Marc Sabat

Euler Lattice Spirals Scenery

for string quartet

PLAINSOUND MUSIC EDITION

Euler Lattice Spirals Scenery (2011/12)

for string quartet

written for and premiered by the Sonar Quartett Berlin
(Wojciech Garbowski, Cosima Gerhardt, Nikolaus Schlierf, Suzanne Zapf)

composed during a one-year residency in Rome
at the Accademia Tedesca Villa Massimo

This work is the third in an ongoing cycle of string quartets in which musical forms emerge as consequences of explicitly notated intonation. The title refers to Leonhard Euler's discovery of a two-dimensional diagram representing the harmonic space subset based on octave equivalence, pure fifths and thirds: a tonal lattice that models triadic harmony, or in James Tenney's terminology: *(3,5) projection space*.

An extended portion of this lattice, comprising 99 distinct microtonal pitch-classes organised as a progression of major and minor triads tuned in Just Intonation, forms the basis of the fourth movement, *Harmonium for Ben Johnston*. Each triad occurs only once, and for the most part connects to its neighbors by a shared common tone, until reaching the small enharmonic seam in the middle of the movement, from which point a retrograde inversion of the triads begins. The triads are ordered in such a way that all possible common-tone progressions are explored, and also that the progression of triads which opens the piece recurs in the middle of the movement, transposed upward by two commas.

To realize this modulation into distant regions, the open strings of the quartet must be precisely tuned in 3:2 ratio untempered fifths, so that the comma distinctions and partial unisons between open strings may be optimised. Thus, the composition is completed by four additional movements, which explicitly compose the tuning procedure *(Preludio)*, investigate the Pythagorean sonorities of the lower natural harmonics *(Pythagoras Drawing I* and *II)*, and present the unisons and commas of higher natural harmonics in the registers they occur *(Harmonium for Claude Vivier)* as an ecstatic singing melody.

Rome, 28 October 2011 / Berlin, 6 March 2012

An informal introduction to the Helmholtz-Ellis Accidentals
by Marc Sabat

Berlin, April 2009

In learning to read HE accidentals, without having to rely on an electronic tuning device, it is important to be familiar with three things:

First, to keep in mind the natural tuning of intervals in a harmonic series, which deviate from the tempered system.

Second, to get to know how the accidentals refer to these overtone relationships.

Third, to observe that each written pitch may be related to many other pitches by natural intervals, and to tune it accordingly.

In most cases, this approach will allow the player to quickly and intuitively play just intonation (JI) pitches quite accurately. Any remaining adjustments can be made by ear, based on the specific sound of JI intervals.

Just intervals are readily learned because they are built up from simple, tuneable harmonic relationships. These are generally based on eliminating beating between common partials, finding common fundamentals and audible combination tones, and establishing a resonant, stable sonority which maximizes clarity: both of consonance and of dissonance.

A well-focussed JI sound is completely distinct from the irregular, fuzzy beating of tempered sounds. Just consonances, when marginally out of tune, beat slowly and sweetly and may be corrected with the most subtle adjustments of bowing or breath. Just dissonances produce a sharply pulsing regular rhythm and have very clear, distinct colors.

To become familiar with the notation and sounds of JI, the fundamental building blocks are prime number overtones 3, 5, 7, 11 and 13, each of which is associated with a specific pair of accidentals and a basic musical interval.

3 is associated with the signs flat, natural, sharp and refers to the series of untempered perfect fifths (Pythagorean intonation). Generally, A is taken as the tuning reference, and the central pitches C-G-D-A-E can be imagined as the normal tuning of the orchestral string instruments. The just C is rather lower than tempered tuning because of the pure fifths. The further this series is extended, the greater the deviation from tempered tuning: the flats are lower, the sharps higher.

5 is associated with arrows attached to the flat, natural, sharp signs and refers to the pure major third. These arrows correct the Pythagorean intervals by a Syntonic Comma, which is approximately 1/9 of a wholetone or 22 cents. So, for example, the note E-flat arrow-up is a just major third below G, and the note F-sharp arrow-down is a major third above D. In most music, flats are often raised by a comma and sharps are lowered. Because of the open string tuning, it is common to sometimes raise F and C (to match A and E) and to sometimes lower A and E (to match F and C). Corrections by one Syntonic Comma have been used throughout Western music history and are relatively familiar to the ear. However, traditionally these corrections have been hidden by players, for example in Meantone Temperament where fifths are mistuned narrow by ¼ comma so that the third C-E ends up sounding pure. More recently, the currently prevailing Equal Temperament has made us accustomed to beating thirds, so at first the pure intervals may seem unfamiliar. To play the arrows accurately, one must carefully learn the sound of the consonant major and minor thirds and sixths, and learn to articulate comma differences clearly.

7 is associated with a Tartini sign resembling the numeral. It corrects the Pythagorean intervals by a Septimal Comma, which is approximately 1/7 of a wholetone or 27 cents. When the Pythagorean minor third is lowered by this amount, it becomes a noticeably low third often heard in Blues music.

11 is associated with the quartertone signs (cross and backwards flat). The accidental is used to raise the perfect fourth by 53 cents, producing the exact tuning of the 11th partial in a harmonic series. The sound is most easily learned by playing one octave plus one fourth and raising it by a quartertone.

13 is associated with the thirdtone signs (cross and backwards flat, each with 2 verticals). The accidental is used to lower the Pythagorean major sixth by 65 cents, producing the exact tuning of the 13th partial in a harmonic series. The sound is most easily learned as a neutral-sounding sixth, one-third of the way between the just minor and just major sixths (closer to minor than to major).

The following table presents the accidentals together with their associated ratios and cents deviations. To calculate the cents deviation from Equal Temperament of a specific written pitch (if desired) the following shortcut may be used:

1.) Find the cents deviation of the Pythagorean pitch, by calculating how many fifths it is away from A, multiplying by 2, and using a plus sign if it is on the sharp side and a minus if it is on the flat side.

2.) For each microtonal accidental, add or subtract its approximate cents value (as given above), keeping in mind whether the accidental is raising or lowering the pitch.

The resulting value should be a cents deviation within 1 or 2 cents accuracy, which is an acceptable starting point for fine-tuning by ear.

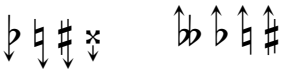
ACCIDENTALS

EXTENDED HELMHOLTZ-ELLIS JI PITCH NOTATION

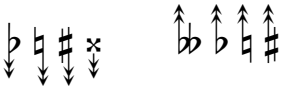
for Just Intonation
designed by Marc Sabat and Wolfgang von Schweinitz

The exact intonation of each pitch may be written out by means of the following harmonically-defined signs:

Pythagorean series of fifths – the open strings
(… c g d a e …)



lowers / raises by a syntonic comma
81 : 80 = ***circa 21.5 cents***



lowers / raises by two syntonic commas
circa 43 cents

lowers / raises by a septimal comma
64 : 63 = ***circa 27.3 cents***

lowers / raises by two septimal commas
circa 54.5 cents

raises / lowers by an 11-limit undecimal quarter-tone
33 : 32 = ***circa 53.3 cents***

lowers / raises by a 13-limit tridecimal third-tone
27 : 26 = ***circa 65.3 cents***

lowers / raises by a 17-limit schisma
256 : 255 = ***circa 6.8 cents***

raises / lowerss by a 19-limit schisma
513 : 512 = ***circa 3.4 cents***

raises / lowers by a 23-limit comma
736 : 729 = ***circa 16.5 cents***

In addition to the harmonic definition of a pitch by means of its accidentals, it is also possible to indicate its absolute pitch-height as a cents-deviation from the respectively indicated chromatic pitch in the 12-tone system of Equal Temperament.

The attached arrows for alteration by a syntonic comma are transcriptions of the notation that Hermann von Helmholtz used in his book "Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik" (1863). The annotated English translation "On the Sensations of Tone as a Physiological Basis for the Theory of Music" (1875/1885) is by Alexander J. Ellis, who refined the definition of pitch within the 12-tone system of Equal Temperament by introducing a division of the octave into 1200 cents. The sign for a septimal comma was devised by Giuseppe Tartini (1692-1770) – the composer, violinist and researcher who first studied the production of difference tones by means of double stops.

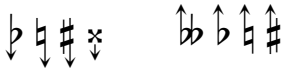
VORZEICHEN

EXTENDED HELMHOLTZ-ELLIS JI PITCH NOTATION

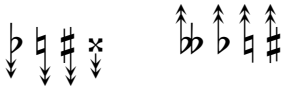
für die natürliche Stimmung
konzipiert von Marc Sabat und Wolfgang von Schweinitz

Die Stimmung jedes Tons ist mit folgenden harmonisch definierten Vorzeichen ausnotiert:

Pythagoreische Quintenreihe der leeren Streicher-Saiten
(… c g d a e …)



Erniedrigung / Erhöhung um ein Syntonisches Terzkomma
81 : 80 = ***circa 21.5 cents***



Erniedrigung / Erhöhung um zwei Syntonische Terzkommas
circa 43 cents

Erniedrigung / Erhöhung um ein Septimenkomma
64 : 63 = ***circa 27.3 cents***

Erniedrigung / Erhöhung um zwei Septimenkommas
circa 54.5 cents

Erhöhung / Erniedrigung um den undezimalen Viertelton der 11er-Relation
33 : 32 = ***circa 53.3 cents***

Erniedrigung / Erhöhung um den tridezimalen Drittelton der 13er-Relation
27 : 26 = ***circa 65.3 cents***

Erniedrigung / Erhöhung um ein Siebzehner-Schisma
256 : 255 = ***circa 6.8 cents***

Erhöhung / Erniedrigung um ein Neunzehner-Schisma
513 : 512 = ***circa 3.4 cents***

Erhöhung / Erniedrigung um ein Dreiundzwanziger-Komma
736 : 729 = ***circa 16.5 cents***

Zusätzlich zu der harmonischen Definition der Tonhöhe durch das Vorzeichen für jeden Ton ist auch der Cents-Wert der Abweichung der gewünschten Stimmung von der Tonhöhe des jeweils bezeichneten chromatischen Tons der gleichstufig temperierten Zwölfton-Skala angegeben.

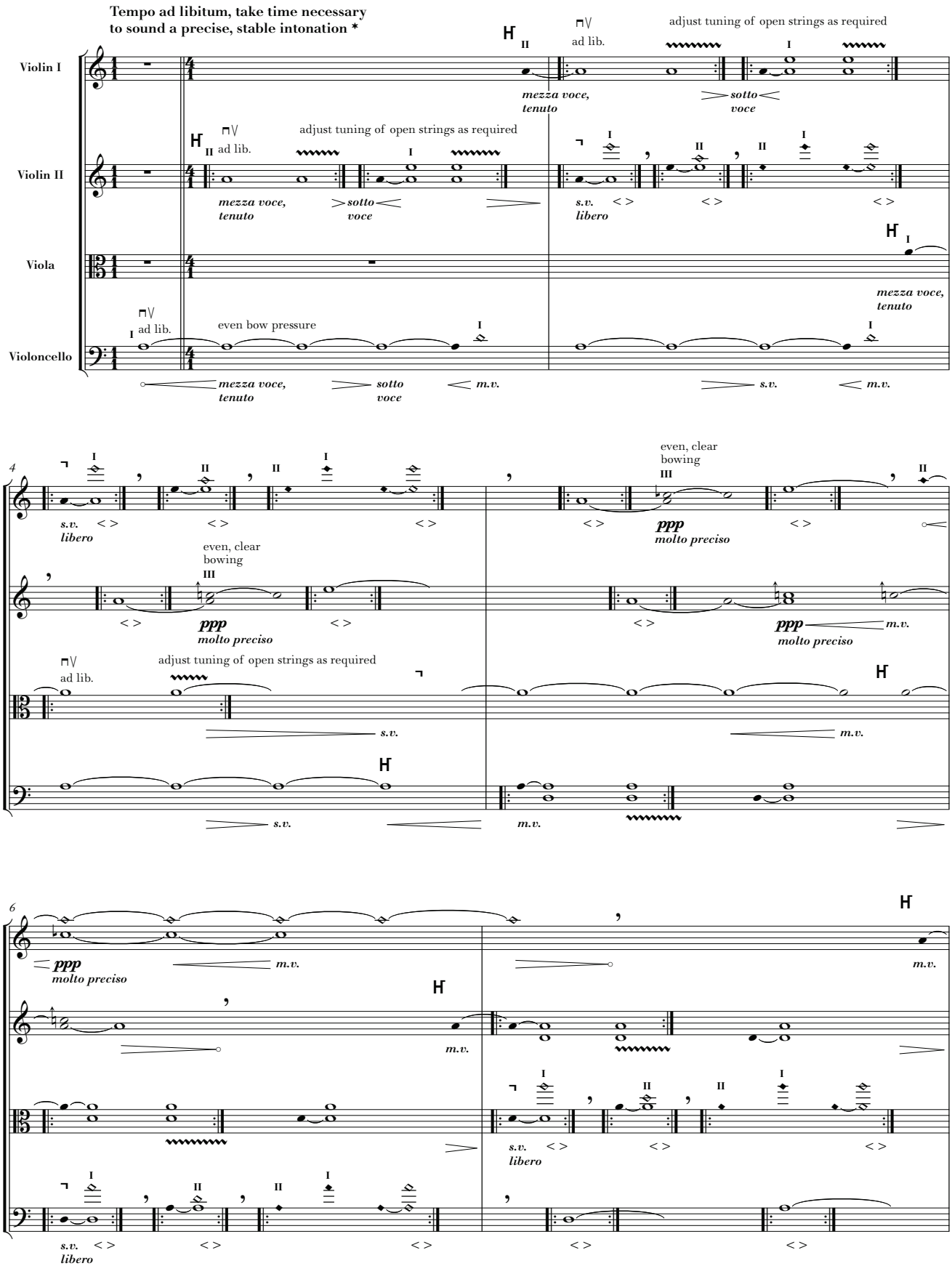
Die attachierten Pfeile für die Alteration um ein Syntonisches Terzkomma sind eine bloße Transkription der Notation, die Hermann von Helmholtz in seinem Buch "Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik" (1863) verwendet hat. Die kommentierte englische Übersetzung "On the Sensations of Tone as a Physiological Basis for the Theory of Music" (1875/1885) stammt von Alexander J. Ellis, der auch eine enorme Verfeinerung der Tonhöhendefinition innerhalb des Zwölftonsystems der gleichstufig temperierten Stimmung durch die Unterteilung der Oktave in 1200 Cents eingeführt hat. – Das Vorzeichen für die Alteration um ein Septimenkomma wurde von Giuseppe Tartini (1692-1770) erfunden, der als Komponist, Geiger und Wissenschaftler die durch Doppelgriffe erzeugten Differenztöne untersucht hat.

Score

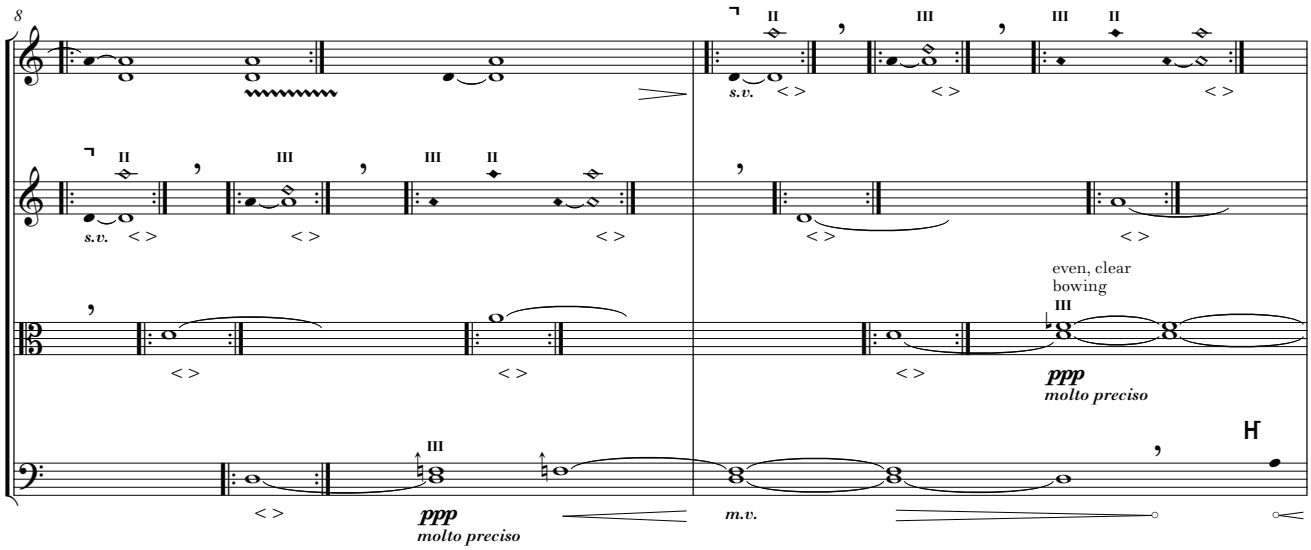
Euler Lattice Spirals Scenery

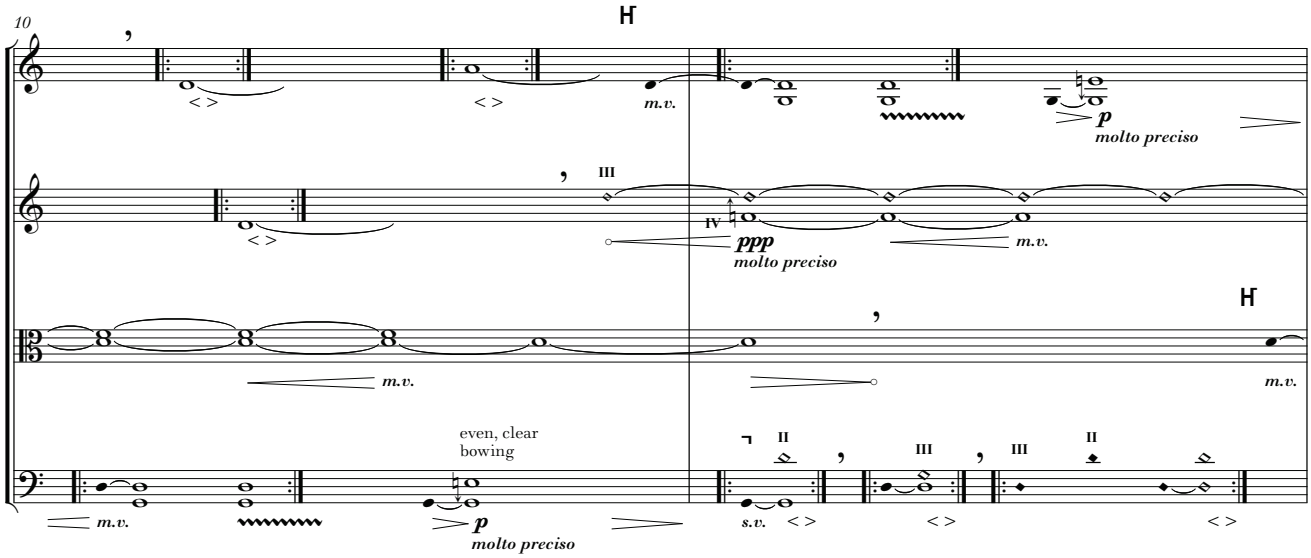
Preludio : Les Quintes Justes

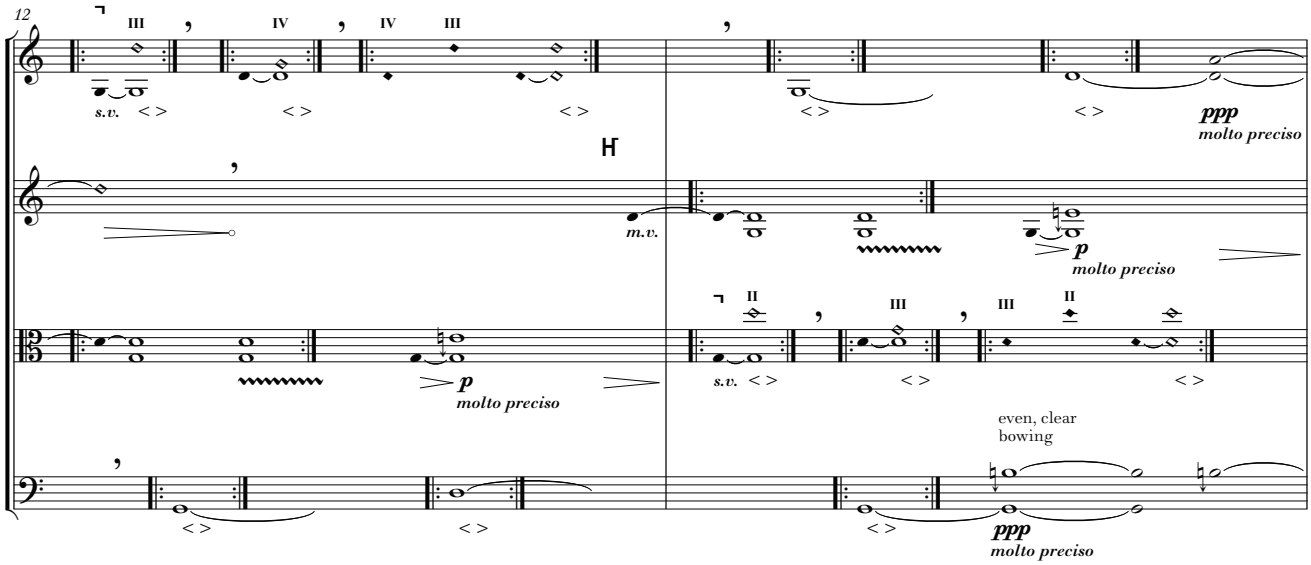
Marc Sabat

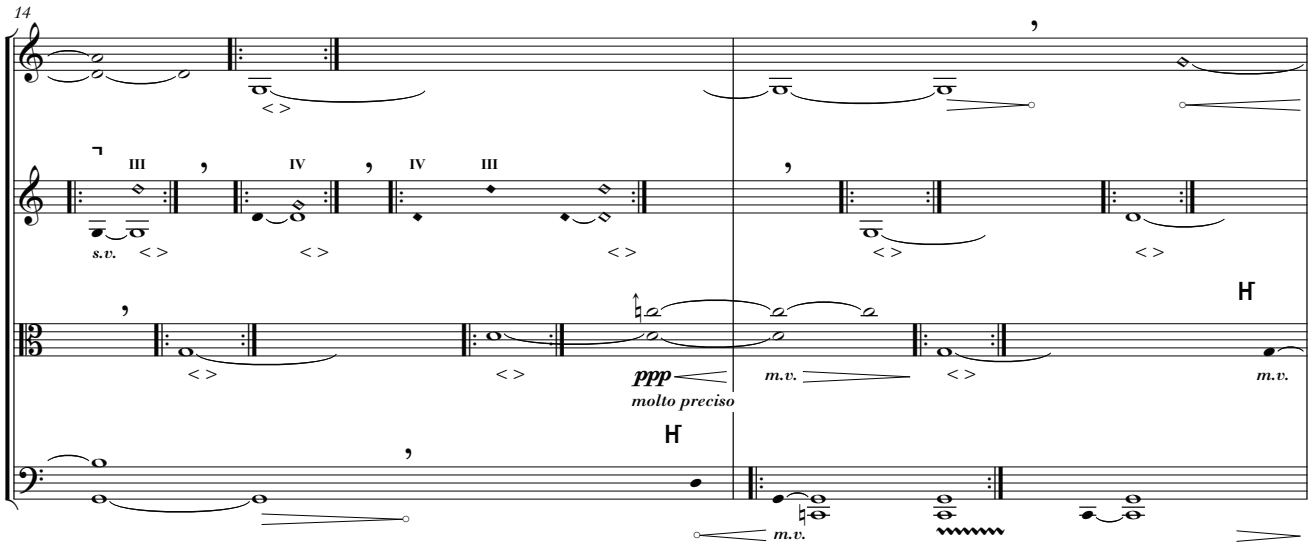


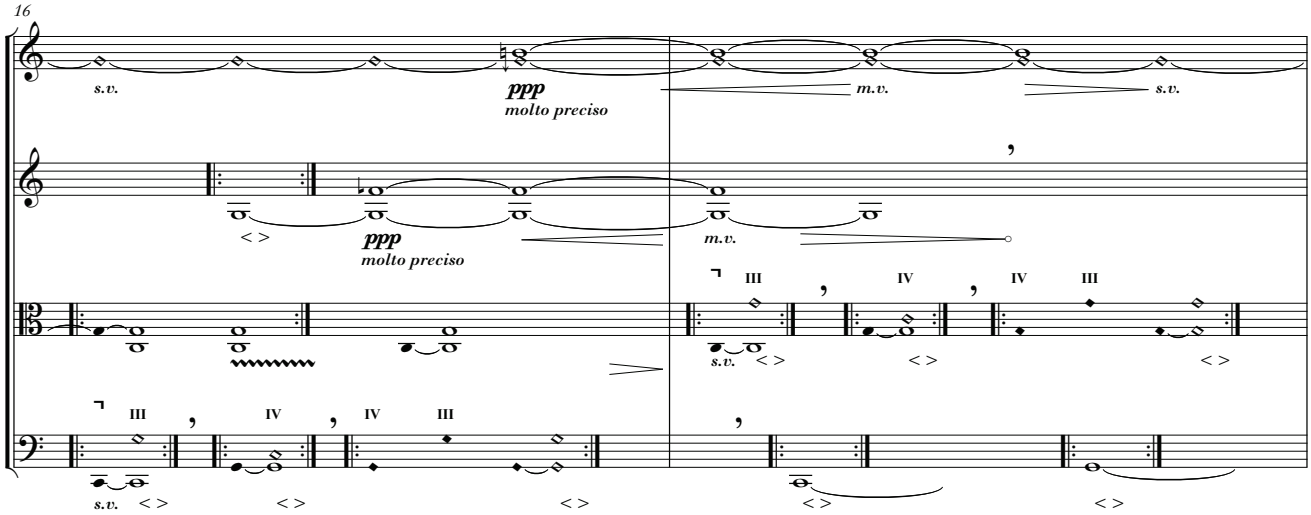
* open strings are to be tuned just with A preferably at 440Hz: measured in cents relative to 12-tone equal temperament : E +2, A 0, D -2, G -4, C -6
before playing this movement, it is sufficient to have the strings relatively close to a good tuning, with the cello A-string tuned exactly —
the patterns to be interwoven dynamically and repeated freely in the manner of normal tuning procedure, to achieve the most precise tuning as swiftly as possible

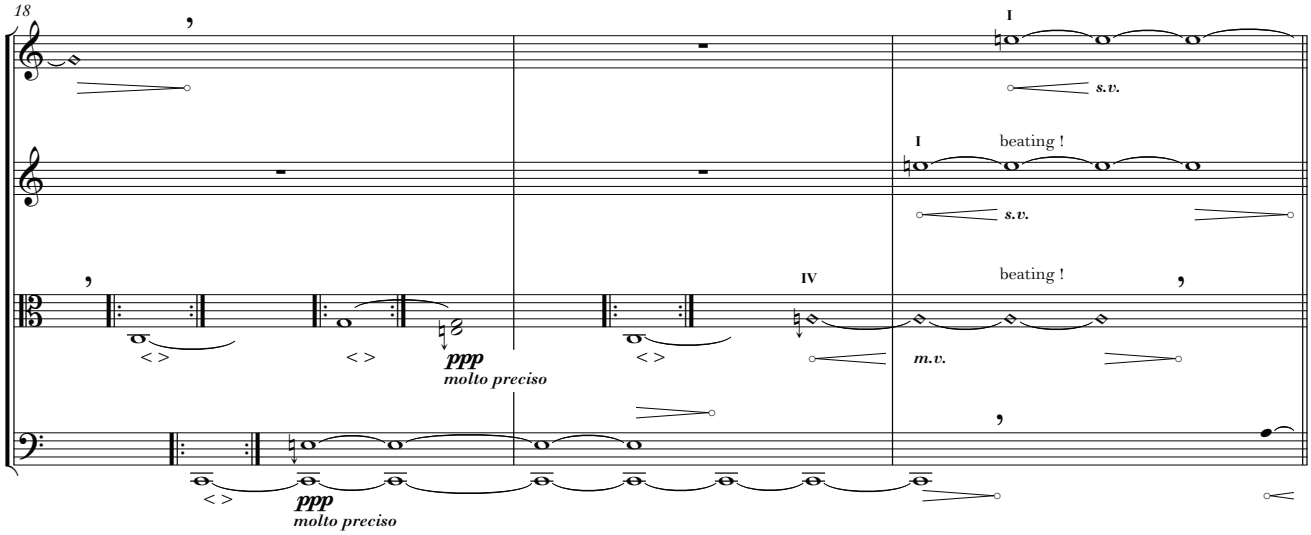

8
s.v.
even, clear bowing
ppp
molto preciso
m.v.


10
m.v.
p
molto preciso
ppp
even, clear bowing
s.v.


12
s.v.
m.v.
p
molto preciso
ppp
even, clear bowing

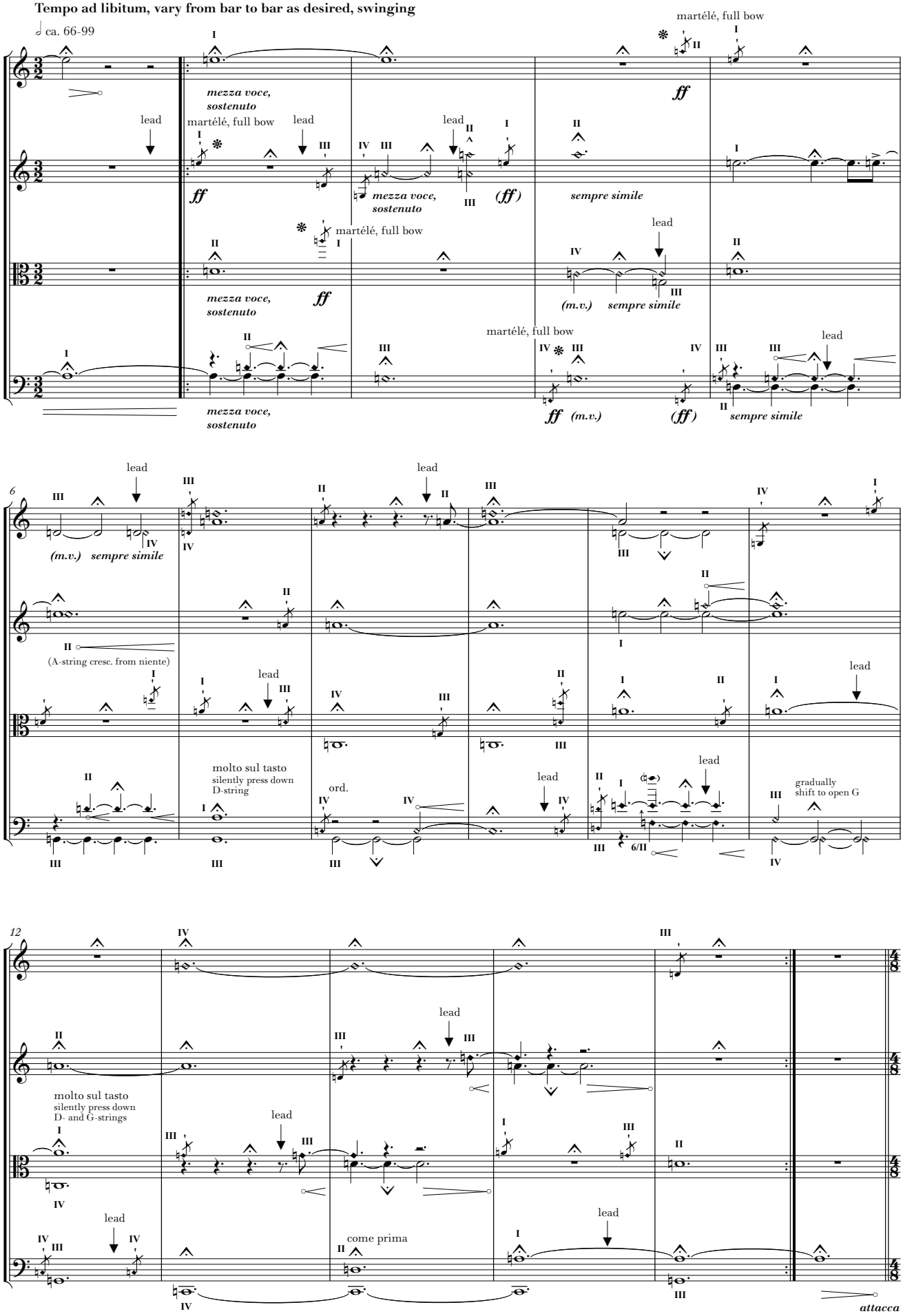

14
III
IV
IV
III
s.v.
ppp
molto preciso
m.v.
m.v.
m.v.
m.v.


16
s.v.
ppp
molto preciso
m.v.
s.v.
III
IV
IV
III


18
I
s.v.
beating !
IV
ppp
molto preciso
m.v.

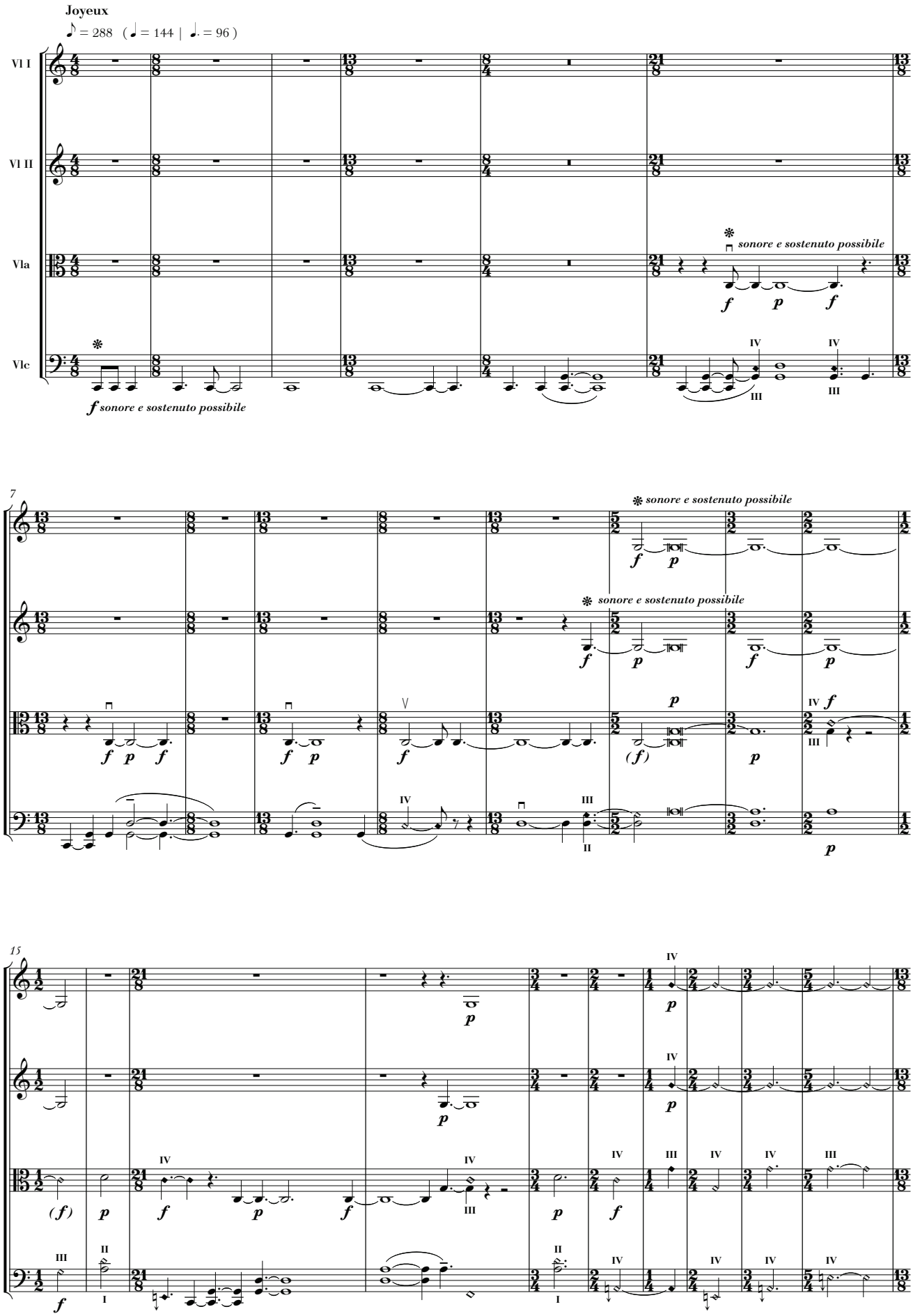
Pythagoras Drawing (I)

Tempo ad libitum, vary from bar to bar as desired, swinging

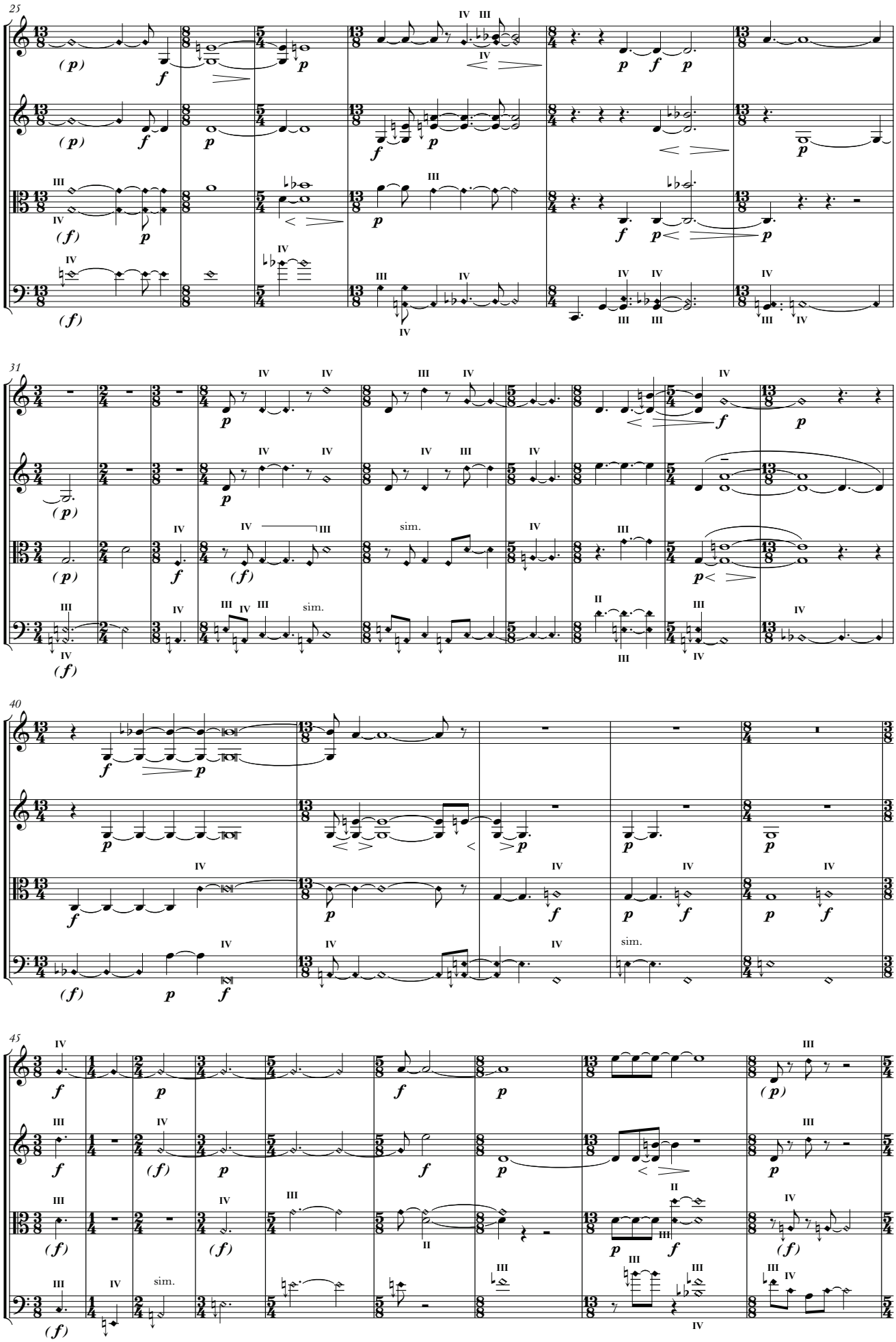


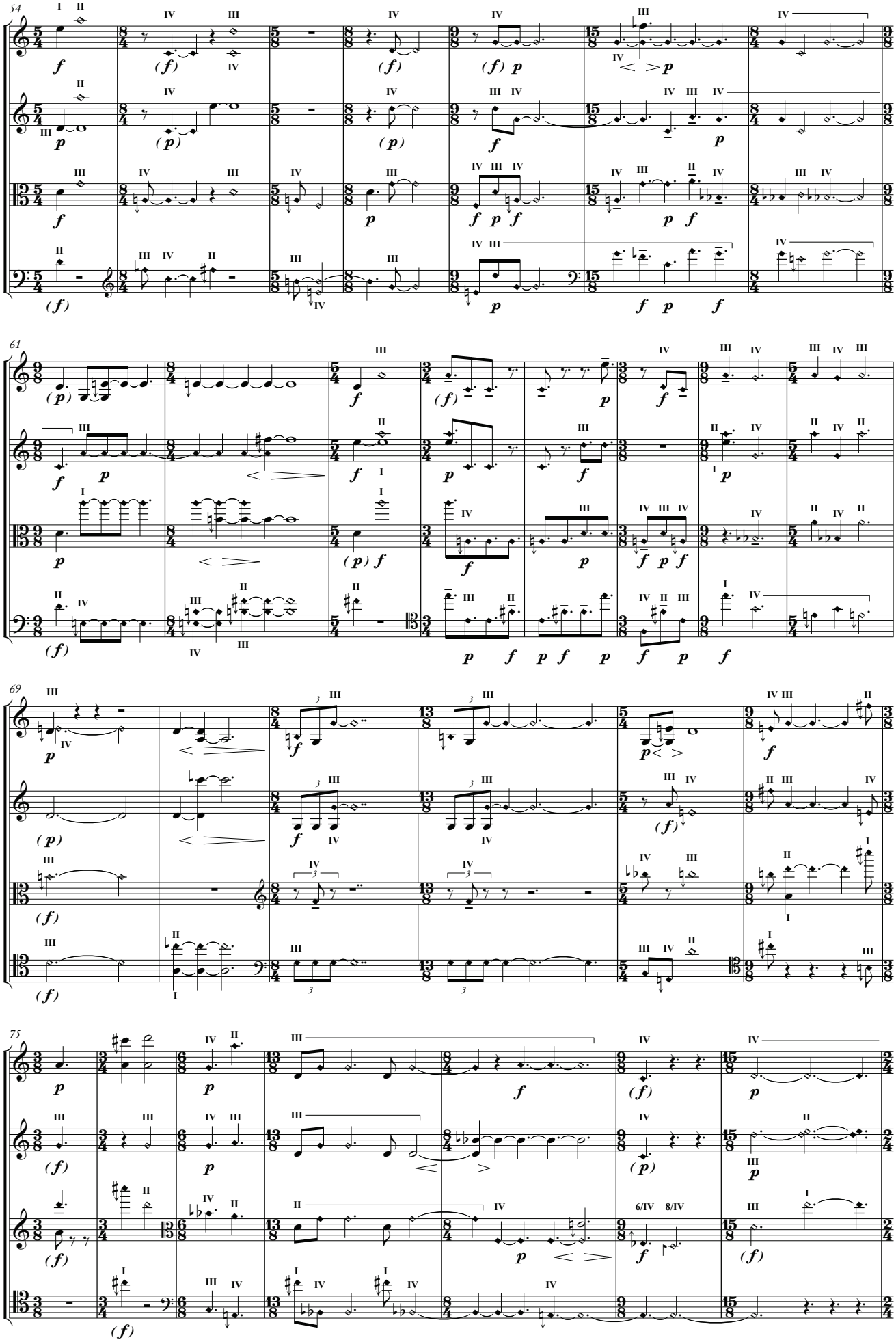
* grace notes placed at beginning and end of bar are not to be deliberately synchronized between the instruments

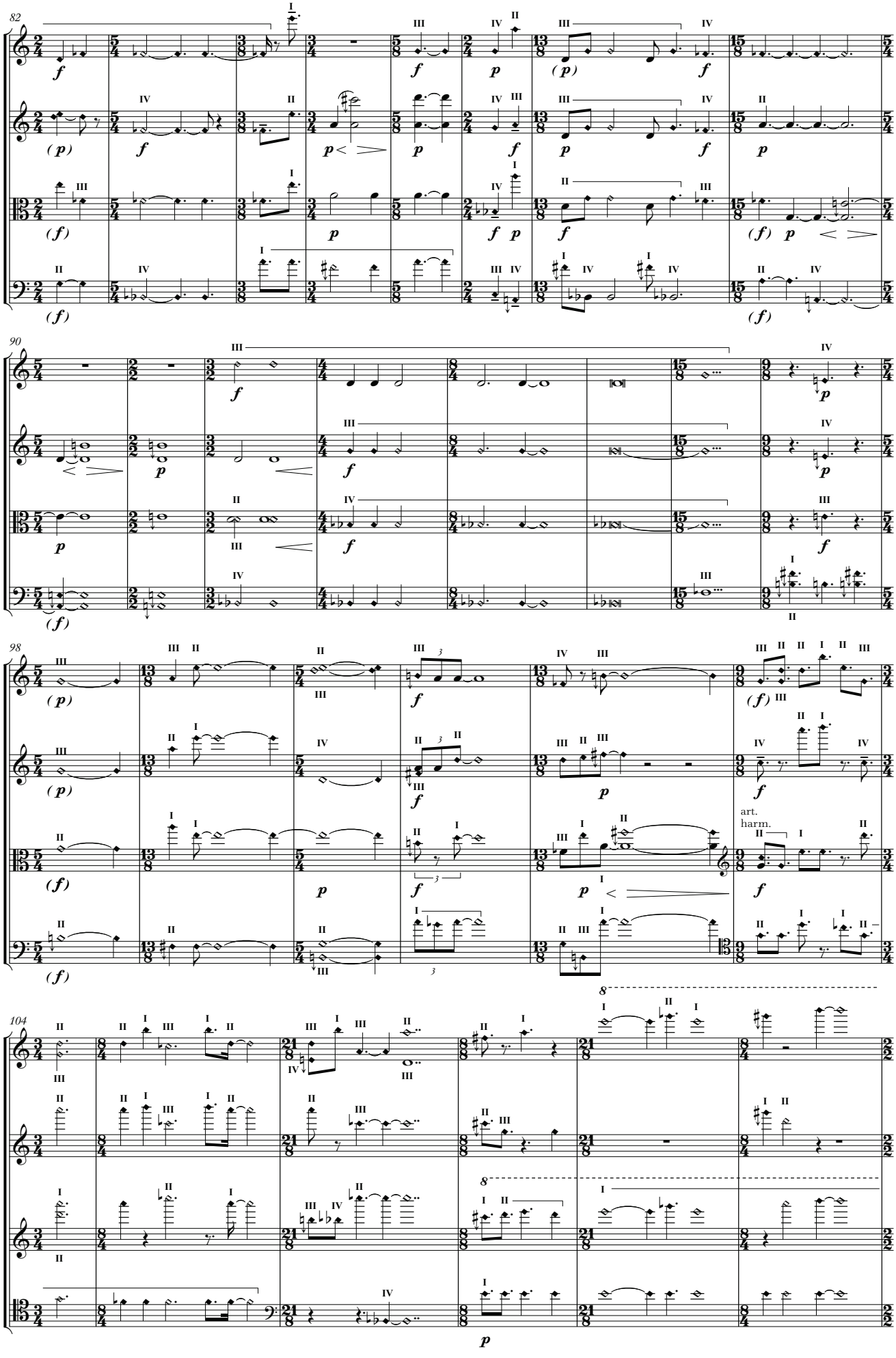
Harmonium for Claude Vivier

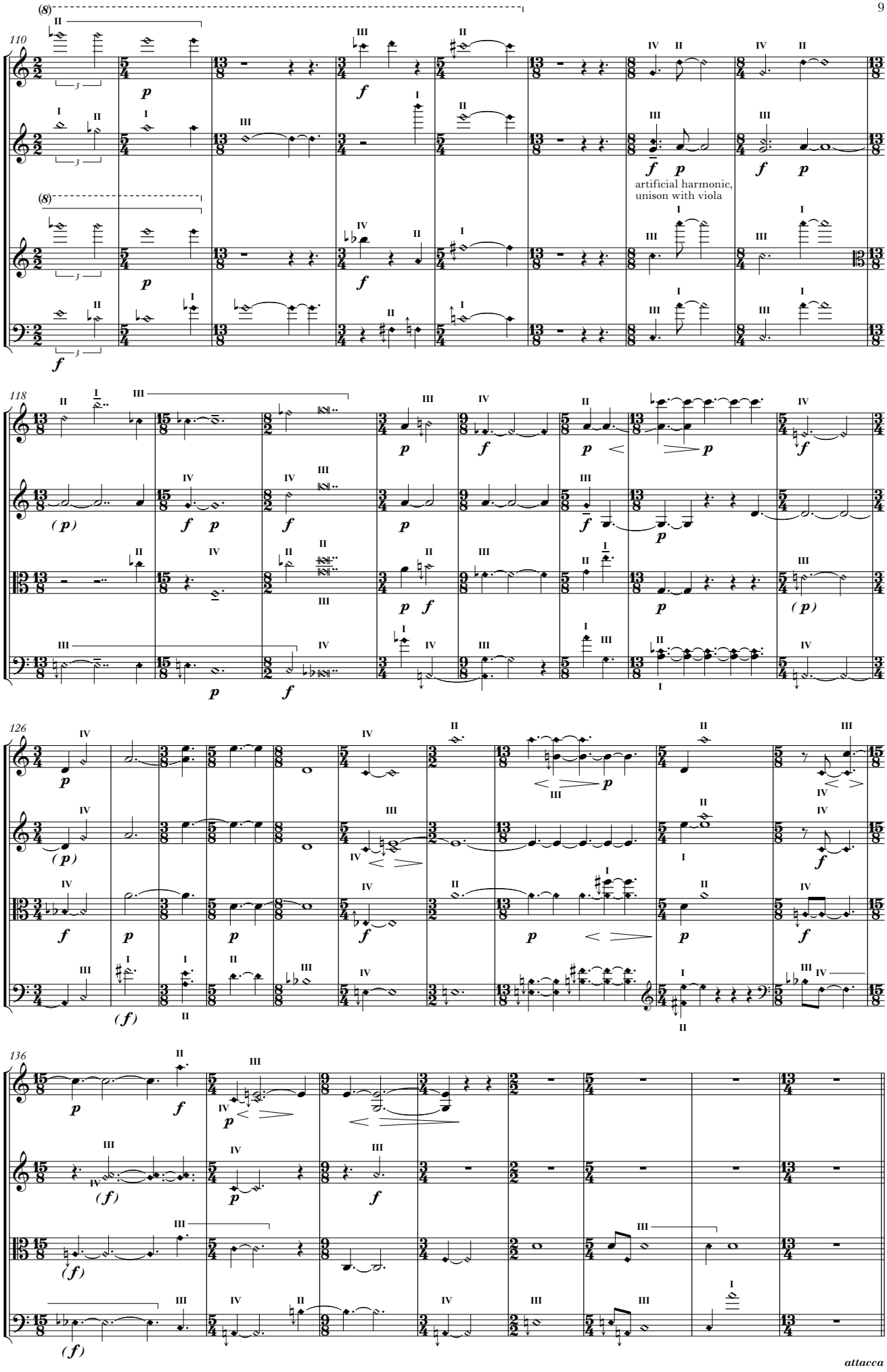


* this section is played on open strings and natural harmonics whenever possible, with the exception of occasional stopped pitches

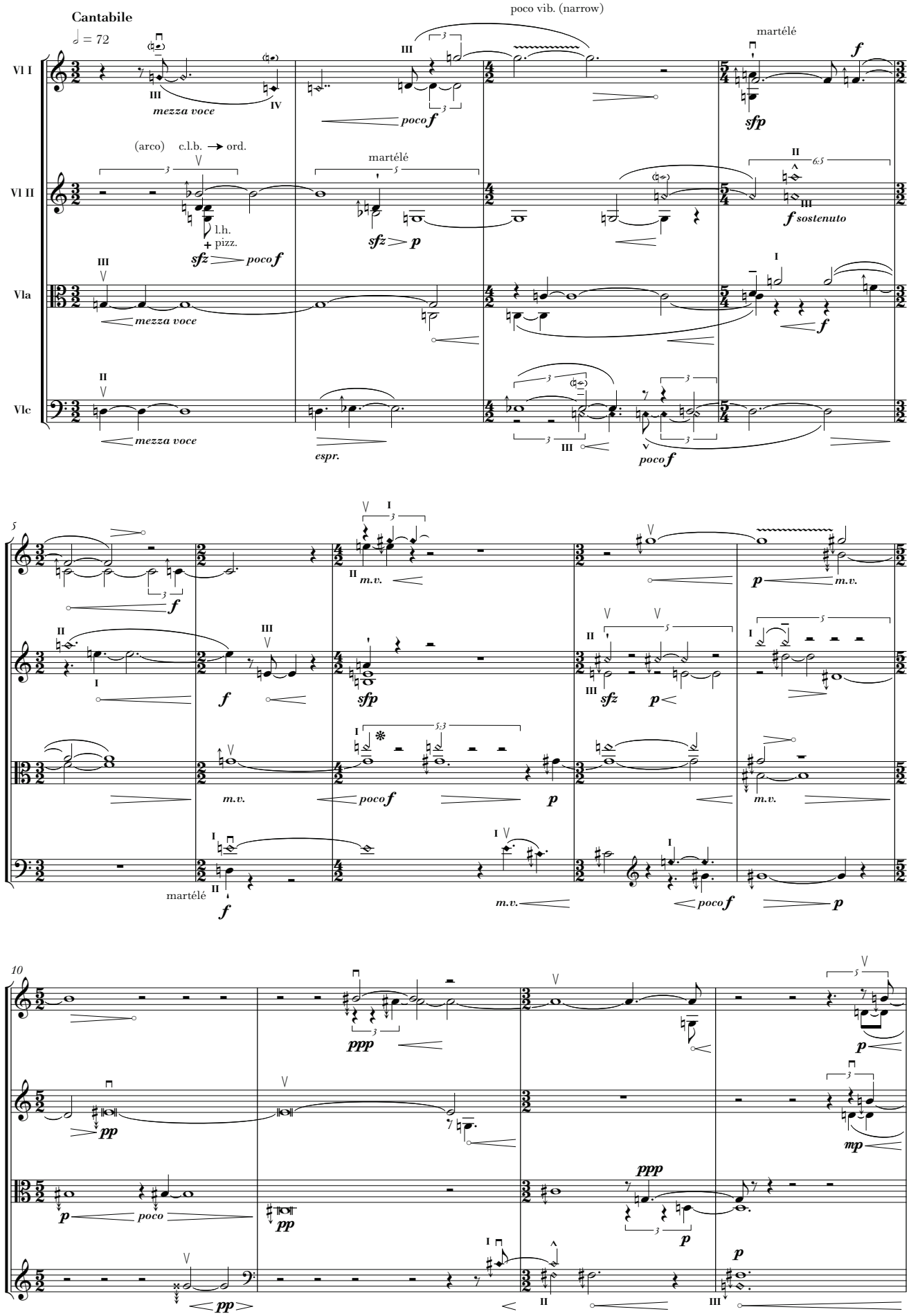

25
31
40
45
sim.

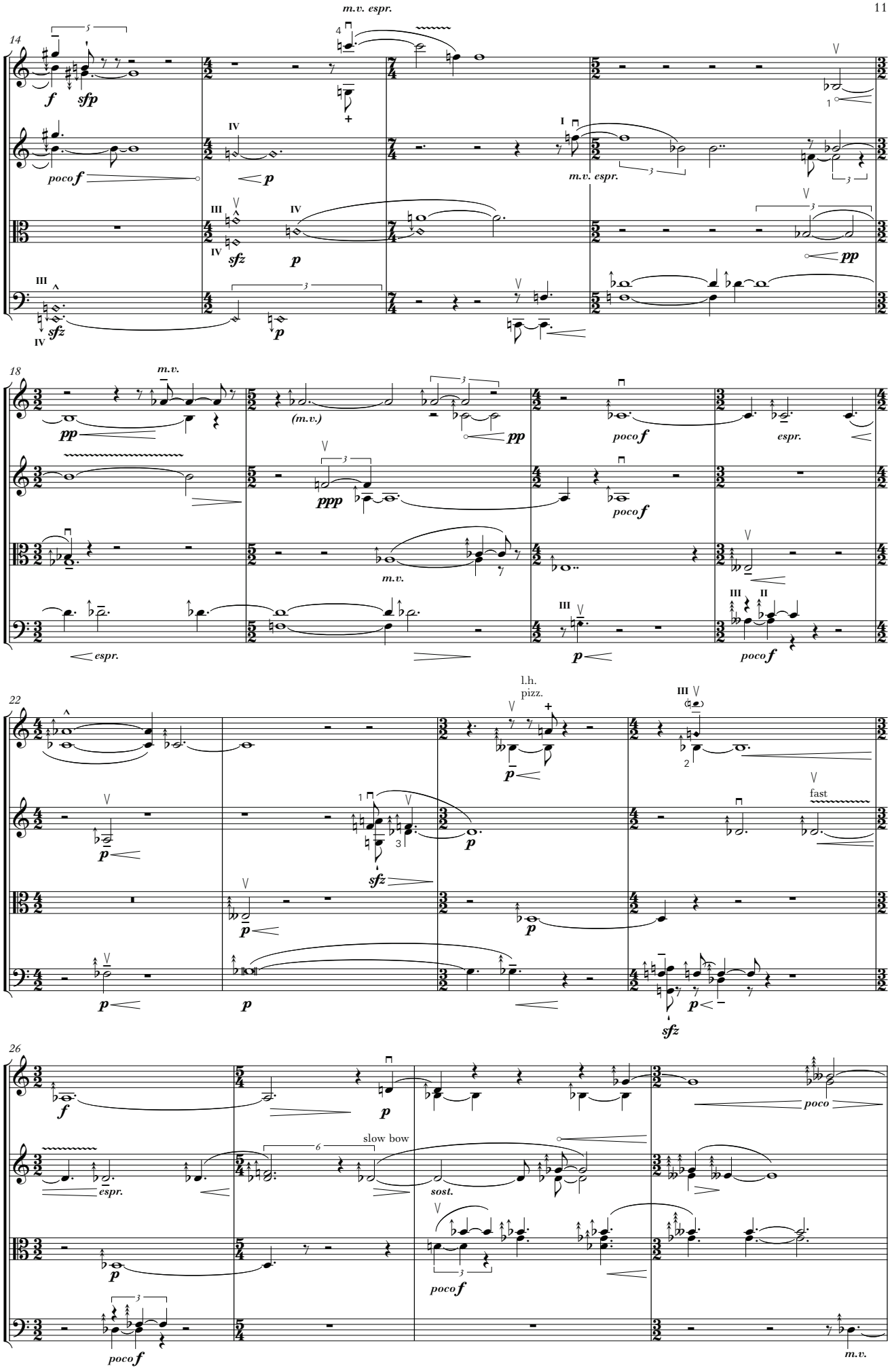

54
61
69
75
6/IV 8/IV

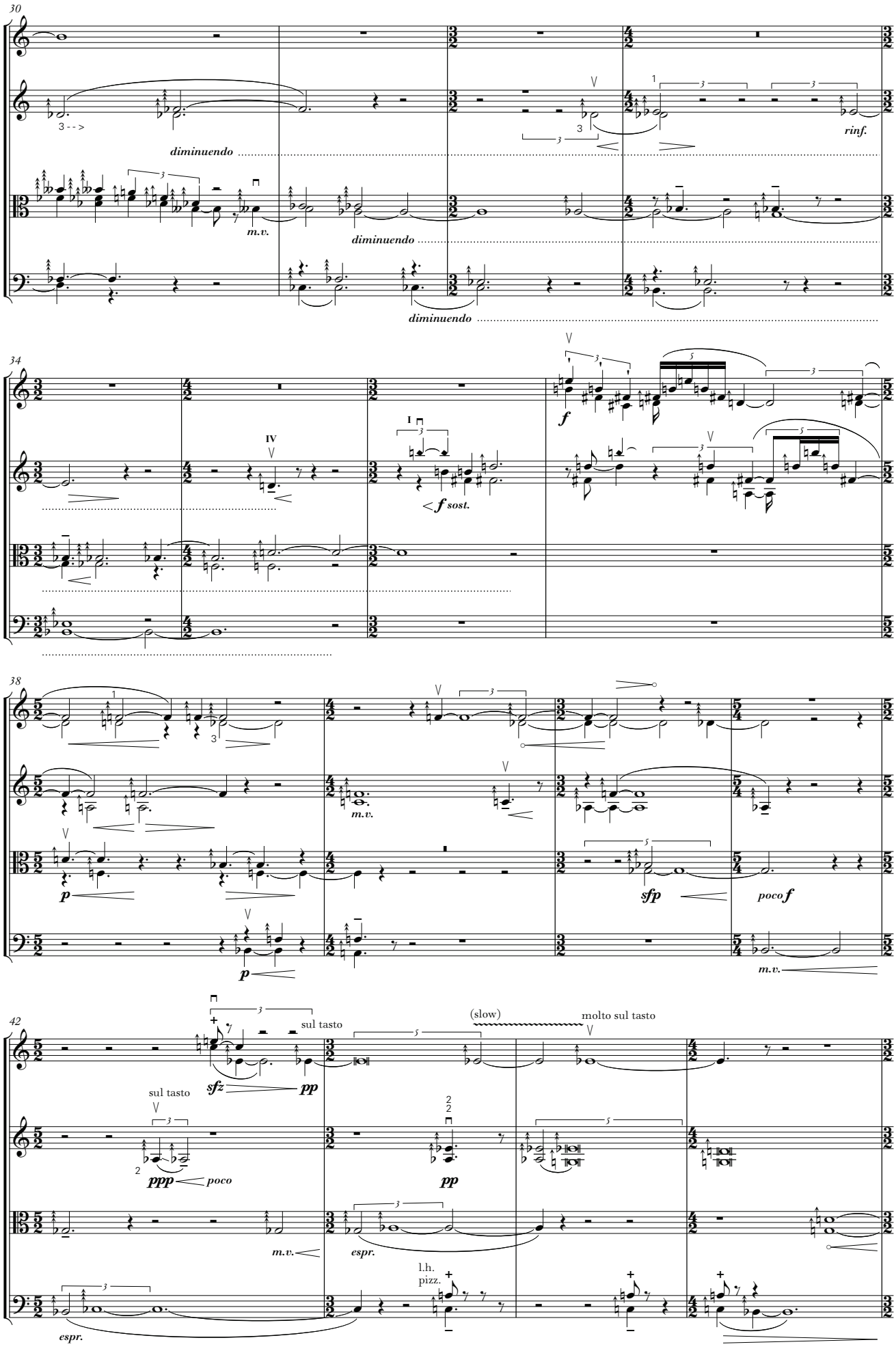

82
90
98
104
art.
harm.

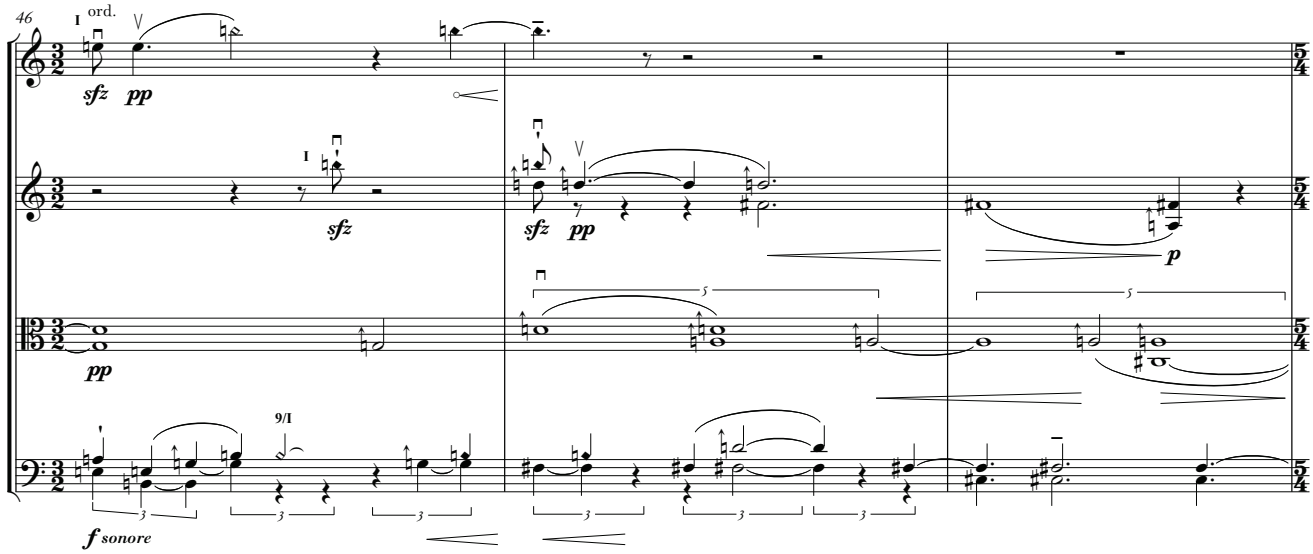

110
artificial harmonic,
unison with viola
118
126
136
attacca

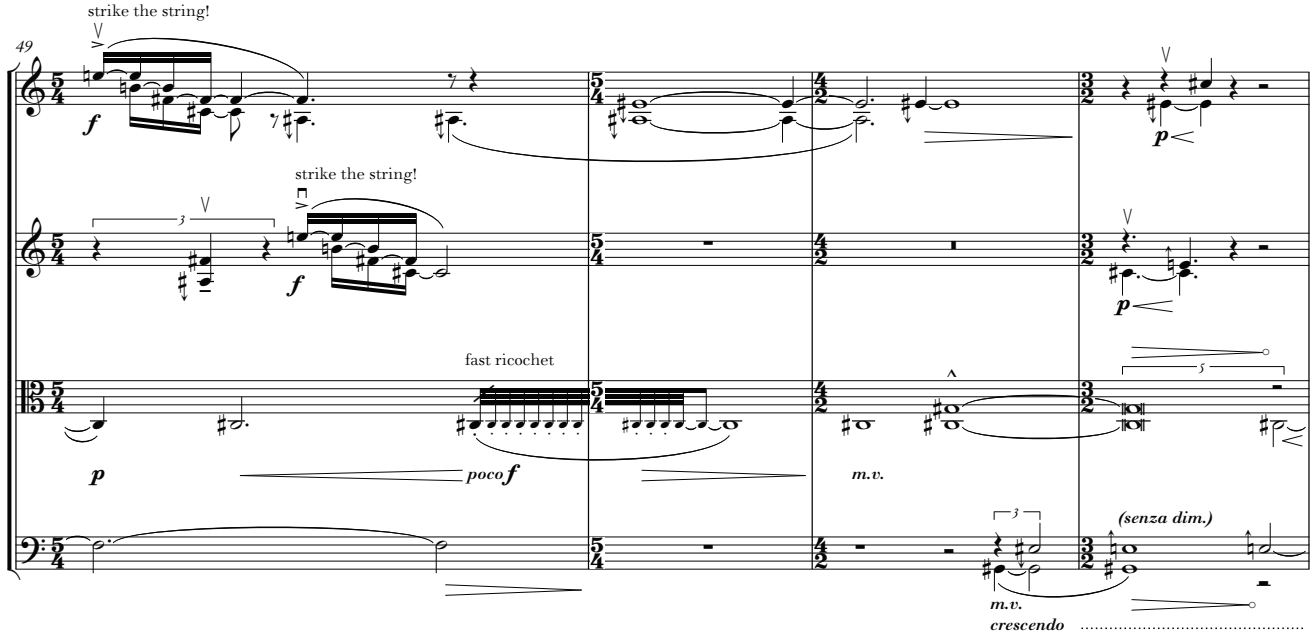
Harmonium for Ben Johnston

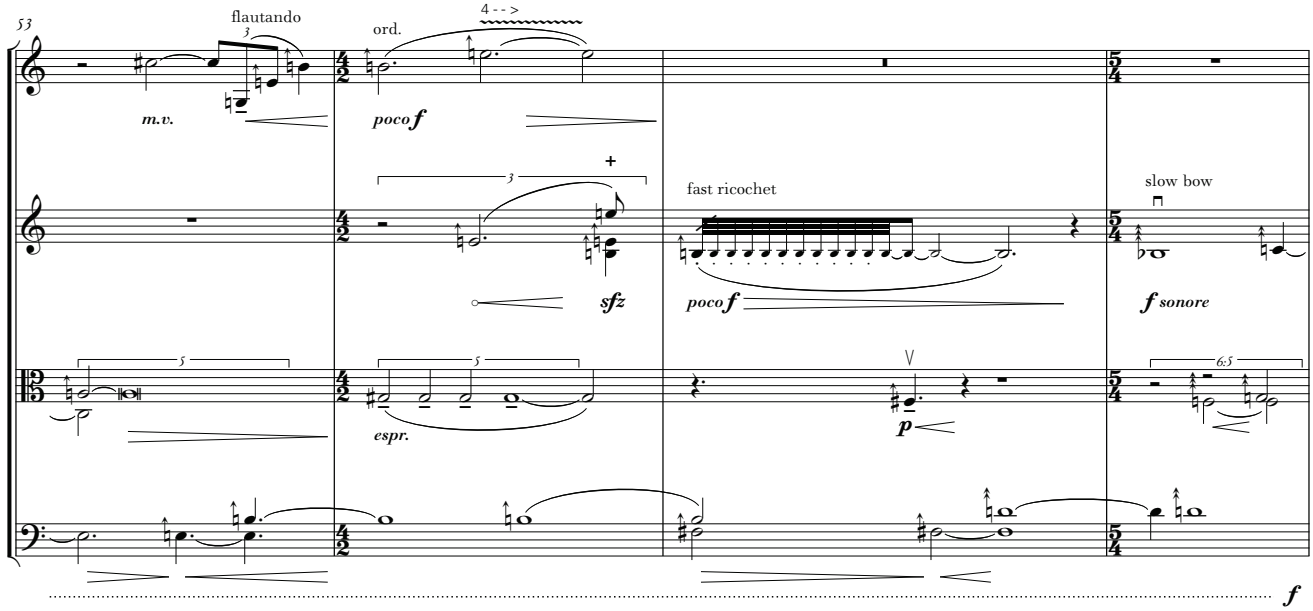


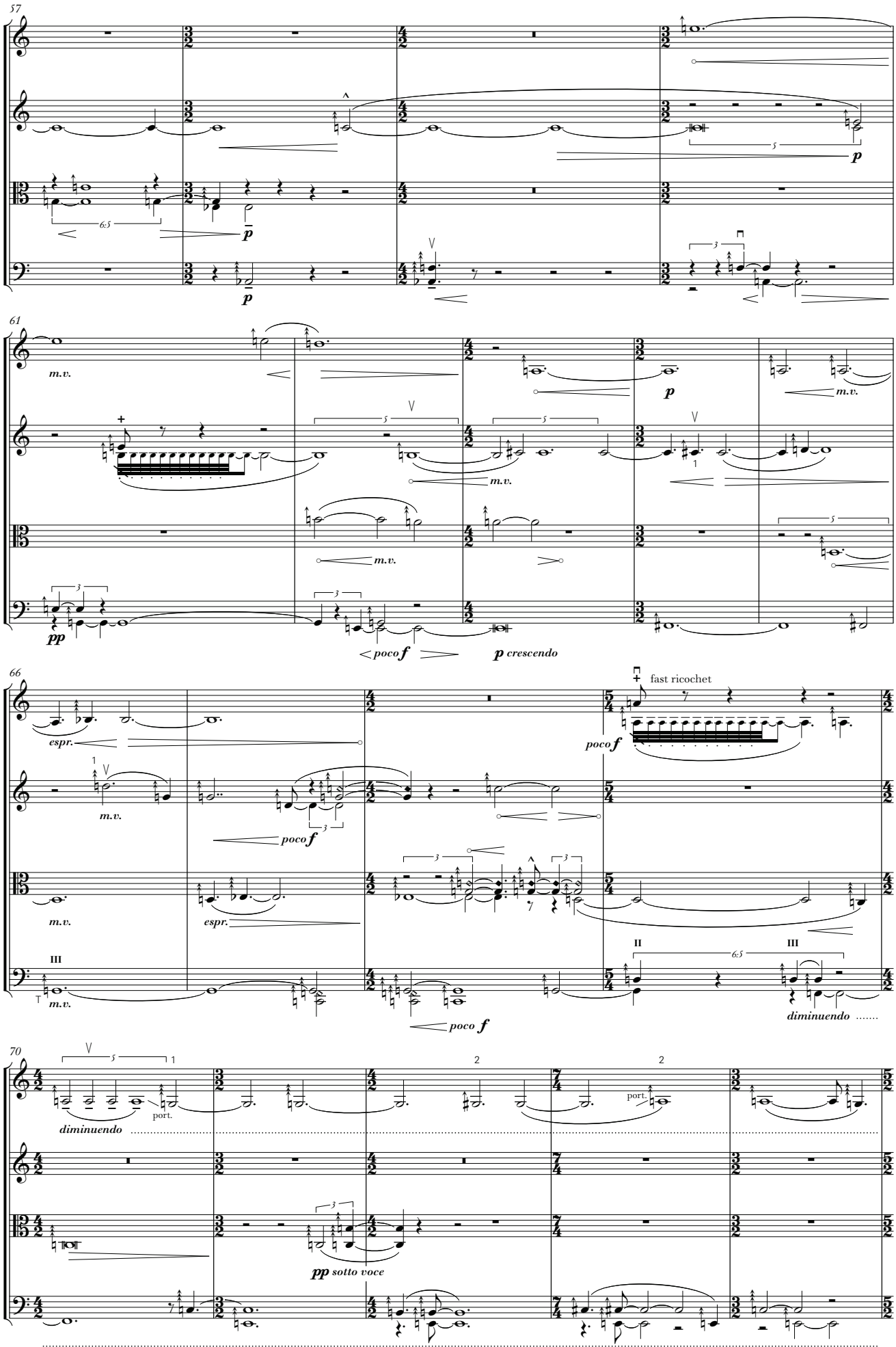

14
m.v. espr.
f
sfp
poco f
p
sfz
pp
m.v. espr.
18
m.v.
pp
(m.v.)
ppp
poco f
espr.
m.v.
22
l.h.
pizz.
fast
sfz
26
f
p
poco
espr.
slow bow
sost.
poco f
m.v.

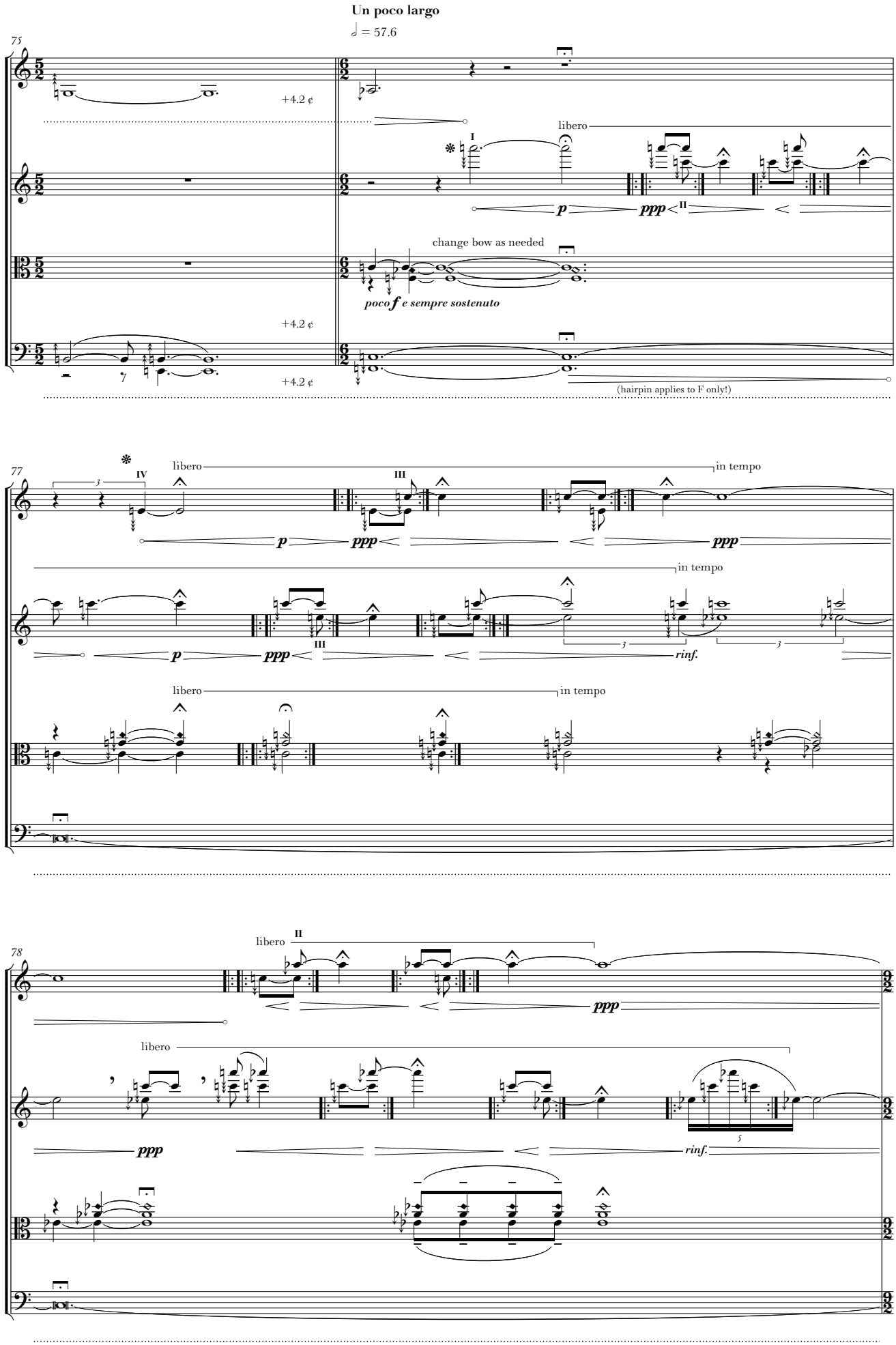

30
diminuendo
m.v.
diminuendo
diminuendo
rinf.
34
IV
I
f sost.
f
38
m.v.
p
p
sfp
poco f
m.v.
42
sul tasto
sfz
pp
sul tasto
ppp
poco
(slow)
molto sul tasto
pp
m.v.
espr.
l.h.
pizz.
espr.


46
I ord.
sfz pp
I
sfz
sfz pp
p
pp
9/1
f sonore

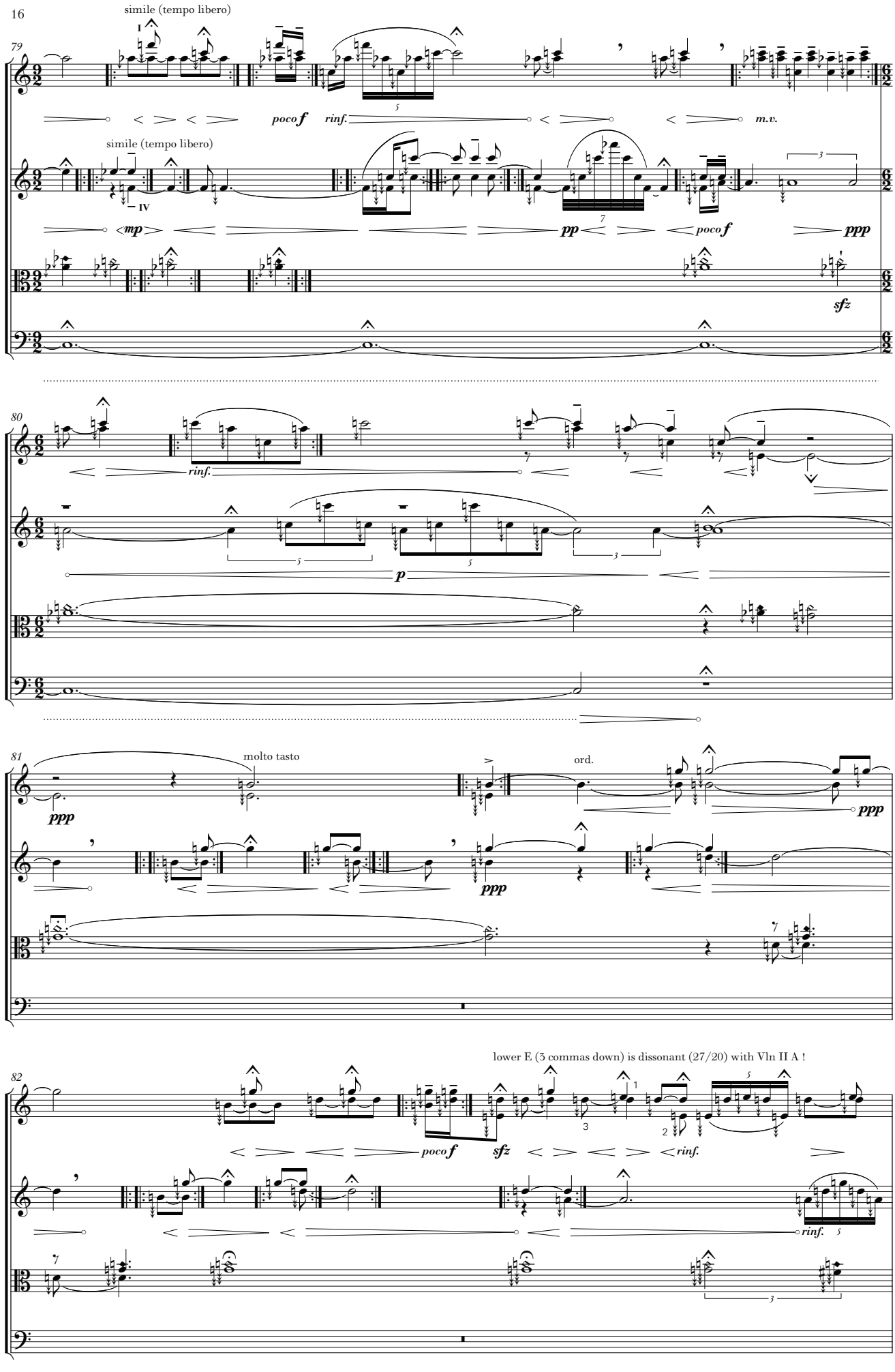

strike the string!
49
f
p
strike the string!
f
p
fast ricochet
p
poco f
m.v.
(senza dim.)
m.v.
crescendo

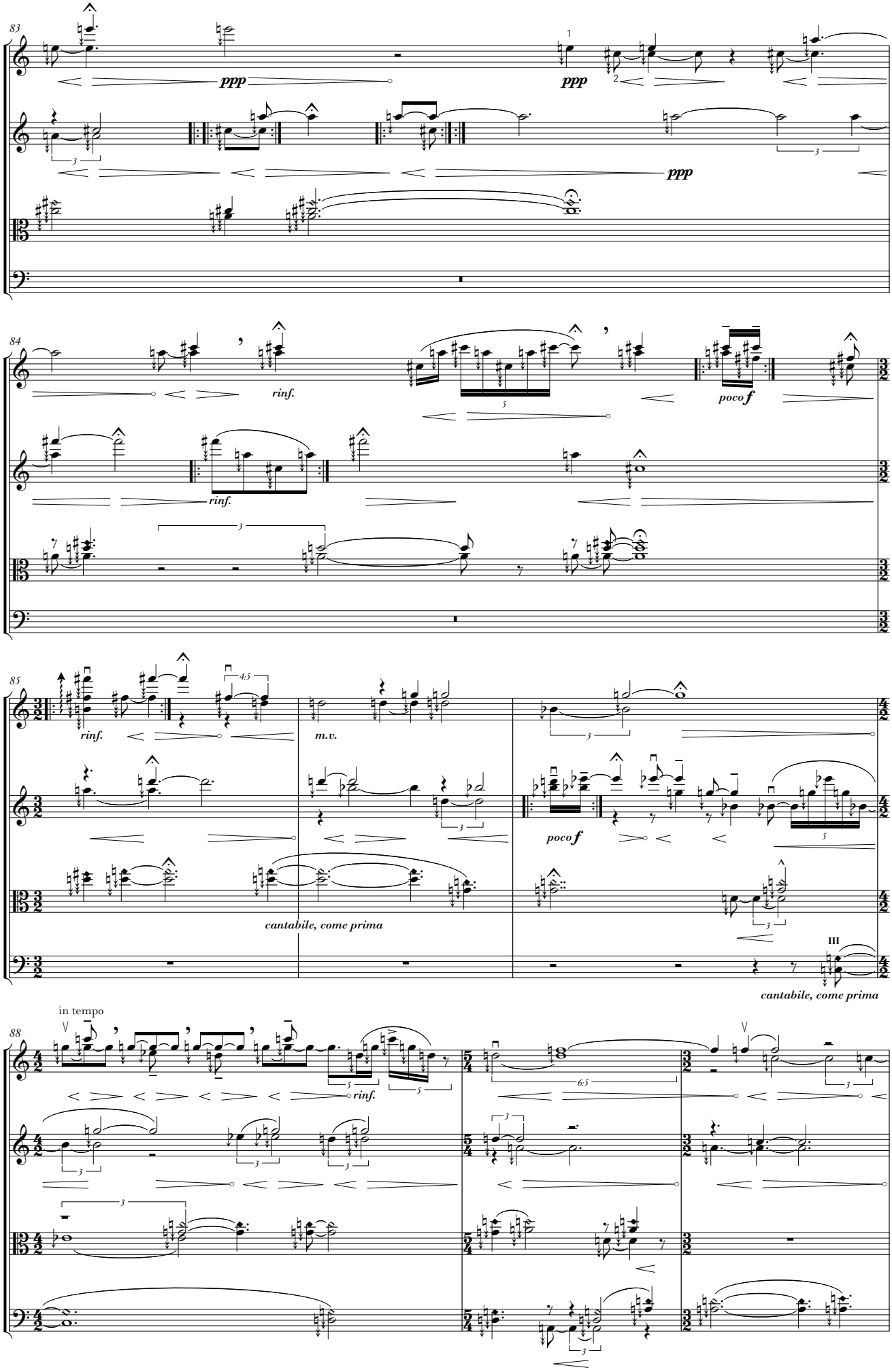

53
flautando
ord.
4 - - >
m.v.
poco f
sfz
fast ricochet
slow bow
poco f
f sonore
espr.
p
f

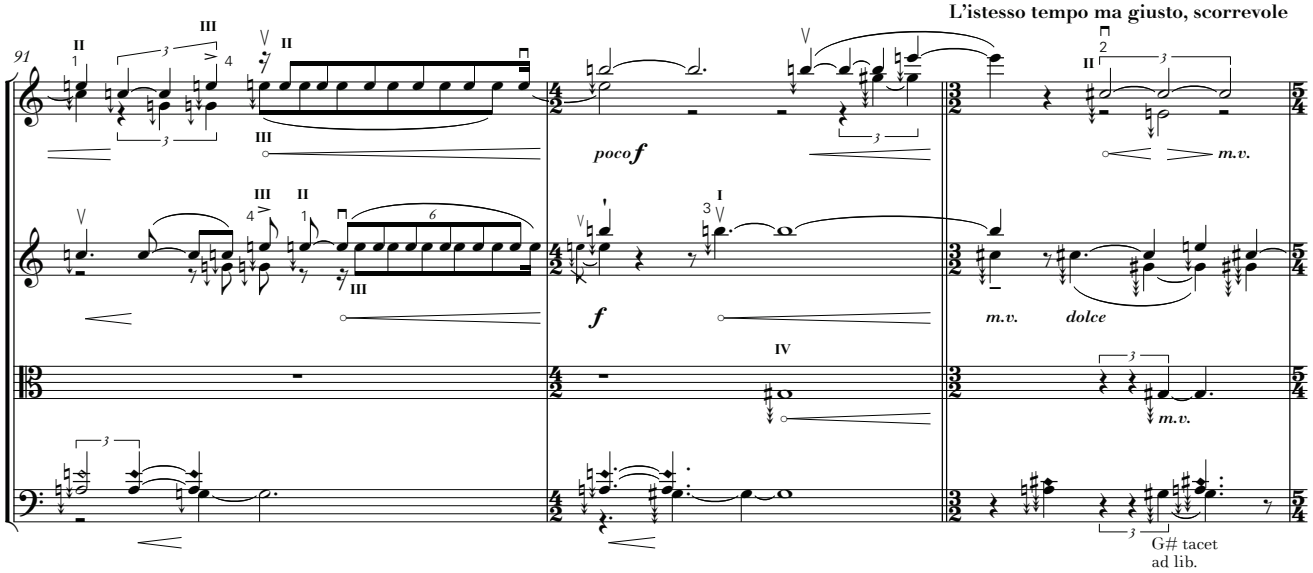

57
p
p
61
m.v.
pp
poco f
p crescendo
66
fast ricochet
espr.
poco f
m.v.
III
II
III
6:5
diminuendo
70
diminuendo
port.
pp sotto voce

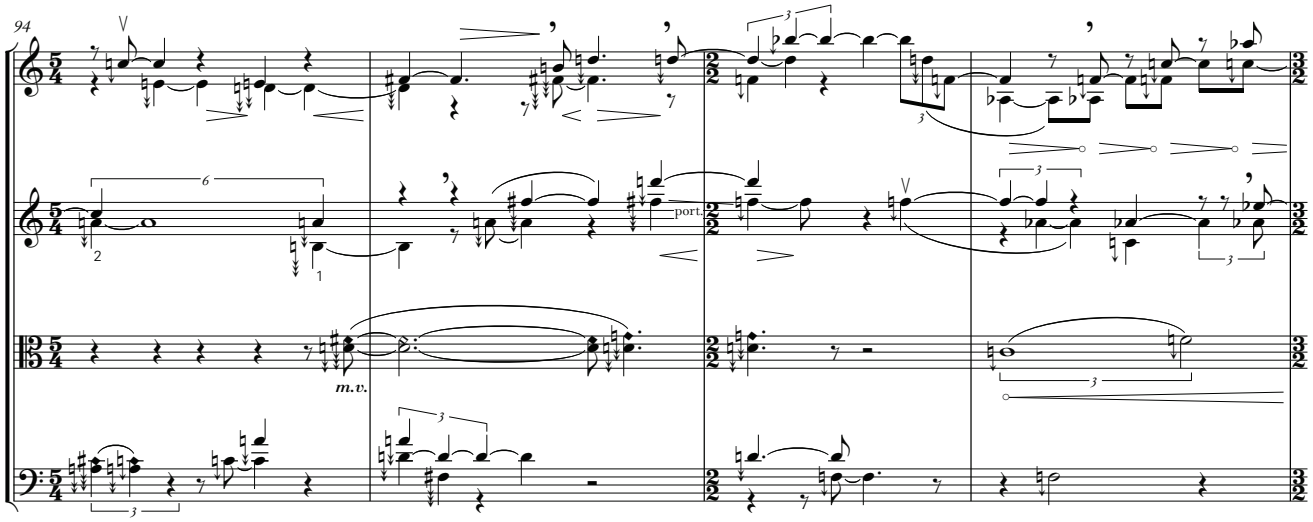


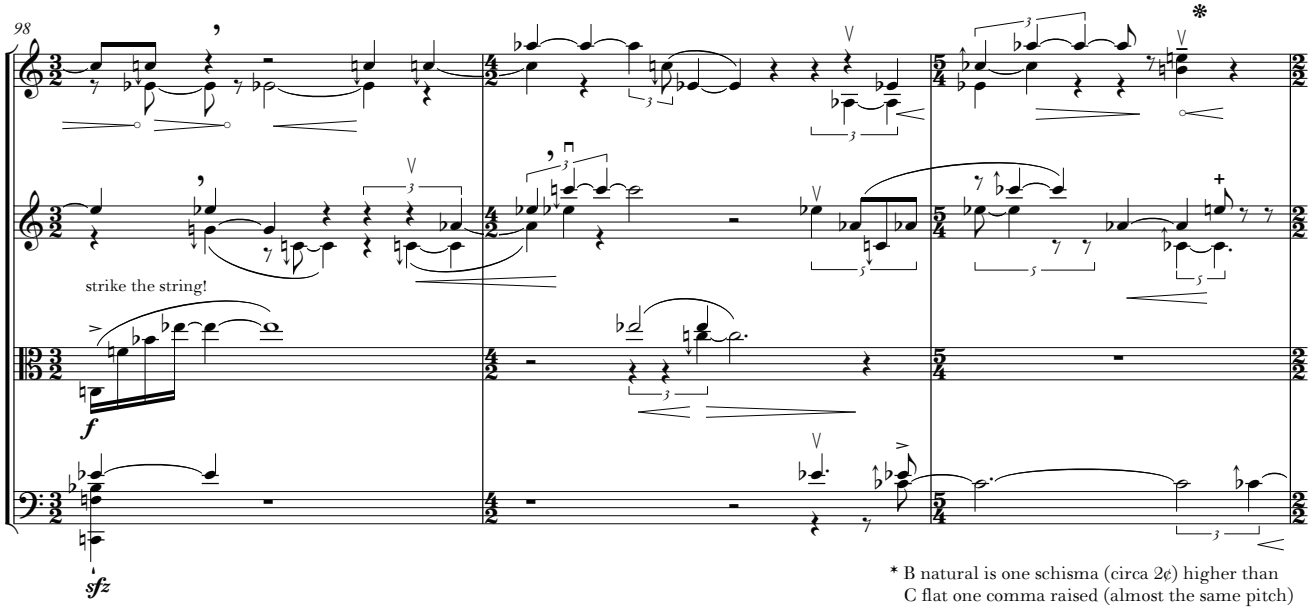
* l.h.: establish, maintain, fine tune hand positions — hold fingers as long as possible
r.h.: molto flautando, change bows and vary speed often and irregularly — emerging into sharp focus and receding again
repeats as many times as needed to set an accurate intonation of the written pattern, sempre un poco ad libitum


79
simile (tempo libero)
I
poco f
rinf.
m.v.
simile (tempo libero)
IV
mp
pp
poco f
ppp
sfz
80
rinf.
p
81
molto tasto
ppp
ord.
ppp
ppp
ppp
82
lower E (3 commas down) is dissonant (27/20) with Vln II A !
poco f
sfz
rinf.
rinf.


83
ppp
ppp
ppp
84
rinf.
poco f
rinf.
85
rinf.
m.v.
poco f
cantabile, come prima
III
cantabile, come prima
88
in tempo
rinf.







* B natural is one schisma (circa 2¢) higher than C flat one comma raised (almost the same pitch)

Tempo primo, cantabile

♩ = 72

101

poco *f* *sostenuto*

f

sfz

rinf.

rinf.

f

rinf.

sfz

105

sfz

f sonore

sfz *p espr.*

m.v.

sfp espr.

poco f

sfz

f sonore

m.v.

p

III

IV *m.v.*

f sonore

m.v.

109

poco f

p

III

p

one comma lower !

pp

rinf.

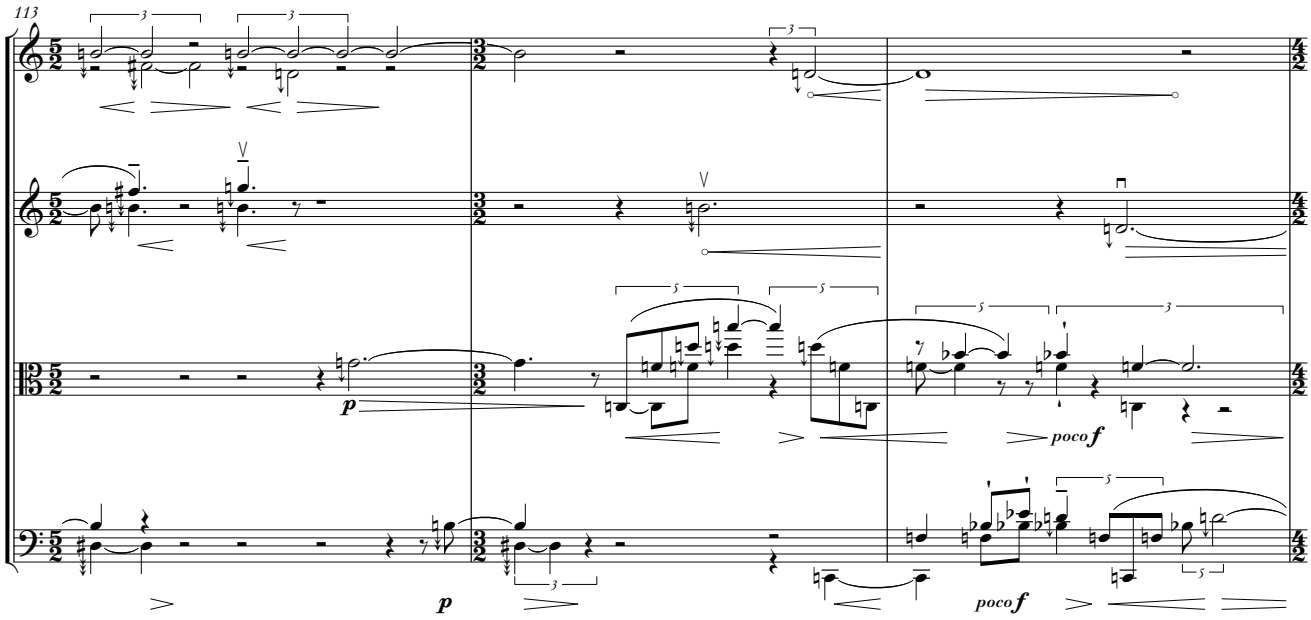
m.v.

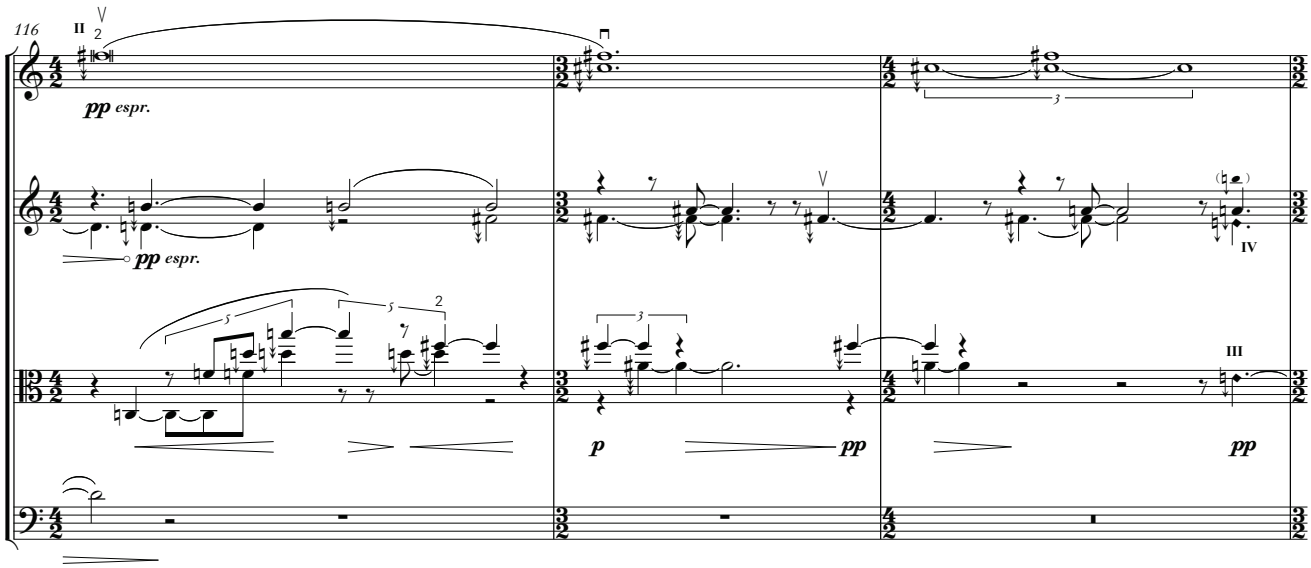
p

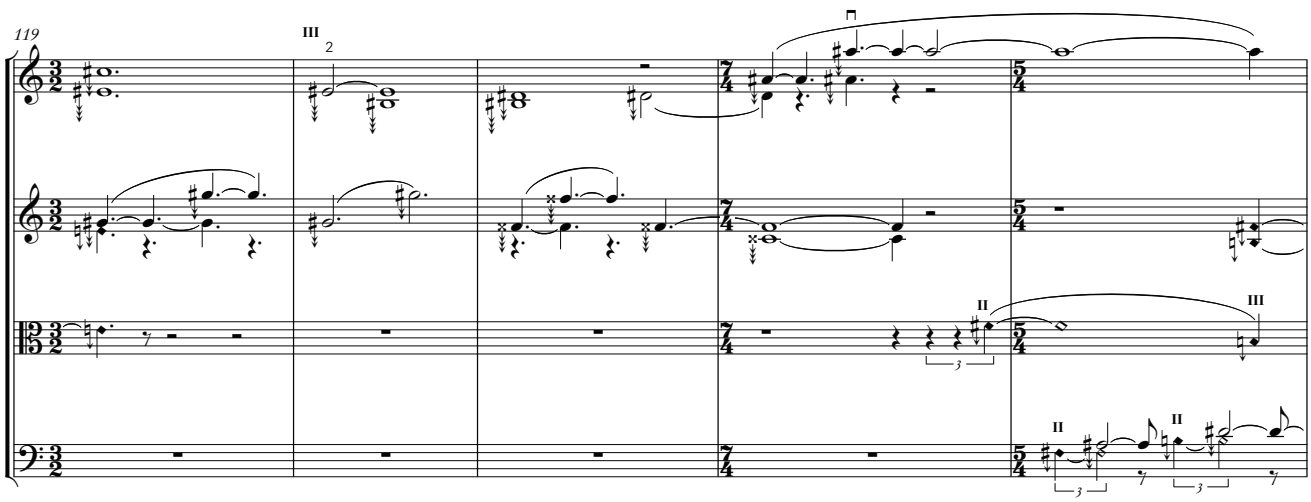
rinf.

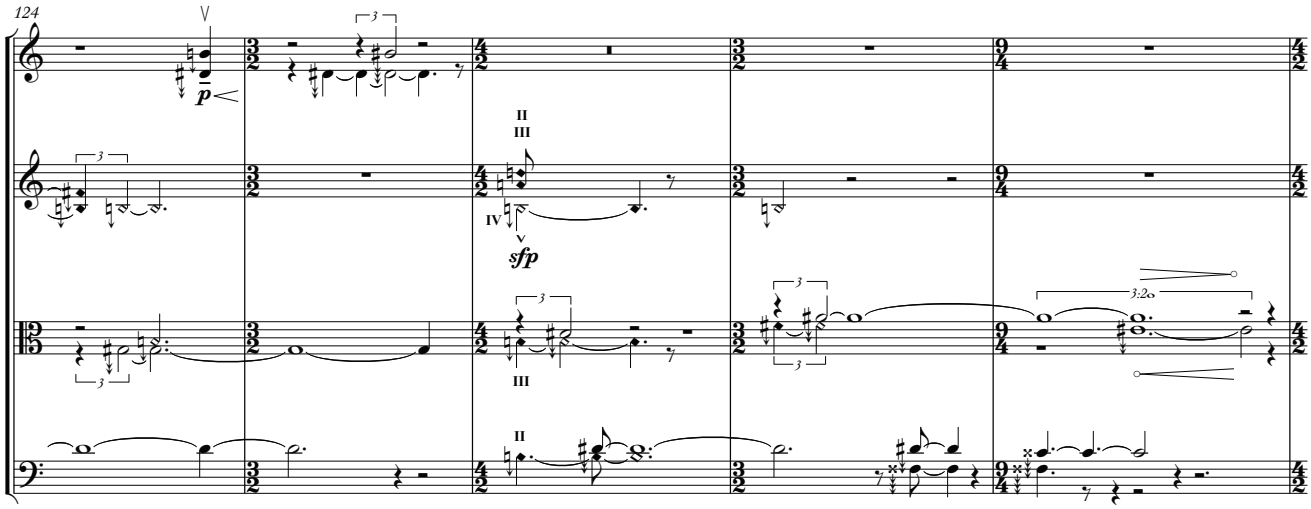
m.v.

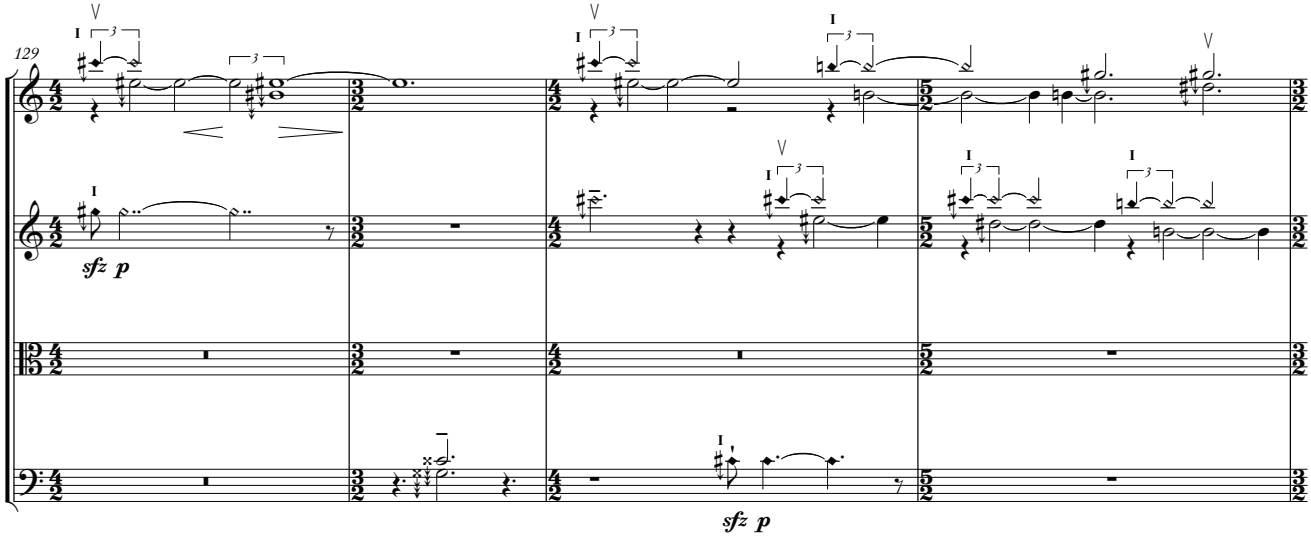
p

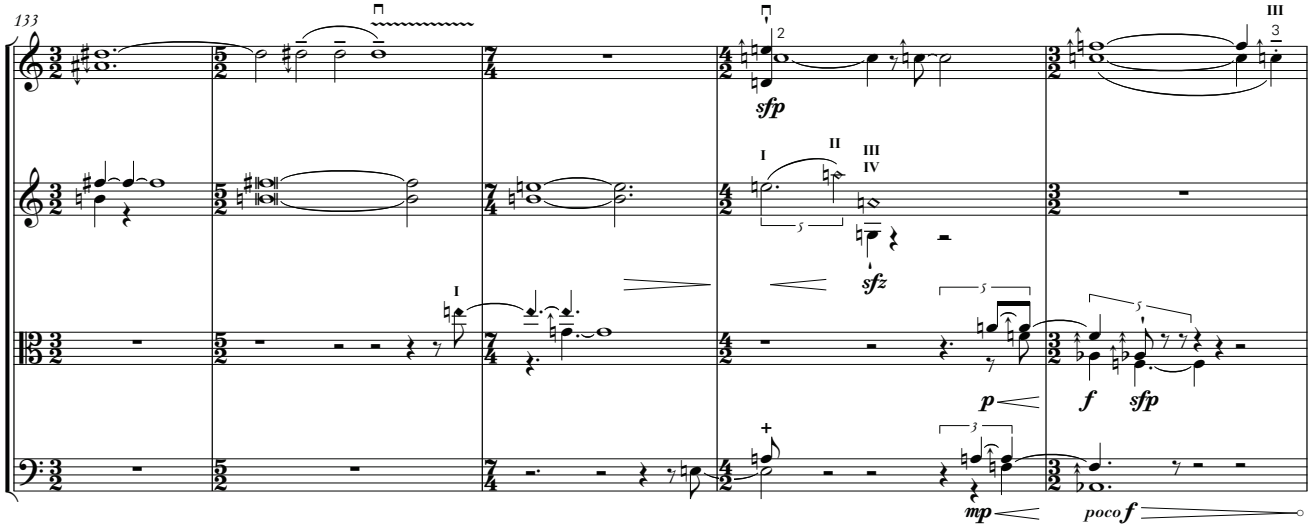

113
p
poco f
p
poco f

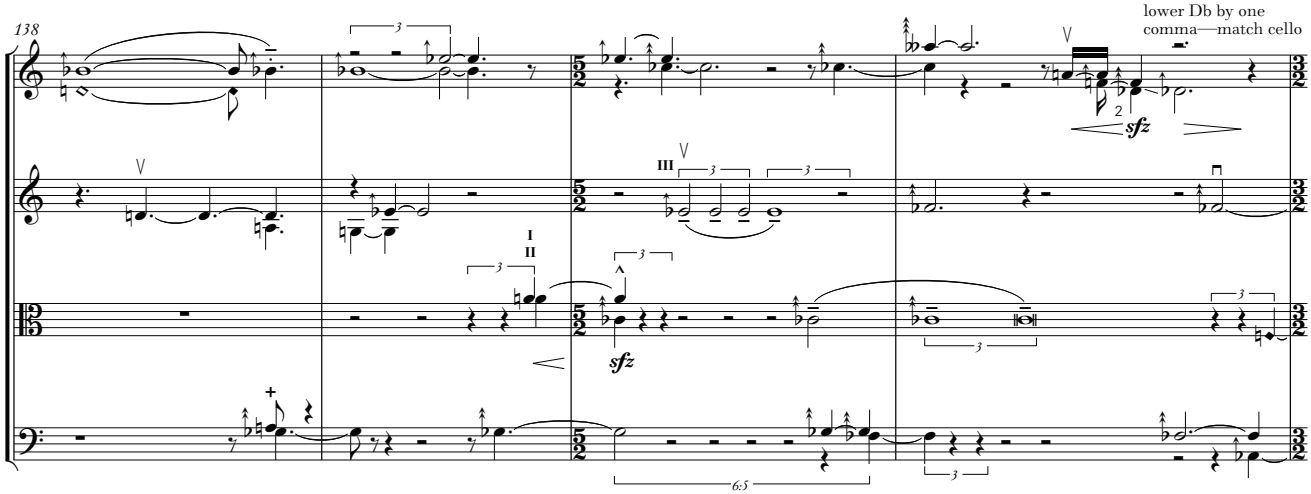

116
II
pp espr.
pp espr.
IV
III
p
pp
pp

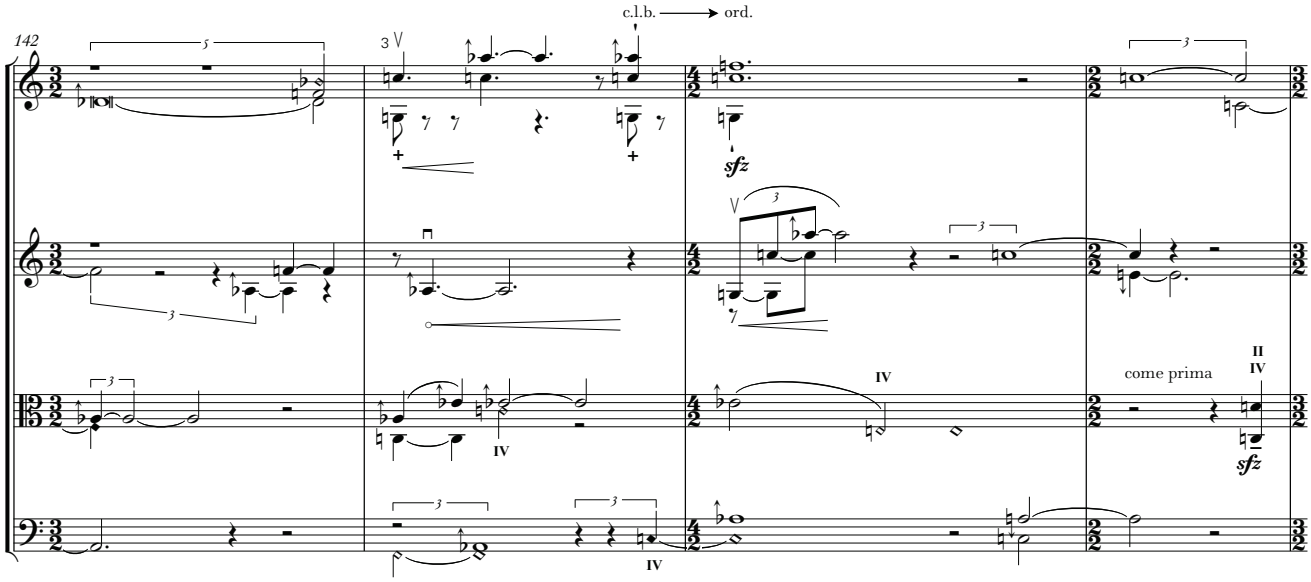

119
III
II
III
II
II

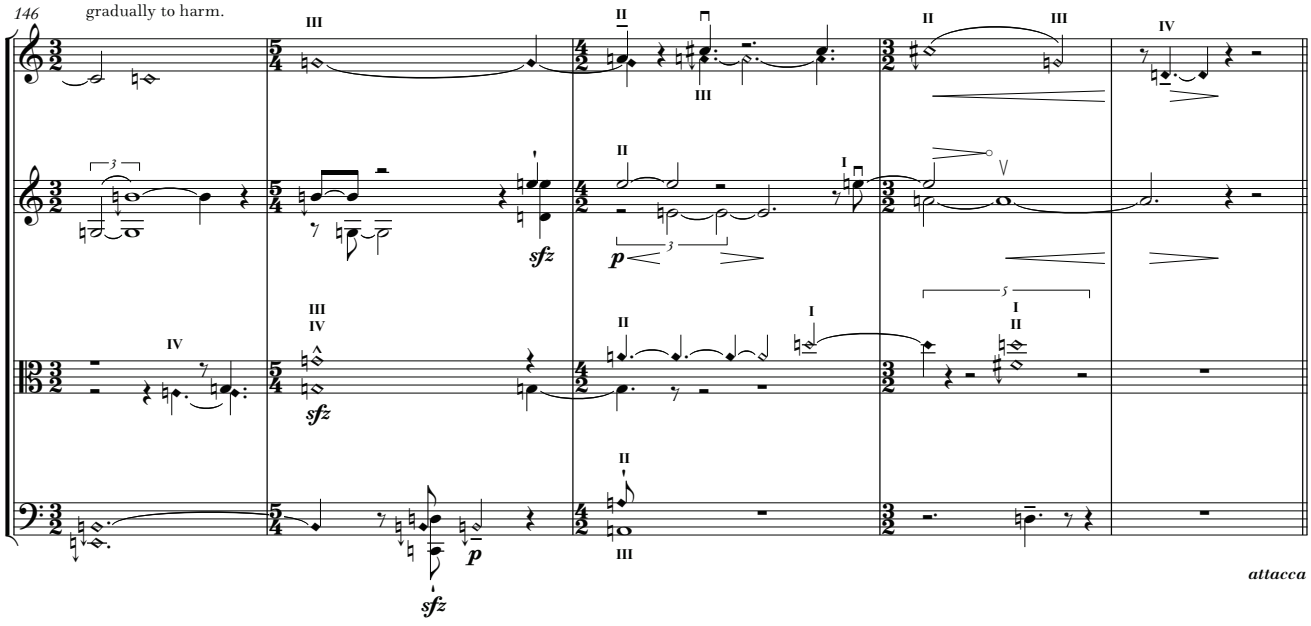

124
p
sfp
3:2


129
sfz p
sfz p


133
sfp
sfz
p
f sfp
mp
poco f

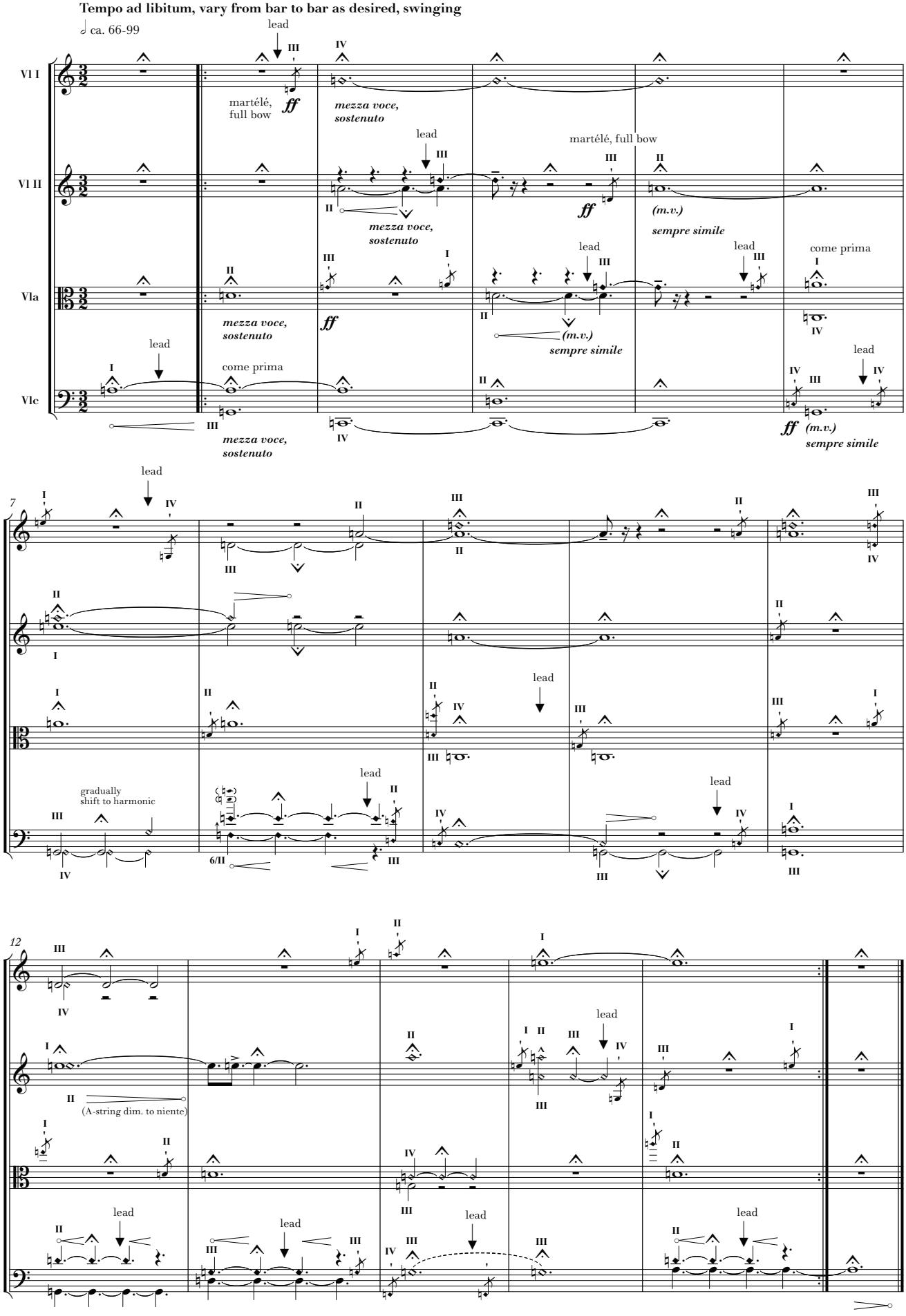

138
lower Db by one comma—match cello
sfz
sfz
6:5


142
c.l.b. ord.
sfz
sfz
come prima
sfz


146
gradually to harm.
sfz
p
sfz
p
sfz
attacca

Pythagoras Drawing (II)

Tempo ad libitum, vary from bar to bar as desired, swinging



Villa Massimo, Roma
5.7.2011 / 29.11.2011