Unicode request for Stein-Zimmermann quarter-tone accidentals

Gavin Jared Bala, gavin.jared gmail.com
Kirk Miller, kirk.miller gmail.com

2023 November 19

This request is for the Stein-Zimmermann quarter-tone accidentals, the most common standard in music notation for quarter-tone accidentals, and for their extension by arrows to denote smaller alterations.

Characters

The proposed characters, along with their PUA points in the Standard Music Font Layout (SMuFL) specification, are:

‡ 1D1EB MUSICAL SYMBOL HALF SHARP. [SMuFL U+E282.] Figures 1–14.

♯ 1D1EC MUSICAL SYMBOL ONE AND A HALF SHARP. [SMuFL U+E283.] Figures 1–14.

ↄ 1D1ED MUSICAL SYMBOL REVERSED FLAT. [SMuFL U+E280.] Figures 1–8, 10–14.

ↄ 1D1EE MUSICAL SYMBOL REVERSED FLAT AND FLAT. [SMuFL U+E281.]
Figures 1–2, 4–8, 10–14.

‡ 1D1EF MUSICAL SYMBOL HALF SHARP UP. [SMuFL U+E299.] Figures 16–17, 19–24.

‡ 1D1F0 MUSICAL SYMBOL HALF SHARP DOWN. [SMuFL U+E29A.] Figures 15, 19–24.

♯ 1D1F1 MUSICAL SYMBOL ONE AND A HALF SHARP UP. [SMuFL U+E29B.]
Figures 15–16, 19–22, 24.

♯ 1D1F2 MUSICAL SYMBOL ONE AND A HALF SHARP DOWN. [SMuFL U+E29C.]
Figures 19–24.

ↄ 1D1F3 MUSICAL SYMBOL REVERSED FLAT UP. [SMuFL U+E290.] Figures 15, 20–21, 23–24.

ↄ 1D1F4 MUSICAL SYMBOL REVERSED FLAT DOWN. [SMuFL U+E291.] Figures 20–21, 23–24.

ↄ 1D1F5 MUSICAL SYMBOL REVERSED FLAT AND FLAT UP. [SMuFL U+E294.]
Figures 20–21, 23–24.

ↄ 1D1F6 MUSICAL SYMBOL REVERSED FLAT AND FLAT DOWN. [SMuFL U+E295.]
Figures 15, 20–21, 24.

Properties

1D1EB;MUSICAL SYMBOL HALF SHARP;So;0;L;;;;;N;;;;;
1D1EC;MUSICAL SYMBOL ONE AND A HALF SHARP;So;0;L;;;;;N;;;;;
1D1ED;MUSICAL SYMBOL REVERSED FLAT;So;0;L;;;;;N;;;;;
1D1EE;MUSICAL SYMBOL REVERSED FLAT AND FLAT;So;0;L;;;;;N;;;;;
1D1EF;MUSICAL SYMBOL HALF SHARP UP;So;0;L;;;;;N;;;;;
1D1F0;MUSICAL SYMBOL HALF SHARP DOWN;So;0;L;;;;;N;;;;;
1D1F1;MUSICAL SYMBOL ONE AND A HALF SHARP UP;So;0;L;;;;;N;;;;;
1D1F2;MUSICAL SYMBOL ONE AND A HALF SHARP DOWN;So;0;L;;;;;N;;;;;
1D1F3;MUSICAL SYMBOL REVERSED FLAT UP;So;0;L;;;;;N;;;;;
1D1F4;MUSICAL SYMBOL REVERSED FLAT DOWN;So;0;L;;;;;N;;;;;
1D1F5;MUSICAL SYMBOL REVERSED FLAT AND FLAT UP;So;0;L;;;;;N;;;;;
1D1F6;MUSICAL SYMBOL REVERSED FLAT AND FLAT DOWN;So;0 ;L;;;;;N;;;;;

Annotations

1D1EB MUSICAL SYMBOL HALF SHARP

   = quarter tone sharp

1D1EC MUSICAL SYMBOL ONE AND A HALF SHARP

   = three-quarter tone sharp

1D1ED MUSICAL SYMBOL REVERSED FLAT

   = quarter tone flat

1D1EE MUSICAL SYMBOL REVERSED FLAT AND FLAT

   = three-quarter tone flat

Chart

Greyed-out cells are already assigned or (light grey) are requested in separate proposals.

Musical Symbols

	1D10	1D11	1D12	1D13	1D14	1D15	1D16	1D17	1D18	1D19	1D1A	1D1B	1D1C	1D1D	1D1E	1D1F
0	|	⌢	𝄞	♯	𝆒	◿	♪	𝅘	♀	m	l	⌃	♪	⁚	⧐	♯
1	‖	⌣	𝄡	♯	𝆓	◣	♪	𝅘	♀	f	↻	↗	l	⁙	▭	♯
2	∥	'	𝄢	♮	𝆔	⍔	♪	𝅘	♀	<	c	↖	l	♭	⁛	♯
3	∣	∥	𝄣	♭	×	▪	♪	𝆷𝅥	⌇	>	∩	⌒	l	⌐	⌐	♩
4	⋮	{	𝄤	𝄴	+	▽	♪	𝆸𝅥	⌇	♪	⌣	⊕	'	⁚	⌐	♩
5	l	(	‖	𝄵	⊗	▼	|	𝆹𝅥	⌔	♪	⌣	⊛	'	⌐	⌐	♩
6	‖:	—	‖	8ᵛᵃ	□	()	⅄	𝆺𝅥	⌕	tr	⊢	⊣	⌐	⌐	♮	♩
7	:‖	=	◌̇	8ᵛᵇ	■	o	⌐	𝆹𝅥𝅮	⌖	∾	⊓	⊥	⊙	⌐	⌐	2
8	:	≡	◌̆	15ᵐᵃ	△	●	⌐	𝆺𝅥𝅮	◌̃	∽	⌐	⊔	○	⌐	(	4
9	D.S.	≣	⊟	15ᵐᵇ	▲		⌐	𝆹𝅥𝅯	◌̈	∾	,	◇	Φ	⌐	♯	5
A	D.C.	≣	⋈	⊞	◣	⌷	⌐	𝆺𝅥𝅯	◌̣	𝅗	◌̊	●	ℂ	⌐	⌐	6
B	𝄋	≣	𝄫	⊢	◣	▮	⌐	>	◌̤	ℓ	◌̊	↓	c	⌐	♯	7
C	⊕	▦	♭	⊣	◿	⊫	⌐	.	r	◌̂	◌̊	↓	⊃	⌐	♯	9
D	╱	▥	♭	𝄽	◣	o	◌.	_	s	◌̃	◌̇	♪	¢	⌐	♩	5
E	⅞	𝄟	♮	𝄾	▽	♩	⌐	.	z	)	Ped.	♪	Φ	⌐	♭	7
F	⅞.	𝄠	♮	𝄿	▼	♩	♪	v	p	)	❋	♪	※	∫	♯	⊞

3

Background

Unicode encodes three sets of accidentals that have been used to represent quarter tones:

- Basic accidentals with up and down arrows, U+1D12C through U+1D131: ♭ ♭ ♮ ♮ ♯ ♯
- Sharp and flat modified with a digit 4, U+1D132 and U+1D133: ♯ ♭
- Persian *sori* and *koron*, U+1D1E9 and U+1D1EA: ♯ ♭

The first two sets were present in the original Musical Symbols block; the Persian accidentals were proposed in [L2/20-159](). However, Unicode does not support what is today the most common standard for quarter-tone accidentals (Gould 2011, p. 96). The basic accidentals with arrows were historically used for quarter tones but are now generally used for even smaller intervals and supplemented with some or all of the symbols requested in this proposal. In the Standard Music Font Layout specification (SMuFL), which assigns many non-Unicode musical symbols to the Private Use Area, these are called the "Stein-Zimmermann" accidentals (Spreadbury 2021), after Richard Stein (1882–1942), who used the sharp signs ♯ and ♯ in his *Zwei Konzertstücke* Op. 26, and Bernd Alois Zimmermann (1918–1970), who used the flat signs ♭ and ♭ in his works (Matmati 2021–2022). However, the sharp signs at least are much older: they were proposed by the Italian composer Giuseppe Tartini (1692–1770) in 1756 (Stone 1980, p. 68).

The Stein-Zimmermann quarter-tone sharp sign ♯ is graphically half a sharp sign, ♯, and similarly the Stein-Zimmermann three-quarter-tone sharp sign ♯ is a sharp and a half. These have graphic variants with one and three diagonal crossbars and two verticals, or with both the verticals and crossbars varying in number (Gould 2011, p. 96; Anon. 2020), as seen in Figure 14, but the requested forms are more common (Anon. 2020).

The Stein-Zimmermann quarter-tone flat sign ♭ is a reversed flat ♭. The Stein-Zimmermann three-quarter-tone flat sign is made up of such a reversed flat and a normal flat. Similarly to the double-flat symbol ♭♭ ~ ♭, it sometimes appears with its component parts disconnected, ♭, and sometimes with them connected (i.e. sharing a stem: ♭). Based on the precedent of the double-flat symbol, on how the three-quarter-tone flat is treated in SMuFL, and on how often it is referred to as a single sign by musicians explaining quarter-tone notation, we consider it appropriate to encode ⟨♭⟩ as a distinct character.

Stein-Zimmermann quarter-tone accidentals are the default glyphs in the software notation packages *Sibelius* (Innervik 2008) and *LilyPond*. They are now so common that they have essentially been adopted as part of common Western musical notation (CMN). Alexandra Greffin-Klein writes on her "Contemporary Violin" blog regarding these accidentals: *If this is*

the system you use, don't even bother mentioning it in your instructions: any musician vaguely interested in contemporary music knows what it is all about. If this is not the case, consider entrusting your creation to someone else...! (Greffin-Klein, n.d.; shown as Fig. 11).

We quote further illuminating anonymous discussion on the Steinberg Forum, regarding whether the default quarter-tone accidentals in the *Dorico* music notation software should be the accidentals with arrows, or the Stein-Zimmermann accidentals (Anon. 2020):

In my experience the majority of microtonal music with quarter-tones written today uses the Stein-Zimmermann notation of course with some variations such as arrows to indicate smaller than 1/4 tone approximations (natural 7ths, eig[h]th-tones etc). [...] Here are just a few examples of composers working with the Stein-Zimmermann set to qualify my point. Please feel free to share composers using the Dorico default, or explain the decision – I'm curious, but either way I'd say it's incontrovertible that Stein-Zimmerman[n] is more widely used and that it therefore makes sense to adopt it as a default.

Patricia Alessandrini, Julian Anderson, Georges Aperghis, Joanna Bailie, Natasha Barrett, John Croft, Chaya Czernowin, Steven Daverson, James Dillon, Brian Ferneyhough, Michael Finnissy, Beat Furrer, Bernhard Gander, Philippe Hurel, Clara Iannotta, Mauro Lanza, Liza Lim, Tristan Murail, Hector Parra, Enno Poppe, Kaaija Saariaho, Rebecca Saunders – nmrz [The entries in this list of composers were originally delimited with line breaks; we have substituted commas for reasons of space.]

Hi—in my experience nmrz is quite right about the need to change the default 24-EDO accidentals. I strongly recommend a rethink for Dorico 4. With love and respect to Elaine [Gould], her book doesn't reflect majority practice in the hundreds of new-music scores I see. The so-called "Stein-Zimmermann" accidentals are beyond question the defaults in C21st "new music"—used by almost everyone, even if they don't know that that's what they're called! It's generally now considered bad practice to use an arrow for a quarter-tone, because arrows are reserved for divisions smaller than, or not cognate with, a quarter-tone, including eighth-tones and the lowering from EDO of the 5th partial (i.e. the just major third in a triad). In every case, an arrow requires explanation in the performing directions, so it has no assumed meaning other than "some kind of alteration in this or that direction." – cpower

Having noted from this quote that the current usage of arrows is *not* for quarter-tones – though that usage is still found in older scores (Greffin-Klein n.d.), e.g. in the works of György Ligeti (Jedrzejewski 2014, Hufflen 2017) – we add some remarks regarding the other currently encoded quarter-tone accidentals. The Persian *sori* ♯ and *koron* ♭ are standard in Persian music notation, but (at least to our knowledge) are not used in contemporary Western classical music. The sharps and flats with a digit 4, ♯ and ♭, are extremely rare: Hufflen (2017) remarks "we have *never* seen them in *any* score."

Before the twenty-first century, composers using quarter-tones tended to invent their own distinctive notation. For examples of the many notations that have been used and invented, see Jedrzejewski (2014), especially the table of quarter-tone notation systems on p. 185–186 (reproduced as Fig. 14); many of these are encoded in SMuFL. It is not unknown nowadays to standardise earlier quarter-tone notation and rewrite them using Stein-Zimmermann quarter-tone accidentals, as in Skinner (2006), the in modern edition of Wyschnegradsky (2017), and on Wikipedia. They are hence not currently requested.

The next logical step beyond quarter-tones is to divide the scale further, into eighth-tones or twelfth-tones. Arrows applied to the basic and Stein-Zimmermann accidentals are "becoming the norm" for eighth-tones (Greffin-Klein n.d.), although it is not unknown to use them for twelfth-tones instead (Chahin 2017). When used for eighth-tones, this creates a degree of redundancy: a half-sharp with an up-arrow, for example, is equivalent to a normal sharp with a down-arrow. There is no redundancy however when arrows indicate twelfth-tones. Arrow extensions are currently supported by Unicode for the basic accidentals; we request support for the remainder (the Stein-Zimmermann accidentals with arrows). These are included in SMuFL as "extended Stein-Zimmermann accidentals" at U+E290–E29F.

There are other accidentals being used for other microtones. Many of these are included in SMuFL and the music notation software *MuseScore*. But in the absence of a universally understood standard notation for such extensions at present, and considering the fact that even third-tones, sixth-tones, and eighth-tones remain much less common than quarter-tones in current practice (Greffin-Klein n.d.), we do not request them.

According to SMuFL, the Stein-Zimmermann sharp accidentals are used in the notation of Arabic music, and the Stein-Zimmermann quarter-tone sharp and quarter-tone flat are used for the notation of Turkish music (they form part of the set of Arel-Ezgi-Uzdilek accidentals). However, both traditions require other accidentals as well, and since those extra symbols have a different user community, we do not include them in this proposal.

References

Felipe de Almeida Ribeiro & Charles Neimog (2020). *Impasses no uso de estruturas microtonais na composição eletroacústica*. Opus. 26 (3).

Alain Bancquart, Carlos Agon, Moreno Andreatta (2008): Microtonal Composition. In Bresson, Agon & Assayag (eds.): *The OM Composer's Book 2*. Editions Delatour France / Ircam.

Anon. (2020) *Default Microtonal / 24-EDO Accidentals.*
https://forums.steinberg.net/t/default-microtonal-24-edo-accidentals/145855

Rami Chahin (2017) *Towards a Spectral Microtonal Composition: A Bridge Between Arabic and Western Music*. Schott Music, Mainz.
https://schott-campus.com/wp-content/uploads/2017/12/Chahin_Towards_Spectral_oa.pdf

Elaine Gould (2011) *Behind Bars: The Definitive Guide to Musical Notation*. Faber Music, London.

Alexandra Greffin-Klein (n.d.) *MICRO-INTERVALS: Achievability, Limits, Notation and How to Practice Them*. http://www.alexgreffinklein.com/en/micro-intervals-and-accidentals/

Jean-Michel Hufflen (2017) History of accidentals in music. TUGboat 38 (2): 147–156.
https://tug.org/TUGboat/tb38-2/tb119hufflen-music.pdf

Kjell Tore Innervik (2008) *Using quartertones in notation software.*
https://prosjekt.nmh.no/quartertonemarimba/pages/mainpages/scoring_software.html

Franck Jedrzejewski (2014) *Dictionnaire des musiques microtonales: 1892–2013*. L'Harmattan, Paris.

Jawher Matmati (2021–2022) *Au-delà de la notation : vers une réconciliation du maître et du marteau*. https://www.conservatoiredeparis.fr/sites/default/files/Recherche-Editions/TEP_MATMATI_2021.pdf

Myles Skinner (2006). *Toward a Quarter-Tone Syntax: Selected Analyses of Works by Blackwood, Hába, Ives, and Wyschnegradsky.*
https://www.tierceron.com/diss/index.php

Daniel Spreadbury (2021). *Standard Music Font Layout (SMuFL), Version 1.4, Final Community Group Report 16 March 2021.*
https://www.w3.org/2021/03/smufl14/

Kurt Stone (1980). *Music Notation in the Twentieth Century*. W. W. Norton & Co., New York and London.

Ivan Wyschnegradsky (2017, originally written 1932; ed. Noah Kaplan, trans. Rosalie Kaplan), *Manual of Quarter-Tone Harmony*. Underwolf Publications.

Figures

Fig. 1. From Innervik (2008), the default accidental keypad in *Sibelius*, showing the four Stein-Zimmermann accidentals. From the *Sibelius Reference Guide*, Version 2023.6, p. 225 (https://resources.avid.com/SupportFiles/Sibelius/2023.6/Sibelius_Reference.pdf).

4.2 Exact micro-intervals

As a semitone is the *exact* division of tones by two, a quarter tone is the exact division of semitones by two, that is, this division yields something *precise*.[28] If quarter tones are used throughout a score, some explanations make the signs' meaning precise. Even if there is no 'official' standardisation, the more frequently used signs are ǂ for a *half sharp*, raising a note by a quarter tone,[29] and ♯♯ for a *sharp and half*, raising a note by three quarter tones. In particular, these notations are used by Iannis Xenakis [37]. Alternative notations exist: ǂ and ♯.

A *half flat*, lowering a note by a quarter tone is often denoted by Ꝓ, with a *flat and half*, lowering a note by three quarter tones, by ⅋, alternative notations being ♭ and ♭.

Rast mode.

Soznak mode.
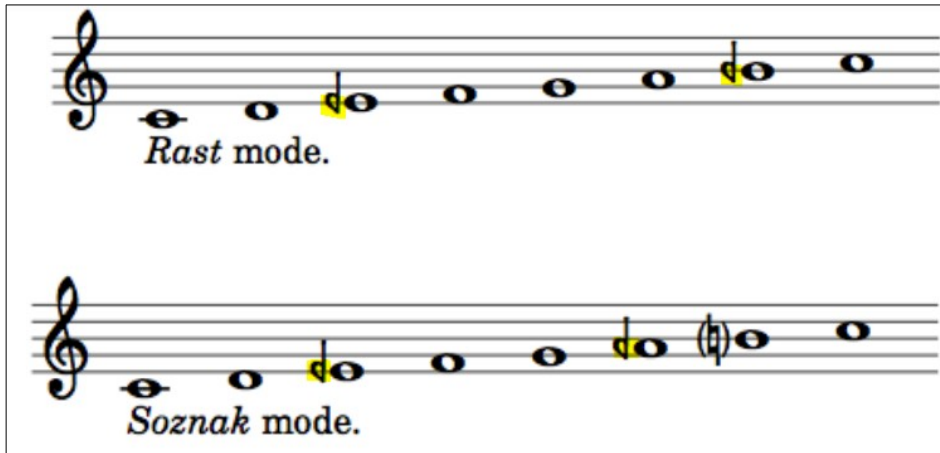
Fig. 2. Hufflen (2017: 153–154), illustrating the Stein-Zimmermann quarter-tone accidentals, mentioning that they are the more frequently used symbols. A fused form of the three-quarter-tone flat is shown. Several additional symbols are mentioned from the Arel-Ezgi-Uzdilek notation used in Turkish music, which is outside the scope of this proposal.

3. OTHER QUARTER-TONE ACCIDENTALS

Among the many quarter-tone accidentals invented over the years there is none
ith identical alterations for both sharps and flats except the arrow system shown
)ove. Nor is any system quite as self-explanatory. But since the approach to the
;e of microtones—whether as structural components (scale steps) with or with-
ιt tonal implications, or as ornamental "bendings"—is still in flux, it seems
)mewhat premature to propose notational standard procedures at this time with-
ut at least providing a glance at a few alternatives for structural quarter tones.
[he ornamental ones present less of a problem.**)

Thus, among the signs for quarter-tone sharps, the oldest and actually most
)nvincing are those first proposed in 1756 by Giuseppe Tartini: ‡ ♯ ♯
(¼)   (¾)

Strictly atonal music, i.e., music in which the pitches have no tonal implica-
ons (leading tones, etc.) could be notated with the three Tartini sharps and no
uarter or three-quarter flats at all. All pitches originally thought of as quarter or
ιree-quarter flats would then have to be "translated" enharmonically into
ιuivalent sharps. The advantage of such notation is that it is easier to write and
:ad than the arrowed accidentals. Its disadvantage is that it lacks quarter and
ιree-quarter flats.

The following example shows the same music as above, notated with Tartini
sharps:

As for quarter-tone flats, no method comparable in practicality and expli-
citness to either the arrows or the Tartini system has evolved so far, although
there is no dearth of inventions.

The most frequently encountered flat adaptations are: ↓ ↘ ♭ and ↓ ↲ ◁

None of these flats conveys as clearly as the Tartini sharps whether it lowers
the pitch by one or by three quarters. Besides, the first three flats can easily be
mistaken for carelessly written regular ones, and the other three are equally am-
biguous except that they are clearly backward.

There is, however, one practical quarter-tone flat—a regular flat written back-
ward (◁)—which is not likely to be mistaken. It has not been included above
because it is part of a system which functions well and which, in fact, has already
attained near standard status in atonal music for woodwinds. This system uses
Tartini's one-quarter sharp (‡) and the backward one-quarter flat just mentioned.

Unfortunately, it does not include three-quarter sharps or flats because its
quarter-tone accidentals can be used only on natural pitches (white keys). Thus a
certain amount of enharmonic manipulating is necessary. Nevertheless, the sys-
tem is highly recommended where appropriate, i.e., in a strictly nontonal con-
text.

The enharmonics function as follows:

a ¾-sharp C must be notated as a ¼-flat D;
a ¾-flat D must be notated as a ¼-sharp C;

Fig. 3. Stone (1980: 68–69). Three of the four Stein-Zimmermann accidentals (all but the three-quarter-flat) used in context, together with some criticism of other flat adaptations.

Fig. 4. Gould (2011: 69). The four Stein-Zimmermann accidentals (including a graphic variant of the half-sharp), with criticism of some of the flat adaptations shown in Fig. 3.

Known as *gadwal* in Arabic,[8] the **quarter-tone scale** was developed in the Middle East in the eighteenth century and many of the first detailed writings in the nineteenth century Syria describe the scale as being of 24 equal tones.[10] The invention of the scale is attributed to Mikhail Mishaqa whose work *Essay on the Art of Music for the Emir Shihāb (al-Risāla al-shihābiyya fī 'l-ṣināʿa al-mūsīqiyya)* is devoted to the topic but also makes clear his teacher Sheikh Muhammad al-Attar (1764–1828) was one of many already familiar with the concept.[11]
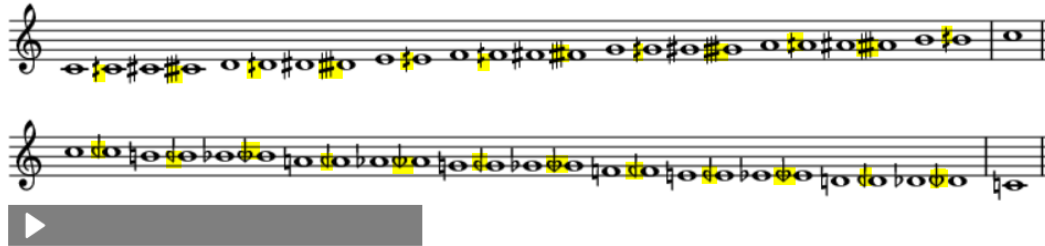
The quarter tone scale may be primarily a theoretical construct in Arabic music. The quarter tone gives musicians a "conceptual map" they can use to discuss and compare intervals by number of quarter tones, and this may be one of the reasons it accompanies a renewed interest in theory, with instruction in music theory a mainstream requirement since that period.[10]

Previously, pitches of a mode were chosen from a scale consisting of seventeen tones, developed by Safi al-Din al-Urmawi in the thirteenth century.[11]

Composer Charles Ives chose the chord C–D♯–F–G♯–B♭ as good possibility for a "secondary" chord in the quarter-tone scale, akin to the minor chord of traditional tonality. He considered that it may be built upon any degree of the quarter tone scale[4] Here is the secondary "minor" and its "first inversion":

Fig. 5. From Wikipedia, https://en.wikipedia.org/wiki/Quarter_tone. The Stein-Zimmermann accidentals used in a quarter-tone chromatic scale (similar to Stone, Fig. 2) and in text. Note the discussion of the work of Charles Ives (1874–1954), "translating" his work to the modern standard Stein-Zimmermann accidentals (he did not use them).

Example 1.8: Quarter-Tone Accidentals

The reversed flat sign (ↄ) represents one quarter tone flat; the conventional flat sign, two quarter tones or one semitone flat (its usual interpretation). The sign for three quarter tones flat (ↄ♭) combines the reversed flat sign and the conventional flat sign. The conventional natural sign has its regular meaning. The sharp sign with one vertical stroke (‡) indicates that the note is raised one quarter tone; the conventional sharp sign indicates that the note is raised two quarter tones or one semitone; and the sharp sign with three vertical strokes (♯), that the note is raised by three quarter tones. The double sharp (×) and double flat (♭♭) are also available with their conventional interpretations; however, in the quarter-tone music I have analyzed, double accidentals appear only rarely, if at all.

(Continued ...)

staff are replaced with pitch-class integers. Even though it takes some time to become familiar with the new accidental signs, I believe that Example 1.9e is the best of the five versions given in Example 1.9. In Example 1.9e, I have written the melody using the accidentals that I use throughout this dissertation.[13]

Example 1.10: Ives, *Allegro,* mm. 3-6 transcribed

[13] For consistency, I renotate musical examples using my own notation, except when I need to make a point about a composer's original notation.

[2] I use the label "circle of fourths" since Wyschnegradsky referred to ic 5.5 as a major fourth. Unlike the conventional ic 5 cycle, which can be written out as a complete circle of perfect fourths, it is impossible to write out an ic 5.5 cycle as a complete circle of major fourths. For example, if we start with the pitch B♭♭ and try to write a series of major fourths, the result is: B♭♭, E♭♭, A♭, D♮, G♮, C♯, F♯, B♮, E♯, A♯, D× and the next pitch in the series would be G five-quarters sharp, a pitch name not supported by my notation. As far as I know, no composer has ever invented an accidental sign to represent a note five-quarters sharp.

Fig. 6. (This and previous page.) Skinner (2006: 12–13, 18, 147). A PhD dissertation analysing some quarter-tone works by Easley Blackwood Jr. (1933–2023), Alois Hába (1893–1973), Charles Ives (1874–1954), and Ivan Wyschnegradsky (1893–1979).

14

A *sharp* pitch is made by adding `is` to the note name, and a *flat* pitch by adding `es`. As you might expect, a *double sharp* or *double flat* is made by adding `isis` or `eses`. This syntax is derived from Dutch note naming conventions. To use other names for accidentals, see Note names in other languages.

```
\relative c'' { ais1 aes aisis aeses }
```

A natural pitch is entered as a simple note name; no suffix is required. A natural sign will be printed when needed to cancel the effect of an earlier accidental or key signature.

```
\relative c'' { a4 aes a2 }
```
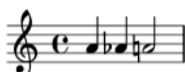
Quarter tones may be added; the following is a series of Cs with increasing pitches:

```
\relative c'' { ceseh1 ces ceh c cih cis cisih }
```

Fig. 7. The *LilyPond* notation reference, available at
http://lilypond.org/doc/v2.24/Documentation/notation/writing-pitches.

Note that the Stein-Zimmermann accidentals do not require explanatory comment: they are simply considered to be *the* quarter-tone accidentals.

§2. In the scale of twenty-four quarter tones, twelve tones belong to the common system of semitones; the other twelve are new intermediary tones. To notate them it is necessary to introduce new signs of alteration: two for ascending alterations (the quarter-tone sharp and the sharp and a quarter) and two for descending alterations (the quarter-tone flat and the flat and a quarter). Combined with the conventional signs of sharp and flat, we have the system of signs of alteration:

The quarter-tone sharp		(raised ¼ tone)
The sharp		(raised ½ tone)
The sharp and a quarter		(raised ¾ tone)
The quarter-tone flat		(lowered ¼ tone)
The flat		(lowered ½ tone)
The flat and a quarter		(lowered ¾ tone)

This is how to write the chromatic quarter-tone scale:

§3. The twelve new tones of the quarter-tone system can also be formed in the relationship between two chromatic scales where one scale is transposed by a quarter tone (higher or lower). The relationship between the two scales resembles two combs whose teeth interlock with one another. So any phrase in semitones can be transposed a quarter tone higher or lower. For example:

A phrase can be transposed three, five, seven, etc., quarter tones higher or lower in any of twenty-four different keys, including twelve new keys and the twelve common keys.

§5. The new signs of alteration create new enharmonics:

A general rule to remember: when the distance between two notes is a whole tone, the ♯ of the lower note is enharmonic to the ♭ of the upper note and the ♯ of the lower note is enharmonic to the ♭ of the upper note. When the distance is a semitone, the ♯ of the lower note is enharmonic to the ♭ of the upper note.

The heptatonic neutral scale has a complete cycle of modulations by the most frequent interval, the neutral third. This cycle plays the same role as the cycle of perfect fourths in the traditional major-minor system. It is interesting to note that in the neutral system a key signature is possible.

Fig. 8. Wyschnegradsky (2017: 1–2, 22). Despite its appearance, the three-quarter-flat symbol is treated as an atomic character, just like the double-flat would be. The last example shows

quarter-sharp accidentals within a key signature.

This 2017 edition is another example of modernising notation. Wyschnegradsky himself used different symbols for the quarter-flat and three-quarter-flat.

Fig. 9. A modern edition (2012, ed. Jonathan Goodliffe) of Francisco Valls' *Composición enarmónica para instrumentos de arco* (original publication 1742). Another example of modernising the original notation to the Stein-Zimmermann accidentals (which indeed the editor simply calls "modern notation" without comment), though the editor also provides a version with the original notation (Valls originally used a diagonal cross-shaped symbol to indicate raising by a quarter-tone).

Available on the International Music Score Library Project (IMSLP) at https://imslp.org/wiki/Composici%C3%B3n_enarm%C3%B3nica_para_instrumentos_de_arco_%28Valls%2C_Francisco%29.

The **quarter-tone** is defined as that pitch which exists midway (48-50 cents or 2 Pythagorean commas) between any two **semitones** (half-tones), with neither semitone predominating. A **semitone** is equal to 100 cents. The quarter-tone may be considered a universal interval, like the tone and semitone, as it exists in numerous Eastern and Western musical cultures. Irish folk tunes, for example, sometimes feature the inclusion of 'half-sharp' notes, quarter tones mid-way between natural and sharp.
[ref: Peter Cooper, Mel Bay's Complete Irish Fiddle Player, Mel Bay Publications, 1995]

Other divisions of the **tone** have their place in Eastern and Western musical cultures. The **eighth-tone** is measured at 24-25 cents (or, for example in Turkish music, a Pythagorean comma).

Quartertone Accidental Signs (there are other sign conventions)	
	3/4 tone flat sesquiflat *trois-demi de bémol* (French) *double bémol barré* (French) *bemol y medio* (Spanish)
	1/4 tone flat semiflat *semi-bemolle* (Italian) *bémol barré* (French) *demi bémol* (French) *bémol inversé* (French) *semibemol* (Spanish)
	1/4 tone sharp semisharp *semi-diesis* (Italian) *dièse barré* (French) *demi dièse avec une seule barre verticale* (French) *semisostenido* (Spanish)
	3/4 tone sharp sesquisharp *trois-demi de dièse* (French) *dièse avec trois barres verticales* (French) *sostenido y medio* (Spanish)

Fig. 10. From Dolmetsch Music Theory Online, by Brian Blood (https://www.dolmetsch.com/musictheory7.htm). A discussion of quarter tones, with the Stein-Zimmermann accidentals used for the illustrations. Although it is acknowledged that "there are other sign conventions," no others are shown.

Of course, the older and more used the technique is, the more the notation tends to stabilize. This is normal. Quarter tones, on the scale of the evolution of the violin technique, are prehistoric!

On most of the scores that find their way to my music stand, the quarter tones are notated like this:
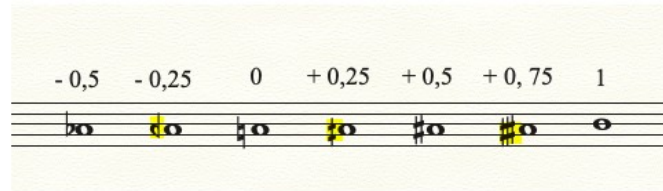
Over the past twenty years, the notation seems to have stabilized on this. Yes, I know, there is also a heart-shaped double flat for the lower triple quarter-tone, but frankly, considering the possibility of enharmonic equivalents, it's been a while since I saw it on a score!

If this is the system you use, don't even bother mentioning it in your instructions: any musician vaguely interested in contemporary music knows what it is all about. If this is not the case, consider entrusting your creation to someone else…!

As I said earlier, this fourth must sound in tune. Therefore, during the silence, I place the fourth D♮-G♮ in 3rd position and move it a quarter tone up.

Then I notice that the E♮ is at a "normal semitone" distance from the G♯, and the C♯ is exactly one tone lower. So E♮ and C♯ must sound perfectly in tune (like E♮-D♮), but when you check C♯ with the open D, it should make you cringe!

In other words, my fourth D♮-G♮ is a reference for my fourth D♯-G♯, my G♯ is a reference for my E♮, itself a reference for my C♯. Up to this note, we are in a kind of temperament raised by a quarter tone, in which the B♭ sounds foreign, at a distance of 1.25 tones from the G♯.

To return to the natural temperament, put the F♯ at a distance of 2.25 tones from the C♯ (actually, imagine that this C♯ is a D). The placement of the F♯ would be obvious. So take this evidence then add a quarter tone. From here on, you're in the clear!

Fig. 11. Greffin-Klein (n.d.) illustrating the Stein-Zimmermann accidentals and stating the ubiquity of their use. Followed by an excerpt from Philippe Hurel's *So nah, so fern* with Greffin-Klein's commentary on playing it in tune, to illustrate use of Stein-Zimmermann accidentals both in music and in text.

Fig. 12. The requested Stein-Zimmermann quarter-tone accidentals in the PUA of the Nishiki-teki font (https://umihotaru.work/nishiki-teki_pua.pdf).

Fig. 13. The Stein-Zimmermann quarter-tone accidentals in SMuFL (https://w3c.github.io/smufl/latest/tables/stein-zimmermann-accidentals-24-edo.html). (The "narrow" forms in the bottom row are stylistic variants; they have the same meanings.)

	+ 1/4	- 1/4	+ 3/4	- 3/4
Behrens Senegalden (1892)	S	+		
Richard Stein (1905)				
Richard Stein (1923)				
Jörg Mager (1915)				
Willi Mollendörf (1917)				
George Rimsky-Korsakov (1925)				
Julian Carrillo (1920)				
Ivan Wyschnegradsky (1918)				
Aloïs Habà (1920)				
Aloïs Habà (1927)				
John Foulds (1931)				
George Enesco (1934)				
Pierre Boulez (1946)				
Mauricio Kagel (1953)				
Sylvano Bussotti (1958)				
Krysztof Penderecki (1959)				

	+ 1/4	- 1/4	+ 3/4	- 3/4
Mordecai Sandberg (1930)				
B. A. Zimmermann (1960)				
B. A. Zimmermann (1961)				
Charles Ives (1965)				
Roman Vlad (1964)				
Paavo Heininen (1963)				
Marek Koplent (1963)				
Klaus Huber (1965)				
Iannis Xenakis (1966)				
Jean-Etienne Marie (1976)				
Alain Bancquart (1967)				
Björn Fongaard (1968)				
Bruno Bartolozzi (1968)				
Raymond Baervoets (1969)				
Gyorgy Ligeti (1970)				
Witold Lutoslawski (1971)				

Fig. 14. Jedrzejewski (2014: 185–186). A list of quarter-tone notations that have been used by various composers, with the Stein-Zimmermann accidentals highlighted in yellow. (Some of the other shapes used, such as Xenakis' and Etienne-Marie's sharps circled in blue, might be construed as glyph variants of the Stein-Zimmermann accidentals.)

6th tones	六分音						
3rd tones	三分音						
whole tones	全音						
half tones	半音						
quarter tones	四分音						
eighth tones	八分音						

Fig. 15. Japanese Wikipedia (https://ja.wikipedia.org/wiki/微分音), notations for various divisions of the tone: whole tones and half-tones in the middle two rows (standard), third-tones and sixth-tones in the upper two rows, and quarter-tones and eighth-tones in the bottom two rows. The quarter-tones use the Stein-Zimmermann accidentals. The eighth-tones use the already encoded basic accidentals with arrows and the four extended Stein-Zimmermann accidentals REVERSED FLAT AND FLAT DOWN, REVERSED FLAT UP, HALF SHARP DOWN, and ONE AND A HALF SHARP UP.

Figure 2. Notation for the subdivision into quarter tones.

Figure 3. Notation for the subdivision into eighth tones.

Figure 4. Notation for the subdivision into sixteenth tones.
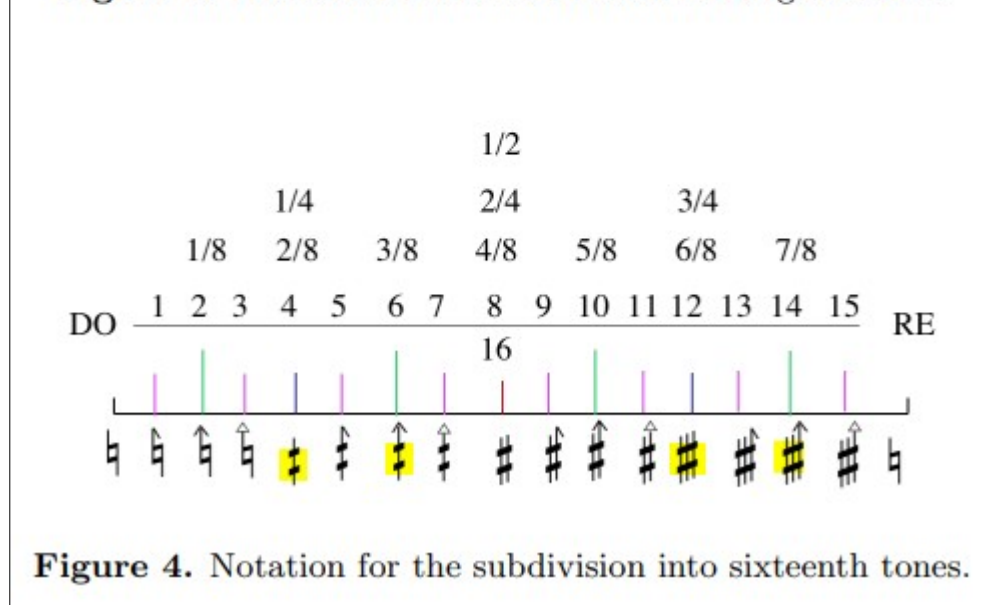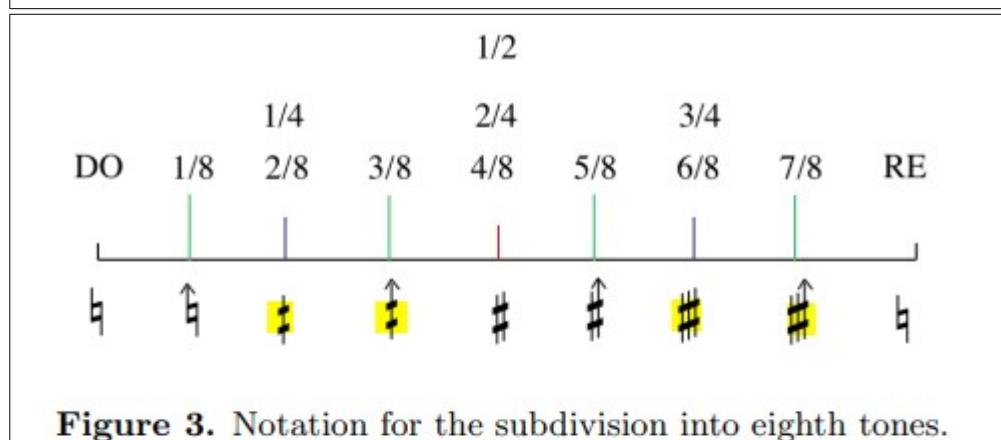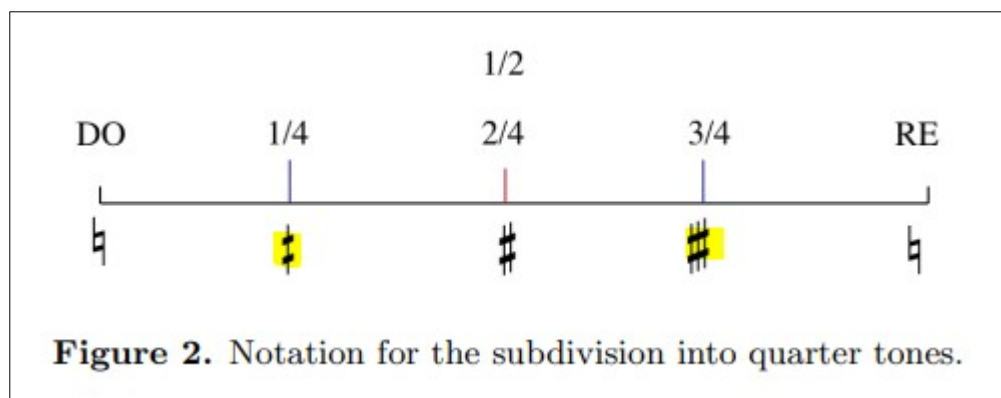
Fig. 16. Bancquart *et al.* (2008). Notation for quarter-tones, eighth-tones and sixteenth-tones used in the OpenMusic software. Quarter-tones are notated using the Stein-Zimmermann accidentals, and eighth-tones by applying arrows. Only raising accidentals and arrows are used. The sixteenth-tones are notated by splitting the arrow: each stroke contributing to the tip of an arrow signifies raising by a sixteenth-tone. (We do not propose the sixteenth-tone symbols as we have not encountered them elsewhere.) The software also proposes notations

for third-tones, fifth-tones, sixth-tones, seventh-tones, tenth-tones, twelfth-tones, and fourteenth-tones, which are also not proposed.

Fig. 1: Modulação por anel entre Dó central (6000 *midicents*) e Dó# oitava acima (7300 *midicents*)[5]. As bandas laterais (*sidebands*) geradas são um Ré -6 cents (6194 *midicents*) e um Sol +70 cents (7970 *midicents*). Fonte: Exemplo dos autores realizado em OpenMusic.
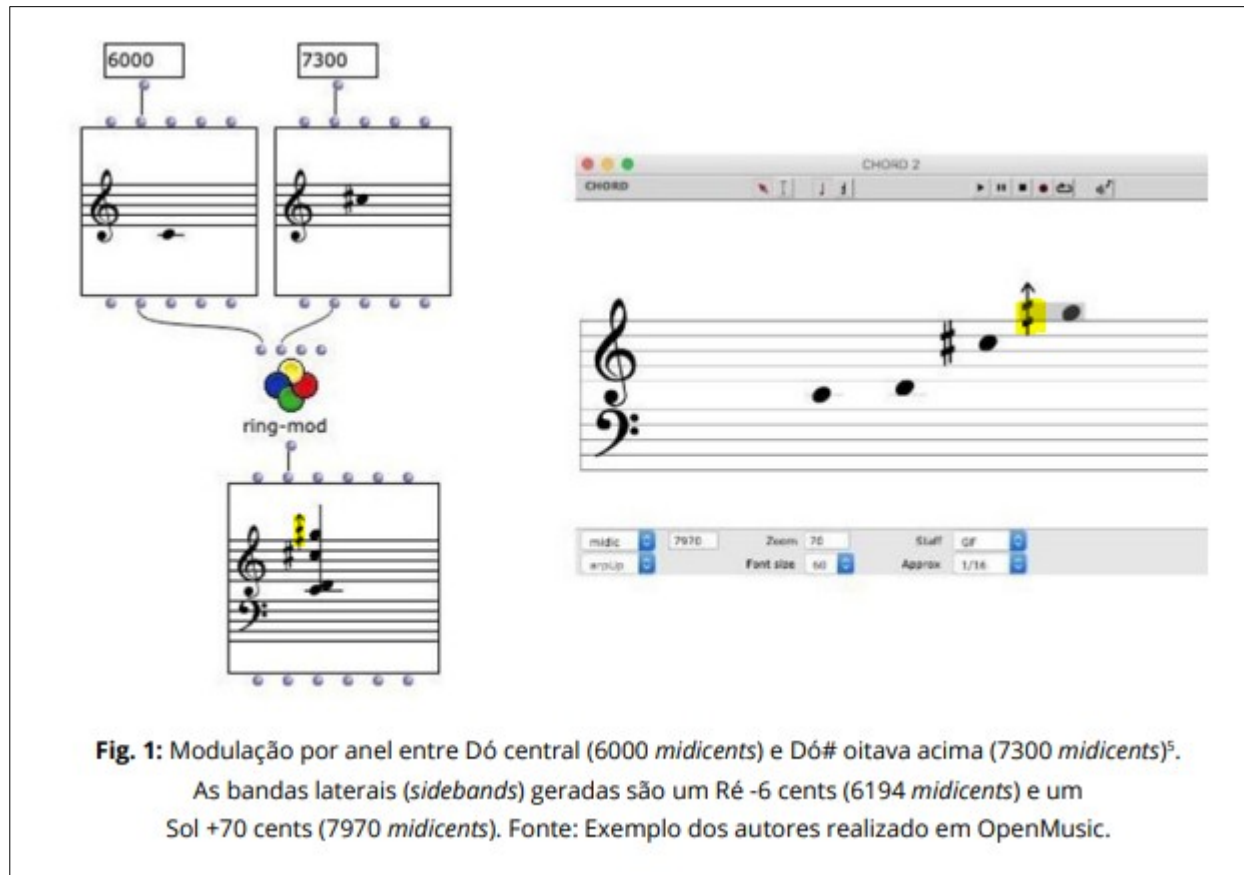
Fig. 17. De Almeida Ribeiro & Neimog (2020).

Fig. 18. Tristan Murail, *Allégories* (1999: 4). Stein-Zimmermann accidentals used for quarter-tones, and U+1D131 ᴍᴜꜱɪᴄᴀʟ ꜱʏᴍʙᴏʟ ꜱʜᴀʀᴘ ᴅᴏᴡɴ used for raising by a 3/8-tone. (Accessible at https://www.tristanmurail.com/pdf/28228.pdf.)

25

Figure 5: Balinese *pélog* (saih 7) Krobokan village
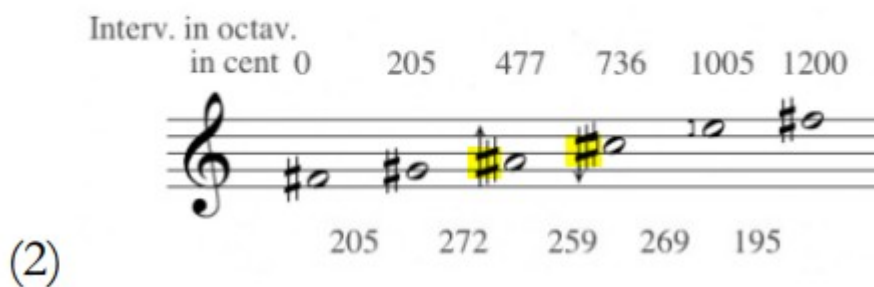
Figure 6: *Sléndro* scale from gender dasa, Kuta village
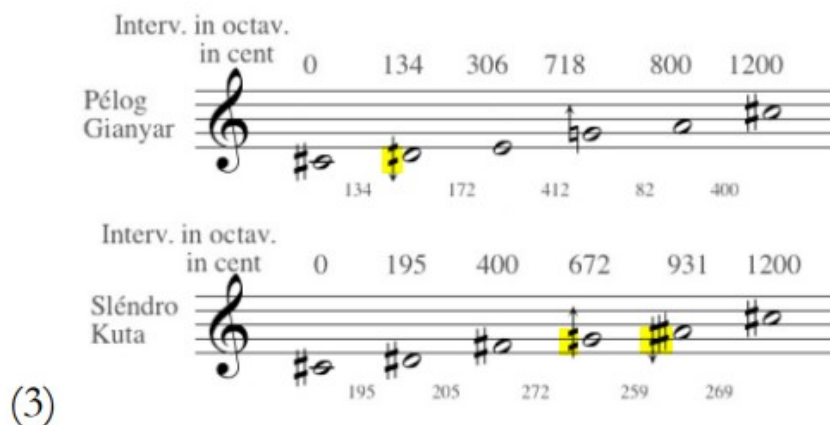
Figure 7: Comparing *pélog* scale with *sléndro* scales[57]

Figure 8: *Sléndro* scale and *pélog* scale from Bali gamelan examples for *prélog* scale and one for *sléndro* scale[58]

Fig. 19. Chahin (2017: 15–16). *Slendro* and *pelog* scales (used in Indonesian gamelan music), approximated in twelfth-tones. The Stein-Zimmermann accidentals are used for quarter-tones, and raising or lowering arrows applied to them (or to the normal accidentals) indicate twelfth-tones.

26

Both systems are used in my theory. The first one, 24-TET, can be seen as an easy way for musicians to read and to perform. The second one, 72-TET, is more precise and better suited for use with overtone music.

Theoretically a composer can go down to about 400-TET, because the human ear barely notices a pitch difference of 2 or 3 cents.[109]

The 72-TET has 72 intervals, each of which has ~16.7 cents. I use both 24-TET and 72-TET tuning systems, which share the accidentals (♮,♯,♯,♭,♭):
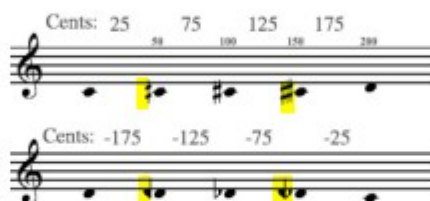
Accidentals used in my composition.
Divisions between *C* and *D* in the 24-TET.
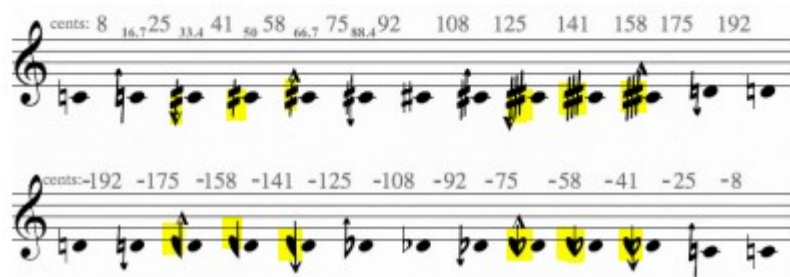
Figure 11: Accidentals used in my composition.
Divisions between *C* and *D* in the 72-TET.

Fig. 20. Chahin (2017: 26). Stein-Zimmermann accidentals used for quarter-tones (24-TET), and their inflections with arrows used for twelfth-tones (72-TET). Chahin uses a filled glyph variant of the reversed flat, with the same meaning as the empty glyph variant.
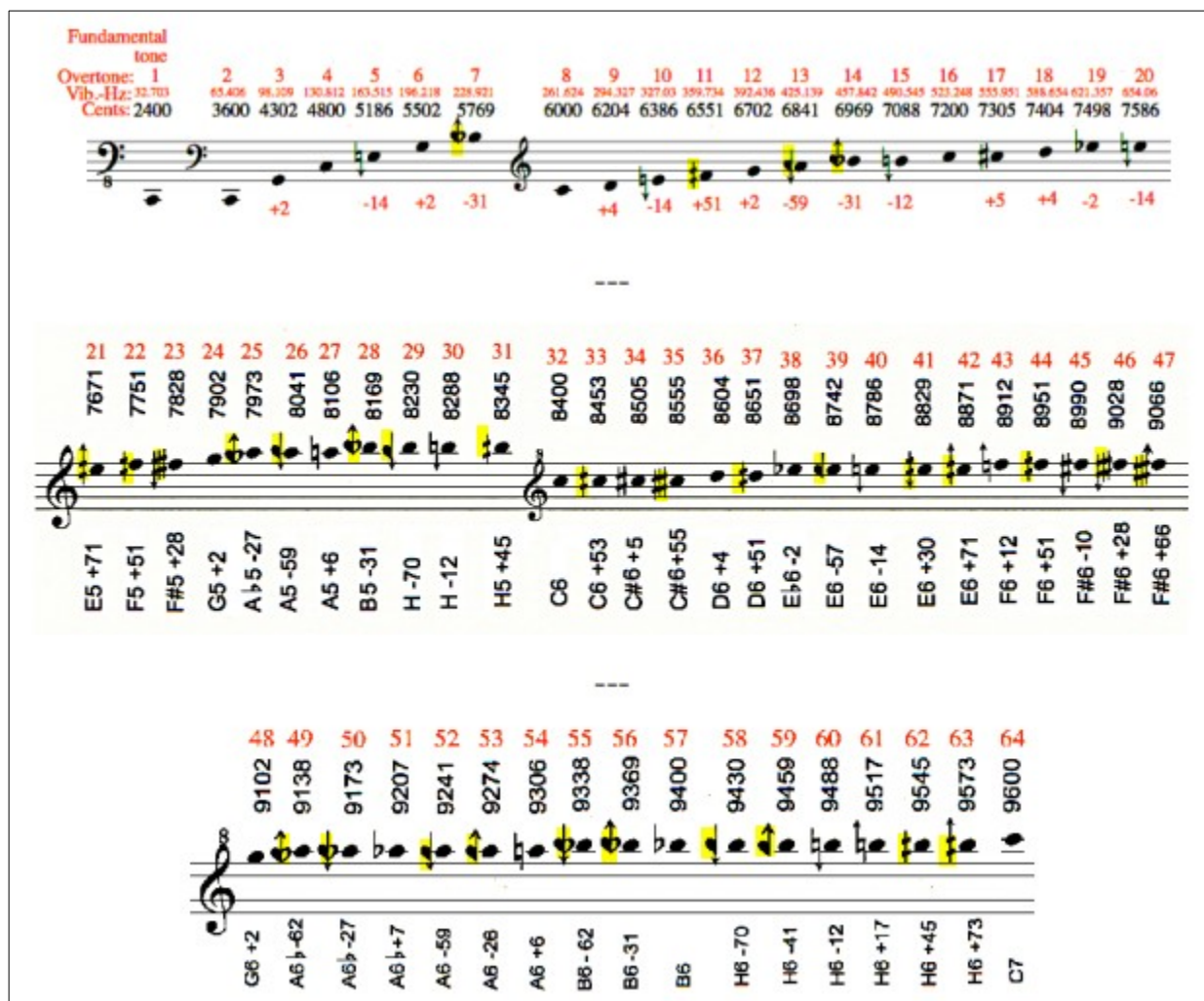
Fig. 21. Chahin (2017: 30). An approximation of the first sixty-four notes of the overtone series in twelfth-tones, notated with extended Stein-Zimmermann accidentals.

ALTÉRATIONS

↑ : Note haussée d'env. 1/8 de ton.

♯ : Note haussée de 1/4 de ton.

♯ : Note haussée de 1/4 de ton + env. 1/8 de ton.

♯ : Note haussée de 1/4 de ton - env. 1/8 de ton.

♯ : Note haussée de 1/2 + env. 1/8 de ton).

♯ : Note haussée de 1/2 de ton - env. 1/8 de ton.

♯ : note haussée de 3/4 de ton.

♯ : Note haussée de 3/4 de ton + env. 1/8 de ton.

♯ : Note haussée de 3/4 de ton - env. 1/8 de ton.

↓ : Note baissée d'env. 1/8 de ton.
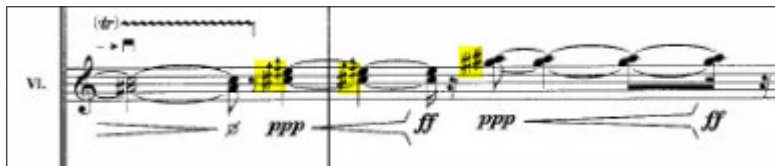
Fig. 22. Philippe Leroux, *Postlude à l'épais* (2016: 2, 14), Billaudot. The sharpening Stein-Zimmermann accidentals, with arrows applied, used to denote eighth-tones.
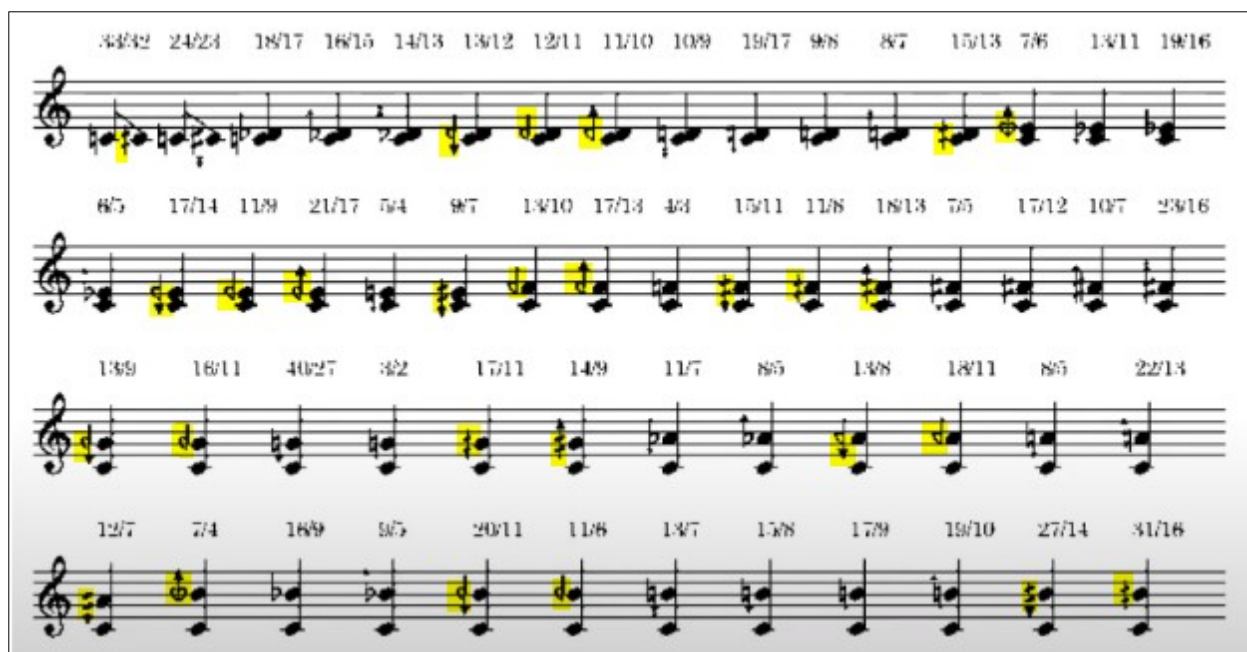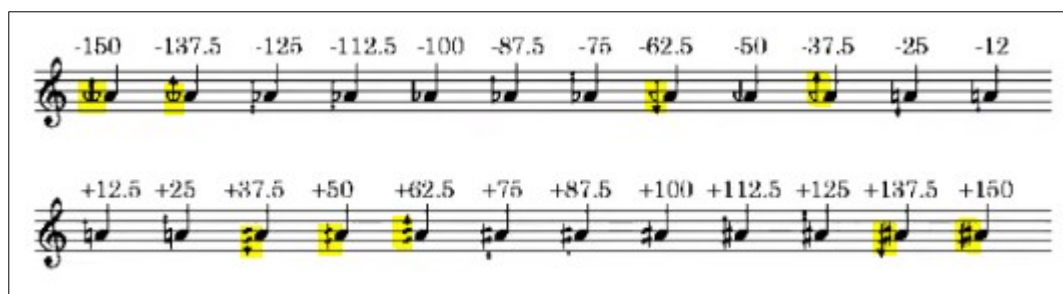
Fig. 23. Randy Wells, *The Persistence of Memory*, taken from score video https://www.youtube.com/watch?v=QAnOwQY55bE.

Extended Stein-Zimmermann accidentals, with the additional help of double-arrows applied to normal accidentals, to notate sixteenth-tones, which are themselves used as an approximation of 31-limit just intonation. (The double-arrowed accidentals are not included in this proposal.)

Glyph	Description	Glyph	Description
	U+E290 *accidentalReversedFlatArrowUp* Reversed flat with arrow up		**U+E291** *accidentalReversedFlatArrowDown* Reversed flat with arrow down
	U+E292 *accidentalFilledReversedFlatArrowUp* Filled reversed flat with arrow up		**U+E293** *accidentalFilledReversedFlatArrowDown* Filled reversed flat with arrow down
	U+E294 *accidentalReversedFlatAndFlatArrowUp* Reversed flat and flat with arrow up		**U+E295** *accidentalReversedFlatAndFlatArrowDown* Reversed flat and flat with arrow down
	U+E296 *accidentalFilledReversedFlatAndFlat* Filled reversed flat and flat		**U+E297** *accidentalFilledReversedFlatAndFlatArrowUp* Filled reversed flat and flat with arrow up
	U+E298 *accidentalFilledReversedFlatAndFlatArrowDown* Filled reversed flat and flat with arrow down		**U+E299** *accidentalHalfSharpArrowUp* Half sharp with arrow up
	U+E29A *accidentalHalfSharpArrowDown* Half sharp with arrow down		**U+E29B** *accidentalOneAndAHalfSharpsArrowUp* One and a half sharps with arrow up
	U+E29C *accidentalOneAndAHalfSharpsArrowDown* One and a half sharps with arrow down		

Fig. 24. Extended Stein-Zimmermann accidentals included in SMuFL
(https://w3c.github.io/smufl/latest/tables/extended-stein-zimmermann-accidentals.html).
As previously noted, the filled reversed flat is merely a glyph variant.

PROPOSAL SUMMARY FORM TO ACCOMPANY SUBMISSIONS
FOR ADDITIONS TO THE REPERTOIRE OF ISO/IEC 10646[1]
Please fill all the sections A, B and C below.
Please read Principles and Procedures Document (P & P) from std.dkuug.dk/JTC1/SC2/WG2/docs/principles.html for guidelines and details before filling this form.
Please ensure you are using the latest Form from std.dkuug.dk/JTC1/SC2/WG2/docs/summaryform.html.
See also std.dkuug.dk/JTC1/SC2/WG2/docs/roadmaps.html for latest *Roadmaps*.

A. Administrative

1. **Title:** *Stein-Zimmermann quarter-tone accidentals*
2. Requester's name: *Gavin Jared Bala, Kirk Miller*
3. Requester type (Member body/Liaison/Individual contribution): *individual*
4. Submission date: *2023 November 19*
5. Requester's reference (if applicable):
6. Choose one of the following:
    This is a complete proposal: *yes*
    (or) More information will be provided later:

B. Technical – General

1. Choose one of the following:
    a. This proposal is for a new script (set of characters): *no*
        Proposed name of script:
    b. The proposal is for addition of character(s) to an existing block: *yes*
        Name of the existing block: *Musical Symbols*
2. Number of characters in proposal: *12*
3. Proposed category (select one from below - see section 2.2 of P&P document):
    A-Contemporary   *x*   B.1-Specialized (small collection)   B.2-Specialized (large collection)
    C-Major extinct   D-Attested extinct   E-Minor extinct
    F-Archaic Hieroglyphic or Ideographic   G-Obscure or questionable usage symbols
4. Is a repertoire including character names provided? *yes*
        a. If YES, are the names in accordance with the "character naming guidelines" in Annex L of P&P document? *yes*
        b. Are the character shapes attached in a legible form suitable for review? *yes*
5. Fonts related:
        a. Who will provide the appropriate computerized font to the Project Editor of 10646 for publishing the standard?
            Kirk Miller
        b. Identify the party granting a license for use of the font by the editors (include address, e-mail, ftp-site, etc.):
            SIL Gentium font release
6. References:
        a. Are references (to other character sets, dictionaries, descriptive texts etc.) provided? *yes*
        b. Are published examples of use (such as samples from newspapers, magazines, or other sources) of proposed characters attached? *yes*
7. Special encoding issues:
        Does the proposal address other aspects of character data processing (if applicable) such as input, presentation, sorting, searching, indexing, transliteration etc. (if yes please enclose information)? *no*

8. Additional Information:

Submitters are invited to provide any additional information about Properties of the proposed Character(s) or Script that will assist in correct understanding of and correct linguistic processing of the proposed character(s) or script. Examples of such properties are: Casing information, Numeric information, Currency information, Display behaviour information such as line breaks, widths etc., Combining behaviour, Spacing behaviour, Directional behaviour, Default Collation behaviour, relevance in Mark Up contexts, Compatibility equivalence and other Unicode normalization related information. See the Unicode standard at www.unicode.org for such information on other scripts. Also see Unicode Character Database (www.unicode.org/reports/tr44/) and associated Unicode Technical Reports for information needed for consideration by the Unicode Technical Committee for inclusion in the Unicode Standard.

---

[1] Form number: N4502-F (Original 1994-10-14; Revised 1995-01, 1995-04, 1996-04, 1996-08, 1999-03, 2001-05, 2001-09, 2003-11, 2005-01, 2005-09, 2005-10, 2007-03, 2008-05, 2009-11, 2011-03, 2012-01)

C. Technical - Justification

1. Has this proposal for addition of character(s) been submitted before? _ _ _ _ _ *no* _ _ _ _ _
   If YES explain _

2. Has contact been made to members of the user community (for example: National Body,
   user groups of the script or characters, other experts, etc.)? _ _ _ *yes* _ _ _ _ _
   If YES, with whom? _ _ _ _ _ *Author is a member of the user community.* _ _ _ _ _ _ _ _ _
   If YES, available relevant documents: _

3. Information on the user community for the proposed characters (for example:
   size, demographics, information technology use, or publishing use) is included? _ _ _ _ _ _ _ _
   Reference: _

4. The context of use for the proposed characters (type of use; common or rare) _ _ _ *music* _ _ _ _ _
   Reference: _

5. Are the proposed characters in current use by the user community? _ _ _ _ _ *yes* _ _ _ _ _
   If YES, where? Reference: _ _ _ _ _ *See figures* _ _ _ _ _ _ _ _ _ _ _ _ _ _

6. After giving due considerations to the principles in the P&P document must the proposed characters be entirely
   in the BMP? _ _ _ _ _ *no* _ _ _ _ _
   If YES, is a rationale provided? _ _ _ _ _ _ _ _
   If YES, reference: _ _ _ _ _ _ _ _ _ _ _ _

7. Should the proposed characters be kept together in a contiguous range (rather than being scattered)? _ _ *yes* _ _

8. Can any of the proposed characters be considered a presentation form of an existing
   character or character sequence? _ _ _ _ _ *no* _ _ _ _ _
   If YES, is a rationale for its inclusion provided? _ _ _ _ _ _ _ _
   If YES, reference: _

9. Can any of the proposed characters be encoded using a composed character sequence of either
   existing characters or other proposed characters? _ _ _ _ _ *no* _ _ _ _ _
   If YES, is a rationale for its inclusion provided? _ _ _ _ _ _ _ _
   If YES, reference: _

10. Can any of the proposed character(s) be considered to be similar (in appearance or function)
    to, or could be confused with, an existing character? _ _ _ _ _ *no* _ _ _ _ _
    If YES, is a rationale for its inclusion provided? _ _ _ _ _ _ _ _
    If YES, reference: _

11. Does the proposal include use of combining characters and/or use of composite sequences? _ _ _ *no* _ _ _
    If YES, is a rationale for such use provided? _ _ _ _ _ _ _ _
    If YES, reference: _
    Is a list of composite sequences and their corresponding glyph images (graphic symbols) provided? _ _ _ _
    If YES, reference: _

12. Does the proposal contain characters with any special properties such as
    control function or similar semantics? _ _ _ _ _ *no* _ _ _ _ _
    _ _ _ _ _ _ If YES, describe in detail (include attachment if necessary) _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
    _
    _

13. Does the proposal contain any Ideographic compatibility characters? _ _ _ _ _ *no* _ _ _ _ _
    If YES, are the equivalent corresponding unified ideographic characters identified? _ _ _ _ _ _ _ _
    If YES, reference: _