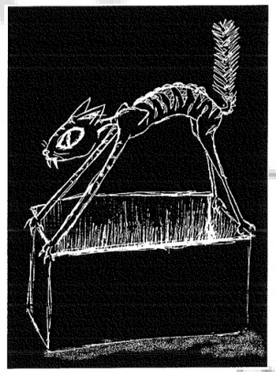
JOHN TARTAGLIA

WAVE FUNCTIONS

for Violin, Viola, and Cello



BEADY EYES PUBLISHING
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Cover art by Jessamy Dipper

Premiered December 1, 1996 by Ensemble Capriccio:
Chouhei Min, violin; Korey Konkol, viola; and Mina Fischer, cello

c. 22 minutes

I. *The Dancing Wu-Li*
II. *Bell's Theorem*
III. *Schrödinger's Cat*
IV. *"Surely, Mr. Feynman…(in memoriam)"*

PROGRAM NOTE:

John Tartaglia's string trio, *Wave Functions,* is a wonderful contemporary example of the connection that has long existed between the weird science of quantum mechanics and the harmonious field of music. The sound waves that make music possible are subject to many of the same mathematical rules as the quantum wave functions that describe the activity of electrons and photons. But John Tartaglia's trio goes far beyond formal similarities to demonstrate that absolute music provides a genuinely appropriate language for expressing the abstract ideas of modern physics.

In the trio's first movement, *The Dancing Wu-Li,* a dark ominous opening warns us, as it were, of the strange unfamiliar world we are entering, where atoms lurk in a nowhere realm of mere possibility until provoked into physical existence by the act of an observer. *Wu-li* comes from the Chinese word for physics, and means patterns of organic change, something nonsensical, or enlightenment—apt descriptions indeed for the chaotic micro world of quantum particles. The movement continues with a kind of dialogue between the void and potentiality, suggesting the unstable circumstances in which particles emerge from nowhere, collide, and then vanish. A waltz appears in which an ordered phrase of notes seems to stop in its tracks, hesitate and retrace its steps, as if reversing itself in time like an anti-electron dancing into the past, far from its electron partner. We can only accept the dance and join in.

The title of the second movement, *Bell's Theorem,* refers to the shocking proof by physicist John Bell that physical reality must be non-local. In other words, two electrons or photons can instantly communicate with and affect each other over great distances without ever exchanging physical signals. Bell's theorem was the death knell for Einstein's long-standing rejection of quantum theory on the grounds that it violates the "local-forces" law of cause and effect. In Tartaglia's somber opening phrases and throughout the movement, we hear the tolling of a bell that is both a musical pun on Bell's name and the mournful proclamation of the death of causality. A later rhythmic, syncopated passage evokes a kind of coordinated ballet, in which all the dancers hypnotically follow the same steps like synchronized marionettes—the perfect musical embodiment of non-local quantum "entanglement."

Schrödinger's Cat is the playful name given to a diabolical thought experiment, devised by Erwin Schrödinger, one of the founders of quantum mechanics, who eventually came to doubt his own theory. Schrödinger wanted to dramatize the ambiguity of certain quantum descriptions, in which a particle apparently can exist in two mutually contradictory states. A photon may be polarized in an upward and a downward direction at the same time, or a hypothetical colored particle can be both black and white. Schrödinger imagines a cat trapped inside a box containing a poison gas apparatus that is triggered by a radioactive mechanism with a 50-50 chance of firing in one hour. At the end of the hour, according to the laws of quantum mechanics, the state of the cat is "half dead and half alive." In the third movement, *Schrödinger's Cat,* Tartaglia treats us to a cat-and-mouse game with the Grim Reaper himself. On sliding strings, we hear the cat meowing in protest, and later even scratching on the box through a *ponticello* effect. There are frequent references to Chopin's death march. And in the end, we are caught suspended simultaneously between major and minor keys in imitation of the perplexing quantum combination of life and death.

The title of the fourth vignette, *"Surely, Mr. Feynman… (in memoriam),* is taken from an autobiographical account of Richard Feynman, one of the illustrious twentieth century physicists who extended quantum mechanics to the complex realm of electromagnetic phenomena, for which he won the Nobel Prize in 1965. Feynman was an authentic iconoclast and eccentric, beloved by his colleagues and students alike for his brilliant physical insights, his down-to-earth style of teaching, and his simple and unassuming ways. In the final movement, Tartaglia has chosen to depart from the strange world of quantum mechanics, and instead to pay tribute in memoriam to one of its greatest proponents, practitioners and teachers. In this touching passage, we hear the solemn tones of the liturgical Hebrew prayer, *Kol Nidre,* traditionally associated with the memorial for the dead. Feynman had little use for religion, and rejected his own Judaism. And yet perhaps it is fitting to acknowledge the irony of a spiritual culture that helped to nurture such a secular view of the world. Or is it that humanity truly occupies a combined state of spirit and matter?

Program notes by Roger S. Jones,
University of Minnesota Morse Alumni Distinguished Teaching Professor of Physics
and author of *Physics as Metaphor* and *Physics for the Rest of Us*.

Dedicated to the memory of Professor Roger Jones, University of Minnesota

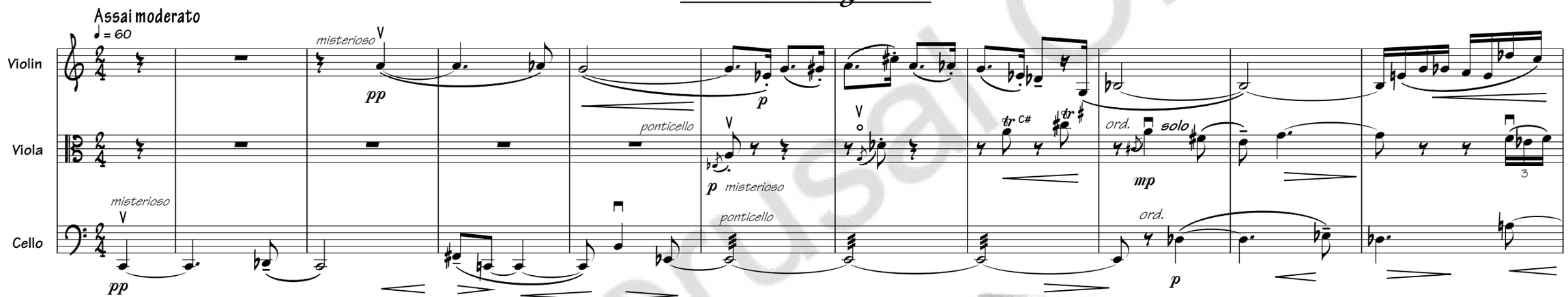
WAVE FUNCTIONS

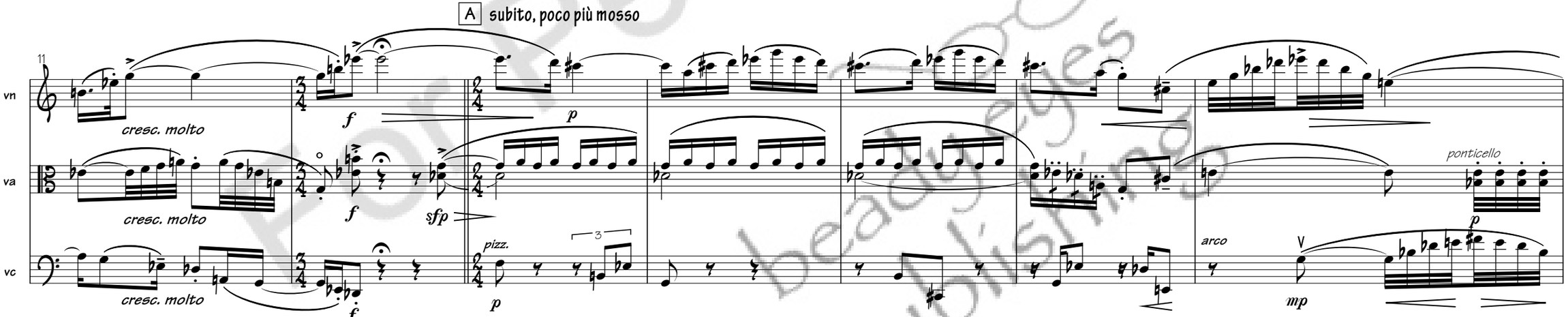
(Four vignettes about the new [quantum] physics)

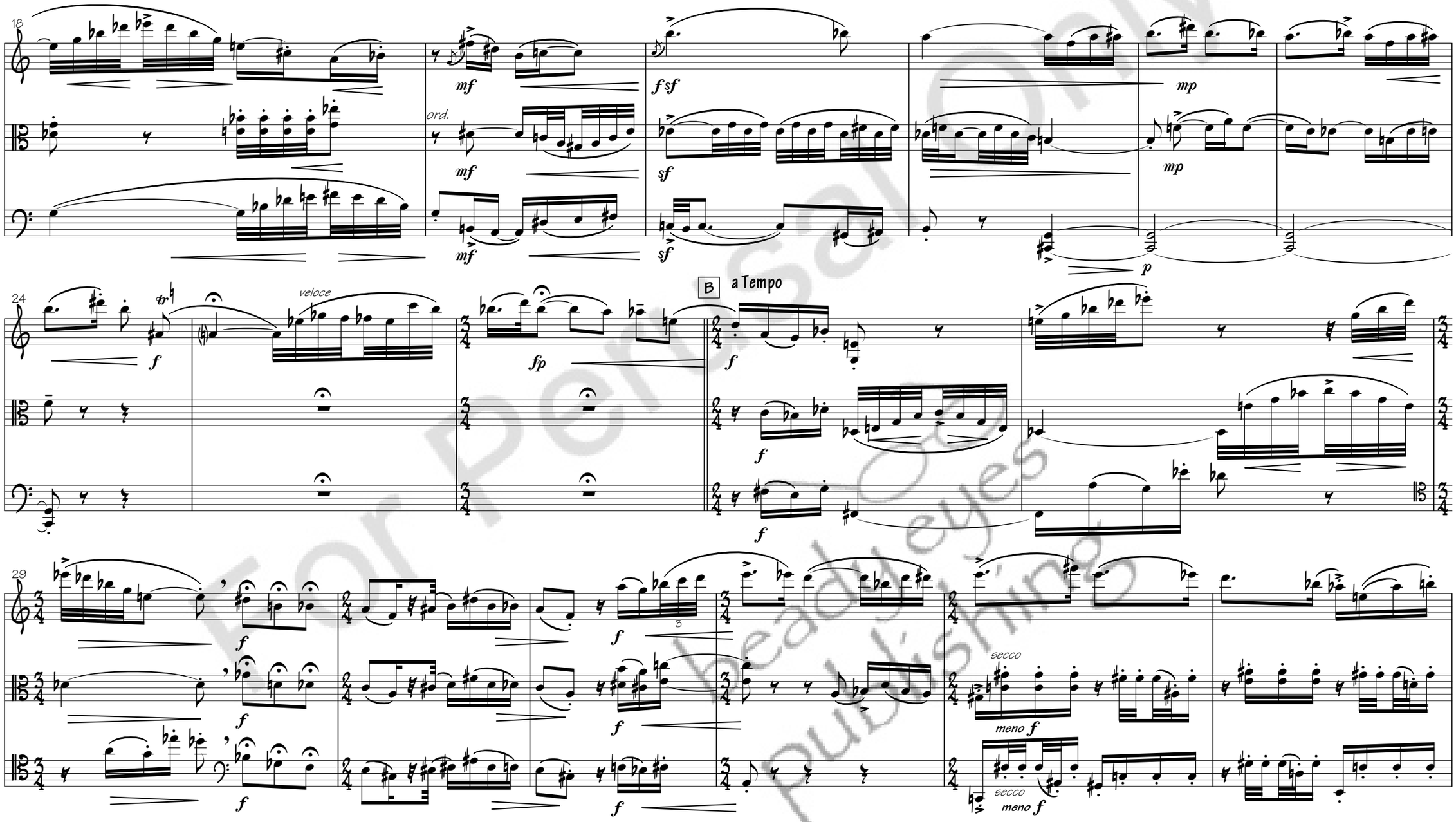
(for string trio)

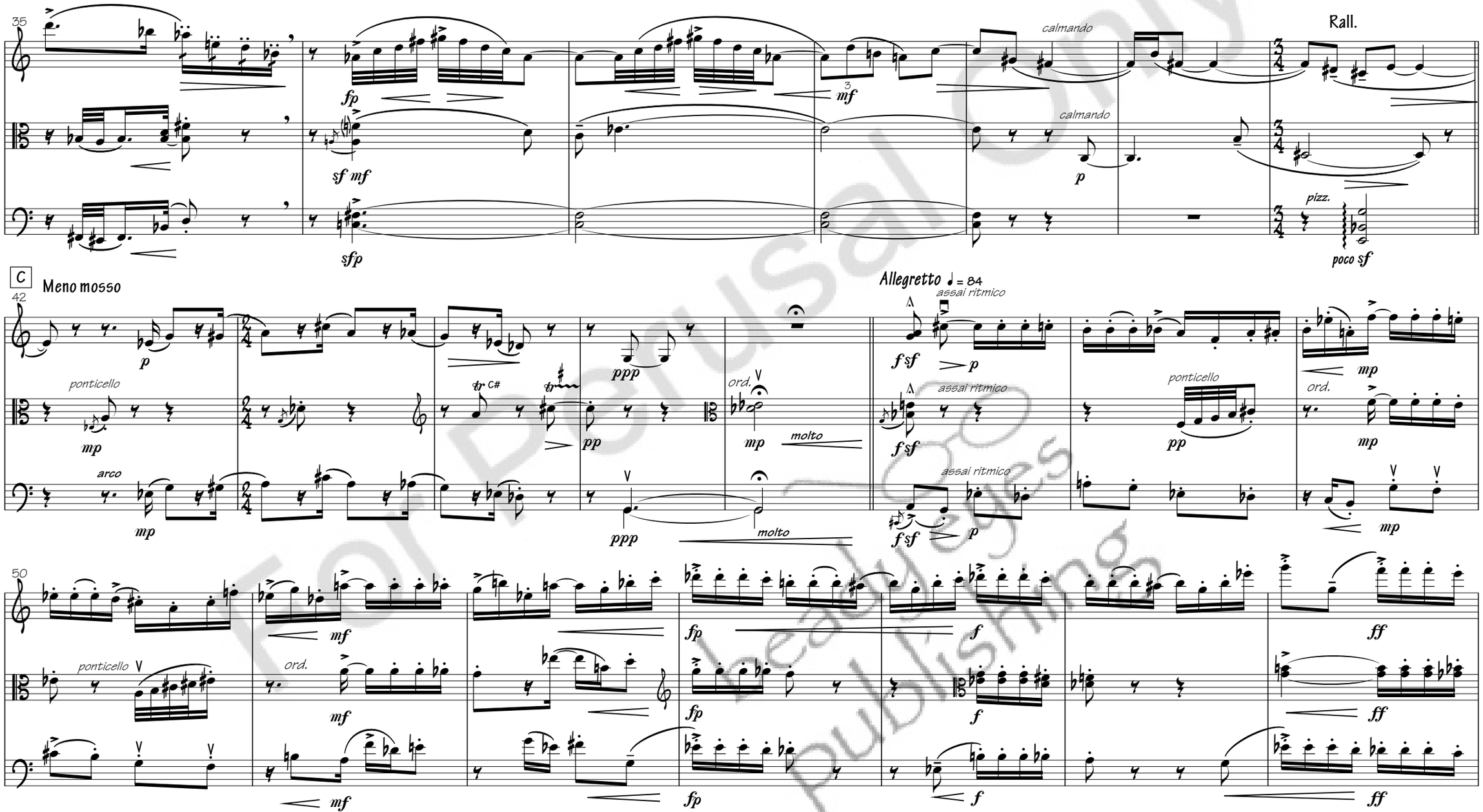
John Tartaglia

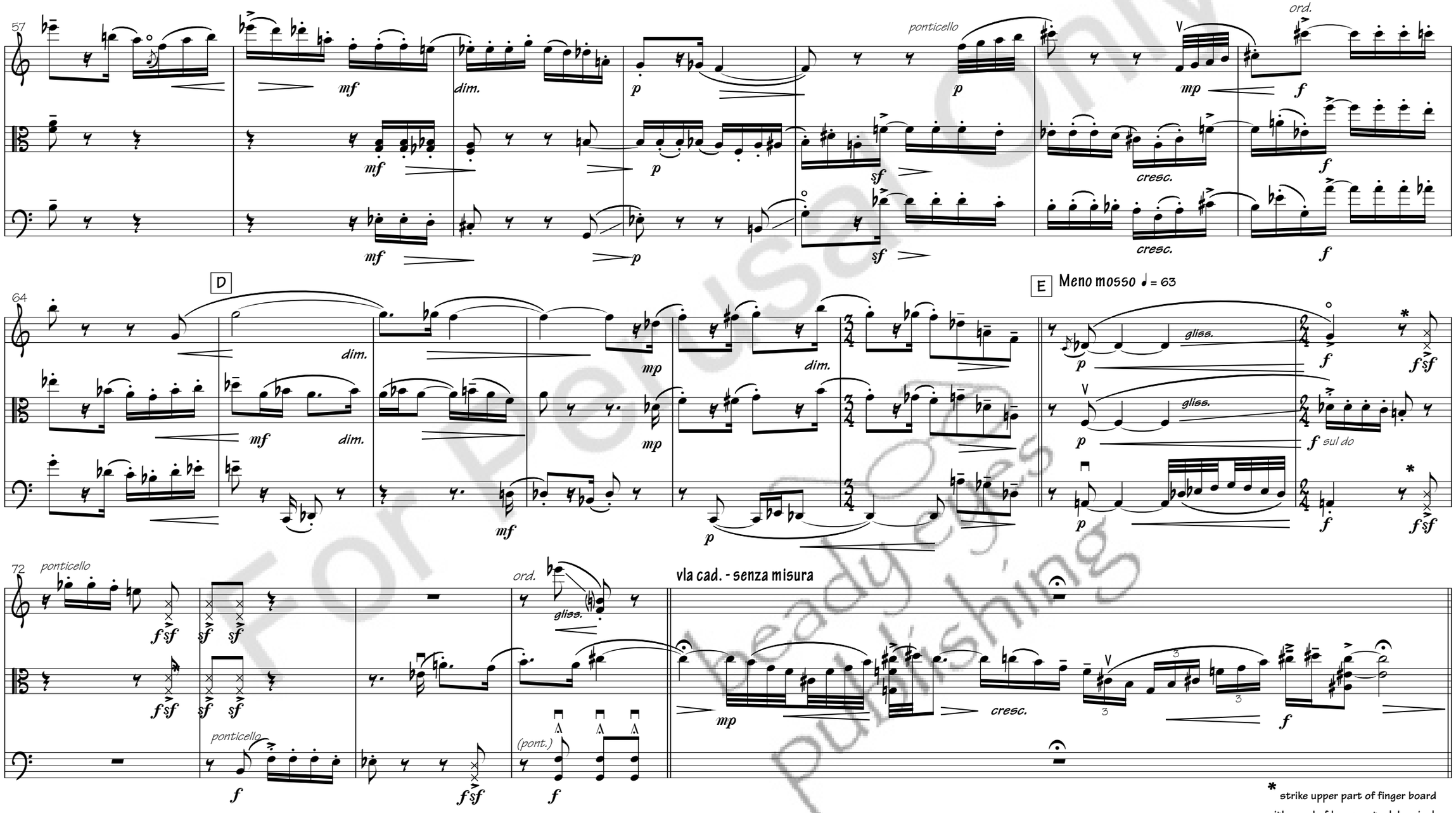
I. The Dancing Wu-Li











F a Tempo primo

77

vn

va

vc

p f ff sostenuto (a Tempo) fp mp ponticello

ord.

85

vn

va

vc

f mf ord.

93

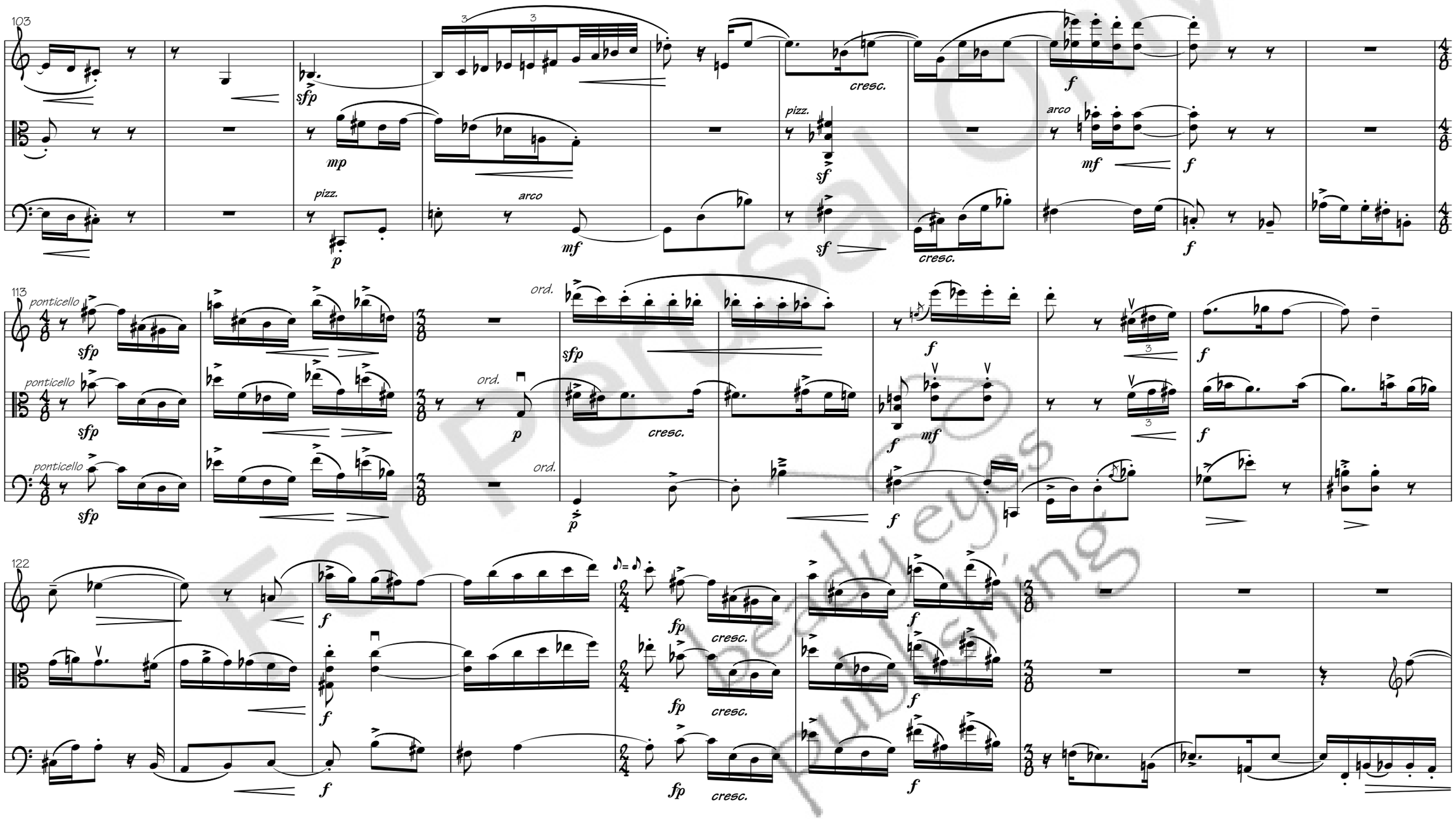
vn

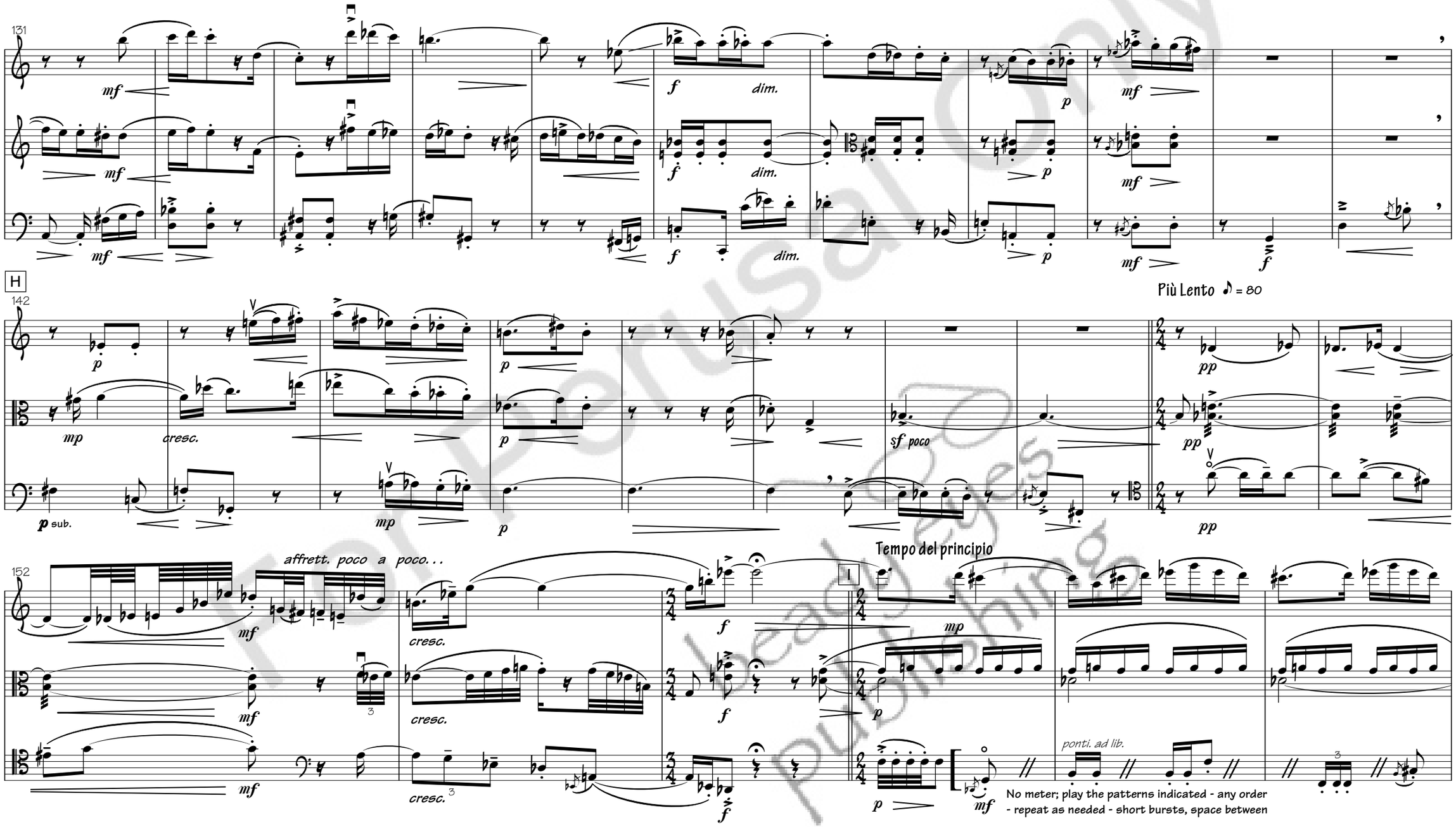
va

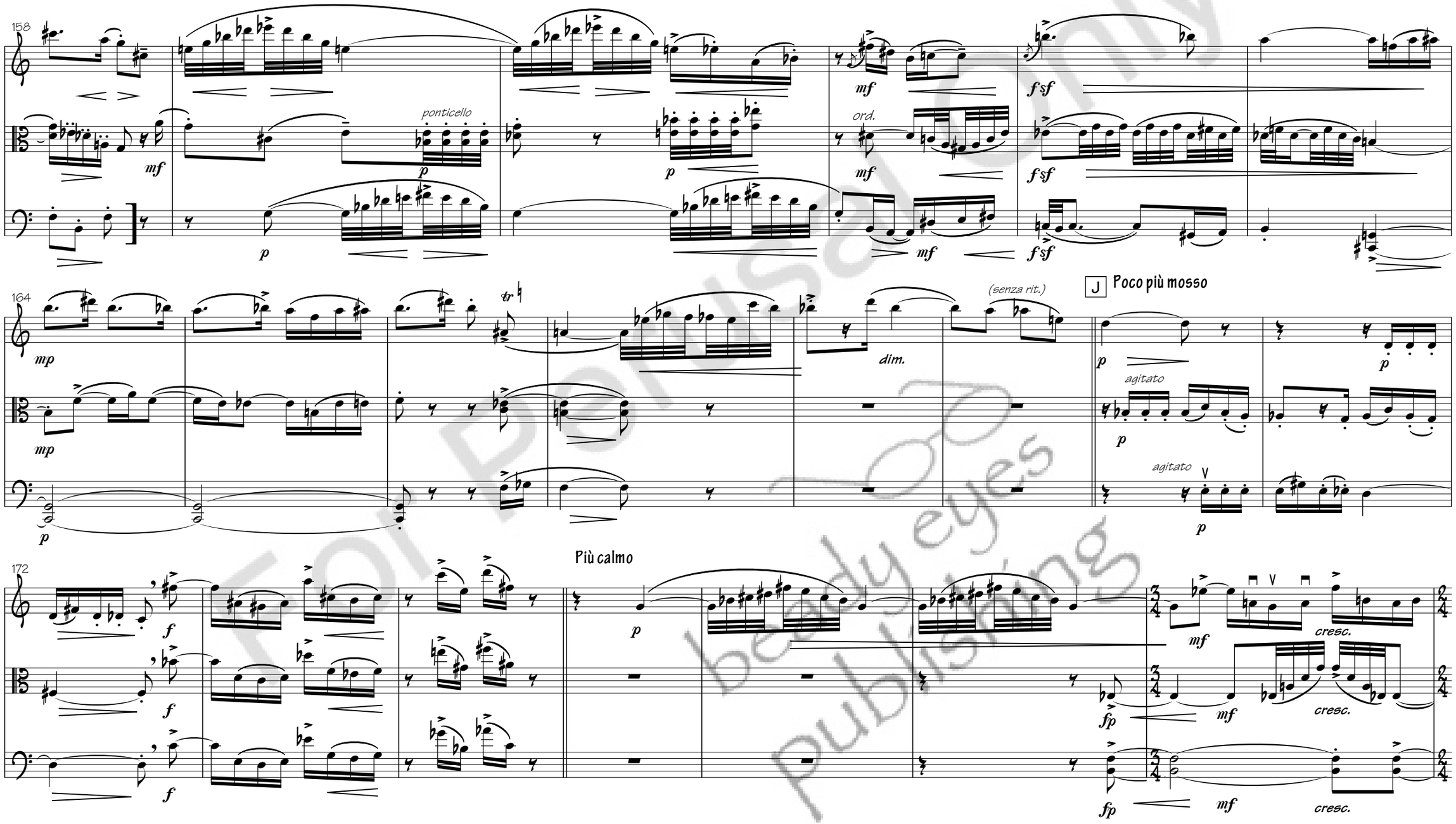
vc

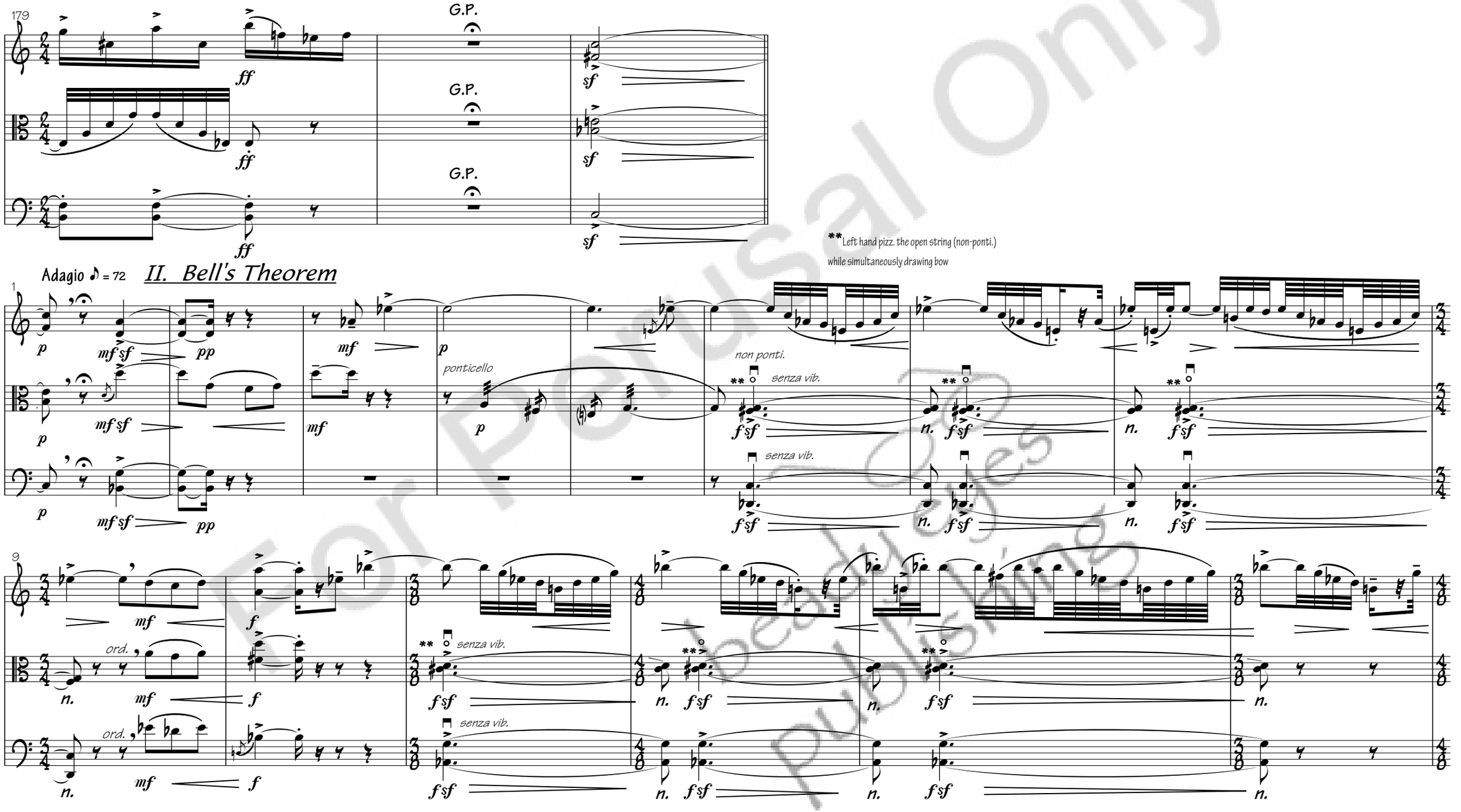
mf cresc. ff fp pp più f poco p

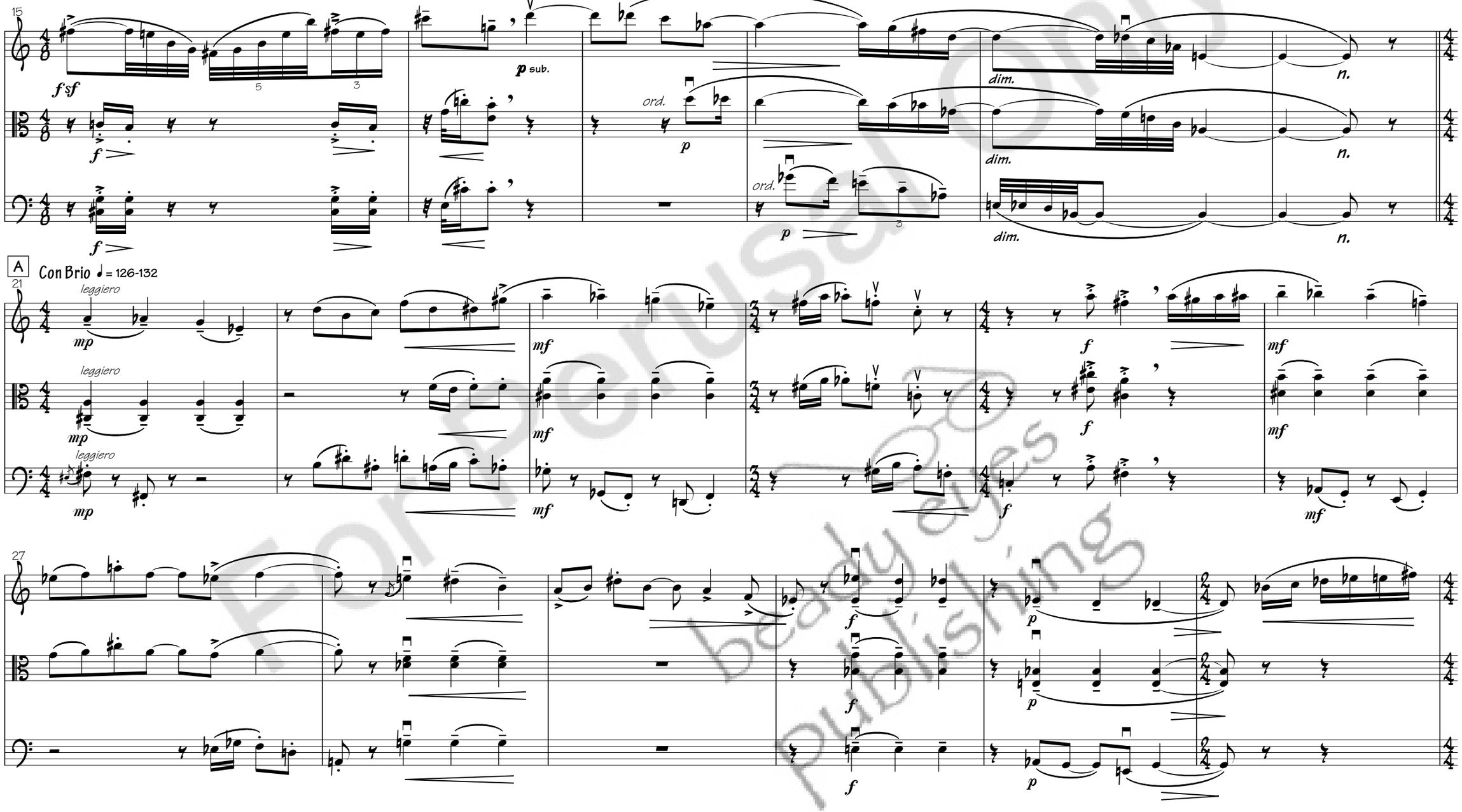
G Waltz (alla Burlesca) ♪ = 132-144

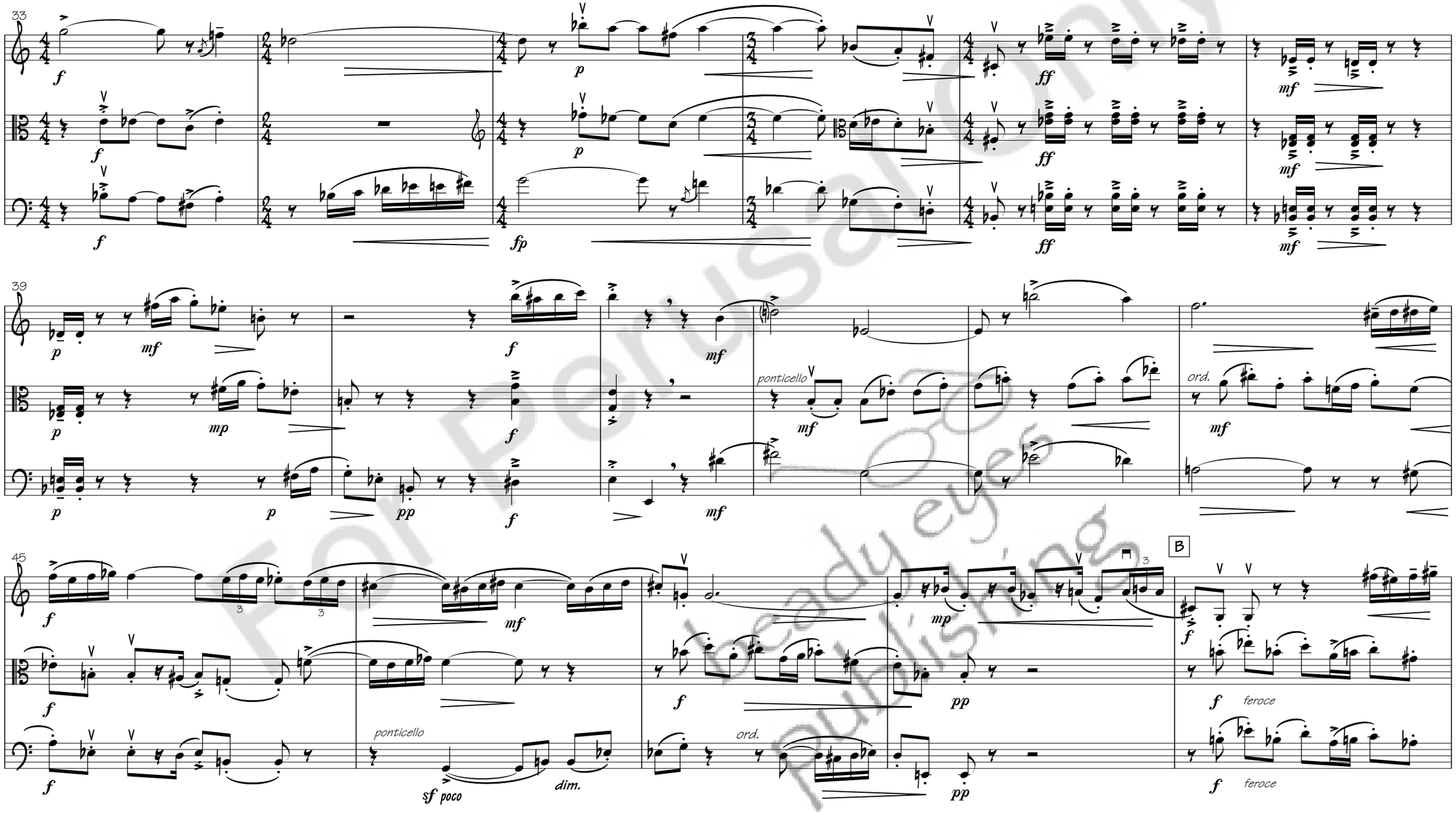


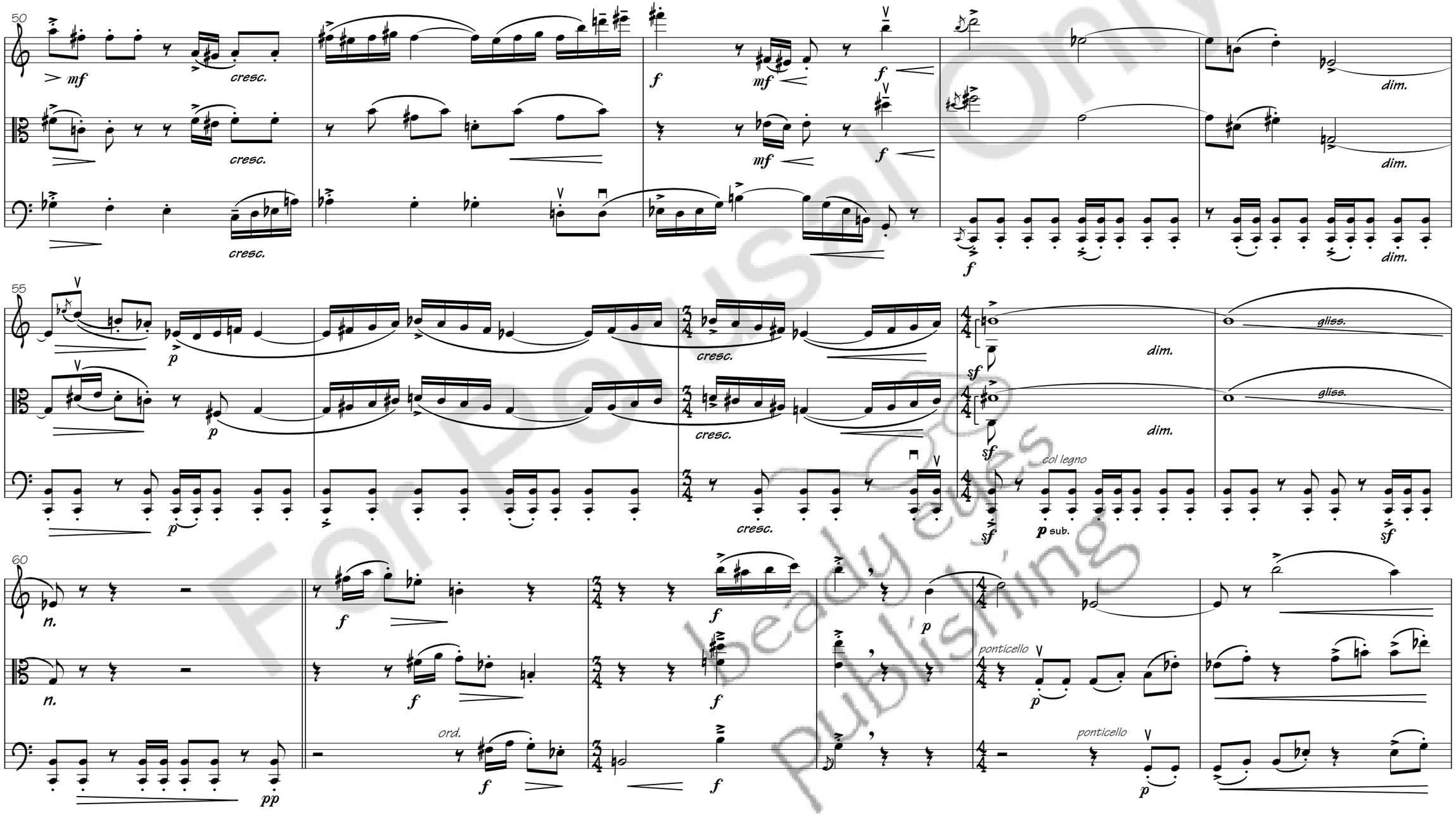


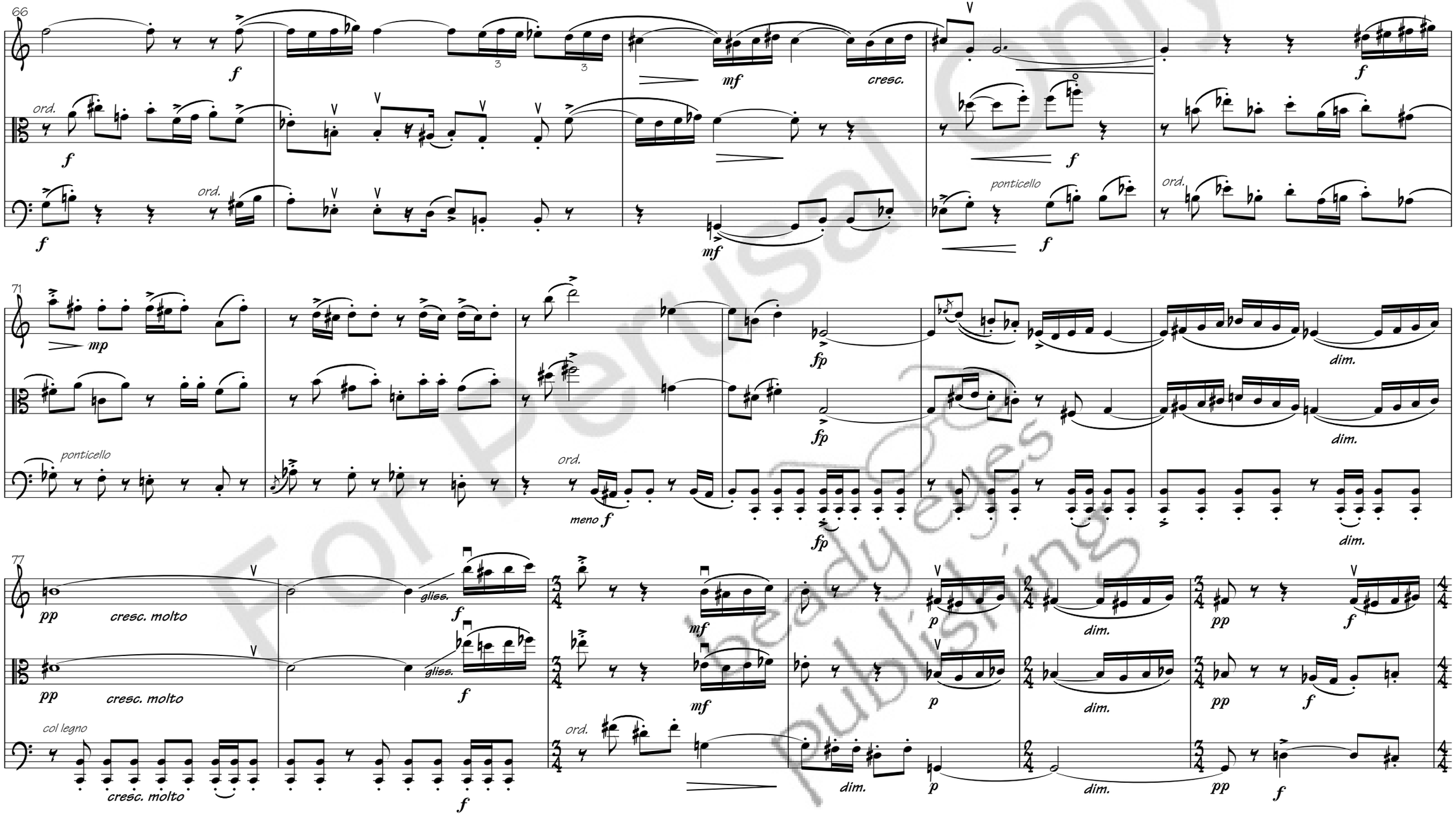


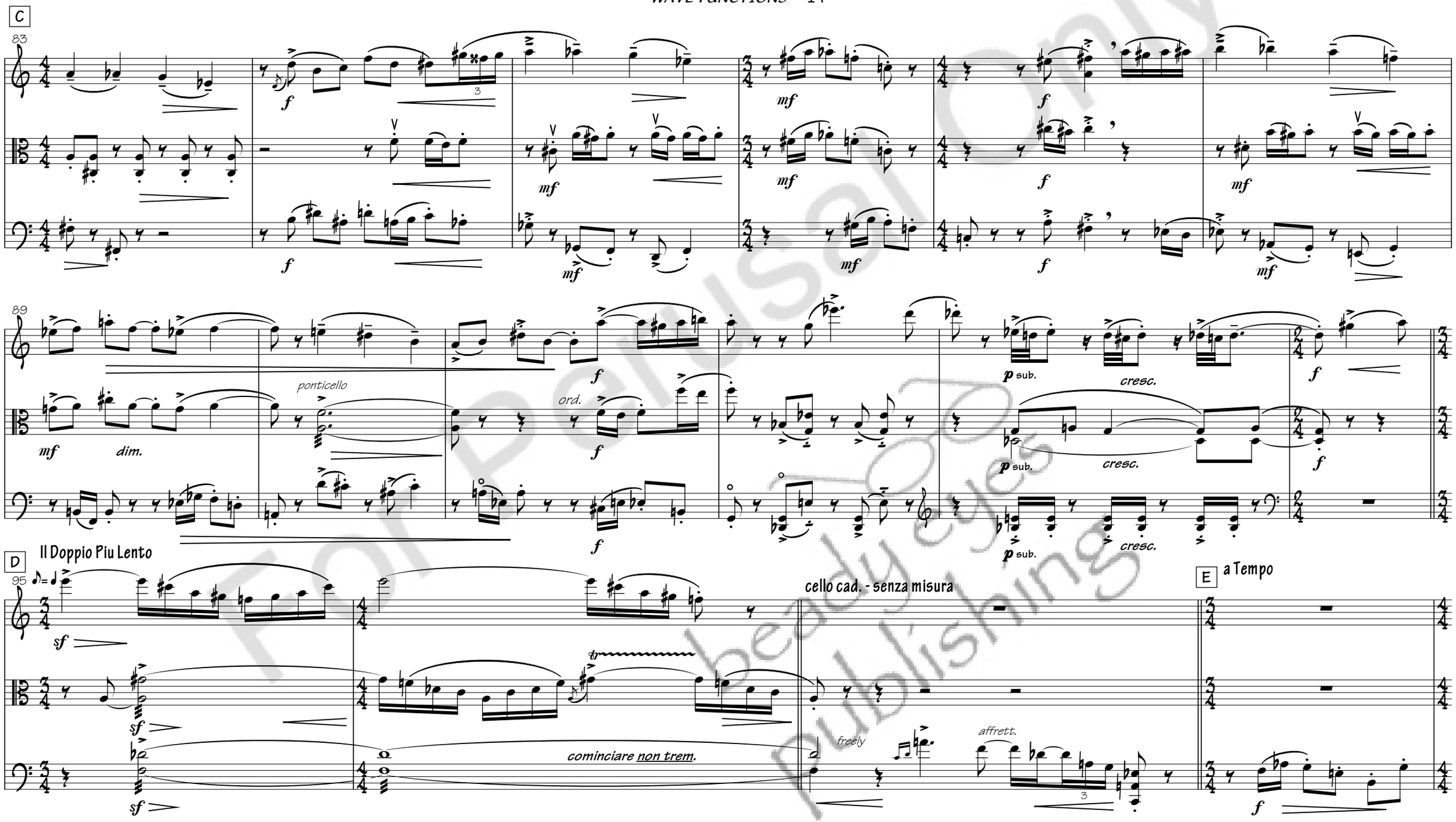


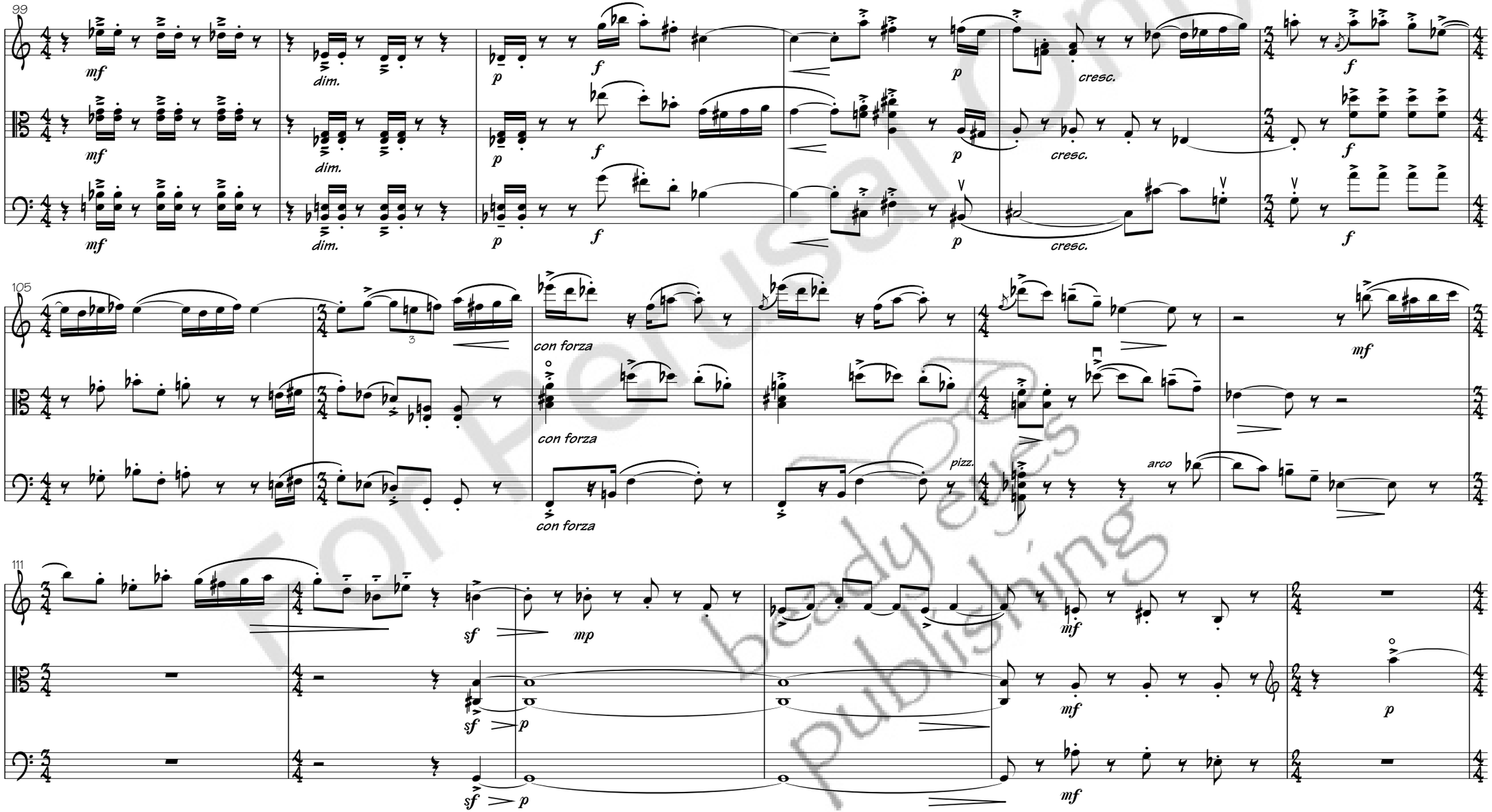


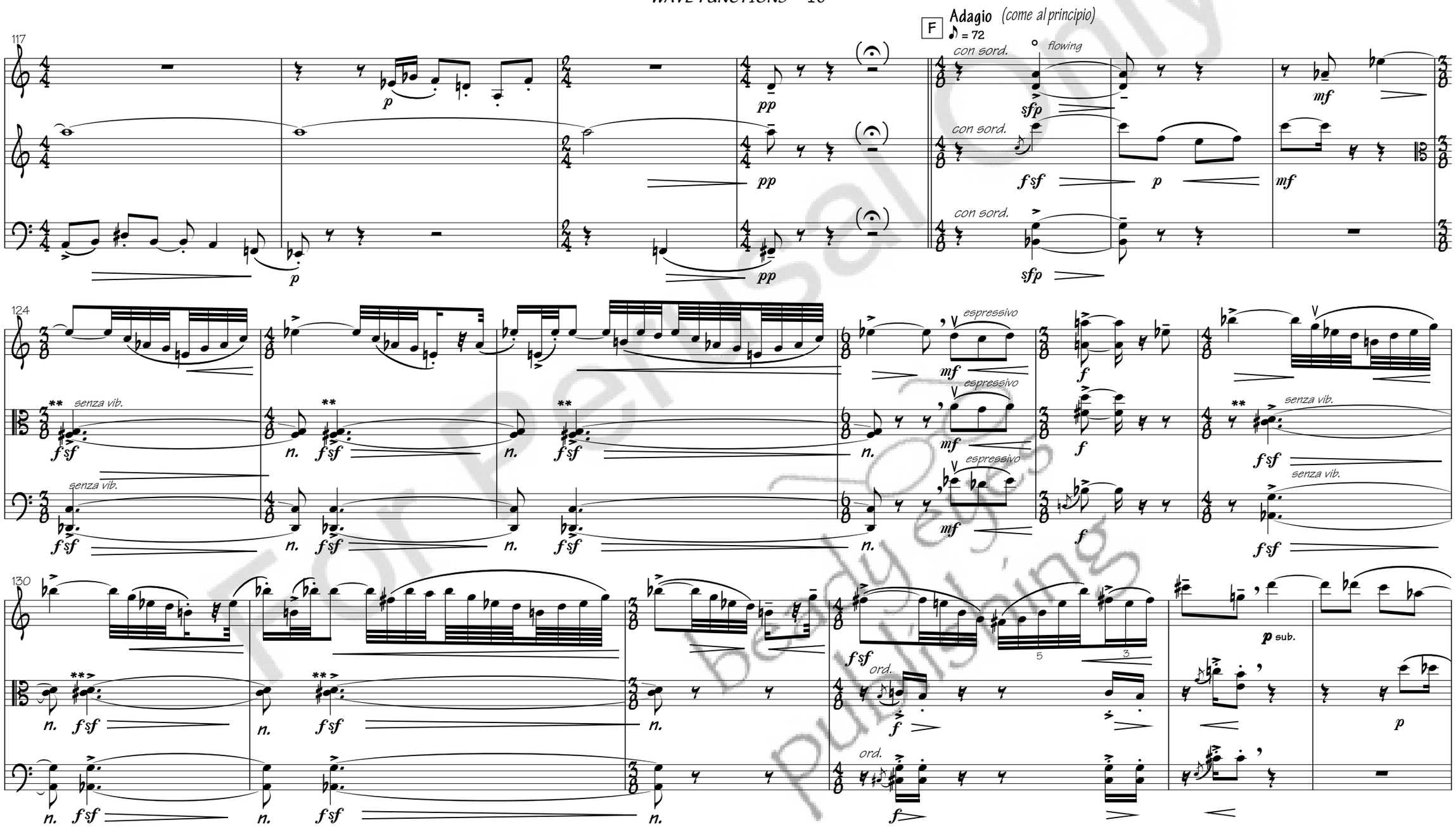


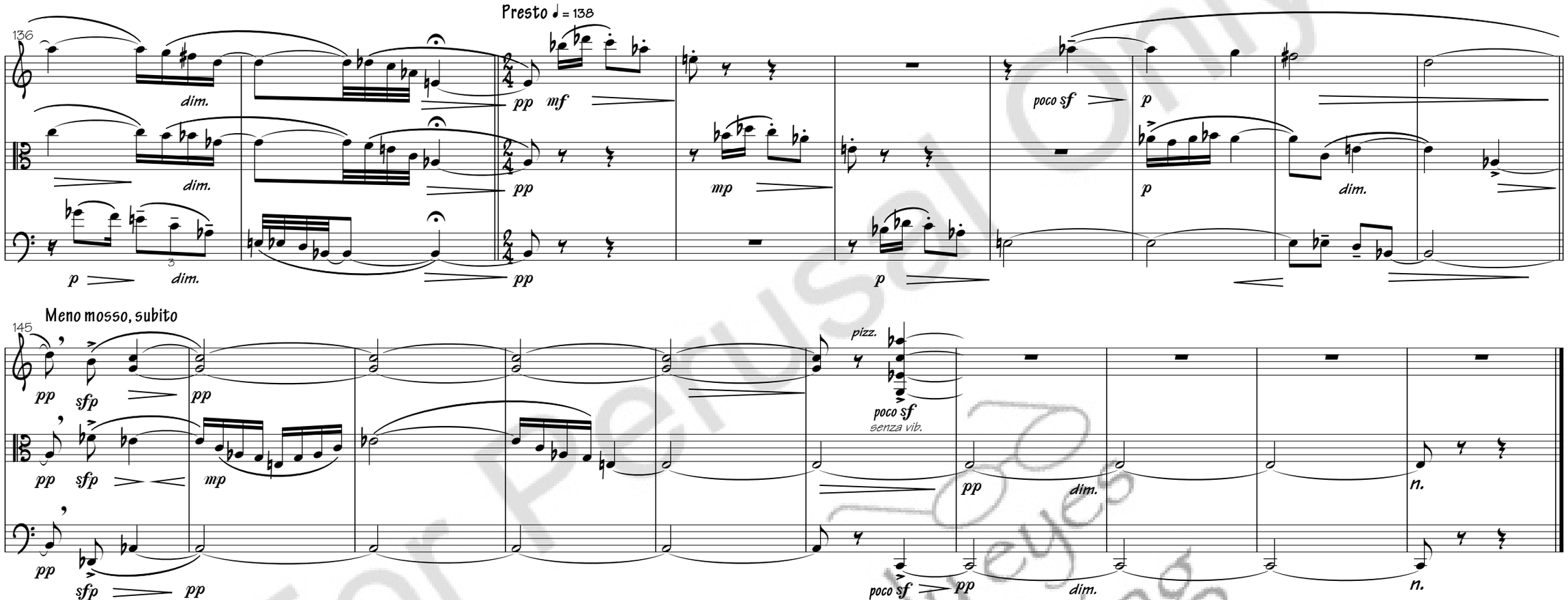




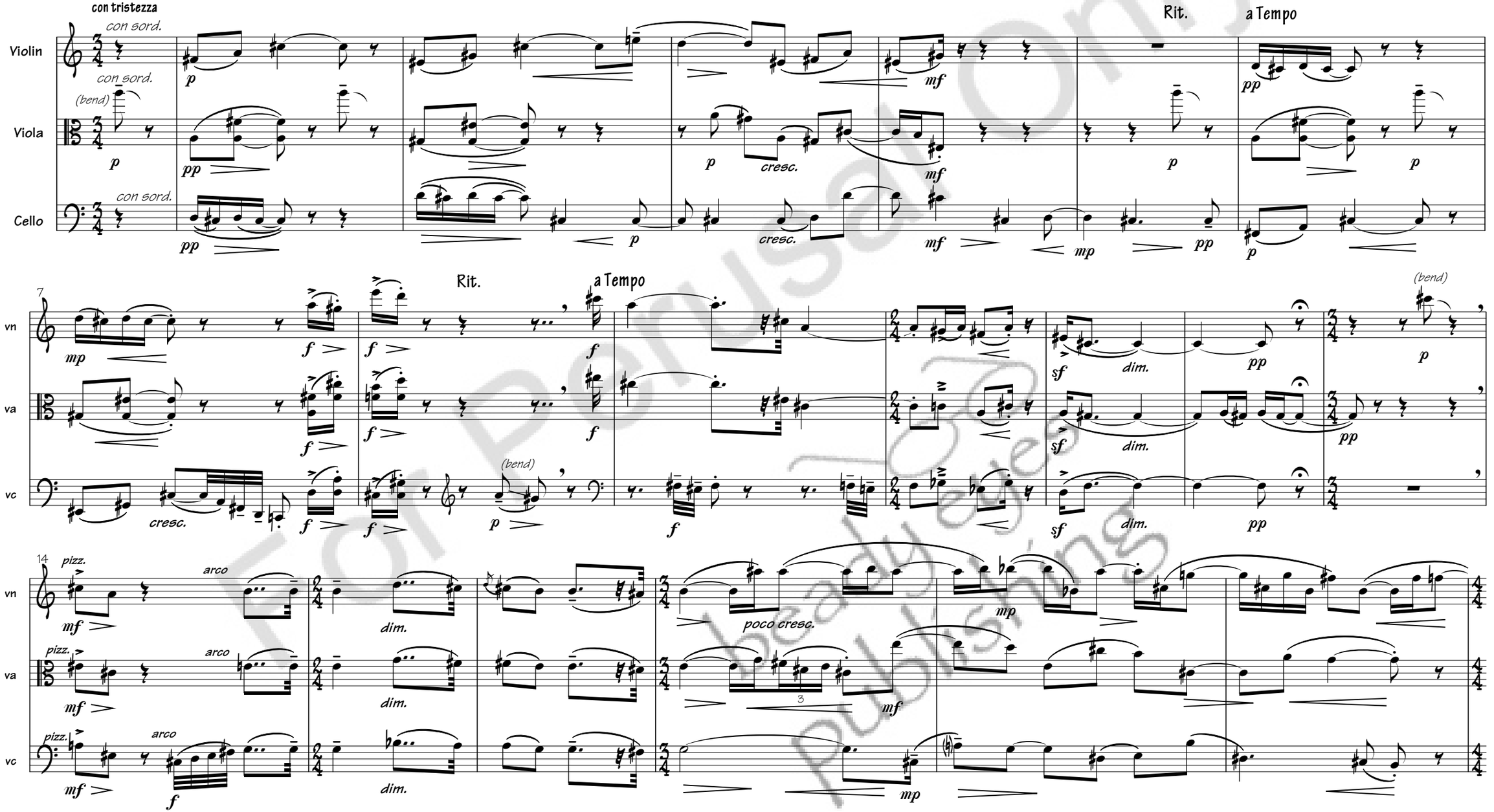


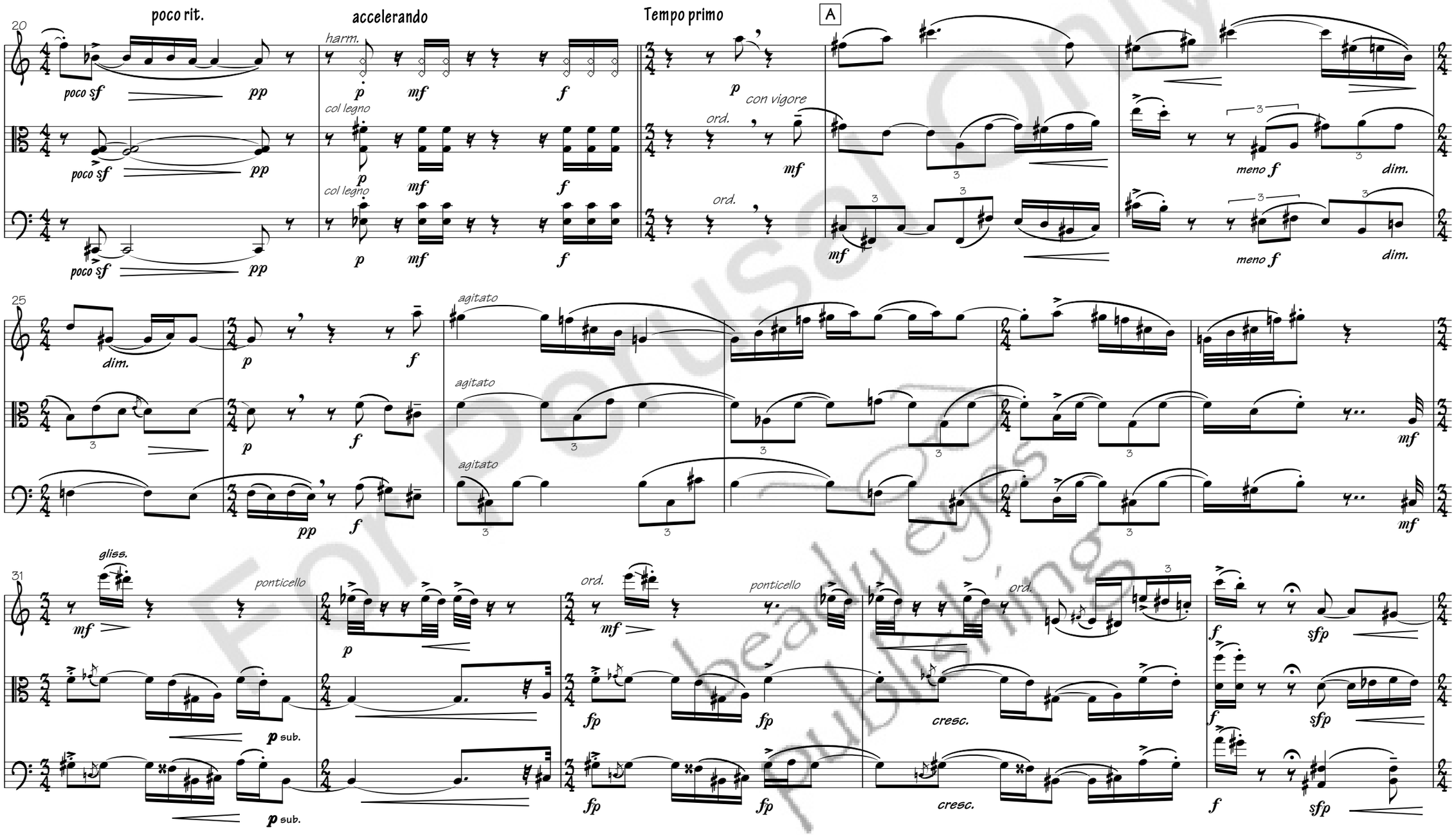


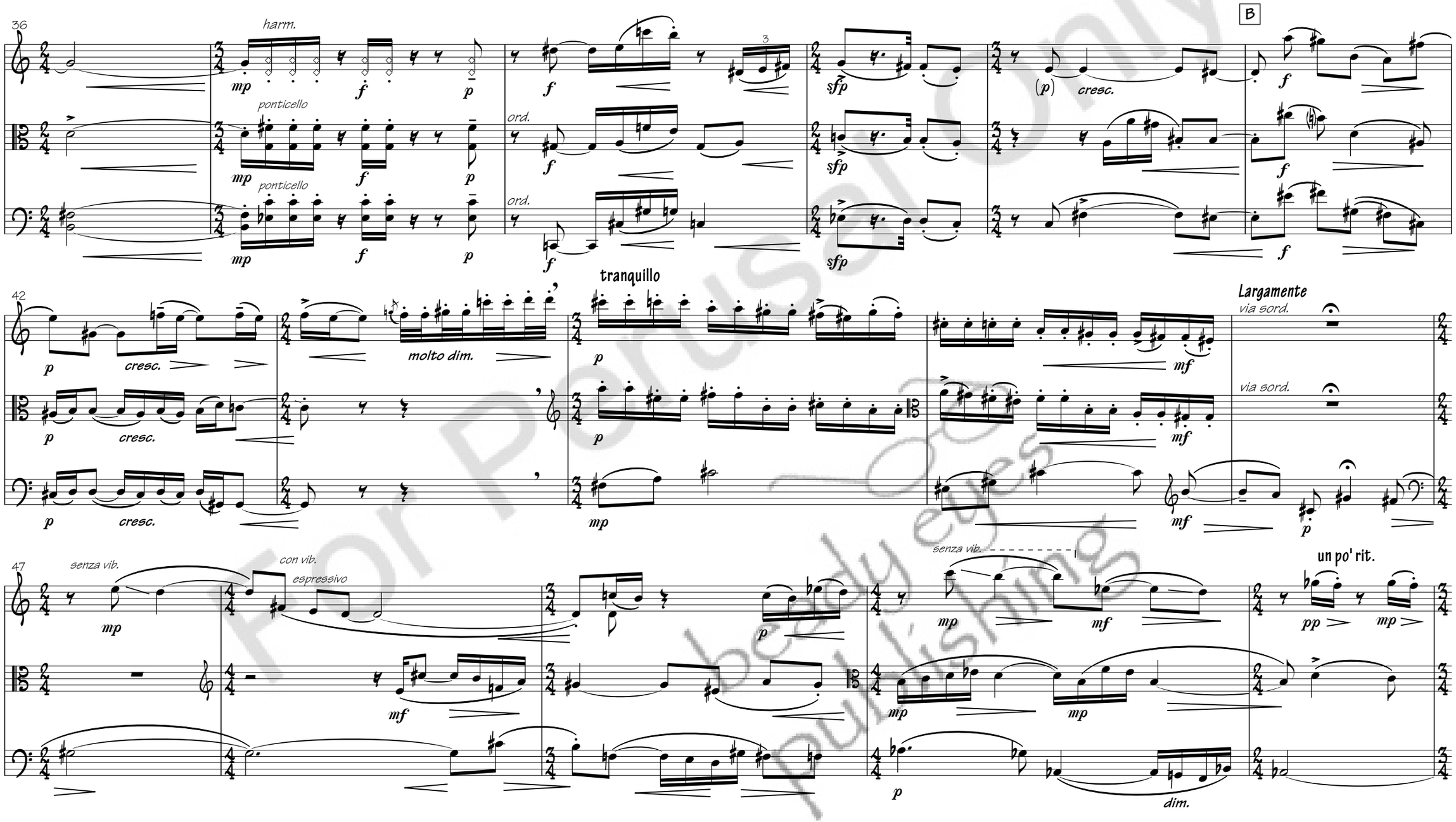


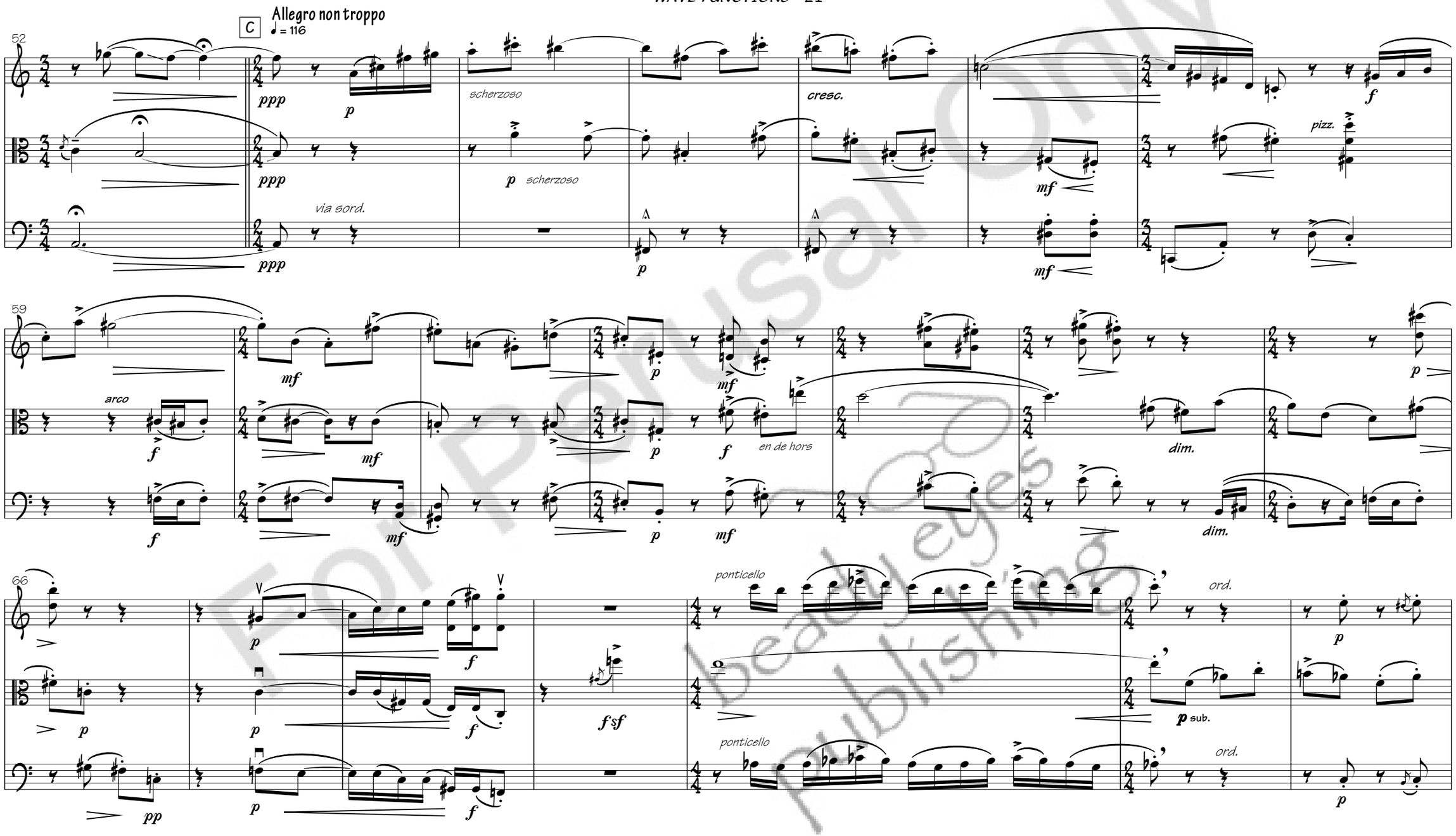


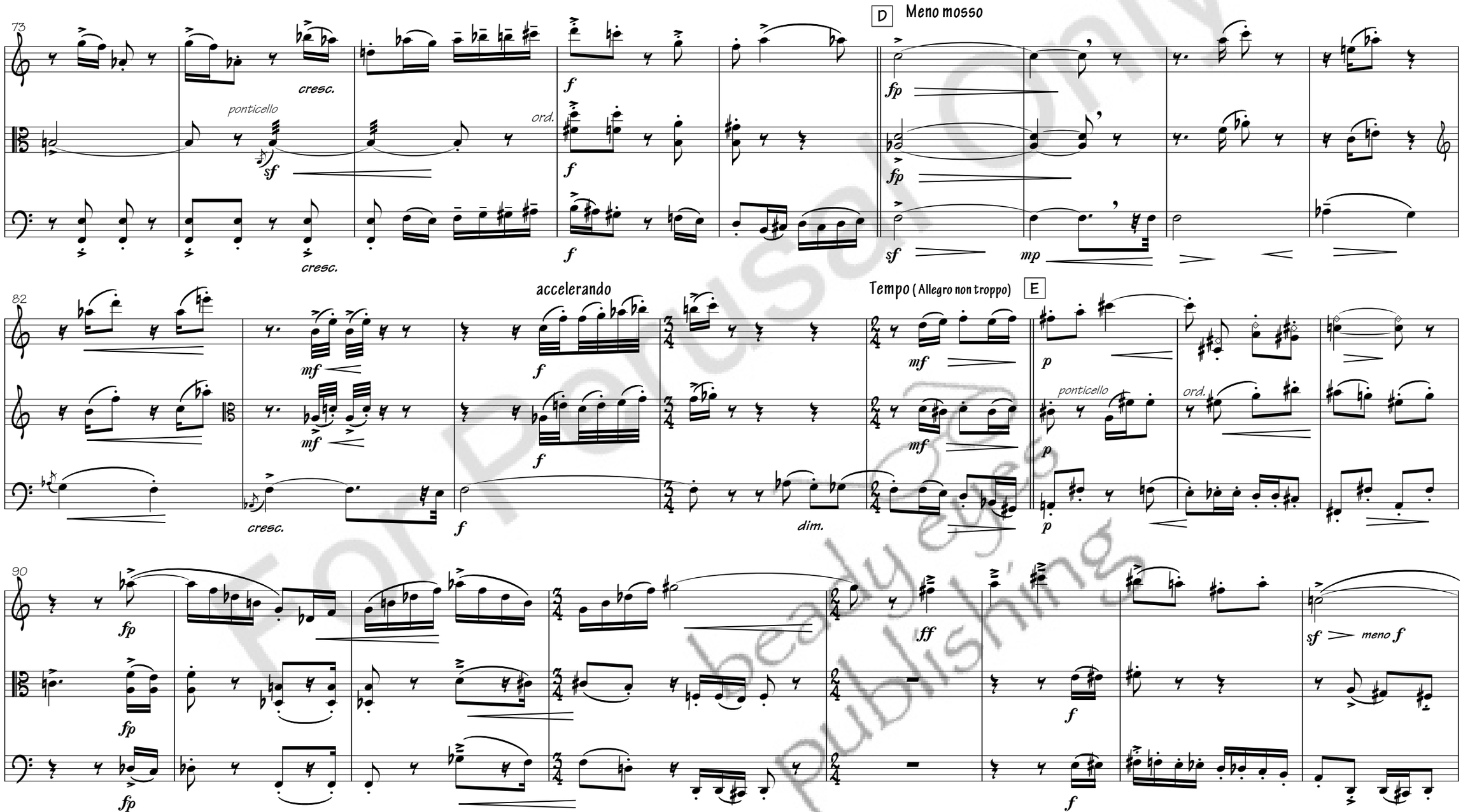
III. Schrödinger's Cat

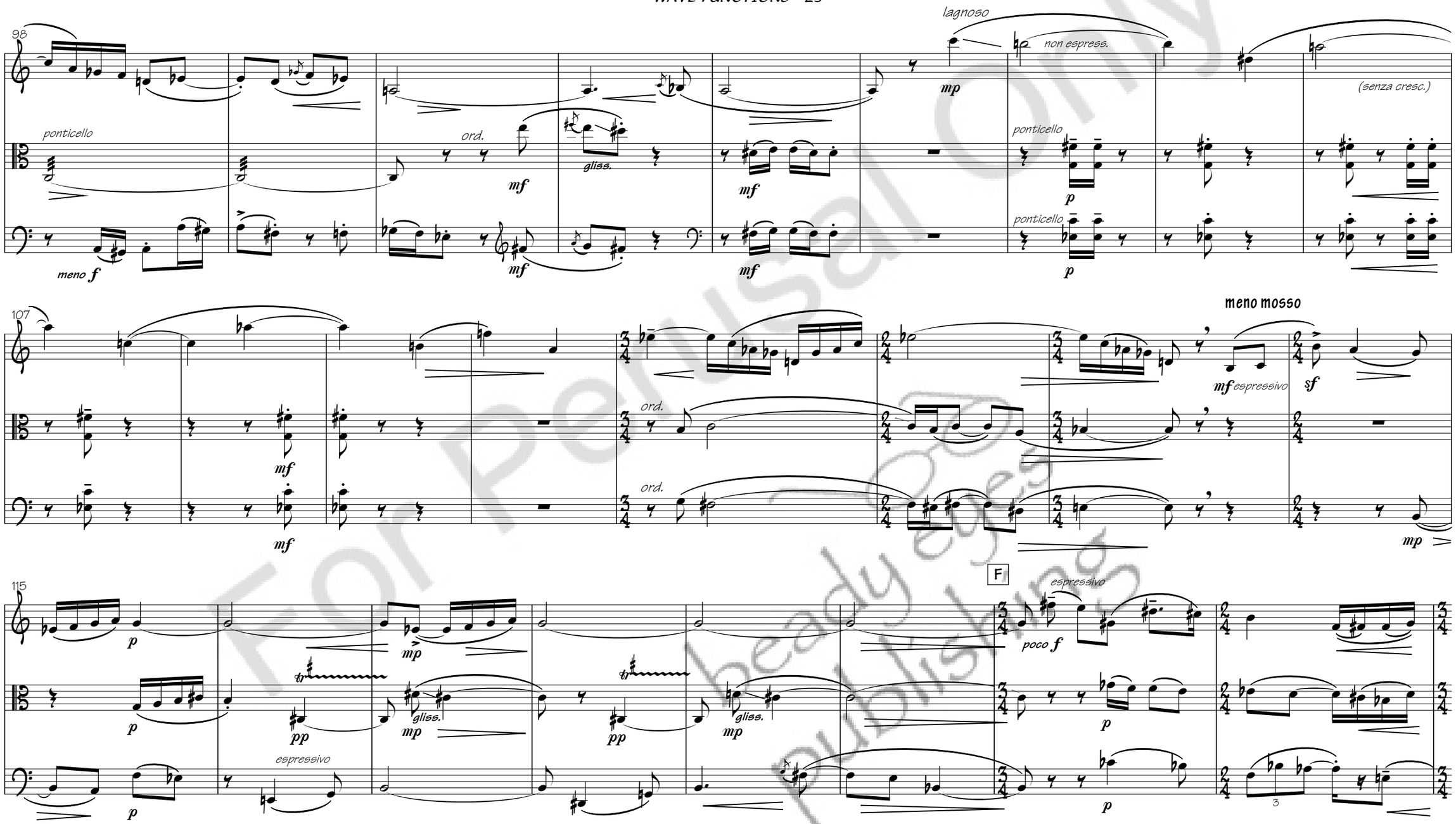


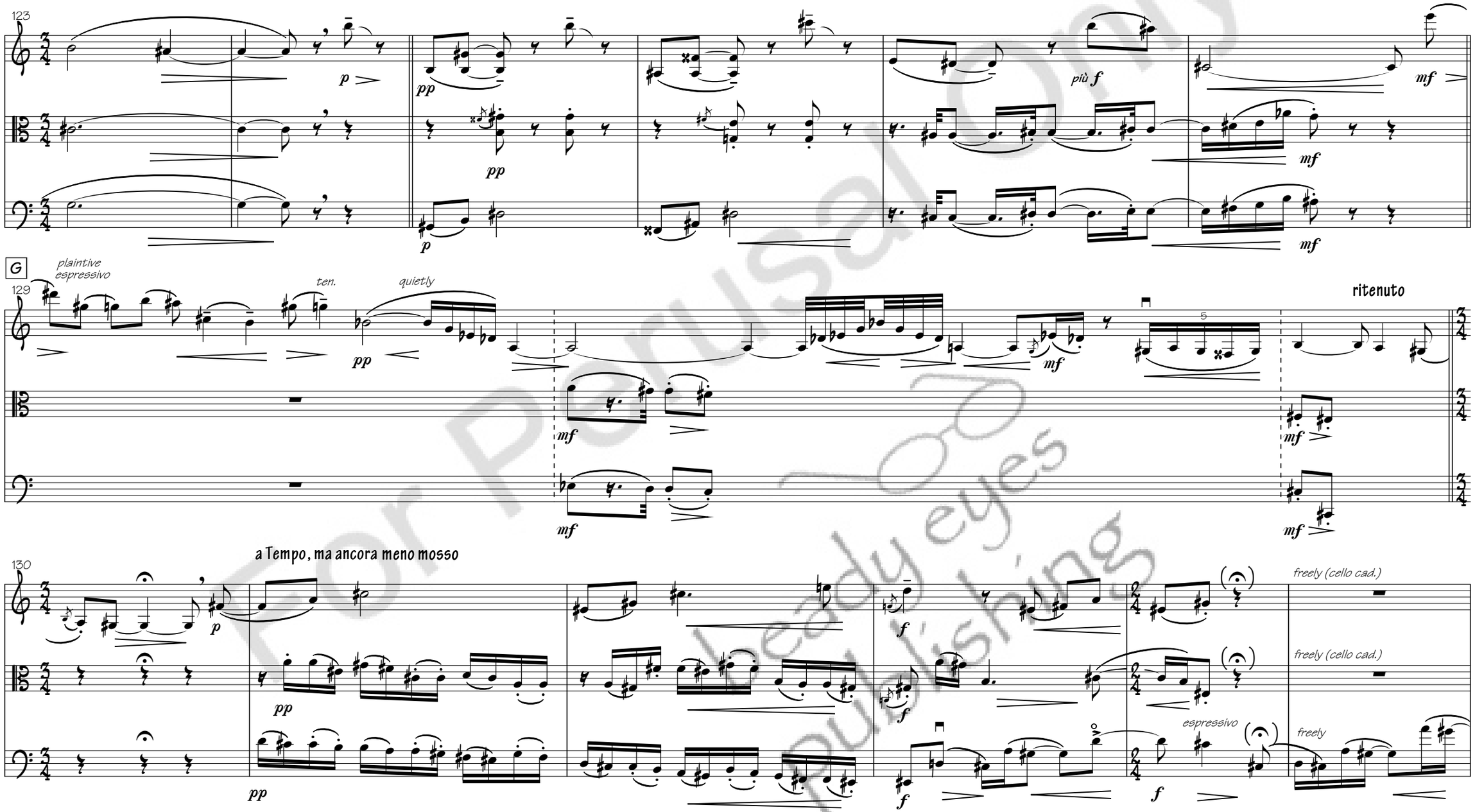


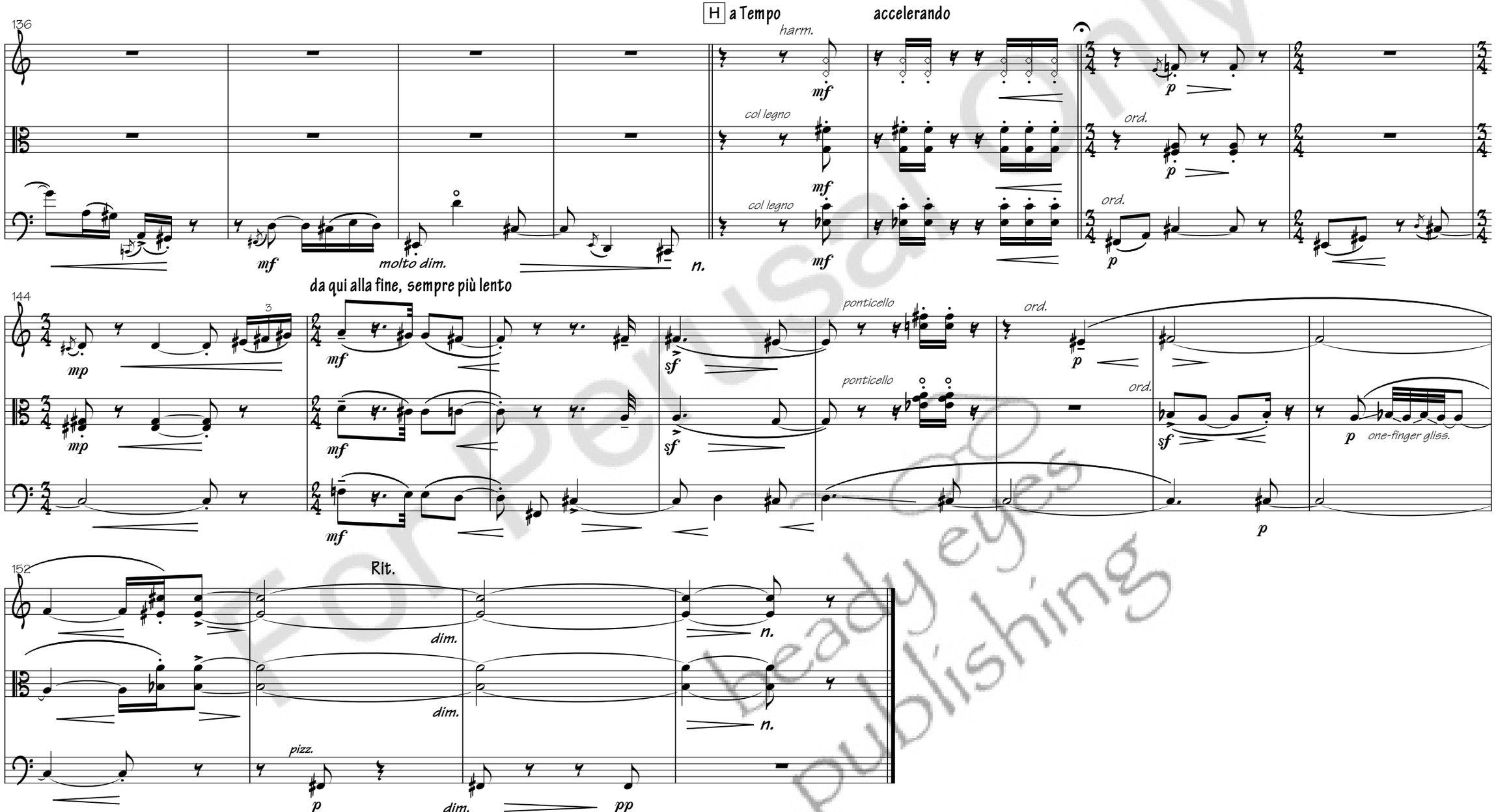




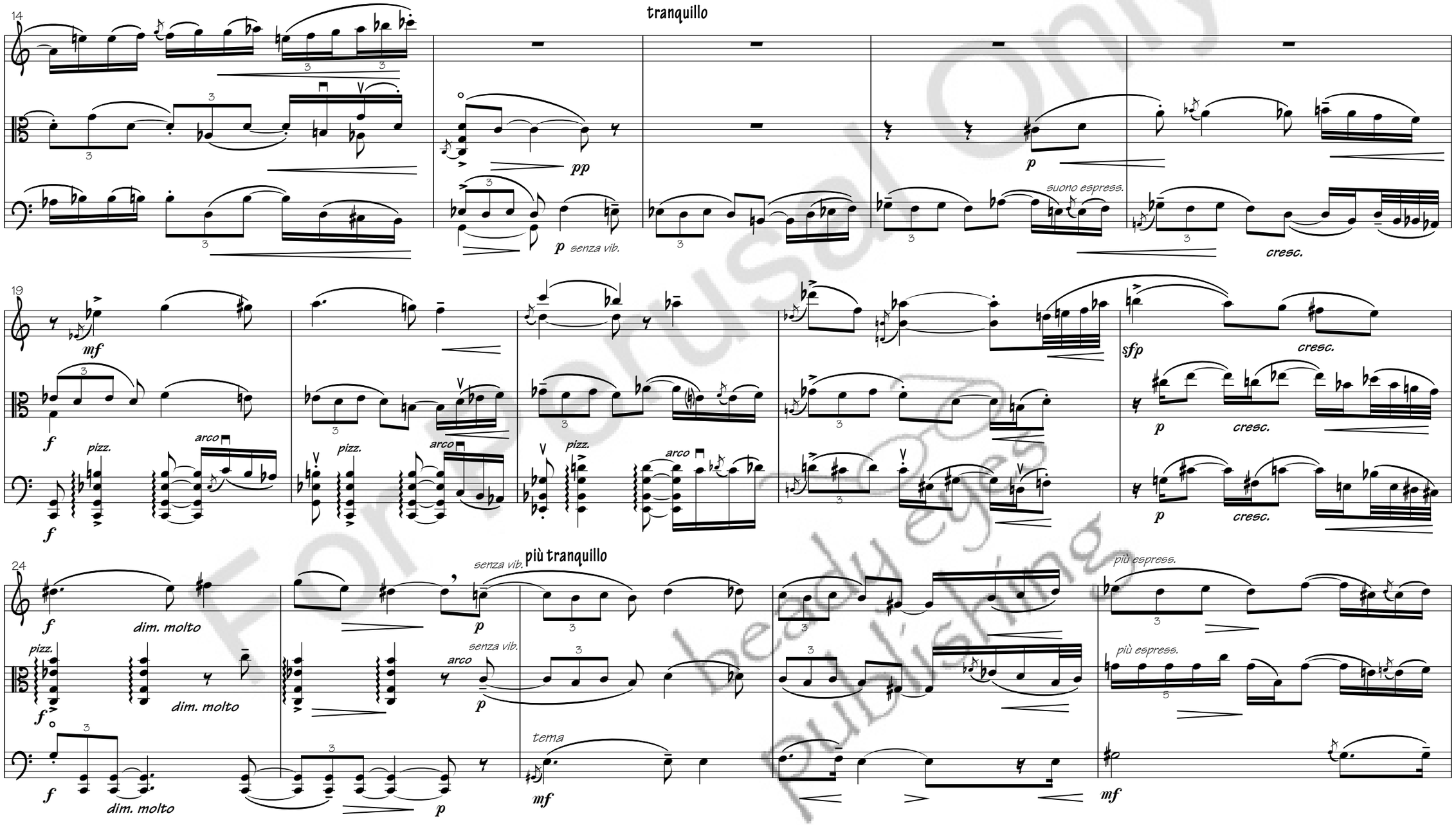


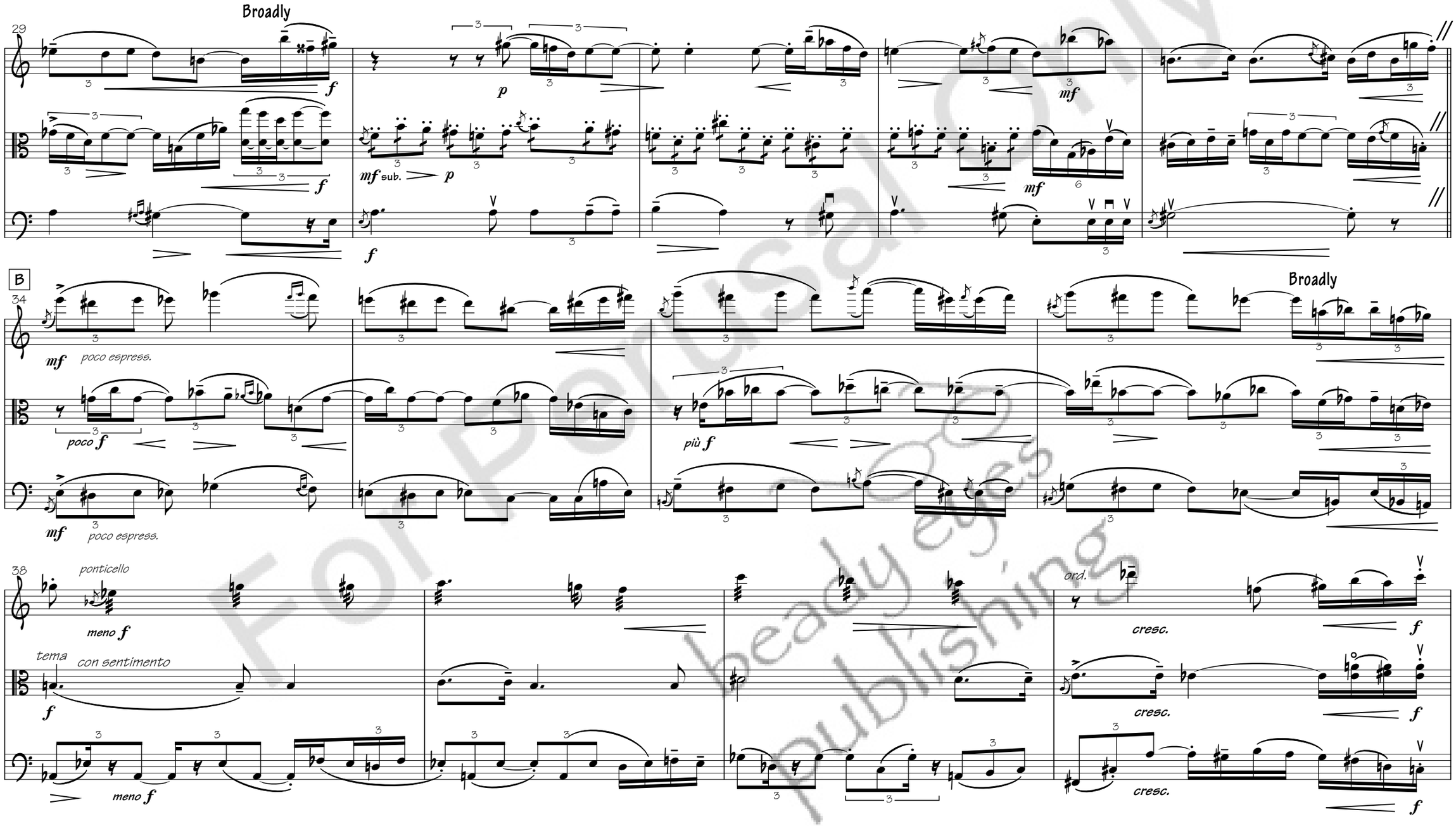


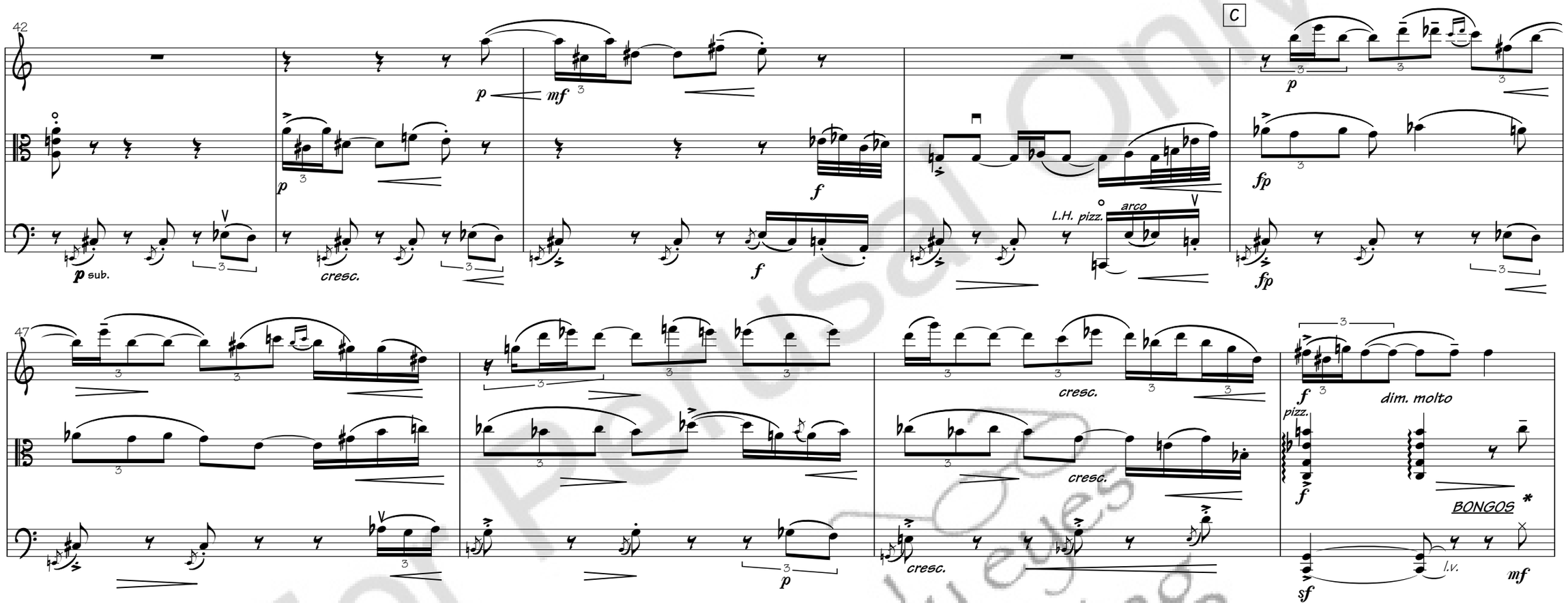




IV. "Surely, Mr. Feynman..." (in memoriam)







*BONGOS - the rhythmic notation on top of the staff indicates a higher pitch by tapping on the side (rib) of the cello. The notation below the staff indicates a low pitch by tapping on the top(belly) of the cello with other hand.
(Experiment to find most contrasted pitches.
For fast patterns use two fingers)