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Aerodynamic

(2020)

For keyboard instrument and sine wave track,
or open instrumentation

Notes / instructions:

1 . If realised with a piano, the keyboard part should be played with sostenuto pedal, but solely to bind the harmonies together. It should generally be changed on every new instance of the motif / chord group, rhythmically consisting of a ¼-note succeeded by a ½-note.

In general, the phrasing of the sine wave part and the keyboard part should be as unison as possible.

2 . The keyboard can either be tuned in Pythagorean tuning, or in 12-TET. Since the 12-TET fifths differ only by 2 cents from the fifths in the Pythagorean tuning, and as the harmony of the keyboard part consists of closely related fifths, the piece can be played on a normal 12-TET piano without sounding too out of tune or cloudy. However, if a Pythagorean tuning is possible, that would be preferred.

3. The accidentals for the **melodic part** belong to the Extended Helmholtz-Ellis Pitch Notation System, created by Marc Sabat and Wolfgang von Schweinitz. More information about this system to be found here:

https://marsbat.space/pdfs/HEJI2_legend+series.pdf

A sine wave track can be provided by the composer, or one can feel free to program / create one oneself (in communication with the composer). It can also be played on a pitch sensitive synthesizer with a sine wave (or similar) sound, either by using a *pitch bender*, or by mapping the frequencies in other ways.
Note that in any case, this part will need to be intonated slightly different (see score) depending on which tuning is used for the keyboard part (12-TET or Pythagorean). Cent deviations from 12-TET for each note and each of the two tuning systems are shown over / under the staff notation.

- When no cent-deviation is shown for a new note, this means +/- 0 cents deviation from 12-TET, whereas when no cent deviation is shown for a note that is already played in the chord group preceding it, this means that the same cent deviation is still valid.
- A deviation is sometimes shown in parentheses (only appearing in the line for the 12-TET keyboard part version), differing only 2 or 4 cents from the preceding note.[1] Practically speaking, this difference is minimal, and does not necessarily need to be stressed too much, especially when the part is played by musicians and not by an electronic track. However, it can be helpful to be aware of the possibilities for these very small, idealized differences in intonation.

The melodic part can also be played by any instrument capable of producing the notes in the written range (in octave treble clef, where the notes sound an octave lower than they would do if they were written in the normal treble clef).

[1] This is because of the difference between true Pythagorean tuning and 12-TET. The 12-TET version is approximating Pythagorean harmony, and since the 12-TET fifths and fourths differ with 2 cents from their Pythagorean ideal versions, the melodic part can only be totally justly intonated to one of the notes in the chord. Mostly, the cent deviation / intonation of the notes are chosen either by tuning to the *fundamental* note of the chord, or by tuning to the one note in the chord that is adjacent to both the other chord notes in the circle of fifths, but when a note in the melodic part stays while the chords "drift", while following this principle, there will occur some changes in the intonation of the melodic part, to ensure that the relations stay as close to their just ideal versions as possible.

4. The harmonic content of the keyboard part derives from a stacking of in total 14 just fifths, i.e 14 different notes. Therefore, to realise the version with the Pythagorean tuned keyboard part without encountering a few wolf fifths, one will need two manuals of tunable keyboards. This can for instance be done with a harpsichord with two manuals, or with the performer switching to a second harpsichord for the first half of page 7, where one needs some Cb's and Fb's.

The *main manual* is to be tuned, **from C to bb"**, with the following cent deviations from 12-TET:

C	Db	D	Eb	E	F	Gb	G	Ab	A	Bb	B
- 6	- 16	- 2	- 12	+ 2	- 8	- 18	- 4	- 14	+/-0	-10	+4

The *second manual* is to be tuned similarly, but from **Ab to bb'**, and swapping the E's with Fb and B's with Cb:

C	Db	D	Eb	Fb	F	Gb	G	Ab	A	Bb	Cb
- 6	- 16	- 2	- 12	E - 22	- 8	- 18	- 4	- 14	+/-0	-10	B - 20

In this way, with a doubling of pitches between the two manuals, the performer can simply play the first half / two first lines of page 7 (or, if preferred - from the 5th chord group on on that page, where the Cb is first introduced) on the second manual, without needing to think about combining the two manuals.

Note that there will be some notes in the specified ranges that are not played, and one can feel free not to tune unused notes, but for consistency and sympathetic resonance, it might be nice to tune the entire specified ranges as described.

If one just has one manual of tuneable keys available, an option is to omit the Fb's and Cb's altogether, without substituting them with E's and B's, and hence avoiding wolf fifths, on the cost of 'thinning out' the harmony in some places.

5. The piece can very well be performed by a different instrumentation all together.
For instance it should work nicely in a quartet of strings (for instance a cello quartet):

1st voice from top: Cello, or viola (on viola, with the C-string tuned septimally lowered, - 33 cents)

2nd voice from top: Cello (spanning more or less the entire register of stopped notes on a cello from C to bb'')

3rd voice from top (higher note of the third system): Viola, or cello

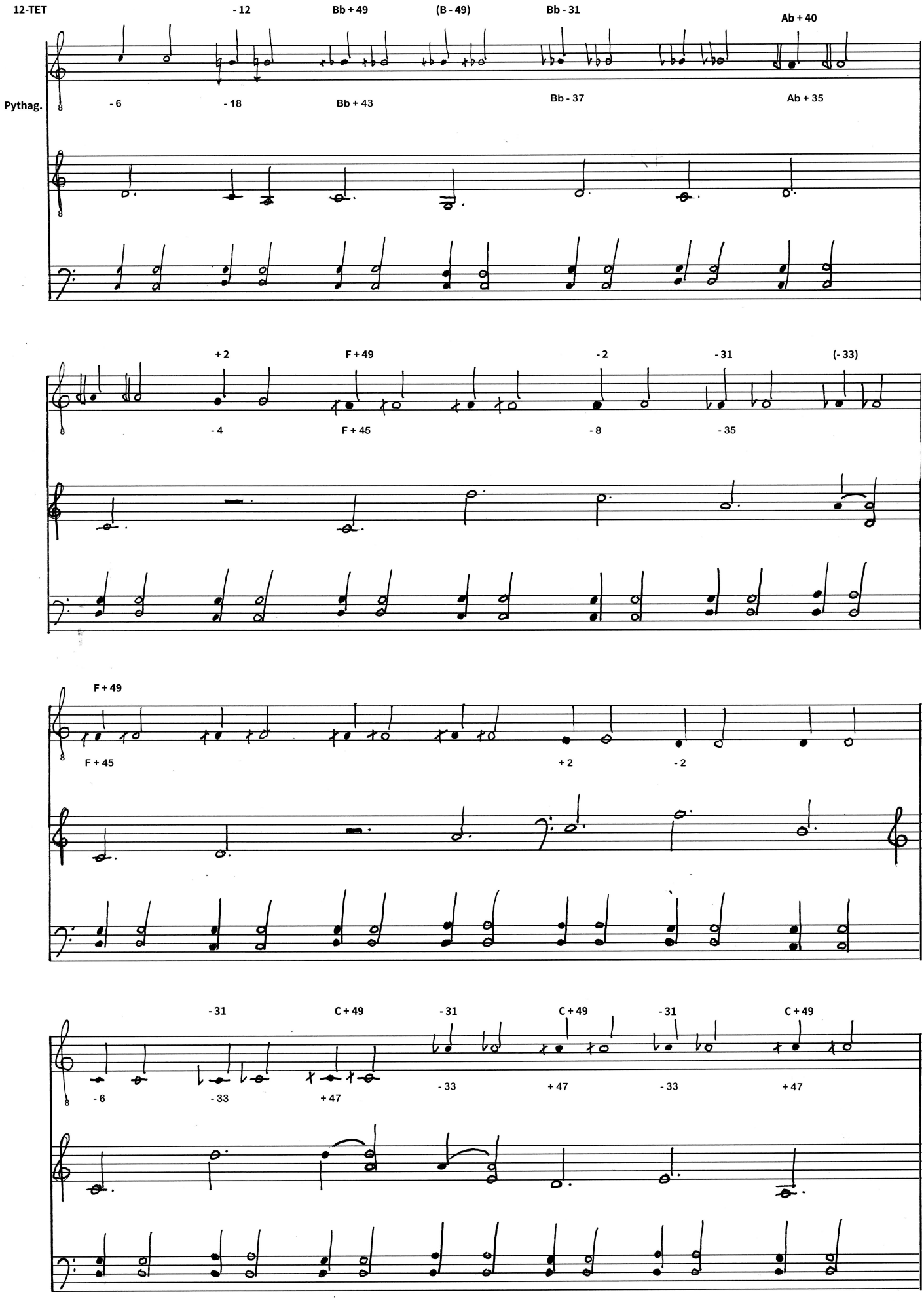
4th voice from top (lower note of the third system): Cello

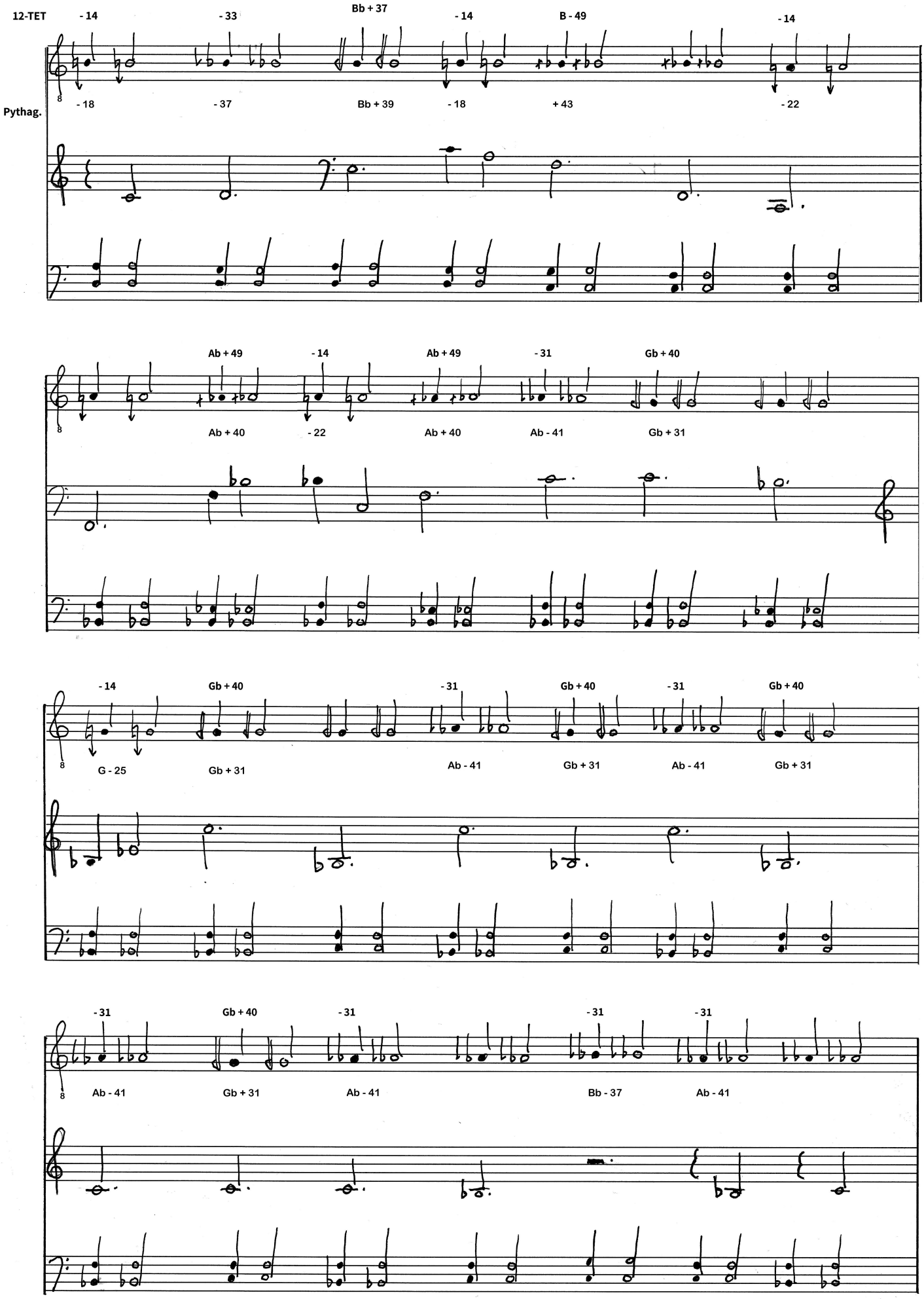
If played like this, by instruments that intonate notes actively, it might be helpful to write in the cent deviations for each note also in the other voices than the first one, using the tuning-charts for the keyboard-manuals above.

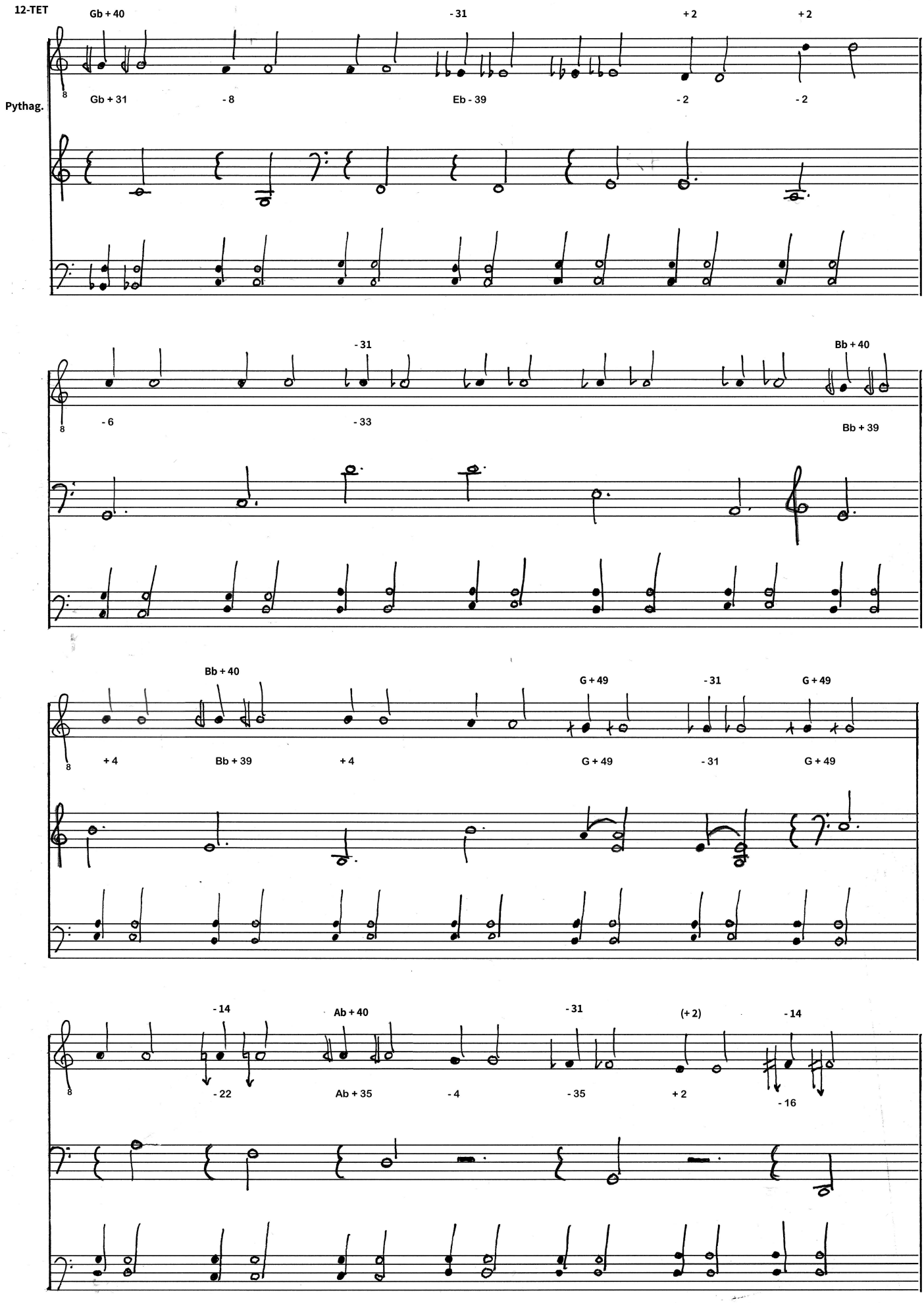
Note that when played without a keyboard instrument or other instrument typically bound to 12-TET, the piece should be intonated in its *just* form, with Pythagorean tuning for the 'keyboard part', and consequently also with the top voice intonating in line with the cent-deviations specified for the Pythagorean realisation.

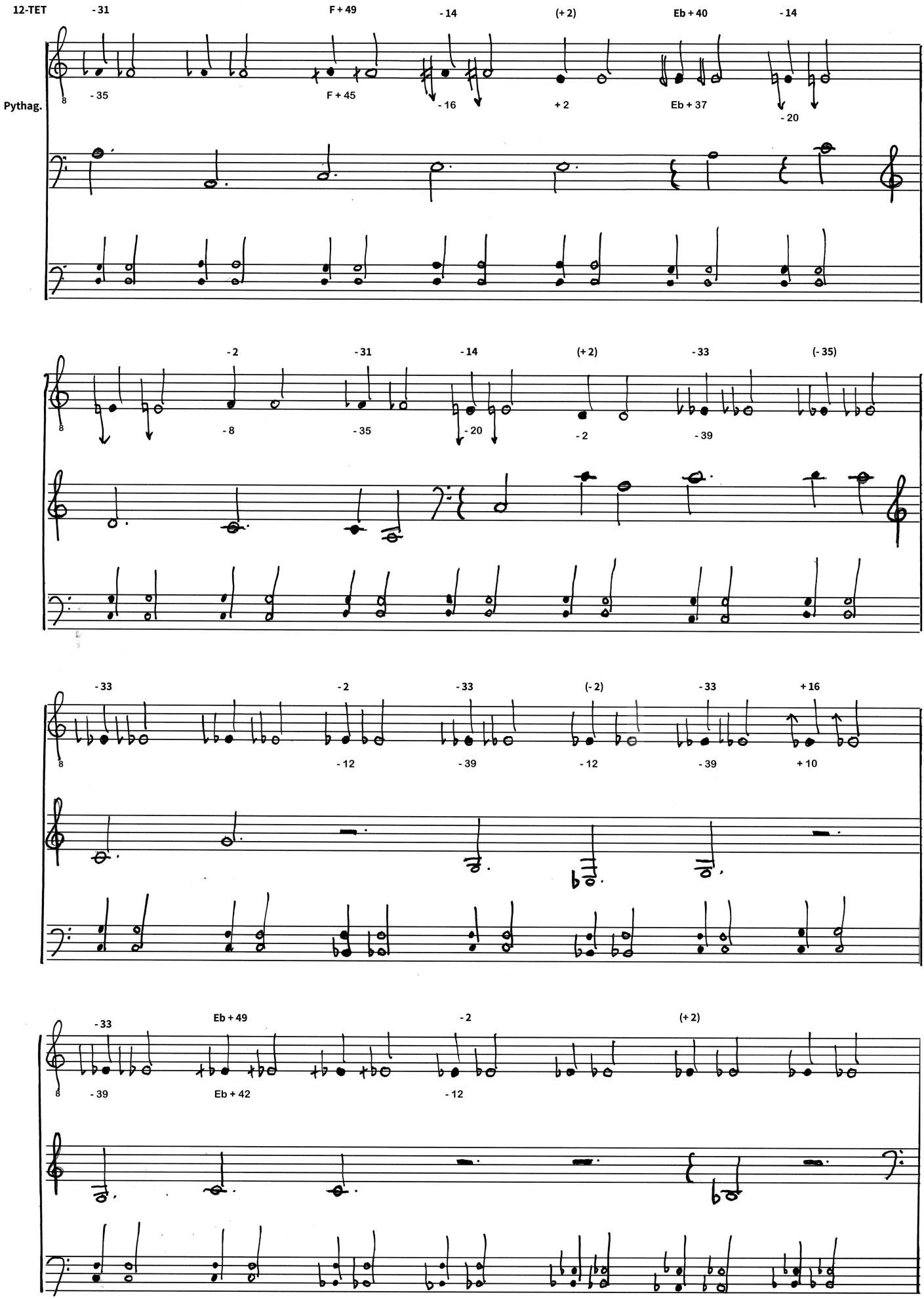
6. If realised without a provided sine wave track, the tempo is free within the scope of approximately ♩= 40 - 60 bpm.

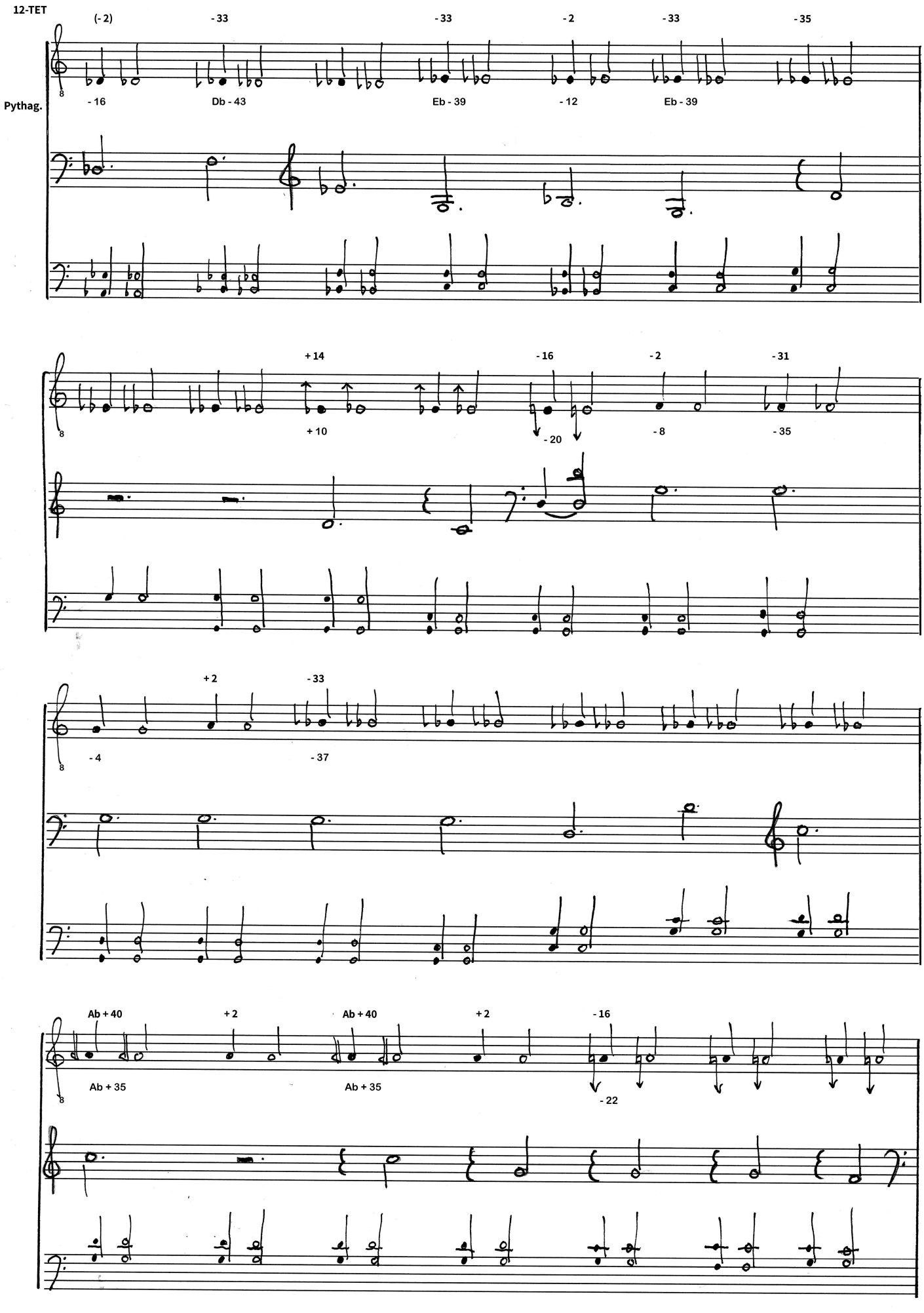
The more actively intonating instruments that are involved, the more time one might need for each chord to stabilize into tune, but preferably the piece should be played fast enough as for not to lose a kind of forward motion and melodic sense.

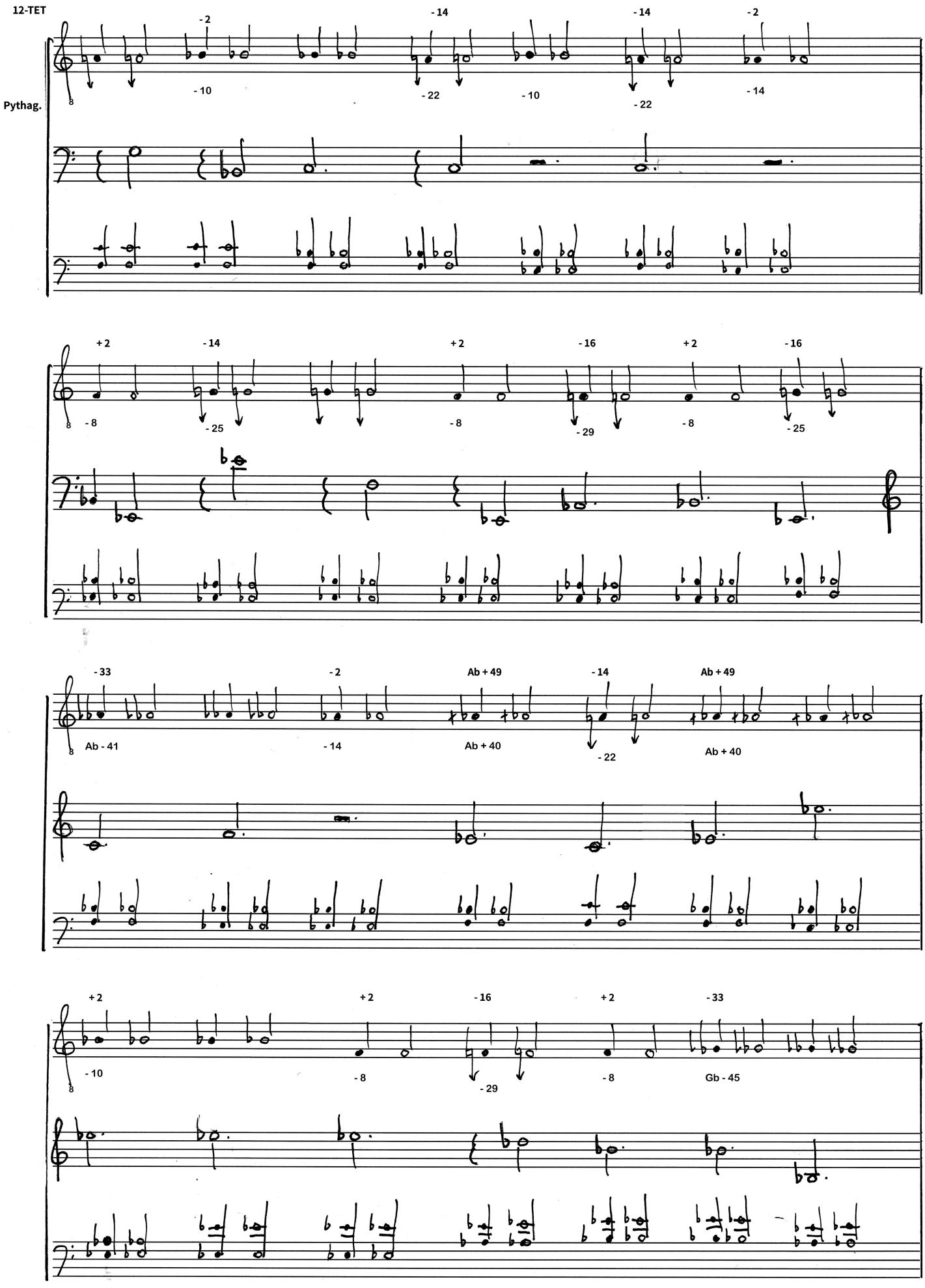

12-TET
- 12
Bb + 49
(B - 49)
Bb - 31
Ab + 40
Pythag.
- 6
- 18
Bb + 43
Bb - 37
Ab + 35
+ 2
F + 49
- 2
- 31
(- 33)
- 4
F + 45
- 8
- 35
F + 49
F + 45
+ 2
- 2
- 31
C + 49
- 31
C + 49
- 31
C + 49
- 6
- 33
+ 47
- 33
+ 47
- 33
+ 47

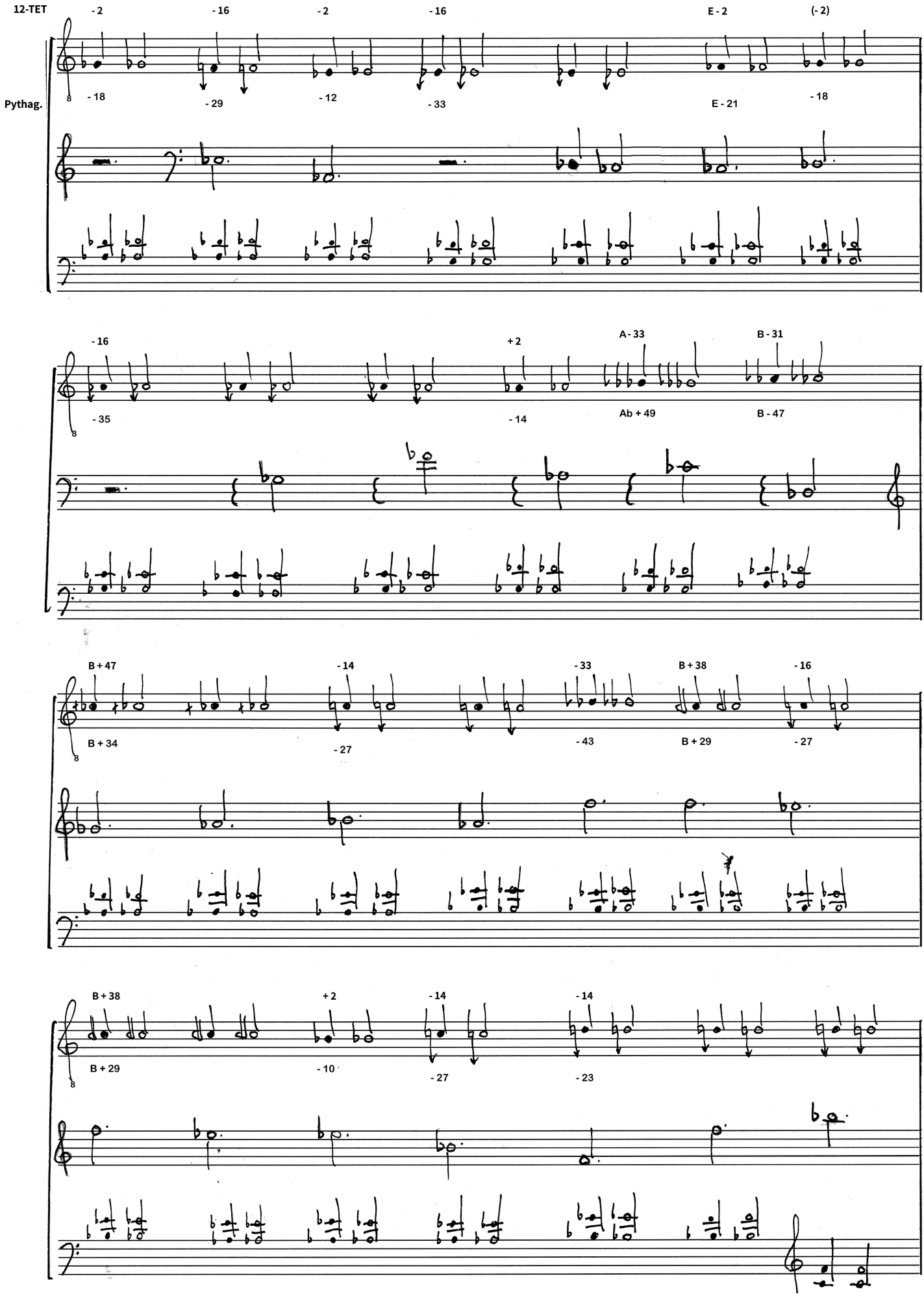

12-TET
- 14
- 33
Bb + 37
- 14
B - 49
- 14
Pythag.
- 18
- 37
Bb + 39
- 18
+ 43
- 22
Ab + 49
- 14
Ab + 49
- 31
Gb + 40
Ab + 40
- 22
Ab + 40
Ab - 41
Gb + 31
- 14
Gb + 40
- 31
Gb + 40
- 31
Gb + 40
G - 25
Gb + 31
Ab - 41
Gb + 31
Ab - 41
Gb + 31
- 31
Gb + 40
- 31
- 31
- 31
Ab - 41
Gb + 31
Ab - 41
Bb - 37
Ab - 41

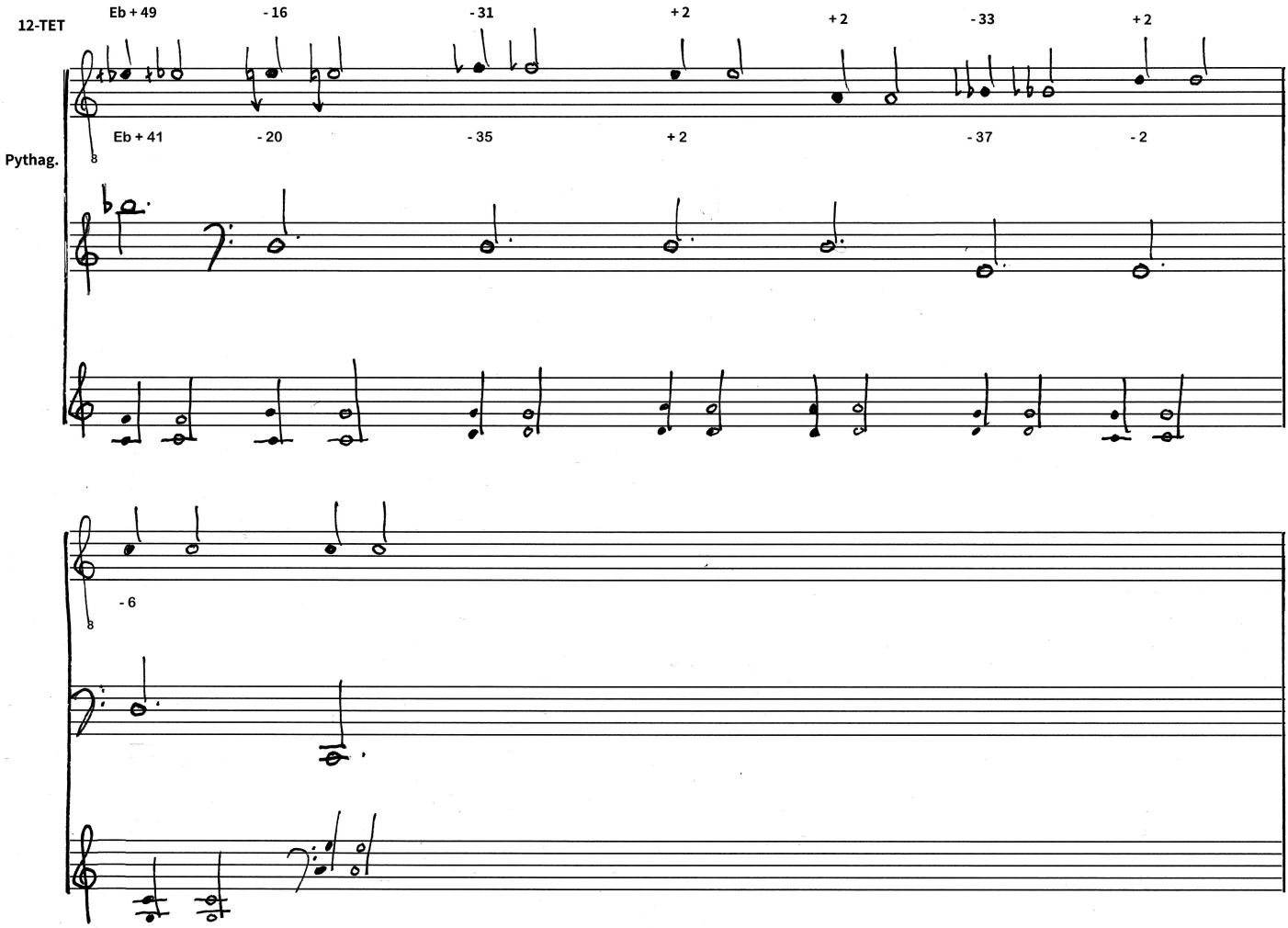

12-TET
Gb + 40
- 31
+ 2
+ 2
Pythag.
Gb + 31
- 8
Eb - 39
- 2
- 2
- 31
Bb + 40
- 6
- 33
Bb + 39
Bb + 40
G + 49
- 31
G + 49
+ 4
Bb + 39
+ 4
G + 49
- 31
G + 49
- 14
Ab + 40
- 31
(+ 2)
- 14
- 22
Ab + 35
- 4
- 35
+ 2
- 16


12-TET
-31
F+49
-14
(+2)
Eb+40
-14
Pythag.
-35
F+45
-16
+2
Eb+37
-20
-2
-31
-14
(+2)
-33
(-35)
-8
-35
-20
-2
-39
-33
-2
-33
(-2)
-33
+16
-12
-39
-12
-39
+10
-33
Eb+49
-2
(+2)
-39
Eb+42
-12


12-TET
Pythag.
(- 2)
- 33
- 33
- 2
- 33
- 35
- 16
Db - 43
Eb - 39
- 12
Eb - 39
+ 14
- 16
- 2
- 31
+ 10
- 20
- 8
- 35
+ 2
- 33
- 4
- 37
Ab + 40
+ 2
Ab + 40
+ 2
- 16
Ab + 35
Ab + 35
- 22


12-TET
Pythag.
-2
-14
-14
-2
-10
-22
-10
-22
-14
+2
-14
+2
-16
+2
-16
-8
-25
-8
-29
-8
-25
-33
-2
Ab + 49
-14
Ab + 49
Ab - 41
-14
Ab + 40
-22
Ab + 40
+2
+2
-16
+2
-33
-10
-8
-29
-8
Gb - 45


12-TET
Pythag.
-2
-16
-2
-16
E-2
(-2)
-18
-29
-12
-33
E-21
-18
-16
+2
A-33
B-31
-35
-14
Ab+49
B-47
B+47
-14
-33
B+38
-16
B+34
-27
-43
B+29
-27
B+38
+2
-14
-14
B+29
-10
-27
-23


12-TET
Eb + 49
- 16
- 31
+ 2
+ 2
- 33
+ 2
Pythag.
Eb + 41
- 20
- 35
+ 2
- 37
- 2
8
- 6
8