offset will be displayed with a pink background, as shown above. If the over-pull offset is low enough to avoid the safety limit, it will appear with a white background, as shown in the next picture. 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.
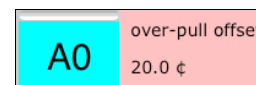
You can turn off over-pull mode by tapping on the stop button (red stop sign). To resume over-pull tuning, to to the **Over-pull** section of the **Settings** menu and tap on the **Begin over-pull** tuning button.

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 running average of pre-measurements done during tuning, as found on earlier versions of TuneLab. 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 closer its correct pitch and TuneLab will switch to it when it comes into range of the correct pitch.

Over-pull Options

There are several settings that you can change which affect how over-pull operates. These options are changed from the **Over-pull** page in **Settings**, as shown here. Tap the **Start** button to start the pre-measuring process from the beginning, discarding any pre-measurements that have already been made. Tap on **Resume** to continue continue pre-measuring after an interruption, keeping any existing pre-measurements. Tap on **Begin over-pull tuning** to switches to over-pull tuning mode using whatever pre-measurement have been made thus far. Tapping on the "**?**" buttons explains the action of the nearby buttons, and tapping on any **'>'** button lets to modify the parameters on that line.

The first option specifies the pre-measure note pattern for the notes you will pre-measure. The choices are

1. every note (A0-C8)
2. every white note
3. Notes C-E-G-C-E-G, etc. from C1 to C8.

Tap on the **'>'** button next to the current pattern to change it. Whatever pattern you select, TuneLab will sequence through those notes during the pre-measuring process. The default pattern is C-E-G-C-E-G, etc. This pattern is normally adequate for typical pitch-raises.

The location of the breaks between the bass bridge and the treble bridge, and between the wound strings and the plain strings is the next option. The example here shows the bass bridge going up to A#2 and the wound strings also going up to A#2. Tap on the **'>'** button next to these options to change either of these breaks. TuneLab uses this information in the calculation of the over-pull offset, as well as to qualify the safety limits described below.

The location of the treble struts is optional. If they are specified, the over-pull calculations will take them into account and reduce the coupling between strings on opposite sides of those struts, to represent the added plate stiffness these struts provide. Without this compensation, the notes just before the treble break tend to end up too sharp because the strut stiffness prevents the pitch from falling back down as it normally would when subsequent strings are tuned.
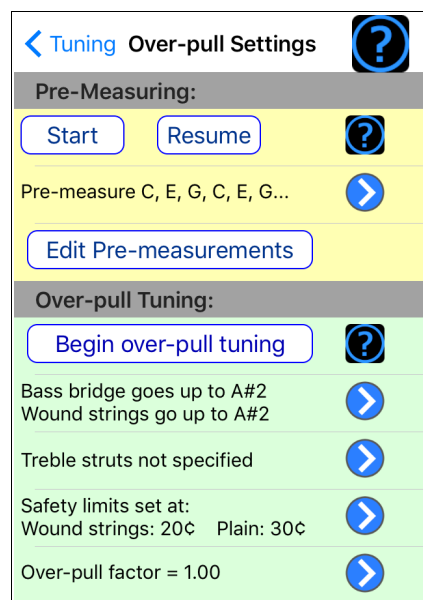
The next options are the safety limits. There are separate safety limits for wound and for plain strings, because wound strings tend to be more sensitive to over-tensioning, and more expensive to replace. The safety limit for either group of strings is the upper limit on any over-pull calculation for those strings. If the over-pull calculation gives an offset that is greater than the appropriate safety limit, the effective over-pull offset will be limited to that safety limit. In the example shown earlier where the pre-measurements were showing the piano to be about 180 cents flat, the calculated over-pull would have been about 45 cents sharp. But this is above the specified safety limit of 30 cents, so the over-pull offset was limited to 30 cents. The fact that a safety limit is limiting the effective over-pull offset is indicated by the pink background color in the box that shows the over-pull offset. When this happens, the safest thing to do is to use the limited over-pull offset and do a second over-pull pass for the whole piano, if needed.

You can set these safety limits to whatever you want by tapping on the **'>'** buttons next to them. But you take all responsibility for what may happen with higher safety limits. TuneLab is initially installed with the most conservative limits in effect. If you want more permissive limits, then you will have to change them.

The last option is the over-pull factor. It applies an adjustable factor of 0.33 to 3.00 to all over-pull calculations. The default is 1.0 for the standard TuneLab calculation.

The button labeled **Edit pre-measurements** lets you review all the pre-measurement that have been made. You will also be able to delete ones that you decide are faulty. If you delete a pre-measurement, TuneLab will simply interpolate between the neighboring entries to calculate the over-pull offset. It is not necessary to pre-measure every note. To view the table of pre-measurements from the main tuning page, it is not necessary to navigate to Settings and Over-pull. If over-pull tuning mode is currently enabled, tap on the over-pull offset to be taken directly to the table of pre-measurements.

Calibration Procedure

This chapter takes you through the process of doing a calibration. **Most iOS devices do not need calibration, so only do this if you suspect that calibration is in error.** The results of the calibration are stored permanently on your device and used every time you run TuneLab. You can check the need for a calibration by comparing TuneLab to some trusted source of pitch.
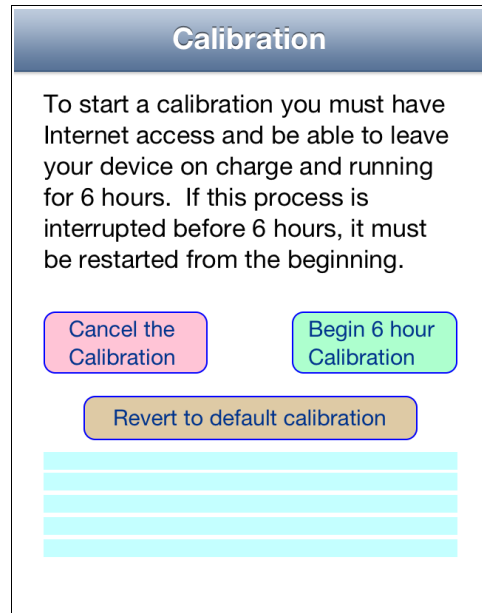
Internet Calibration

If you decide to do a calibration, the preferred method of calibration is **Internet Calibration**. This method uses Internet time servers to measure out a precise six-hour period of time. During that time, the calibration software counts audio samples from the iOS sound system. The result is a measure of the audio sample rate to an accuracy of 0.01 cents.

To perform an Internet calibration your device needs access to the Internet and six hours of uninterrupted running time. This is most conveniently done by starting a calibration just before retiring for the night. To avoid running down the battery, the device should be connected to a charger overnight while calibration is running. If a interruption (like a phone call or text message) should occur before the six hours are over, the calibration will be aborted, and you will have to start the calibration over again from the beginning.

The Internet calibration screen is show on the right. Just follow the prompts on the screen. **Revert to default calibration** erases any existing calibration, returning your device to the default calibration it had when TuneLab was first installed. The light colored bands at the bottom of the screen show diagnostic data during the process. In particular, the first four lines of diagnostic data show the Internet round-trip time for the time server queries.

Internet time servers are queried briefly once at the beginning of the six-hour calibration period and once more at the end. Internet access can be either by wi-fi or by a cellular data plan. After starting the calibration by tapping on **Begin 6 hour Calibration**, do not turn off the device, since this process cannot run in background. After the calibration is done, there will be one final prompt asking if you want to adopt the calibration that was just determined. This prompt can be left showing for as long as needed. Interruptions that occur after the final prompt is displayed will not abort the calibration, so you do not have to worry about responding immediately to that prompt. It can wait indefinitely until you are ready to respond.

Calibration

To start a calibration you must have Internet access and be able to leave your device on charge and running for 6 hours. If this process is interrupted before 6 hours, it must be restarted from the beginning.

Cancel the Calibration	Begin 6 hour Calibration

Revert to default calibration

Other ways to calibrate: A trusted source of pitch

If you don't want to use Internet calibration, you can calibrate using a trusted reference pitch. One source of trusted pitch 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.nist.gov/time-distribution/radio-station-wwv/telephone-time-day-service`

Using NIST Tones for Calibration

To use the NIST standard frequency service to do a calibration, start by selecting **Do a calibration** from the **Settings** menu. Then select **500 or 600 Hz NIST tones** as the reference source. Do not try to make the call to the NIST with your iPhone. You need to use a different phone because TuneLab cannot be running at the

same time as you are making a phone call. Position the iPhone so that its microphone is right over the speaker of the phone that is calling NIST. Follow the on-screen instructions and make sure the microphone of your iPhone is close to the telephone speaker. 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.
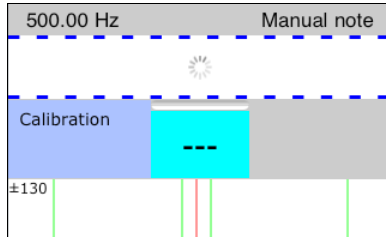
Here is what the middle of the main tuning page looks like during a calibration. It is similar to locking mode in that the offset is being adjusted automatically to lock on to the sound it hears. But unlike locking mode, there is no note displayed in the current note display, and there is an activity indicator (a spinning wheel) in the middle of the phase display. You can cancel a calibration at any time before it finishes by tapping on the stop button (red stop sign).

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), you can use it as a calibration source by entering the each 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 offsetting it by swiping through the phase display, as described in Chapter 1. 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, the frequency of that CyberFork is 439.858 Hz. Write that number down and enter it at the appropriate time when using that tone source to perform a calibration.
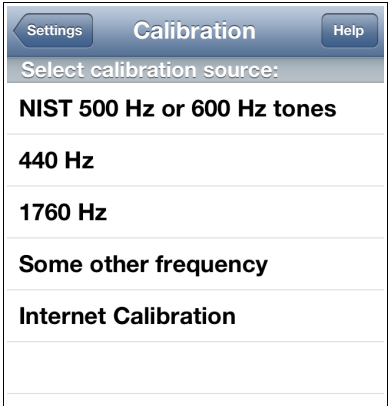
Regardless of whether you use a tone source or Internet Calibration, the resulting sample rate is displayed in the **About this version** screen in Settings.

Historical Temperaments

TuneLab normally produces an equal temperament. But historically this 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 iPhone by entering the 12 offsets, as described below.

Loading Temperament Files

To add an historical temperament to the current tuning, go to **Settings** and select **Load temperament**. This will show you the list of historical temperaments that are currently on your device. If you see one that you want to use, just tap on it. If you have an historical temperament applied and would like to remove it from the current tuning, tap on the first entry in the list of historical temperaments, which says -**Cancel temperament-**. This will return your tuning to Equal Temperament.

When an historical temperament has been added to the current tuning, then 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 **Temper xx.xx**. As you change notes, the "temper" 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 using **Make temperament** from **Settings**. All you need to know is the 12 offsets that define the temperament. After you enter the 12 offsets, you will be prompted to enter a name for the new or modified temperament. When you make a new temperament file, you can then select it into any tuning curve just like the original historical temperaments that came packaged with TuneLab. Note that creating a temperament does not automatically select that temperament into the current tuning. If you want to select your newly-created temperament into the current tuning, you have to select it explicitly yourself.

Working with Tuning Files

It is possible to use TuneLab without ever saving a tuning file. Just make a new tuning for every piano you tune. But if you tune the same piano regularly you can save time by saving the tuning file for that piano. If you save the tuning file, then the next time you tune that piano, or some piano that is very much like it, you can skip the initial setup of measuring the inharmonicity. You will be able to proceed directly to tuning. Even if it is not the same exact piano, you may want to use a tuning file from a similar make and model piano.

Loading Tuning Files
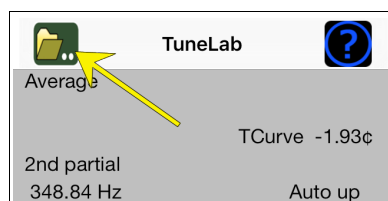
To select an existing tuning file, tap on **Load tuning file** in the Files menu from the main tuning screen. This will bring up a display like the one shown on the right. You have the option of organizing your tuning files into folders. If there are any folders in the current folder, they will appear with the light yellow background, as shown for **Baldwin**, **Samples** and **Steinway** in the example. You can navigate up and down through the file system hierarchy (if you have one) by tapping on a folder to navigate down to that folder, or tapping on the button in the upper left corner of the screen to navigate up to the parent folder. If you don't want to use folders to organize your tuning files, you can just store all your tuning files in the root folder.
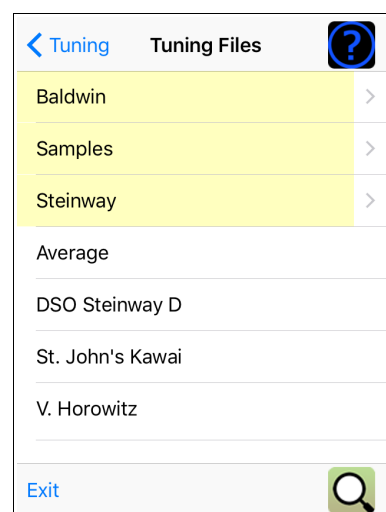
Suppose you wanted to load the tuning file "**DSO Steinway D**". Just tap on that name and the tuning file will load.

While navigating the folder hierarchy, you can delete tuning files and empty folders by swiping from right to left through the item you want to delete. If you want to delete a folder, you must delete all the files in that folder first. You can also move and rename files from this list by touching and holding the file for two seconds, as described later.
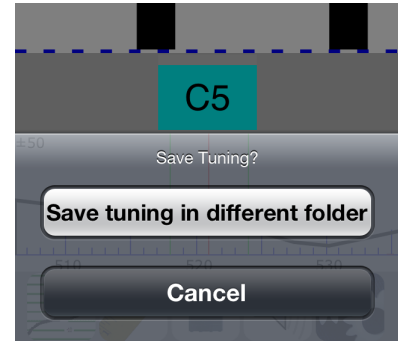
At the bottom right of the screen there is the search button that let you search for tuning files instead of having to scroll through a long list of files looking for the one you want. Tapping the search button will bring up a standard search bar as shown here. As you enter characters in the search field, the files in the current folder will be filtered to show only the ones that qualify. There are also buttons for "**Starting with..**" and "**Containing..**" If you select "Containing.." then files will qualify if the characters you enter appear anywhere in the file name. If you select "Starting with.." only files that start with the characters you enter will be shown. The selected button will also display the number of qualifying files, which is seven in the image shown here.
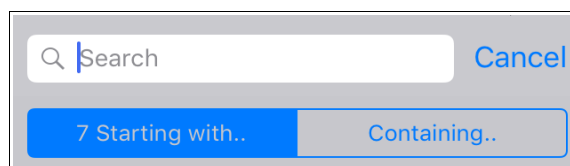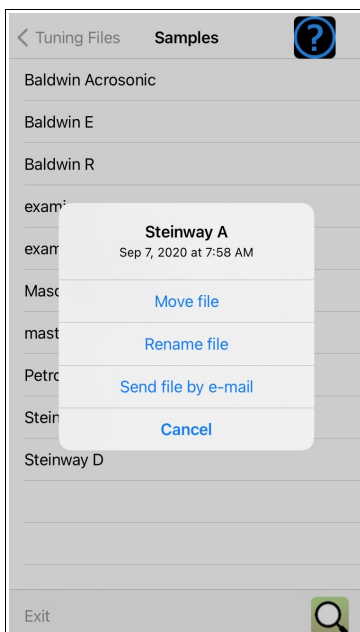
Saving Tuning Files
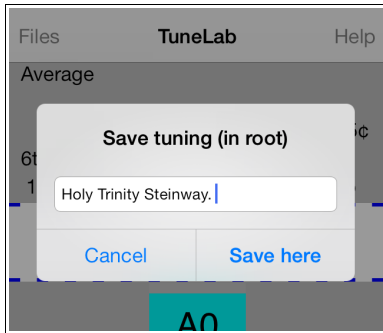
When you tap on **Save Tuning As..** in the **Files** menu, a screen like the one on the left appears. If you want to save the current tuning in the folder indicated (in this case, the root of the file system), just enter the new name of the tuning file and tap on **Save here**. If you want to save the tuning in some other folder, tap on **Cancel**. Then you will see a prompt like the one on the right. Tap on **Save tuning in different folder** and you will see a list of files and folders, similar to the one shown when loading a tuning file. As it was in the loading files case, you can navigate up and down the file system hierarchy to switch to the folder where you want to save the file. If the folder does not yet exist, you can create it by tapping on **New** in the lower right corner of the screen, and then tap on **Create new folder**. When you have navigated to the folder where you want to store the file, tap on **New**, and then **Create new file**. You will once again see a prompt similar to the one at the top of this page where you can enter the name of the file to be stored.

Moving / Renaming / E-mailing Tuning Files

If you store a tuning under a certain name and in a certain folder and later decide you really want that file to have a different name or reside in a different folder, you can make that change from the **Load tuning file** screen. Locate the file you wish to rename or move and **touch and hold on to that name for about two seconds** until a screen like the one on the left appears. From this menu you can choose to move the file to a different folder, rename the file, or send the file by e-mail to the address of your choice. This last option can be a quick way of sharing a tuning file with someone else. If you choose to move the file, a screen like the one on the right will appear where you can navigate to the folder of your choice or create a new folder, just as with the Save Tuning screen.

As with the **Save to** screen, you can create new folders by tapping on **New** in the lower right corner. When you find the folder where you want to move the selected file, tap on **New**, and then **Create new file** to move the selected file to that folder under the name you entered.
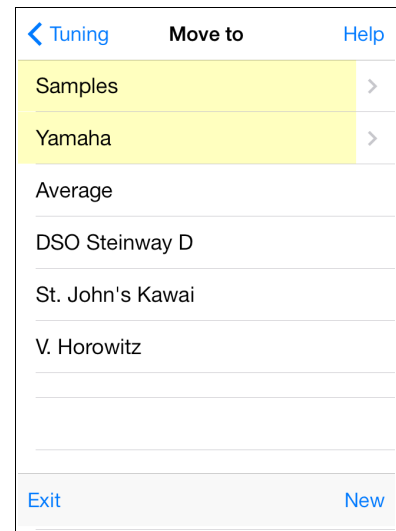
Cloud File Storage

In addition to the usual local file storage for tuning files, you also have the option to use Internet cloud file storage provided by Dropbox. To use this option you will need to register for a Dropbox account. Although there are fees for premium services from Dropbox, you only need the basic free service to manage tuning files from TuneLab. See www.dropbox.com for details on how to sign up for the free service. TuneLab does not support accessing tuning files directly from Dropbox. Files must be downloaded from Dropbox to be stored locally on your device before you can load a tuning from them. Only files stored locally on your device may be used directly in TuneLab.

After you have registered a Dropbox account, you can upload all the tuning files from your device to your Dropbox, and you can download all the tuning files from your Dropbox to your device (or some other device). This is the easiest way to switch from one iOS device to another without losing any of your tuning files.

In the **Files** menu ( ) on the main tuning screen there is an option called "**Dropbox Operations**". Selecting this item lets you login to Dropbox by entering your Dropbox ID and password. After you log in, you will have three choices: **Upload**, **Download**, or **Unlink**, using the buttons show here.
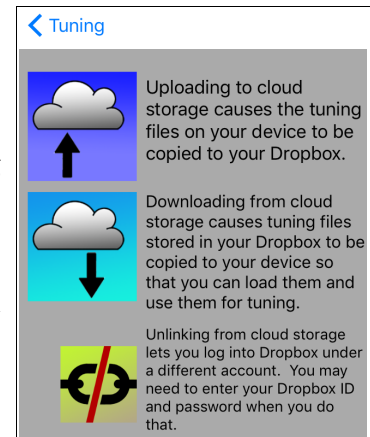
Tap on the button for **Uploading** or **Downloading** to upload or download tuning files. The button at the bottom unlinks from Dropbox. Use this to log into Dropbox under a different account.

Here is what the screen looks like after tapping on the **Download** button. The very first time you do this, the "**OK**" button will say "**Link to Dropbox**". After that it will say "**OK**" as shown here. At this point you can select between transferring all the files or just the files the have been created or modified since the last upload or download by the setting of a switch. If you only have a few files, or if this is the first time you have transferred them, then you might as well transfer them all. But if you have a large number of files, you might want to transfer only the new ones, since it can take a long time to transfer all the files, and it is unnecessary if those files have been transferred previously.
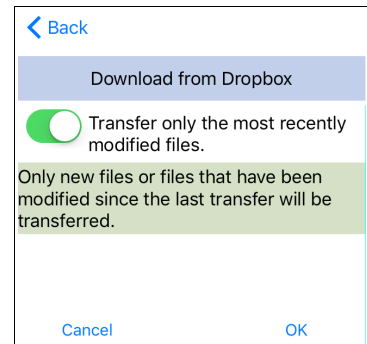
Typically, the way you would use this is to upload only the new files after you make or modify some tunings. That way all your tuning files will be backed up in Dropbox. Then if you need to change iOS devices, you can download all the tuning files onto the new device.

Tuning Exam Report Files and Dropbox

Although tuning files are the primary reason for using Dropbox with TuneLab, any Tuning Exam reports you have stored in TuneLab will also be transferred. You can also seen tuning exam report files by e-mail by **tapping and holding** on the exam report file name for about two seconds.

The PTG Tuning Exam

The Piano Technicians Guild administers a series of examinations for the Registered Piano Technician (RPT) classification. One of those examinations is the tuning exam. Certain electronic tuning devices are used to aid in the administration of several phases of this exam.

The first step in the tuning exam is the recording of a master tuning. This is normally done ahead of time by a committee of PTG-certified tuning examiners. The master tuning is determined on a specific piano, and that piano may then be used to administer the tuning exam for a number of examinees. Although an electronic tuning device may be used by the committee to establish a first pass at the master tuning, the final master tuning is normally arrived at after intensive scrutiny and aural adjustment by the members of that committee. As the tuning is finalized, the offsets for each note are recorded into what becomes known as the master tuning. This tuning is used as a standard with which to compare and grade various examinees' tunings. Sometimes the master tuning is recorded all at once after the whole tuning has been established, and sometimes the committee will record small sections of the tuning as they are developed in order to minimize the possibility of tuning shift before the notes are measured.

The second step is the preparation of the piano for the examinee. The preparation involves detuning the piano according to a pattern set by the PTG so that the examinee will not be able to benefit from the previous tuning, but at the same time will not be overly inconvenienced by having to do a pitch raise in addition to a normal tuning. The PTG-specified detuning pattern contains alternating positive (+) and negative (-) offsets that average out to zero. TuneLab Piano Tuner produces that pattern of offsets when put into the detuning mode, as described later. After the detuning has been accomplished, the examinee may now tune the piano.
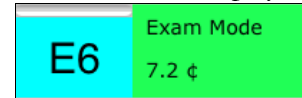
The third step is to record the examinee's tuning. This is done in the same way as the master tuning was recorded. The resulting tuning file should be saved under a name that identifies the examinee.

The fourth step is to create a grading report that compares the examinee's tuning with the master tuning. This report is used by the tuning examiners as a basis for assigning penalty points and for aural investigation of discrepancies. During these investigations the examinee is given the opportunity to demonstrate the correctness of his or her tuning through aural verification. Based on these demonstrations, the examiner may erase penalty points for some of the discrepancies to arrive at a final point score. In addition to these comparisons, there is also a separate evaluation of the examinee's ability to set the fundamental of A-440 to his or her own reference tone. This evaluation is also included in the final assessment of the examinee's performance.

Exam Capture Mode
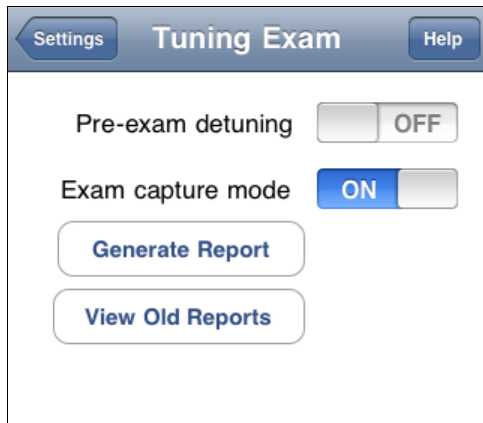
This mode of TuneLab Piano Tuner is used to record the master tuning and to record the examinee's tuning. To enter this mode, go the **Settings** and select **PTG Tuning Exam**. You will see the screen shown on the left. From this screen you can switch on the **Exam Capture Mode**. In this mode the main tuning screen will show a status box on the right side of the current note display, as shown in the box on the right. The offset in cents shown in that box is the offset that will be recorded for that note.

This offset is rounded to the nearest 0.1 cents, as specified by the PTG. Also, in the Exam Capture Mode, the partials for each note are no longer adjustable. The partials are forced into the selection specified by the PTG for the Tuning Exam.

This captured offset can be modified by adjusting the custom offset for the current note by first adjusting the main offset. The main offset can be adjusted by the same methods as described in Chapter 4 - *All About Offsets*. That includes swiping through the Phase Display for manual offset adjustment, or using Locking Mode for automatic adjustment. Whenever a non-zero main offset is showing in this mode, the background of the status box is yellow, as shown here, which indicates that an offset is pending, but not yet transferred to the custom offset for the current note. The transfer can take place using the methods described in Chapter 4, but in Exam

Capture Mode, there is an easier way. Just tap on the status box with the yellow background. That will instantly transfer the main offset to the custom offset for the current note, and at the same time turn the status box background to green, indicating that there no longer is any pending offset that needs to be captured. If Locking Mode is used to lock on to the piano tone, tapping on the status box will not only capture the offset but will also turn off Locking Mode. All this is done to streamline the process of capturing a master or examinee's tuning. After the entire tuning has been captured, save the tuning file under an appropriate name and then turn off Exam Capture Mode.
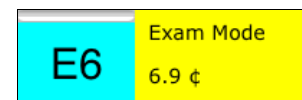
Pre-exam Detuning

Go to **Settings / PTG Tuning Exam** and turn on the switch for **Pre-exam detuning**. This will cause the status box to the right of the current note to appear as shown here. The reddish background is to warn you that detuning is in effect. It also shows the detuning offset that would be used for the current note. In order to make the detuned piano conform closely to the overall stretch of the master tuning, the master

tuning should be loaded before switching on **Pre-exam detuning**. As with Exam Capture Mode, this mode also will enforce the PTG-specified partials for each note.
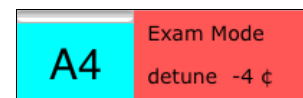
Generating a Report

After recording the examinee's tuning, you can generate the report that compares this tuning with the master tuning that was captured earlier. First load the examinee's tuning. If the examinee's tuning has just been captured and saved, it is already loaded as the current tuning. Then from the PTG Tuning Exam page, tap the button labeled **Generate Report**. The first step in generating a report is to select the temperament octave, as shown on the right. The PTG Tuning Exam specifies that the examinee's tuning will be offset before comparison with the master tuning so that the average error in the temperament octave is zero. After setting the picker to the appropriate octave, tap on the **pick master** button. This will show the tuning files in much the same way as when a tuning file is loaded. But now, instead of loading the file that you select, the selected file will just be used as the master tuning to create the report. After you select the master tuning, you will be returned to the **Report** page and now you will have the option to view the report that was just generated. You can tap on **view report** now, or you can come back to that report at a later time. The report has already been written, and it will continue to exist in your device under the name of the examinee's tuning file name. If you want to come back to view this report later, you can tap on **View Old Reports** from the **Tuning Exam** page. This will display a list of all stored reports according to the name under which they were originally stored. You can select any stored report in order to look at it again. If you want to delete old reports from your device, this also is the page where you would do that. Simply swipe horizontally through the name of the report you wish to delete and tap the **delete** button that appears.
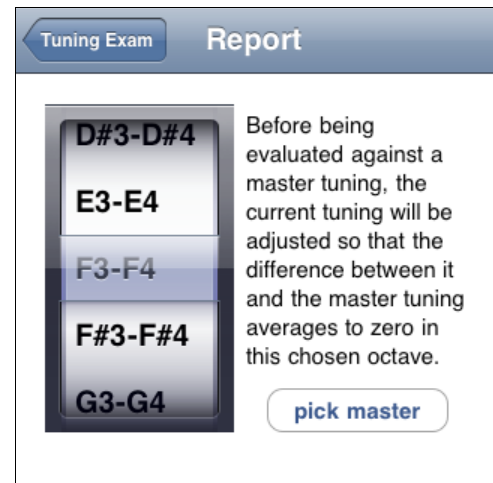
This Tuning Exam Report does not automatically take into account the evaluation of the examinee's ability to set A-440 to an absolute standard. That evaluation must be done separately and taken into account manually by the examiner. In order to measure the examinee's A-440 you must turn off any exam mode in order to be able to force the fundamental to be used for A-440, because in the exam modes, the second partial is used for that note. With exam mode turned off, you can simply lock onto the examinee's A-440 using any tuning file and no offsets. Then from the main offset you can read the examinee's error.

## Saving Exam Reports in Dropbox or Sending Reports by e-mail

When you upload tuning files to Dropbox cloud file storage, exam report files will also be uploaded. See Chapter 8 for more details on using Dropbox file storage.

You can also seen tuning exam report files by e-mail by **tapping and holding** on the exam report file name for about two seconds.

Extras

Gestures on Main Tuning Screen

- **Adjust the offset** by swiping left or right through the Phase Display. The Phase Display will turn yellow to indicate that offset adjustment is enabled. (See "*Offset Menu*" below for other options for affecting the offset.)
- **Change Notes** by tapping the left or right lower quadrants of the Spectrum Display.
- **Change Octaves** by tapping the left or right upper quadrants of the Spectrum Display.
- **Change Directly to any Note and Octave** by tapping the Current Note Display.
- **Change Partials** by swiping from left to right or right to left across the entire Spectrum Display.
- **Zoom the Spectrum Display** in or out using a two-fingered pinch gesture inside the Spectrum Display. Six zoom levels are available.
- **Zero the offset** using the ***Offset Menu*** below, or by tapping the Phase Display with two fingers at once.
- **Disable Auto Note Switching** by swiping from the Current Note Display to the left side of the screen.
- **Enable Auto Note Switching** and **Change the Type of Auto Note Switching** by swiping from the Current Note Display to the right side of the screen.
- **Go directly to the most recent Setting screen** by touching and ***holding*** the Settings button shown here.
- You can access an ***Offset Menu*** of actions in two ways. You can tap on the offset, if it is showing, or you can swipe from the Current Note display up and to the right in the general direction of the offset field, as shown here. The Offset Menu offers a choice to reset the offset to zero, transfer the offset to the custom offset for the current note only, and establish the offset as a *floating reference* (as described below) for subsequent transfers to the custom offset. (You can reset any of the the Custom Offsets to zero by using the **Custom Offsets** item in the **Settings**.)
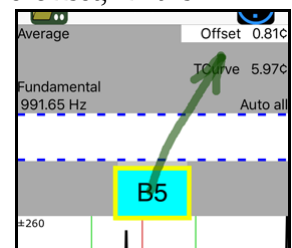
Floating Reference

The "Floating Reference" that appears in the *Offset Menu* has only one very specialized use in setting custom offsets with respect to an already-offset tuning. Here is when it might be needed:

Suppose a piano is being tuned to a non-standard pitch, like A-435. In that case you would adjust the offset for -19.78 cents, which makes A4 have a pitch of 435 Hz. Now suppose you want to make a custom offset for the note C5 that agreed with an aural tuning adjustment that you had made. You might use the locking mode to lock on to the aurally-tuned C5, or you might adjust the offset manually so TuneLab matched the note C5. At this point, if the non-standard pitch were not being used, you could use the ***Offset Menu*** to transfer the offset into the custom offset for C5. That would transfer the entire offset, whatever it was, into C5 and leave the offset at zero. But that would not work in this case, because you don't want the entire offset transferred to C5. You

only want that portion of the offset that is above and beyond the fixed -19.78 cent offset to be sent to the custom offset for C5 and the original -19.78 cents should be left in the overall offset to maintain the A-435 pitch.

You can solve this problem as follows: After adjusting the offset to -19.78 cents or whatever is needed for the non-standard pitch you desired, use the **Offset Menu** and select **"Save -19.78 as floating pitch"**. Then when you adjust the offset to something like -19.00 cents to match the aurally-tuned C5, select the **Offset Menu** again and you will see the option of **"Xfer offset from floating ref to C5"**. If you select this item in the menu, the overall offset will be returned to -19.78 and the custom offset for C5 will now be 0.78 cents, which is the difference between -19.00 and -19.78, which is what you wanted to happen.
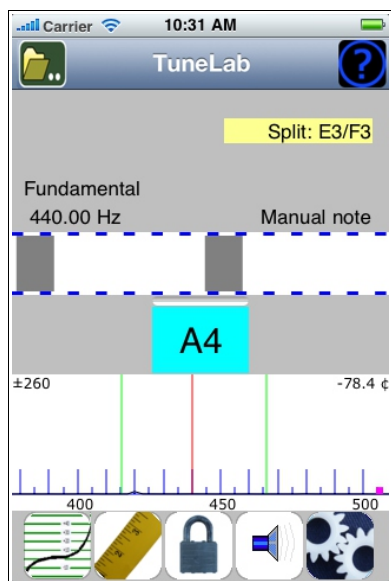
Split-Scale Tuning

<u>**This feature has been largely superceded by 3-part tuning, which does a better job at addressing the problem Split-Scale Tuning was meant to address. It is no longer recommended and is documented here for reference**</u> only. When a piano has a large jump in the inharmonicity at a break (usually between wound strings and plain strings), it may be desirable to create a custom tuning that has special provisions to accommodate that break. Split-Scale Tune was meant to address that problem.

A classic TuneLab tuning is based on a smooth stretch function that changes gradually from A0 all the way up to C8. But a Split-Scale tuning is based on a function that abruptly changes at the break. Above the break the tuning is normal, making it a blend of competing criteria. But below the break the Split-Scale tuning switches abruptly to satisfy just one criterion - the 6:3 octave. Ensuring that the 6:3 octaves are perfect may compromise some other tuning goals, such as uniformly progressive thirds and tenths.

To use Split-Scale tuning, measure inharmonicity as you normally would, either manually or with the aid of automatic measure sequencing. Then afterward measure the inharmonicity on both sides of the break. If one of those readings exceeds the other by at least 60% then TuneLab will take the presence of those two consecutive inharmonicity readings as the indication that it should use Split-Scale tuning. TuneLab looks through all your inharmonicity readings and evaluates all the "break" readings (readings from adjacent notes) according to the 60% criteria. So if you happened to have included more than one break, TuneLab will determine which is the true break by taking the one with the largest percentage change in inharmonicity. Also, TuneLab will not consider anything as a break unless it is between C2/C#2 and E4/F4. If you do establish a Split-Scale tuning and then change your mind and want a normal tuning, then use **Edit Inharmonicity Constants** from the **Settings** page and delete one of the readings at the break, or simply switch to 3-part tuning, which automatically disables Split-Scale Tuning. For example, the following set of inharmonicity readings would trigger Split-Scale tuning:

```
A0: 0.227
A1: 0.060
A2: 0.073
E3: 0.150   (just below the break)
F3: 0.090   (just above the break)
A3: 0.240
A4: 0.647
A5: 1.920
A6: 5.453
```

When a Split-Scale tuning is in effect, the main tuning page will have a display with a yellow background as shown on the left. The field where this is displayed is also shared with the rarely-used custom offset. So the Split-Scale indicator will not be seen if there happens to be a custom offset for the current note. You can also see that Split-Scale is in effect by looking at the tuning curve as shown on the right. A vertical line will be drawn through the tuning graph and the deviation graph at the break if Split-Scale is in effect.

You will also notice that the left side of the deviation graph is a flat line. That is consistent with the fact that Split-Scale produces perfect 6:3 octaves below the break at the expense of everything else.