Motive and Spatialization in Thomas Tallis' *Spem in Alium*
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Abstract

This paper is an analysis of Thomas Tallis' 40-voice motet *Spem in Alium*. A piece of this scale and complexity posed challenges in terms of voice leading and counterpoint in this musical style due to its forces, scale, and complexity. In this analysis I suggest that *Spem in Alium*, due to the peculiarities of its nature, compelled Tallis to experiment with two specific elements—motive and spatialization, the specific treatment of which arises from the fundamental properties counterpoint and voice-leading and combines to create this unique form of antiphonal music. From this combination of factors, the piece's distinctive "polyphonic detailism" emerges. [1]

Origins of work and project

Suggestions as to how and why such a work came to be are varied and unreliable. In her book *Thomas Tallis and His Music in Victorian England*, Suzanne Cole lists a variety of possible reasons claimed by different writers: an attempt to improve upon a 36-voice work of Ockeghem, for quasi-political reasons, as a response to a royal payment of 40 pounds, as a protest on behalf of forty generations of English Catholics slandered by the Protestant Reformation, and for Elizabeth I's 40th birthday celebration[2]. Paul Doe in his book *Tallis* also suggests that is might have been for the sake of personal fulfillment, though as a sole motivation seems less likely.[3] Thomas Legge in his preface to the score makes the most convincing argument as to its origin however: inspired by a performance of mass of 40 voices by Alessandro Striggio in London, June of 1557, Tallis was encouraged to undertake the challenge of composing a work with similar forces. Legge believes this endeavor was facilitated by a Henry FitzAllen, 19th Earl of Arundel, and his music-loving son-in-law Thomas Allen, 4th Duke of Norfolk.

The significance of this is not as obscure as it might seem. Aside from a documented performance of the work at Arundel house, FitzAllen's estate, Legge states that:

> FitzAlan possessed the largest musical establishment outside the court, and in 1556 had purchased from Mary Tudor the fabled Nonsuch Palace, England's largest Renaissance building, as his country residence. The music collection held in the library there is known to have been extensive, as in 1596 a catalogue was drawn up, which happens to reveal the existence of a score of *Spem in alium*.

[1] (Legge, 2008: ii).
[2] (2008: 97-98).
[3] (1976: x)

> Nonsuch also possessed an octagonal banqueting hall with four first-floor balconies, which intriguingly suggests the architectural features that Tallis incorporated into his composition: it is conceivable he designed the work to be sung not only in the round, but perhaps with four of the eight choirs singing from the balconies.[4]

If one assumes that the traditional choir format is not what was intended for performance of this work—and there is every indication that it was not—then the question must be dealt with of just what the disposition of the singers was supposed to be and what effect this will have on the listener. If we accept Legge's intriguing supposition, that means that *Spem in alium* has not only a circular, rotational element at play, as is sometimes imagined—essentially an x- and a y-dimension—but that the music was originally intended for performance in a room with four upper balconies, adding vertical or a z-dimension, thus suggesting the enticing possibility that the project was designed and composed with such an orientation in mind. A ramification of this is, in a very real way, this piece has perhaps never really been heard before, at least in its originally intended form.[5]

From this point of origin, I set about finding ways to consider, describe, or even simulate what this kind of performance would be like. It did not take me long to understand however that any analytical consideration of spatialization in this piece was going to be inseparable from motive. Therefore in order more deeply understand this music I felt had to account for how motive operates in this piece more broadly.

This turned out to be more complex than it would seem at first. For one, an extant, in-depth analysis of motive in this piece was not to be found, and in fact the analytical literature on this piece is comparatively scant, containing only broad descriptions of form for the most part or focusing instead on the piece's murky and incomplete history. Also, methods for investigating motive and indeed analyzing early music in general are a topic of some debate, the study of which ultimately yielded few useful methods.[6] In addition, there are very few analytical methods for any type of music that are helpful in describing what I see the essential relationships that result from a properly spatialized hearing of this piece, which is fusion of interval, rhythm, and text. My conceptualization of motive needed to consider the intersection of the intervallic and the phonemic—not merely textual—to achieve a more complete understanding of how it is that Tallis works with his materials in order to achieve the sound masses of this work.

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[4] (Legge, 2008: ii).

[5] This even applies to Janet Cardiff's "40 Part Motet" installation, which has done much in recent years to bring a new level of popularity to this work and goes a long way towards representing the authentic antiphonal complexity of this piece; her installation is certainly much closer to the original intent of the work than any recording (Berwick 2006: Bloomberg.com).

[6] For an authoritative treatment of the state of analysis of early music, see Margaret Bent's "The Grammar of Early Music: Preconditions for Analysis" in *Tonal Structures in Early Music* (1998: 16-59).

Attempting to understand the usage of motive in a work of this time period in turn led me in turn to consider the more basic aspects of the piece, namely the contrapuntal and voice-leading rules that govern its discourse. At first this was in service of a kind of idea about automating the analysis—using a search algorithm to find all instances of a motivic relationship throughout a piece. Though this is in fact possible and might be interesting to pursue, it turned out to not really be necessary with this particular piece, as the kind of permutations that Tallis uses are not of the sort in which a lot of complex reverse-engineering is necessary. Motive in this piece develops more organically, and thus an approach that takes this into account seemed more appropriate. However, a benefit of this idea was a survey of the techniques of computational musicology with, which were in fact used to fruitfully analyze the voice-leading of this piece and in turn definitively prove the part-writing constraints that in turn create the compositional conditions that Tallis has to respond to and push to their limits in order execute such a compositional task. So, from a theory about spatial orientation of the piece's first performance, I was led to consider and analyze motive, which in turn lead me to consider the effect of the fundamental melodic interval content in the piece on its motivic content and usage.[7]

Part Writing/Melodic Interval content/Computational Musicology

A central feature of *Spem in alium* is the design and composition of the individual vocal parts and how they combine to produce emergent properties of musical texture and form. This is especially true when the demands of motivic complexity and the amount of simultaneous parts increase. As the choirs progressively concatenate into larger and larger meta-choirs, the concomitant motivic deformation accelerates until all one hears are the emergent sound of multiple layers of material, the above mentioned polyphonic detailism, consisting of morphing clouds of counterpoint which are inextricably bound to a very narrow range of musical possibilities. What we really hear at the points of maximum density in this piece is the accumulation of the essence counterpoint, the simultaneity of an epoch writ large.

In pursuit of a better understanding of the rules governing part writing and counterpoint in *Spem in Alium*, I explored the application of statistical methods and data analytics. Though I originally had hoped to pursue more sophisticated searches in regards to motive by developing a motive recognition algorithm, I had to scale my ambitions back a bit and instead focus on these main topics: (1) loading and parsing the data of a musical score into a data set; (2) creating a flexible method for searching any combination of either individual or multiple voices for analysis; and (3) graphing and interpreting the

[7] I realized that the development of an algorithm to detect motivic repetition would only help so much, and only in specific areas of the piece. By the time I had gotten that far into it, it did not as seem relevant anymore, as I had figured out quite a bit manually.

results.[8] For this project, this information was used to create histogram comparisons between of all sequential melodic intervals of the first five voices of the piece in score order, essentially focusing only on the five voices of Choir I (one choir out of eight).[9]

For the purposes of this project, I analyzed the individual sequential, i.e. melodic interval content of Soprano I, Alto I, Tenor I, Baritone I and Bass I, the first five voices in order in the score. In addition, the aggregate sequential interval content of all five voices was examined as Choir I. Below is the histogram for Soprano I, with the x-axis representing all the intervals used and with a minus indicating a descending interval and a plus representing an ascending interval. The y-axis represents frequency of occurrence, irrespective note duration, rhythm or rests.[10]

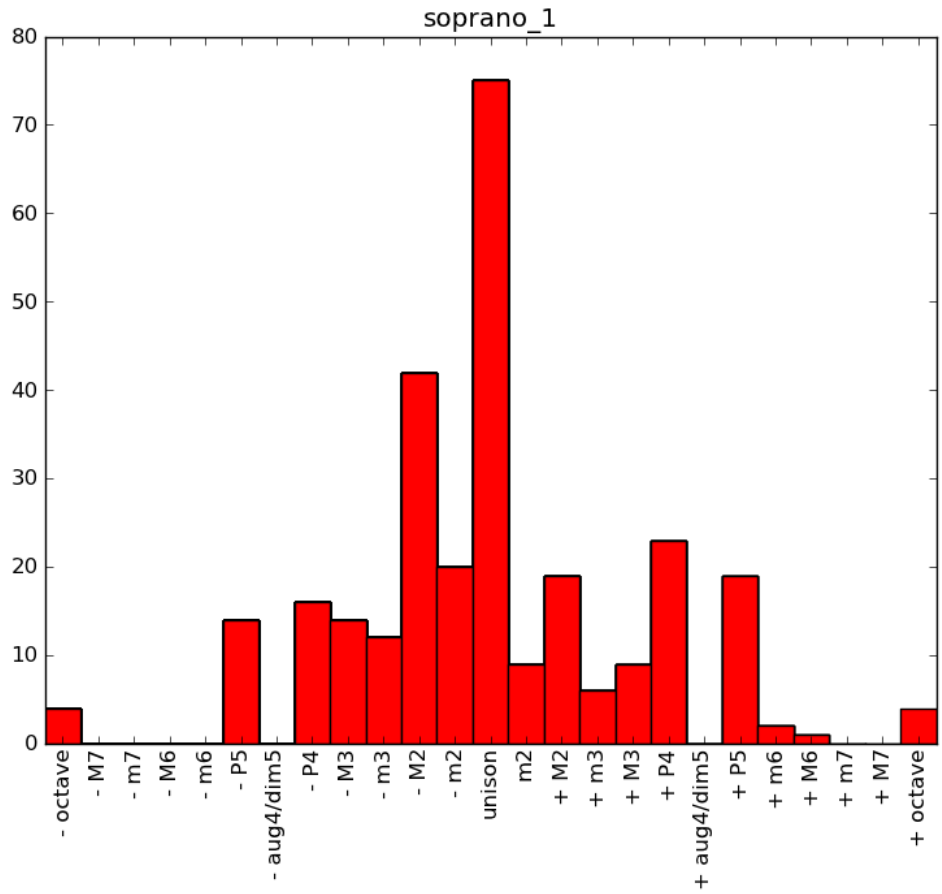

Figure 1: Histogram of sequential melodic intervals in Soprano I

[8] In addition to writing my own scripts, once I had the score as a data set, I also experimented with using the Python musical analysis package music21, and gathered some interesting preliminary data about overall pitch and rhythm, which can be seen in Appendix 1.

[9] For more information regarding methodology and coding, see Appendix 2.

[10] For histograms of the other voices, please consult Appendix 3.

And here is the histogram for Choir 1 in its entirety:

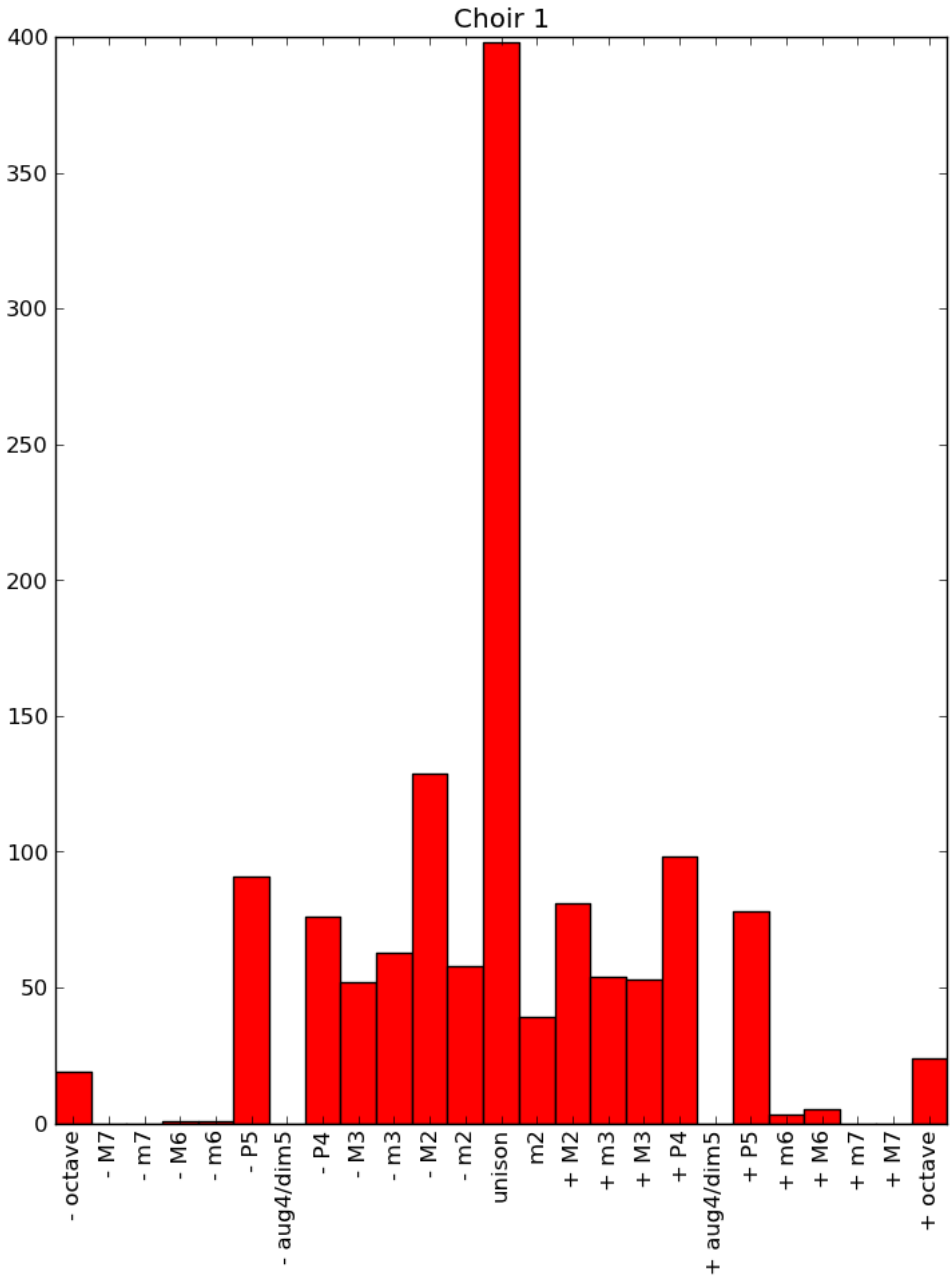

Figure 2: Histogram of all of sequential melodic intervals of Choir I

Clearly, all of these graphs display a great deal of similarity. Their consistency, given the amount of musical variation present in the piece, is startling. Even more surprising is that these are not absolute pitches which are indicated here but rather interval, or the change in pitch from one to the next. However, this is because the data is very strongly correlated with the traditional rules of contrapuntal propriety. The complete avoidance of any melodic intervals of a diminished fourth/augmented fifth or of a major or minor seventh

(either ascending or descending in both cases) is absolute, an iron-clad rule. The relative paucity of ascending or descending melodic major or minor sixths is also very typical of the style. This is certainly a validation of the traditional conception of Renaissance polyphony.

Looking closely at the details though, the role that each voice plays individually within the choir becomes clearer. The soprano and the tenor have more varied interval content than the other parts. Also, typically, the bass has a greater number of leaps of a perfect fifth than any other part. The alto part contains quite a lot of repetition, with more unisons than any other part—110 or so, at least 30 more than any other part. As mentioned earlier, this is proof of the characteristics which are generally though of as stylistically typical for polyphonic vocal writing in the Renaissance, but it is interesting to see how this borne out in this data. Even without explicitly engaging the temporal elements of this music or even correlating the data with rhythm or motive, evidence of Tallis' approach to composition and part writing is clear. One significance of this huge amount of intervallic redundancy is that, aside from being an affirmation of the methods used to construct the individual parts and providing concrete evidence of the individual melodies' construction, these characteristics also contribute to forming the distinctive sound of the overall sound masses, all but forcing the motivic material in the more massive entry groupings to be little more than a navigation of very strict rules of part writing. A twenty-voice entry for instance, if it is not a literal doubling and retains any similarity regarding its rhythmic profile, only has a limited number of options.

Harmony

When first tackling this piece, I began with a harmonic analysis. Unsurprisingly, this told me very little. Though Tallis was influenced by continental developments in his later years, he still carried many aspects of the Middle Ages into his work. The result of this is that harmony in his music is a largely structural affair, whose function serves to give coherence to the intersection of multiple melodies; is simultaneously architectural and coloristic, but however not "functional", at least in the sense of later eras. Paul Doe confirms this as he has characterized harmony, even in Tallis' later music, as the resource he is most reluctant to use for direct expressive purposes, especially in comparison to contemporaneous continental developments.[11] There are moments in *Spem in Alium* where dramatic motivic entries of combined choirs occur in 'block' harmonies, bringing about moments of arresting harmonic shifts.[12] On the whole though, as this piece pushes the boundaries of this style of this epoch to their limits, the harmonic content in general is forced to recede in significance somewhat, providing mostly successions of colors punctuated by dramatic moments.

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[11] (Doe, 1976: 45)

Structure/Overall form

Below is a graph from Whittaker's "An Adventure", an insightful assessment of *Spem in Alium*'s overall form and general characteristics.[13]

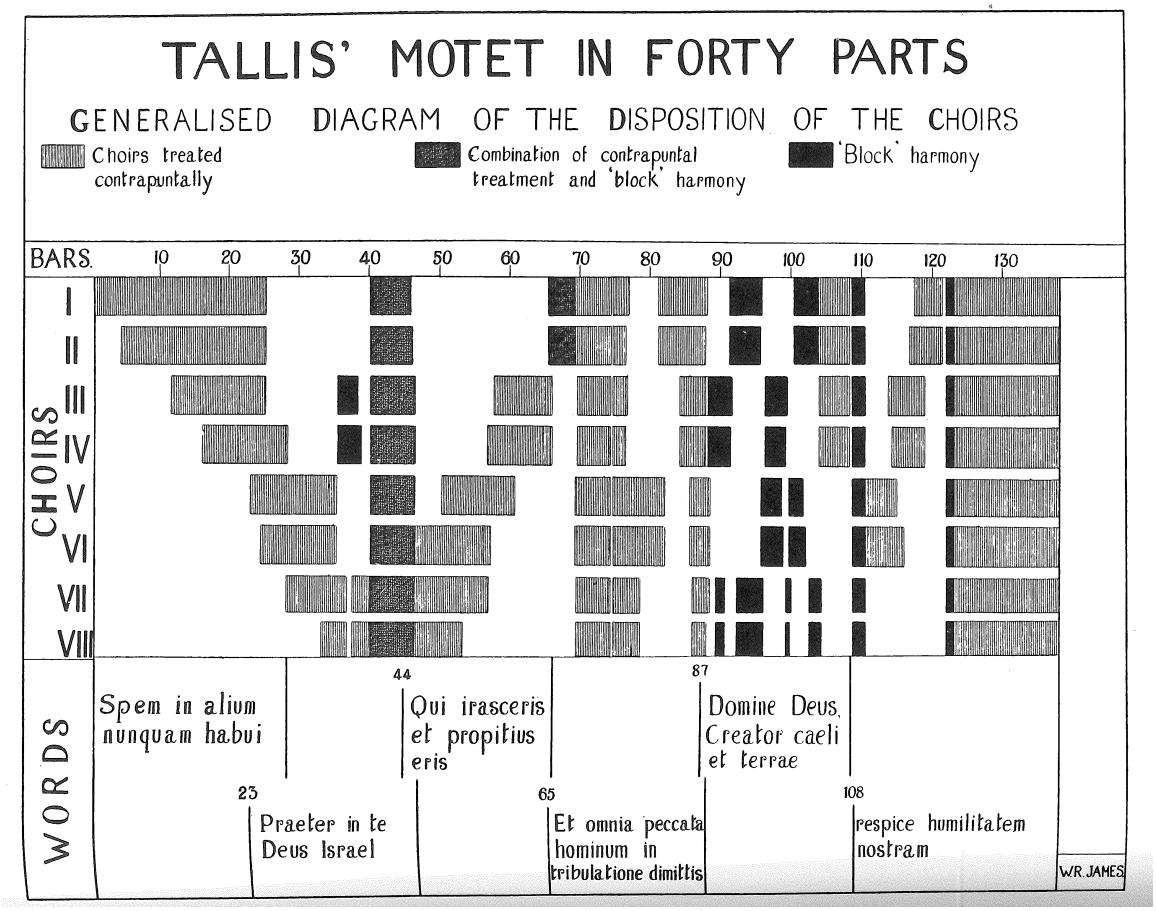

Figure 3: a formal graph of *Spem in Alium*

There is quite a bit that can be assessed from this graph. First of all, the overall form can be divided neatly into two parts: the first half, which consists of the V-shape interrupted with a dramatic full choir entry at measure 40 and then continues until its culmination in another full choir entry at measure 69 which dovetails into the second half, and begins the more antiphonal section where the choirs aggregate into progressively larger groups.[14]

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[13] (Whittaker 1970: 86-89)

[14] Legge shrewdly notes that this first full choir entry at measure 40 is unlikely to be a coincidence, as it matches the number of voices in the piece and perhaps even coincides with the circumstances of the work's genesis. He also notes that the overall length of the piece is 69 "long notes" and that in the Latin alphabet, the letters TALLIS add up to 69 (2008: ii). It seems worth adding to this that it is surely not a coincidence that the other full choir entry is at measure 69.

Just past measure 80 for instance, a similar rotational order to the opening, only in extreme diminution can be seen as Choirs I and II, Choirs III and IV, Choirs V and VI, and Choirs VII and VIII all have simultaneous entrances with each other or as an entire group essentially for the remainder of the piece (there are staggered entrances between measures 110 and 120 but these do little to detract from the overall effect.

Whittaker wisely categorizes the characteristics of the musical materials in this diagram into three different categories: (1) choirs treated contrapuntally; (2) combination of contrapuntal treatment and "block" harmony; and (3) "block" harmony. This assessment is insightful and mostly accurate. Though my treatment of this work is more concerned with motive and spatialization, this graph gives clear indications not only of form but a provisional picture of what the spatialized experience of this piece would be. It is important when looking at this graph to imagine the sonic difference between the contrapuntal sections, in which there is a dedication to motivic identity and development, resulting in a highly controlled, rotating texture with a heterogeneity displacement of rhythmic, melodic and phonemic articulations, and the block harmony sections where harmony, rhythm and text are unified as much as possible, and the interstitial combinations. As we look at the thematic materials we can consider them and their relationship to piece's larger form and ultimately spatialization in more depth.

First Entry Group

Tallis kept one foot in the Middle Ages but absorbed into his style in the midpoint of his extremely long career musical characteristics that we normally associate with the Renaissance: the repetition of musical 'sentences' and the idea of symmetry; the linear development of individual voice by scale-wise movement, sequence, or systematic rhythmic organization; the integration of the texture by imitation; the introduction of harmonic tension by means of suspensions; and finally a decrease in melismatic writing and greater use of syllabic setting in both imitative and chordal textures.[15] However, despite this, there is a "persistent formality about most of his melodic material, particularly the imitative ideas."[16] All of these characteristics are on display in the opening, as seen in the example below, first thematic area. There is a sentence-like structure that matches the text, even acting as a clause that pauses and continues on as opposed to coming to a full stop; a clear sense of symmetry; suspensions; few melismas, and a great deal of imitation. Yet as Doe suggests, there is the impression of some kind of formality here, even within this first theme, the most lush of all of the material to come.

[15] (Doe, 1976: 14 and 44)
[16] (Doe, 1976: 42)

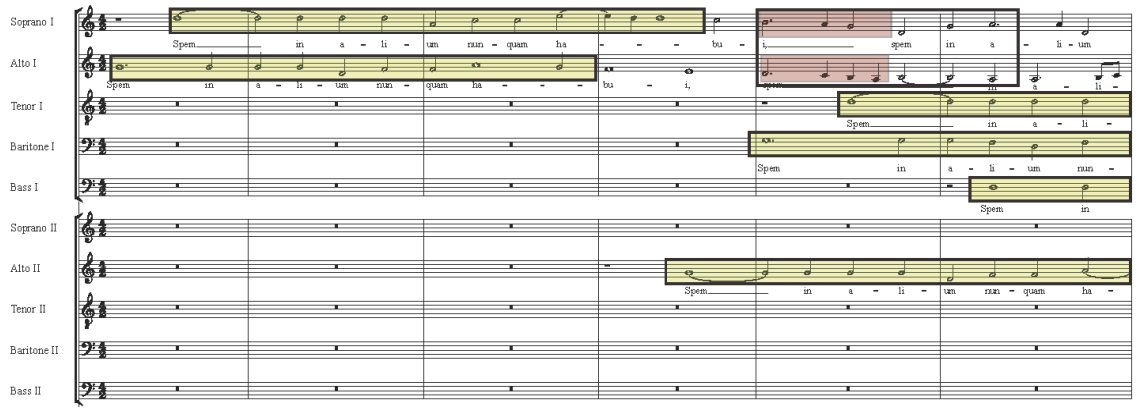


Figure 4: First Entry Group

The theme itself consists of the rhythmic component with its speech-like naturalness, with four repetitions of the opening pitch, then descent of a perfect fifth, followed by an ascent of two thirds. From this high point there is then a descent with 7-6 suspensions, followed by a melismatic continuation. Each individual component becomes material for development: the rhythmic figure of 4+2+2+2, the dramatic strong-beat descent of a perfect 5th, the triadic rise, the overall contour, the suspensions, and the melismatic descent. All of these different components of the opening theme are first utilized as motivic components in a fairly literal ways that however become increasingly abstract. Notice how the melismatic sentence continuation of measure 5 transforms into a significant auxiliary material in mm. 7, 10, 11, and onwards for instance. It would however be a mistake to imagine that Tallis is somehow thinking like a serialist composer with indefinite resources of permutation, as this language is very tightly controlled melodically and intervallically. It is far more likely that he chose a theme that has characteristics that would facilitate a natural continuation of this canonic-style development while allowing the voluminous free material to come a consistency of texture within this section. As it is the longest and most harmonically rich theme, it is the main opportunity for extended contrapuntal development of the multiple facets of the theme.

This kind of texture is representative of most of the first thematic area and of the contrapuntal sections of the first half of the piece, as can be seen below. Immediately the basic elements of the original theme are broken into motivic components:

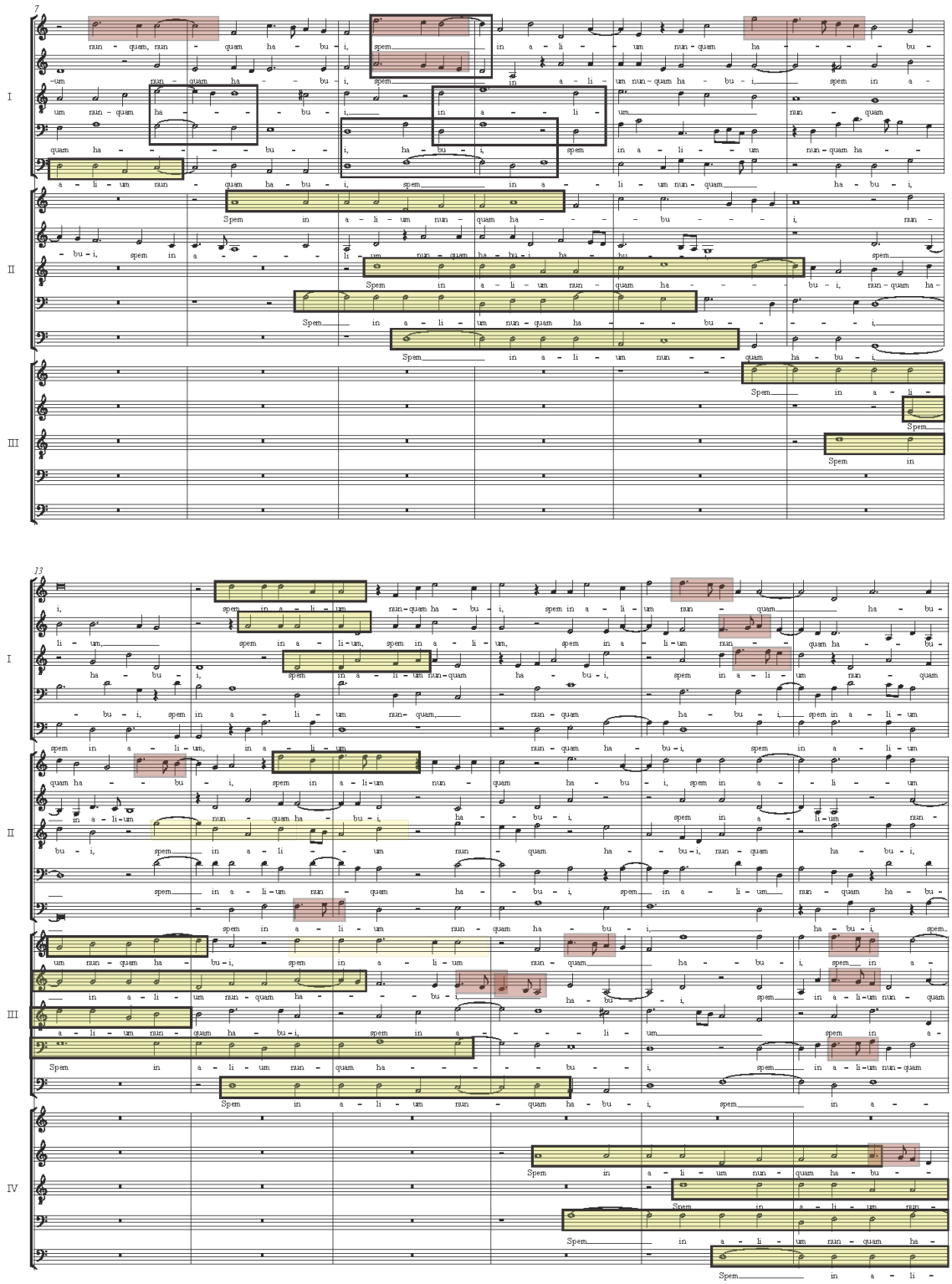


Figure 5: First entry group continued (mm. 7-18)

The imitative entries continue in a mostly literal fashion, usually entering on G, D, and A, creating a stable structure that encompasses all the other voices. One can see the imitative

continuation of the subsidiary material (shown in orange) and also other pairs of freer imitative material, marked in un-colored boxes. It can also be observed here that the motivic entries are become less strict and somewhat truncated insofar as strict imitation is concerned, for instance in Bass II, measure 11. At measure 14 we get some second-generation copies of the original motive, essentially in diminution, in Soprano I, Alto I, Tenor I, Soprano II, and Soprano III. This is an important moment, as it shows evidence of Tallis' motivic abstraction, even though it deforms the motive substantially. There is still enough of the original musical gesture present, combined with the phonemic constancy, to relate it to the original material. [17] [18]

So how is this related to spatialization? Below is a representation of the spatialized movement of the motivic material as theorized by Legge. These graphs are indexed with the color-coded motivic analysis in the attached score and labeled with their part abbreviation and choir number. This is intended to provide a sense of the hypothesized space and how the listener would be tracking the clearly identifiable motives. Each arrow point represents a subsequent entry point of a motive (for instance, in mm. 4-7 the voice entries are Alto II, Baritone I, and Tenor I, and Bass I respectively, with Soprano I and Alto I singing the auxiliary thematic material, which, as it is less important is not marked in respect to sequence of the main motive).

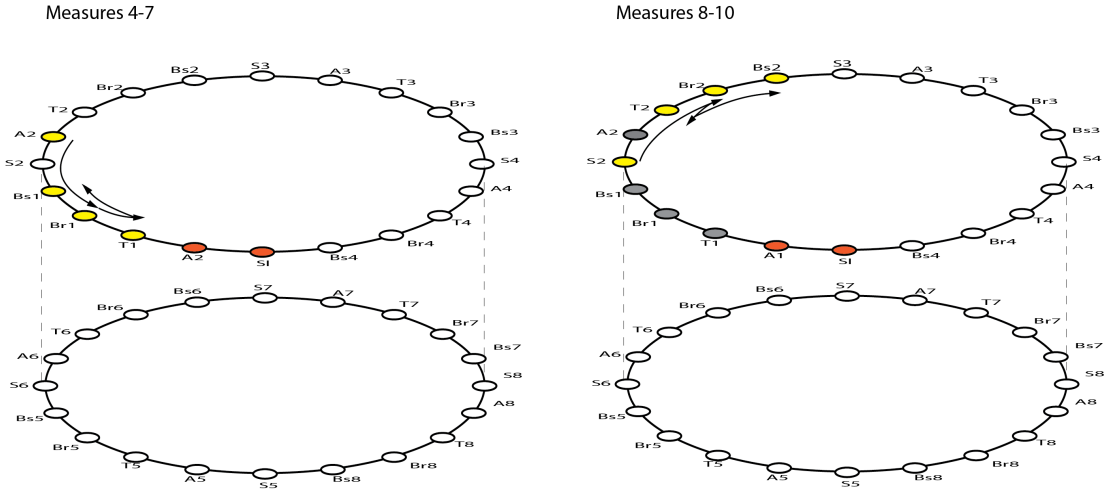


Figure 6: Spatial representation of mm. 7-10

Second Entry Group

[17] For a catalogue of the thematic material, please consult Appendix 4.
[18] For the full color-coded analysis, please consult Appendix 5.

The second thematic area begins in measure 23 with the text "Preater in te, Deus Israel". After a period of maximal density in which the second motive sneaks in, Choirs I-IV quickly wrap up, exposing the new theme. Unlike before, the thematic material here is brief to the point that it is almost only a motive, hardly a melody or complete theme at all. The subsequent "Deus Israel" component that always accompanies the "Preater in te" material only have the slightest correspondence to one another. This is because of the use that this motive is put to and the amount of abstraction that it must endure in the following passages, beginning in measure 35, shown below.

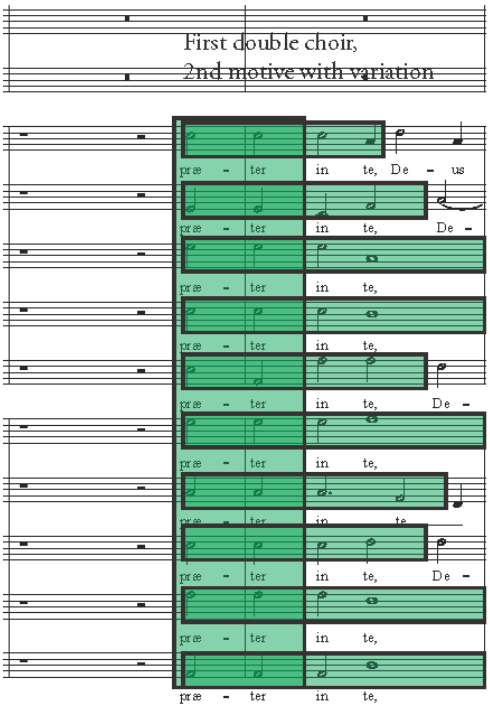


Figure 7: mm. 35-36

This is the beginning of the first "block harmony" section and the first example of a double choir entry. Interestingly, the motivic material, minimal as it is, still must bend to do this job while not disobeying the basic rules of voice leading, something that becomes a progressively greater problem as the piece continues. Tallis' solution here is to basically reference the original motive—three half notes at the same pitch level followed by a whole note up a second, married with the text of course—and allow it to essentially become three half notes that repeat on the same pitch level followed by basically anything that would work. However he has to alter a few of the third half notes to achieve even this. Essentially, here is where the idea of motivic repetition comes up against the reality part-writing rules, especially the prohibition of parallelisms, and the small gamut of permitted harmonic consonances.

This happens again at measure 40, the first entry of all of the voices together, though this time the problem is even more severe, the motive even more abstracted and truncated. Notice also how the fragment of the opening theme is still being utilized, in the second entry group, as shown in the dark orange boxes.

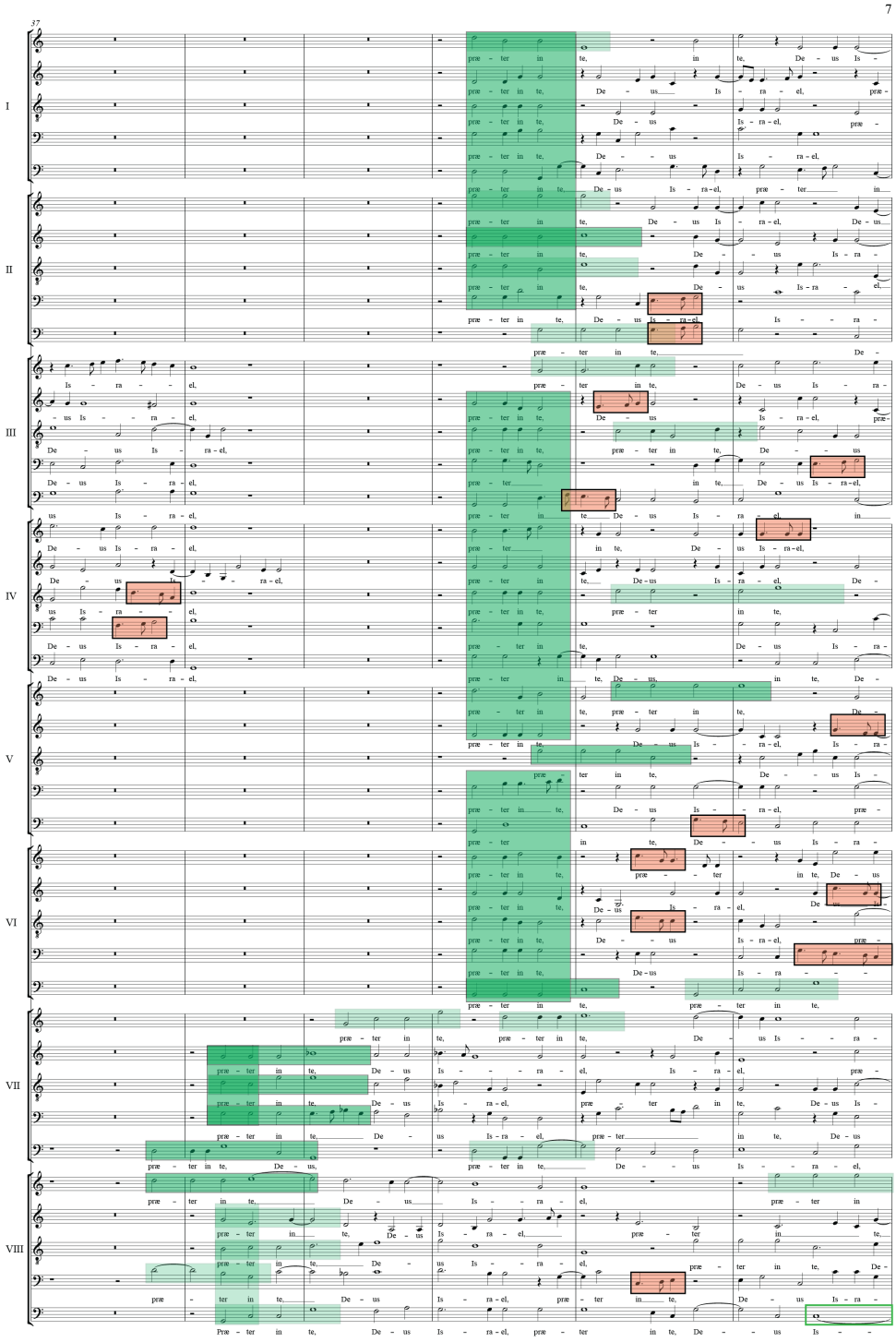


Figure 9: measures 37 to 42

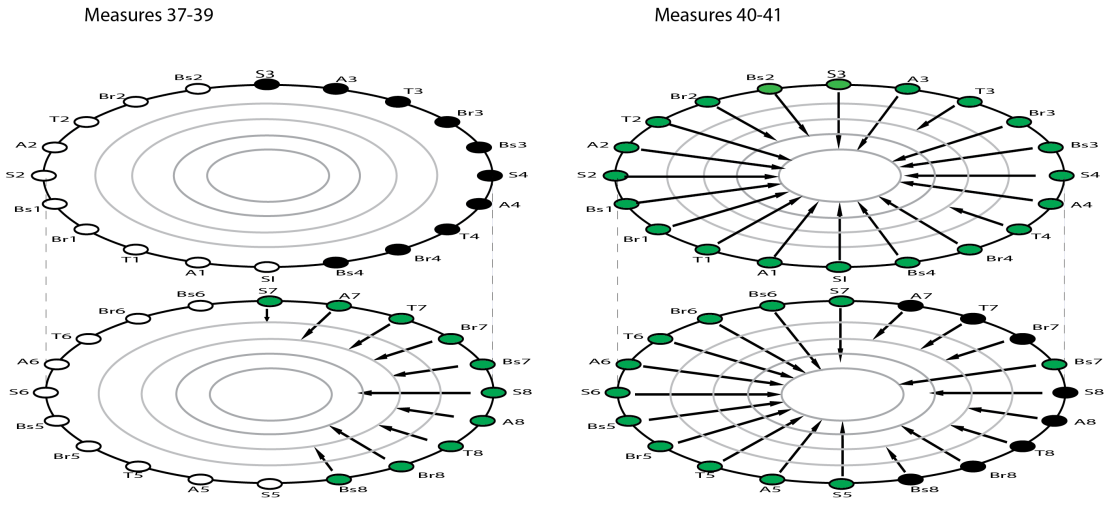


Figure 10: Spatial representation of measures 37-41

Third Entry Group

Thematic area three is the pattern of entries through the choirs is completed and begins to circle back in the reverse direction. The main theme begins in Bass VII, measure 45 and winds its way back "up" to Choir III. There is nothing exceptional about this section compared to what has come before it. If anything, the work is easier here, as the theme itself is shorter than Theme 1. In fact, an argument could be made that Theme 3 is in fact a motivic extension of Theme 1, as it has the same characteristic descent of a perfect fourth followed by an ascent of a major third. It is also usually followed by a long melodic decent, also characteristic of the opening theme. Please consult the annotated score in appendix 5 for more details.

Fourth Entry Group

This is where things get interesting. In measure 65 we have the beginning of the fourth entry group, beginning with "et omina". This is the first true double choir entry (even though it is 4 voices + 4 voices, not 5 + 5). It is an exposed entry, in even rhythmic values and not particularly polyphonic, which very clearly differentiates it from what came before in the third entry group. Then we arrive at the exact middle of the piece, the point at which we reach measure 69 according to the score. Here we suddenly have a dramatic, asymmetrical assemblage of every voice. Quite unlike before at measure 40 however, there seems to be a maximizing of spatial differentiation, as seen below.

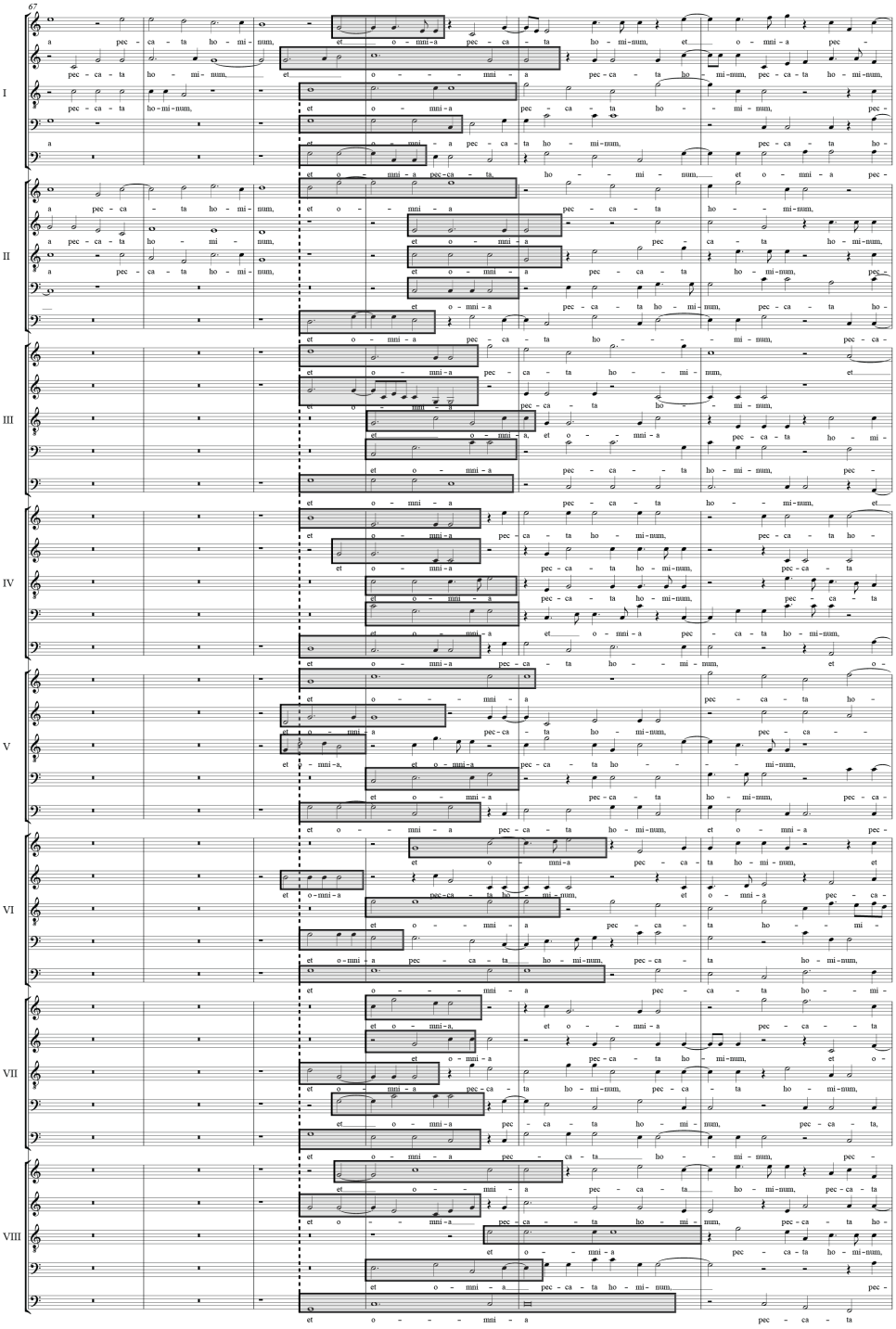


Figure 11: Measures 67-72

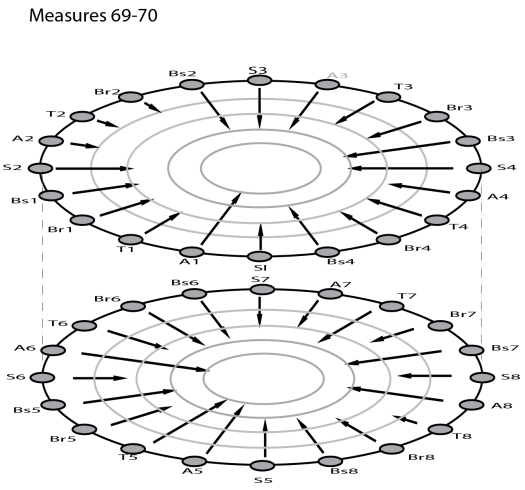


Figure 12: Measures 69-70

Note: The concentric circles in this case represent the progression of time. The circle furthest towards the middle represents the earliest entry; each progressive circle outwards indicates a later point in time.

Materially, we have also reached a point of close to complete motivic disintegration. The basic sequential phonetic material of "et omina" is almost all that holds this passage together in any thematic fashion. However, in this case, due to the intended spatial disposition of the performers, that phonemic verisimilitude is significant. The first, second, and third entry groups all display different aspects of Tallis' approach towards motivic deconstruction in service of the desired formal shape of the piece, but each of these entry groups attempts to stay tethered to at least some formal aspect of the thematic material, normally breaking it down into component blocks that can be used motivically in subsequent voices of continuing material. So what we are left with here is the text and the sound of the system itself, a cloud of sound formed by the rules of voice leading and counterpoint.

As Bent notes, counterpoint is at its core a dyadic system. Each point is considered relationship to one other point at a time; the rules governing the behavior of those points and the individual melodic material are so narrow that they produce a robustness that channels the musical discourse and in a very real sense allows composition to take place.[19] This works in conjunction with a he material and cultural conditions of musical

[19] (Bent, 1998: 33) This in no way means that harmony was not a consideration. Clearly in this piece is plays a significant architectural role for instance. However it never trumped the other concerns.

production to produce the sound of this moment.[20] As shown definitively in the computational analysis, the elements of melodic composition are highly constrained, and the rules of harmony even more so. These conditions provide the framework that contributes to create the texture of this musical fabric.

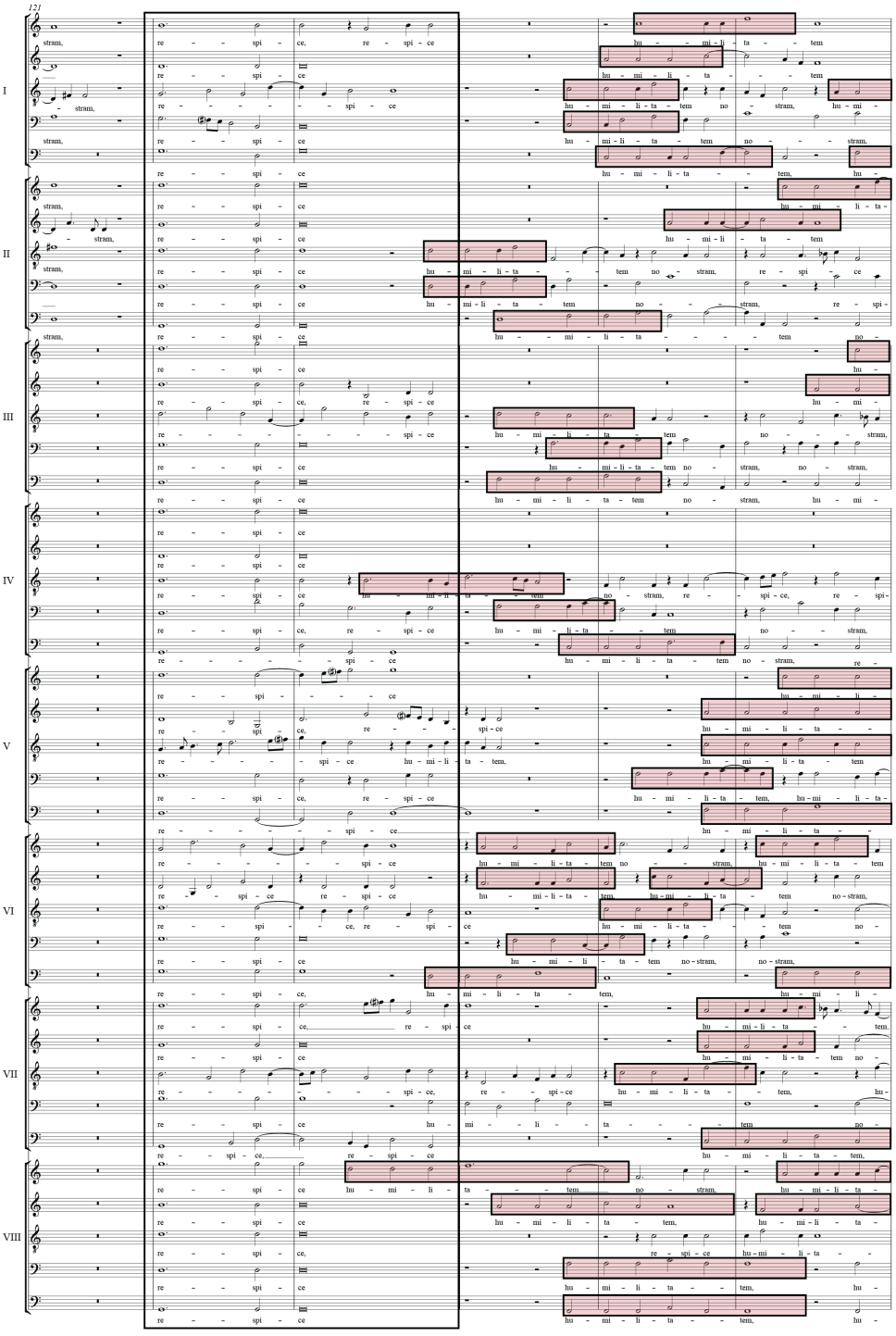
Since there is no recourse to other techniques here such as those used subsequently—like simultaneous entry groups or homorhythmic passages—spatialization, which is more difficult to picture here, is essential to the true effect of this passage and is inseparable from its shape. In the appropriate performance situation, this moment would be not be as chaotic as it would appear in the score, yet conversely it is nowhere near as bland as it is on a stereo recording. Whatever the case, it is easy to imagine that the intent is a representation of diversity and variety, a joyous mess, marvelously synthetic microcosm of Tallis' vision of humanity.

Fifth Entry Group

Measures 78-87 see things coming back into focus, as slightly ragged entry groups of smaller double choir formations transition into more defined block chord entries, which begins the transition into the fifth entry group. Measure 86 is the last gasp of the all-over texture before we begin with the new text, "Domine Deus creator caelie et terre". The fifth entry group is similar to the fourth in some respects, but is far more focused. All of the singer's entries occur together now in paired meta-choirs. The focus is now squarely on antiphonal movement. In the spatial orientation I have suggested, there are essentially four opposed directions that the sounds emanate from: lower west (Choirs I and II); lower east (Choirs III and IV); upper west (Choirs V and VI); and upper east (Choirs VII and VIII).

A particular thing happens motivically in this section. We are not, like the previous section, dealing with a very low amount of motivic information, though it is the only theme with a built-in rest. Still, we do not have anything like the motivic definition of entry groups one, two, and three. Try as he might, Tallis can barely eke out any polyphony or strict motivic repetition, only a few stepwise progressions and movement by thirds, perfect fourths and perfect fifths. Instead we now have an essentially homophonic texture. During these block entries there is a definite general shape of contrary motion in the upper and lower voices either of the individual choir or the double-choir. This gives the block entries a bit of motivic consistency, even if motivic development is not exactly what how it would be characterized.

[20] By this I mean ostensibly the modal system and the types of music theory that existed at this time.



Sixth Entry Group

The sixth entry group is a synthesis of characteristics of the different entry groups. It contains two "pillars" of block harmony in measures 108 and 122—the first one is an A

major sonority, the second a G major one and both of them are on the word “respice”, which translates to “look” in English—and there is also counter-clockwise rotational movement of motivic entries through all of choirs between these harmonic blocks. In essence entry group six is entry group three in diminution, combined with largely homorhythmic block harmonies. This is however combined with a new feature, a polyphonic dovetailing the double choir entry patterns into one another. After the arrival in 122, all 40 voices enter polyphonically, a welter of sound from all directions but with a strong material focus. I

The sixth entry group contains the maximum sustained polyphony of all of the 40 voice sections of the piece and is clearly an attempt at synthesis. The thirds within the thematic material itself facilitates this synthesis, as it can be deployed canonically like the other themes, but with more flexibly of rhythmic and harmonic configurations than other themes. Antiphonal effect is from every point. I believe no representation, either on recording or graphically, can represent the experience of this point of the piece, as the excess of “polyphonic detailism”, the abundance of identifiable humanity woven into the musical fabric, is lost without the element of spatialization.

Summary of spatialization by section

Entry groups one, two, and four all display very different usages of spatialization. Entry group one has an elegant, slow pace, moving gradually and predictably from one place to the other. The theme, the longest one, facilitates its graceful rotation and facilitates a disassembly into usable motivic components, which becomes a source of organic motivic complexity. Entry group two brings a surprise being both rotational and containing the first full choir entry, introducing a textural dichotomy. Entry group three is the reverse of one for the most part. Entry group four is quite different again, having a large amount of differentiation with very little motivic consistency. Entry group five is a massive, mostly homophonic double choir section. Entry group six is the attempt at synthesis that brings the work to a dramatic conclusion.

Conclusion

Perhaps the extreme pressures of the material conditions of this piece, however they came about, caused Tallis music to expand out towards an unexpected experimentalism. Whatever the reason, the two most important musical elements that Tallis uses are motivic deconstruction and spatialization in ways that are shocking to imagine in context of the time. Perhaps these elements are a reaction to the requirements of the piece; perhaps the idea was central and the performance was subsequent to it, though that is harder to imagine.

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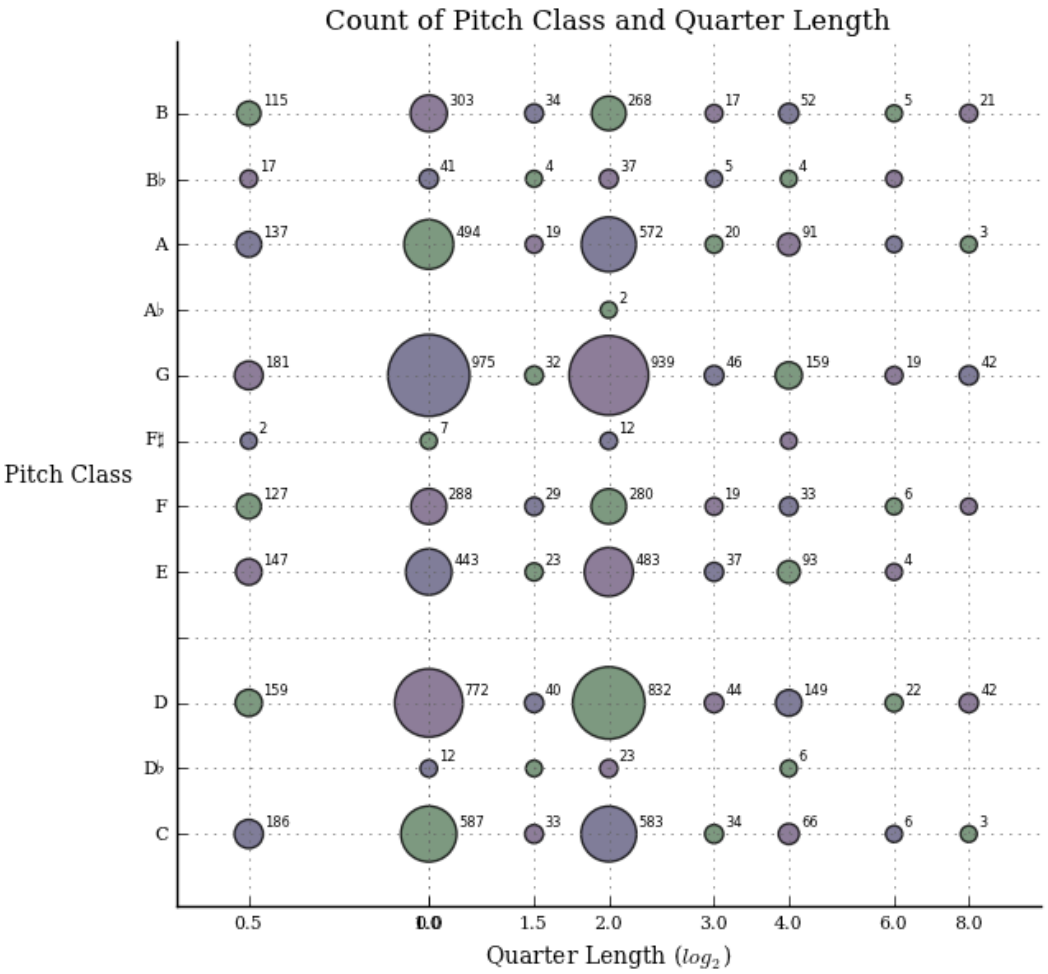
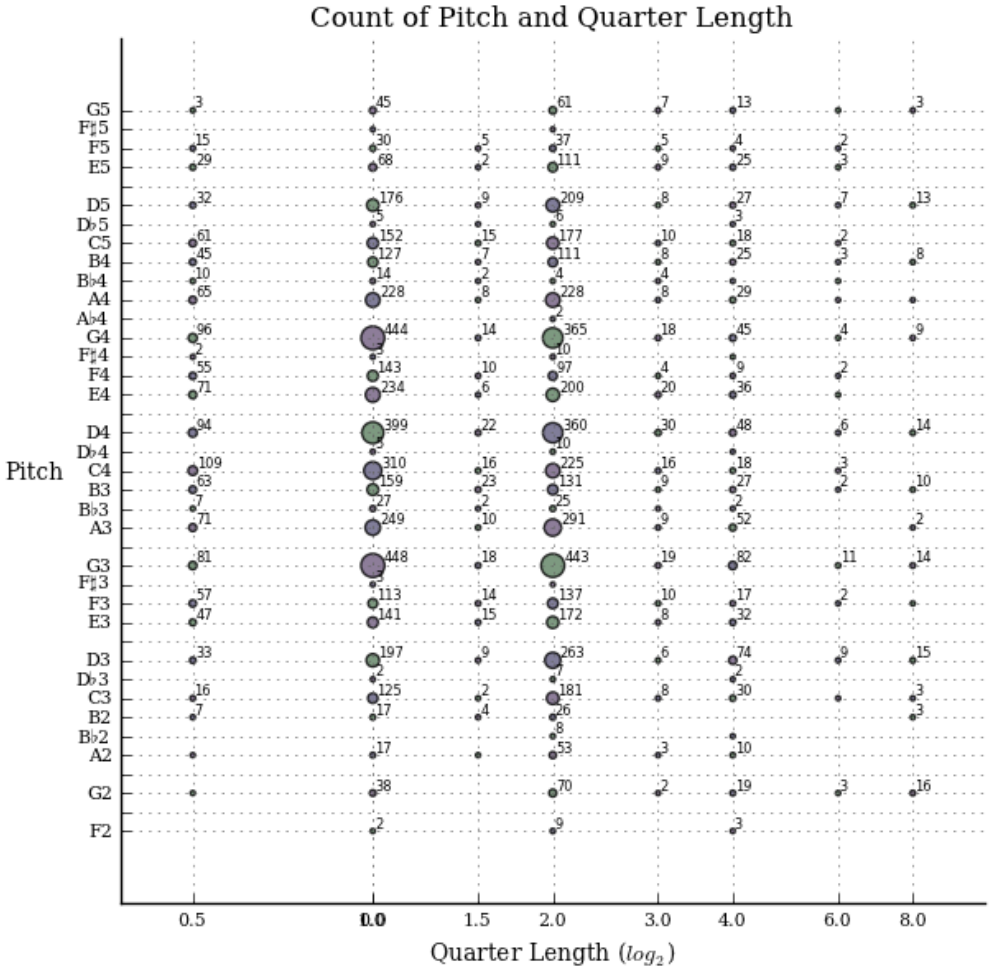
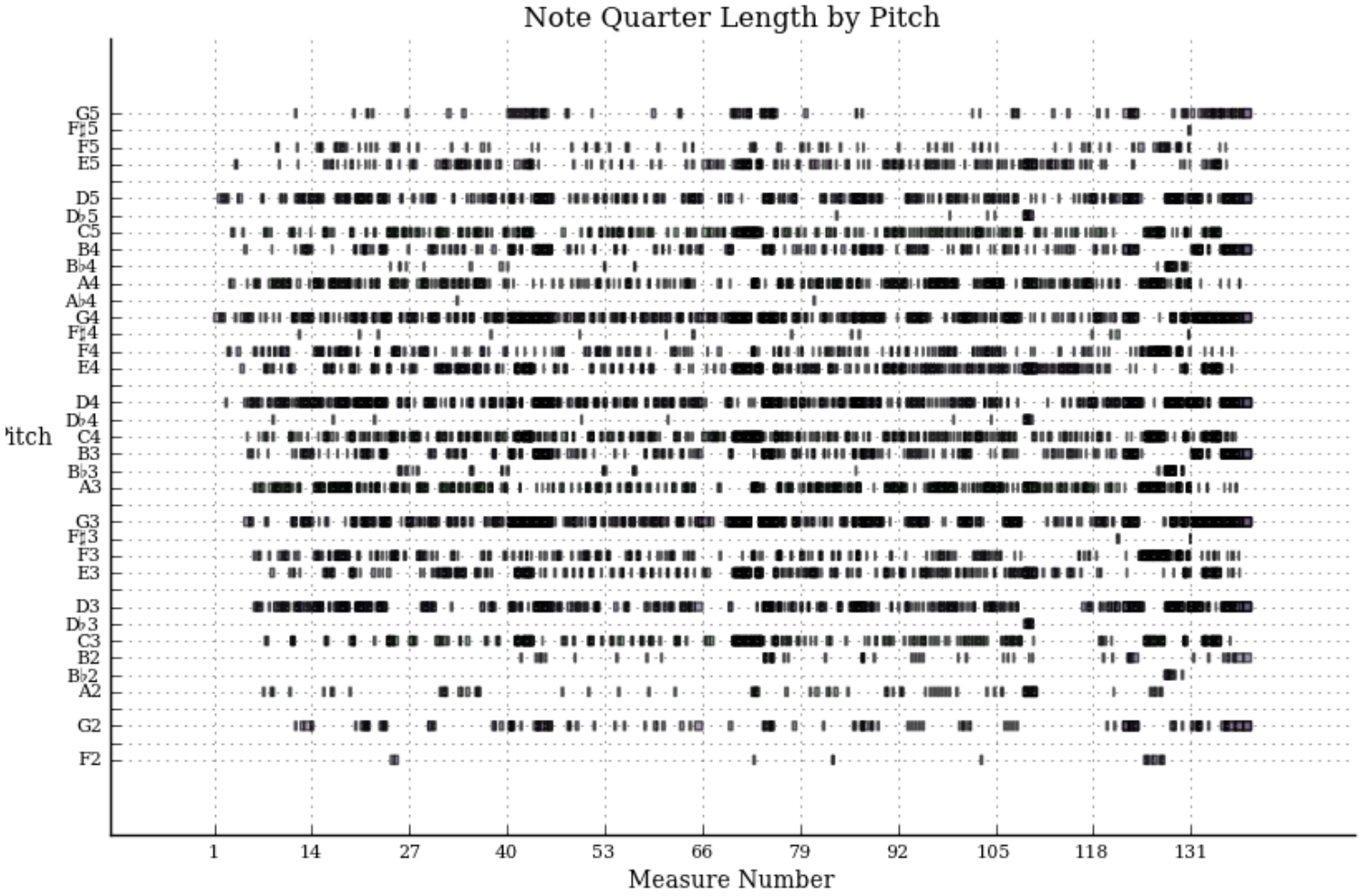
Appendix 1
Music21 graphs




Count of Pitch and Quarter Length
Pitch
G5
F♯5
F5
E5
D5
D♭5
C5
B4
B♭4
A4
A♭4
G4
F♯4
F4
E4
D4
D♭4
C4
B3
B♭3
A3
G3
F♯3
F3
E3
D3
D♭3
C3
B2
B♭2
A2
G2
F2
0.5
1.0
1.5
2.0
3.0
4.0
6.0
8.0
Quarter Length (log_2)


Note Quarter Length by Pitch
G5
F♯5
F5
E5
D5
D♭5
C5
B4
B♭4
A4
A♭4
G4
F♯4
F4
E4
D4
D♭4
C4
B3
B♭3
A3
G3
F♯3
F3
E3
D3
D♭3
C3
B2
B♭2
A2
G2
F2
itch
1
14
27
40
53
66
79
92
105
118
131
Measure Number

Appendix 2

Python scripts and methodology

Loading and parsing the musical data proved a difficult component of this project. I was able to locate a MIDI file version of *Spem in alium*. My first step was to load the entire piece into a DAW called Logic. This was the first step in cleaning the data, as I was able to quantize the entire piece in order to get rid of extraneous data and round all the values to integers and align all of their temporal values for the most part. Subsequently, by using an application called MIDIConverter, I was able to take all of this data and convert it into a text file.

My next task was to write a Python script that would load and clean the data further. MIDIConverter has multiple occurrences of meta-data that, though helpful in some cases, for these purposes needed to be expunged. MIDIConveter helpfully arranges all the data in the text file in order according to instrument or voice. (This is not the case with some other MIDI converters that I tried—sometimes the data is listed by time only, irrespective of voice).

After a list of lines is created, the module **voice_evaluator** is used to either accept or reject individual lines. After getting rid of the extraneous information, all the data was assigned to five main categories:

(1) time_val (onset of each event, measured in milliseconds from beginning),
(2) is_note_on (a redundancy in this case),
(3) channel (also irrelevant for the present purposes),
(4) pitch (represented by a MIDI number),
(5) velocity (only non-zero velocities concern us here, since no velocities are indicated in the original score, making them artifacts of the MIDI file only).

Unfortunately, MIDIConverter only gives "note on" messages and indicates notes off with a velocity of zero. Therefore since the sequence of events—not time per se—were all that were needed for the purposes of this project, all of the lines with a velocity of zero were gotten rid of. Next, pitch and time_val are assigned back to each voice but now as a dictionary that indexes all the data by instrument name/voice. The MIDI numbers (where middle C = 67) are indexed by voice and converted to "delta pitch" or sequential interval. From there the module **num_to_pitch** is used to convert this data to musical terminology.

Main Script

```
# -*- coding: utf-8 -*-
"""
Created on Wed May  1 13:37:37 2013

@author: k_w_d
"""
import voice_evaluator as VE
from num_to_pitch import *
from voice_class import Voice
import collections


"""open file"""
file_n = "tallis_v1.mid.txt"
f = open(file_n, "r")
file=f.read()

"""read and filter all lines"""
lines=file.split("\n")
NewList=filter(VE.AcceptLine,lines)
del NewList[0] #gets rid of first meta-track

"""find and fliter beginnings and ends of voices"""
start_list=filter(VE.FindVoice,lines)
del start_list[-1] #get rid of extra continuo voice
stop_list=filter(VE.FindEnd,lines)
del stop_list[0]; del stop_list[-1]

"""make separate lists of individual voices' lines"""
num_voices=len(start_list)
start_index=[]
stop_index=[]
voice_list=[]

for i in range(num_voices):
for j in range(len(NewList)):
if NewList[j]==start_list[i]:
start_index.append(j)

for k in range(num_voices-1):
voice_list.append(NewList[start_index[k]:start_index[k+1]])

"""find last voice"""
last_voice=NewList[start_index[num_voices-1]:]
end_marker=last_voice.index("531552 Meta TrkEnd")
voice_list.append(last_voice[0:end_marker+1])

"""parse the voice data into different categories"""
instruments = {} # makes a dictionary
for voice in voice_list:
instrument = voice[0]
lines = voice[1:-1]
pitches = []
pitches_and_timevals = []
for line in lines:
# alternatively: timeval, noteon, channel, pitch, velocity = line.split()
# OR for notes only: notes = [int(line.split()[3][2:]) for line in lines if
int(line.split()[4][2:]) > 0]
parts = line.split()
timeval = int(parts[0])
```

```
is_note_on = ("On" == parts[1])
channel = int(parts[2][3:])
pitch = int(parts[3][2:])
velocity = int(parts[4][2:])
if velocity == 0:
continue
pitches.append(pitch)
pitches_and_timevals.append([pitch, timeval])

instruments[instrument] = pitches

voice_names = ["soprano_1","alto_1","tenor_1","baritone_1","bass_1"]
voice_keys = ['0 Meta TrkName "Instrument 1"','0 Meta TrkName "Instrument
2"',
'0 Meta TrkName "Instrument 3"','0 Meta TrkName "Instrument 4"',
'0 Meta TrkName "Instrument 5"']
choir_1 = [Voice(voice_names[n], instruments[voice_keys[n]]) for n in range(5)]

"""define interval labeling"""
interval_name = []
for i in range(-12, 13):
interval_name.append(num_to_pitch(i))
# for numbers: interval_name = [-12,-11,-10,-9,-8,-7,-6,-5,-4,-3,-2,-
1,0,1,2,3,4,5,6,7,8,9,10,11,12,13]

"""get interval data for choir 1"""
for n in range(5):
choir_1[n].delta_pitch = VE.get_delta_pitch(choir_1[n].pitches)

"""create dictionary of each interval for each voice"""
for n in range(5):
choir_1[n].interval_count = collections.Counter(choir_1[n].delta_pitch)

"""plot histograms"""
max_interval=12
num_intervals=2*max_interval+1
grand_total = [0]*num_intervals
for n in range(5):
plt.figure()
freq_of = []
for i in range(-12, 13): # could be changed:
if i in choir_1[n].interval_count:
count_i=choir_1[n].interval_count[i] #getting them in order
else:
count_i=0
freq_of.append(count_i)
grand_total[max_interval+i]+=count_i
histogram(choir_1[n].name, interval_name, freq_of)

plt.figure()
histogram("Choir 1", interval_name, grand_total)
plt.show()
```

Modules

voice_evaluator

```
# -*- coding: utf-8 -*-
"""
Created on Fri May  3 11:59:14 2013

@author: k_w_d
"""
```

```
def AcceptLine(string):
    if string.find("Instrument")!=-1:
        return True
    elif string.find("Meta TrkEnd")!=-1:
        return True
    elif string.find("On")!=-1:
        return True
    else:
        return False

def FindVoice(string):
    if string.find("Instrument")!=-1:
        return True
    else:
        return False

def FindEnd(string):
    if string.find("Meta TrkEnd")!=-1:
        return True
    else:
        return False

def get_delta_pitch(pitches):
    delta_pitch = []
    num_pitches = len(pitches)
    for n in range(num_pitches-1):
        delta_pitch.append(pitches[n+1]-pitches[n])
    return delta_pitch
```

num_to_pitch

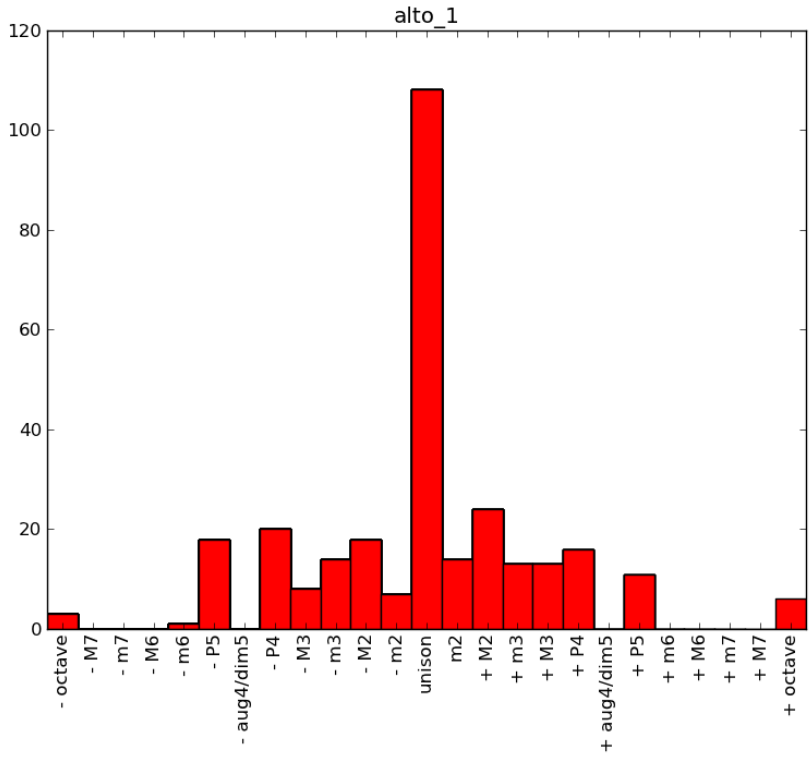
```
# -*- coding: utf-8 -*-
"""
Created on Wed May  8 09:39:12 2013

@author: k_w_d
"""

import numpy as np
import pylab as plt

def histogram(title_string, interval_name, freq_of):

    plt.title(title_string)
    pos = np.arange(len(freq_of))
    width = 1.0
    ax = plt.axes()
    ax.set_xticks(pos+(width/2))
    ax.set_xticklabels(interval_name,
rotation='vertical',verticalalignment='top')

    plt.bar(pos, freq_of, width, color='r')


def num_to_pitch(seq_interval):
    if seq_interval == -12:
        return ("- octave")
    elif seq_interval == -11:
        return ("- M7")
    elif seq_interval == -10:
        return ("- m7")
    elif seq_interval == -9:
        return ("- M6")
```

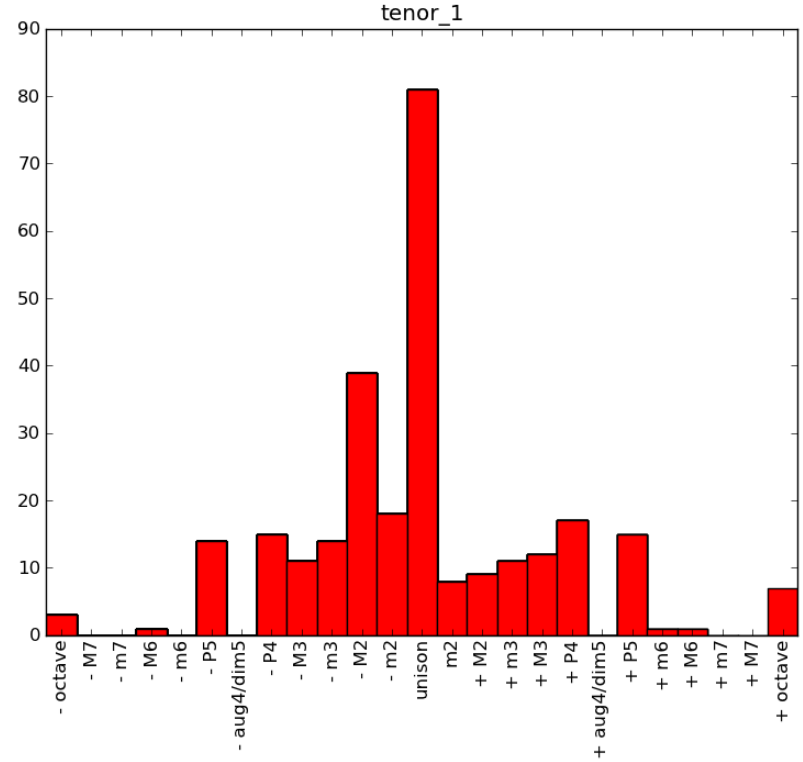
```
    elif seq_interval == -8:
        return ("- m6")
    elif seq_interval == -7:
        return ("- P5")
    elif seq_interval == -6:
        return ("- aug4/dim5")
    elif seq_interval == -5:
        return ("- P4")
    elif seq_interval == -4:
        return ("- M3")
    elif seq_interval == -3:
        return ("- m3")
    elif seq_interval == -2:
        return("- M2")
    elif seq_interval == -1:
        return ("- m2")
    elif seq_interval == 0:
        return ("unison")
    elif seq_interval == 1:
        return ("m2")
    elif seq_interval == 2:
        return("+ M2")
    elif seq_interval == 3:
        return ("+ m3")
    elif seq_interval == 4:
        return ("+ M3")
    elif seq_interval == 5:
        return ("+ P4")
    elif seq_interval == 6:
        return ("+ aug4/dim5")
    elif seq_interval == 7:
        return ("+ P5")
    elif seq_interval == 8:
        return ("+ m6")
    elif seq_interval == 9:
        return ("+ M6")
    elif seq_interval == 10:
        return ("+ m7")
    elif seq_interval == 11:
        return("+ M7")
    elif seq_interval == 12:
        return ("+ octave")
    else:
        return ("Other")
```

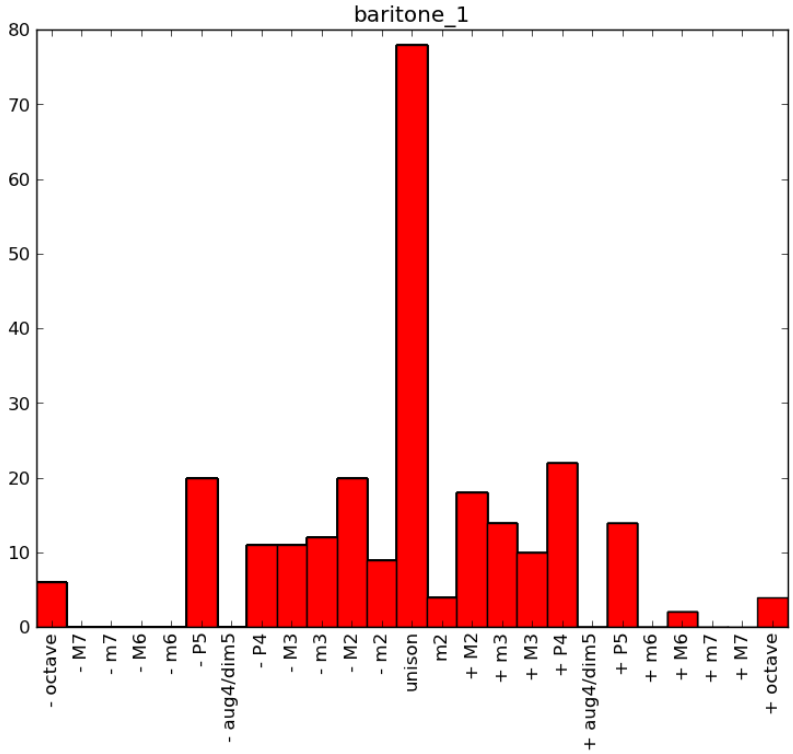
voice_class

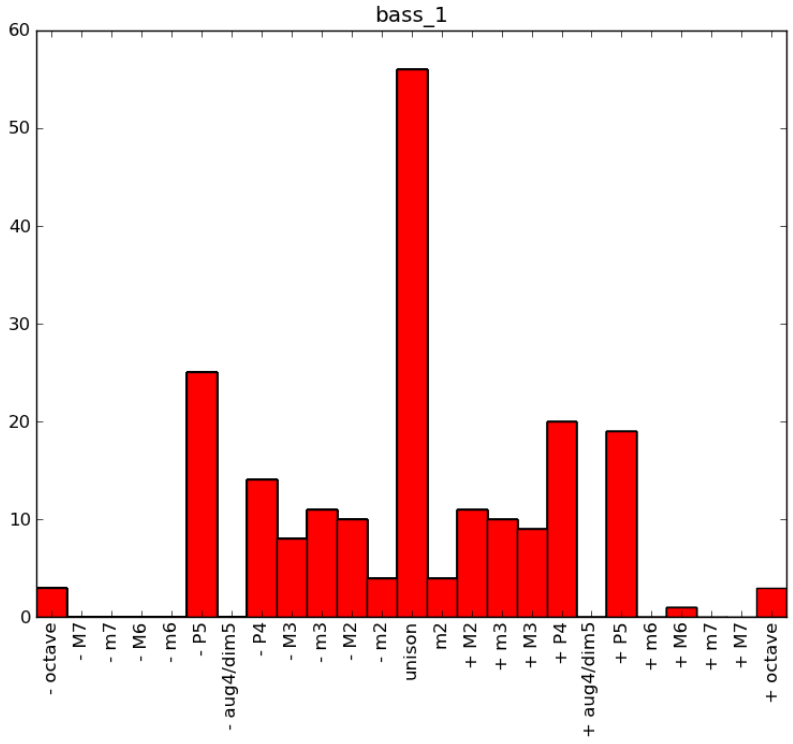
```
# -*- coding: utf-8 -*-
"""
Created on Thu May  9 15:13:29 2013

@author: k_w_d
"""

import copy

class Voice:
    def __init__(self, name, pitches):
        self.name = name
        self.delta_pitch = []
        self.interval_counts = {}
        self.pitches = copy.copy(pitches)
```

Appendix 3


alto_1
120
100
80
60
40
20
0
- octave
- M7
- m7
- M6
- m6
- P5
- aug4/dim5
- P4
- M3
- m3
- M2
- m2
unison
m2
+ M2
+ m3
+ M3
+ P4
+ aug4/dim5
+ P5
+ m6
+ M6
+ m7
+ M7
+ octave


tenor_1
90
80
70
60
50
40
30
20
10
0
- octave
- M7
- m7
- M6
- m6
- P5
- aug4/dim5
- P4
- M3
- m3
- M2
- m2
unison
m2
+ M2
+ m3
+ M3
+ P4
+ aug4/dim5
+ P5
+ m6
+ M6
+ m7
+ M7
+ octave

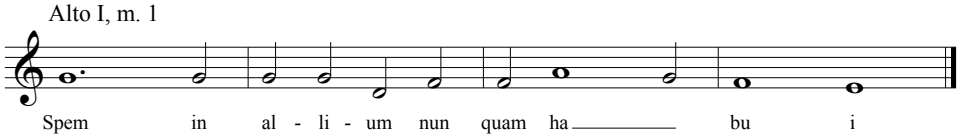

baritone_1
80
70
60
50
40
30
20
10
0
- octave
- M7
- m7
- M6
- m6
- P5
- aug4/dim5
- P4
- M3
- m3
- M2
- m2
unison
m2
+ M2
+ m3
+ M3
+ P4
+ aug4/dim5
+ P5
+ m6
+ M6
+ m7
+ M7
+ octave


bass_1
60
50
40
30
20
10
0
- octave
- M7
- m7
- M6
- m6
- P5
- aug4/dim5
- P4
- M3
- m3
- M2
- m2
unison
m2
+ M2
+ m3
+ M3
+ P4
+ aug4/dim5
+ P5
+ m6
+ M6
+ m7
+ M7
+ octave

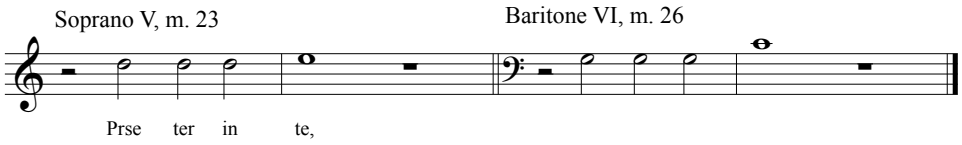
Appendix 4
Catalogue of themes

Spem in Alium Thematic and Motivic Material

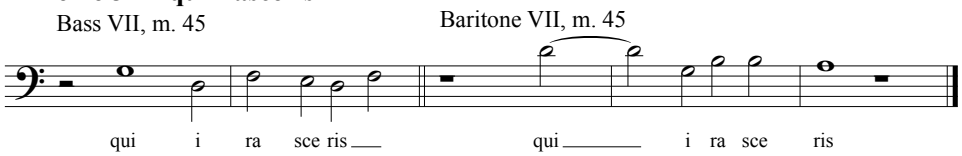
Theme 1—"Spem in alium nunquam habui"



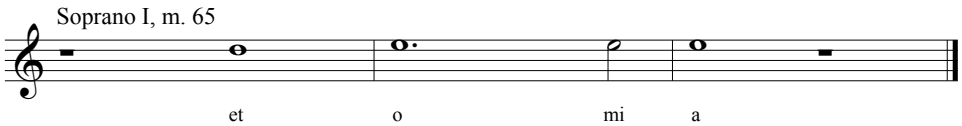
Theme 2—"Paeter in te, Deus Israel"



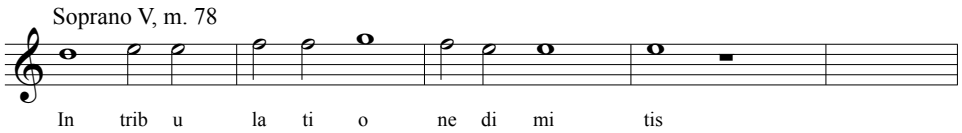
Theme 3—"qui irasceris"



Theme 4a—"et omina peccata hominem"

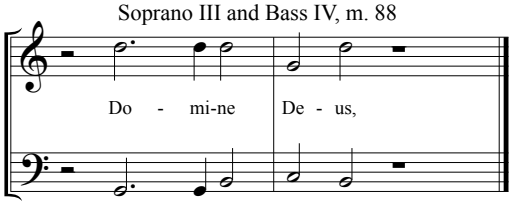


Theme 4b—"in tribulatione dimitis"



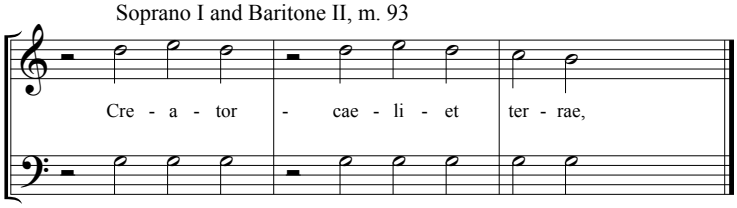
Theme 5a—"Domine Deus"

Soprano III and Bass IV, m. 88



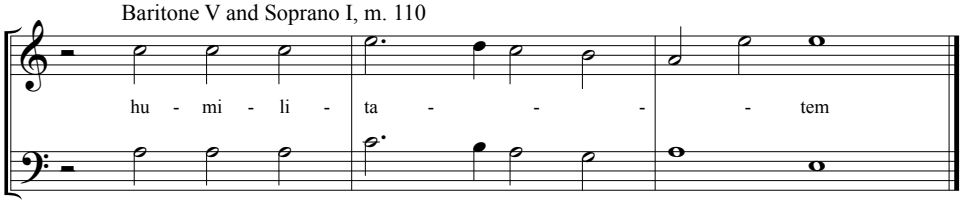
Theme 5b—"Creator caeli et terrae,"

Soprano I and Baritone II, m. 93

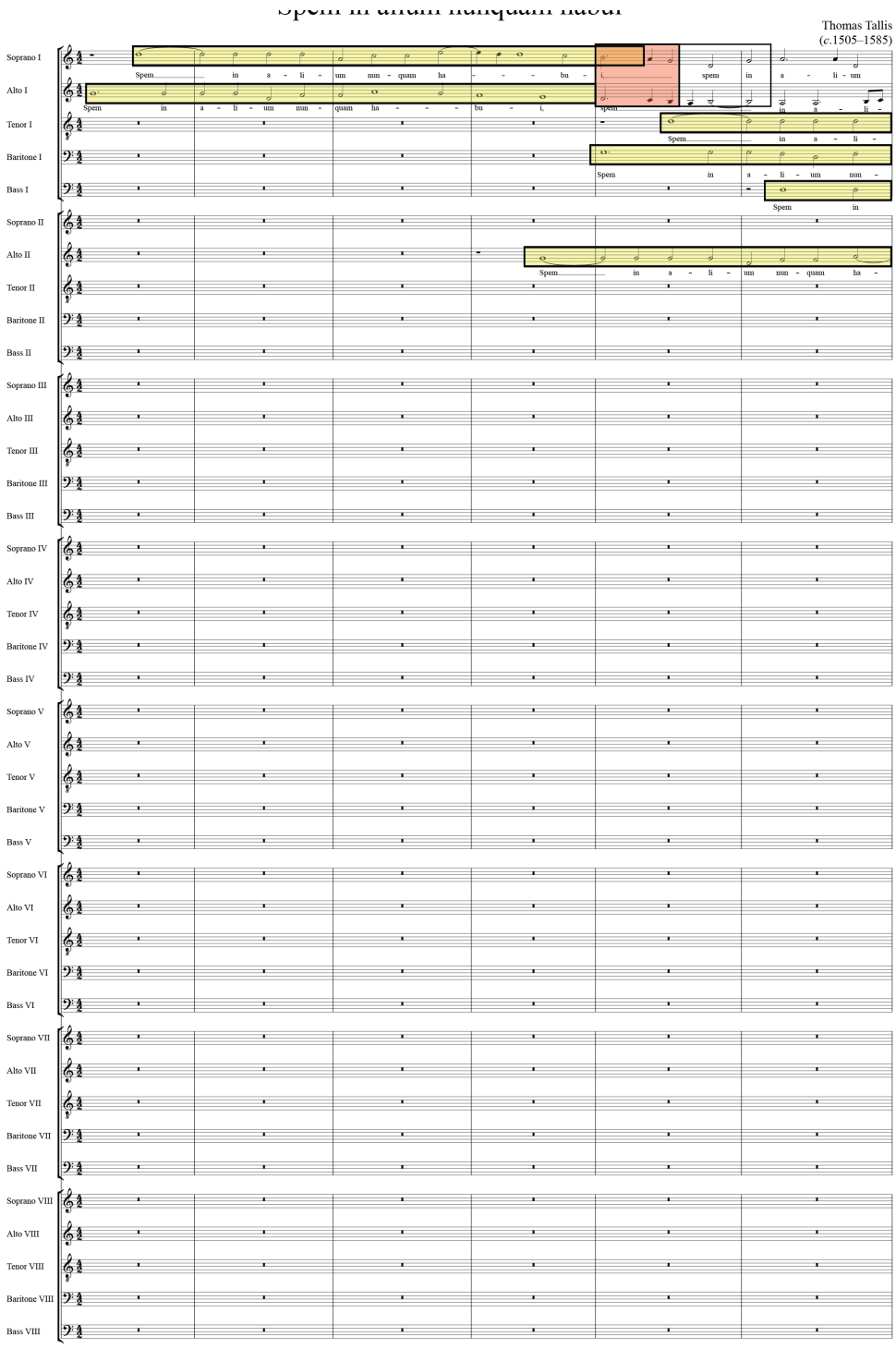


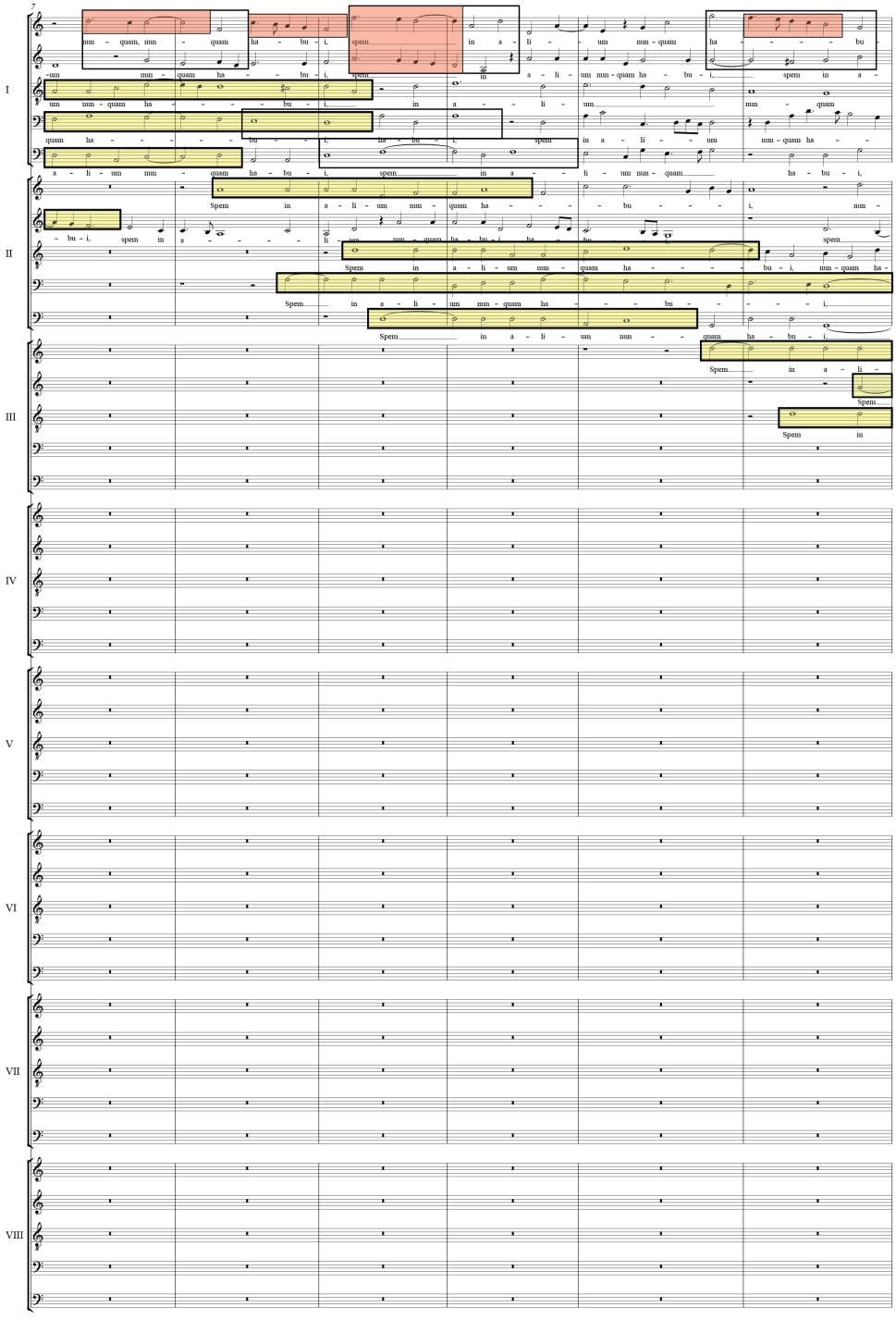
Theme 6—"Humilitatem nostram"

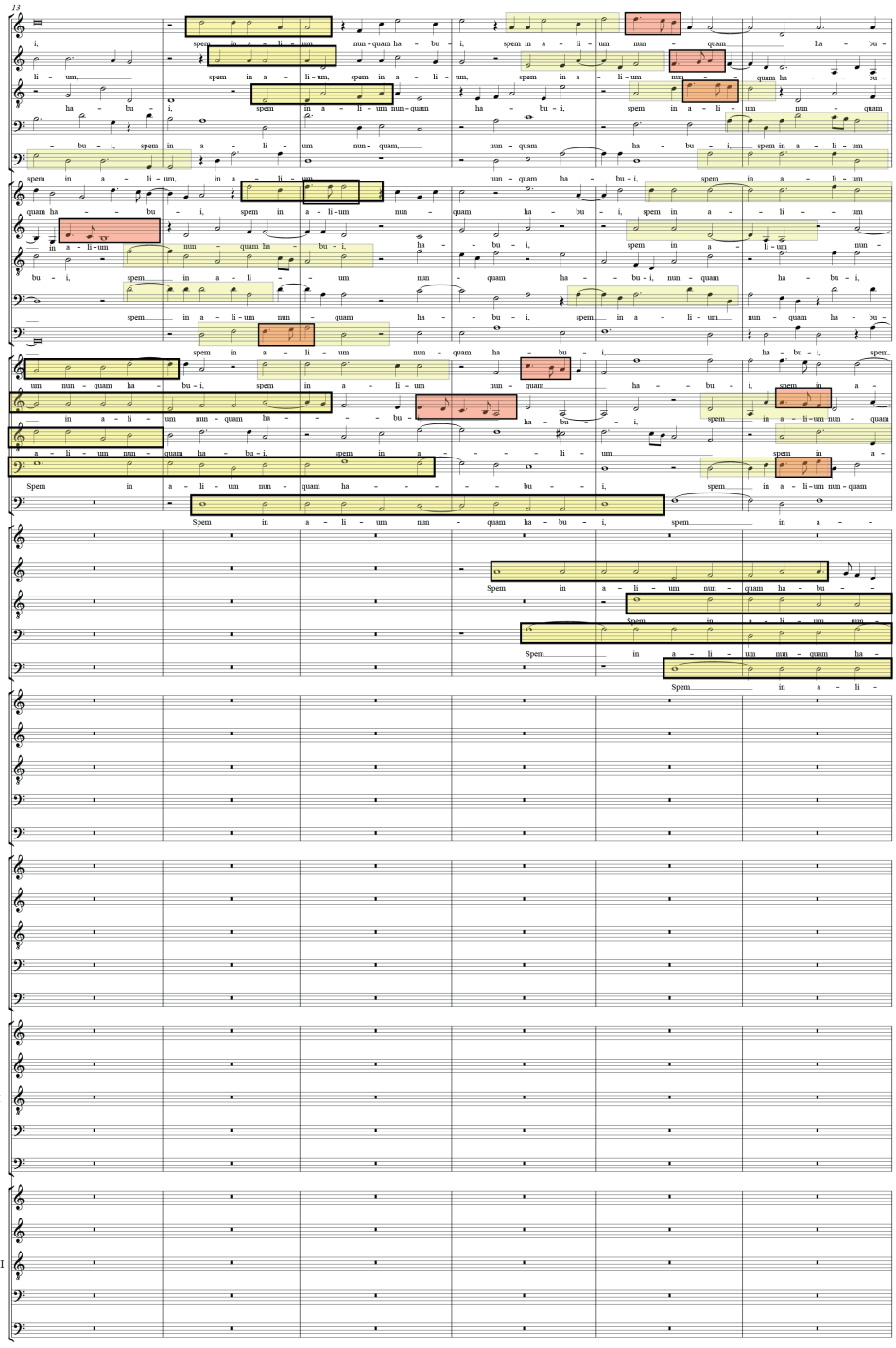
Baritone V and Soprano I, m. 110

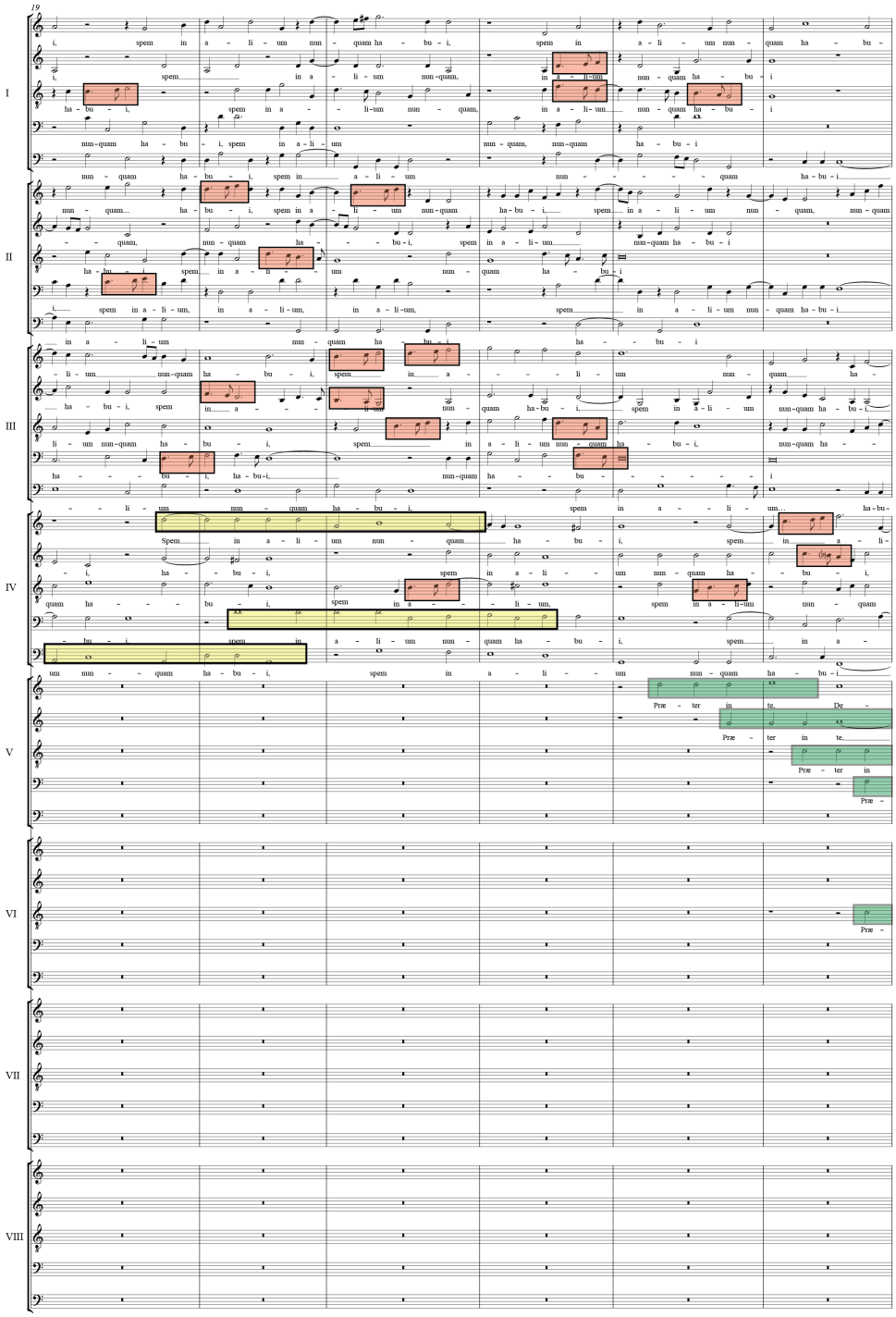


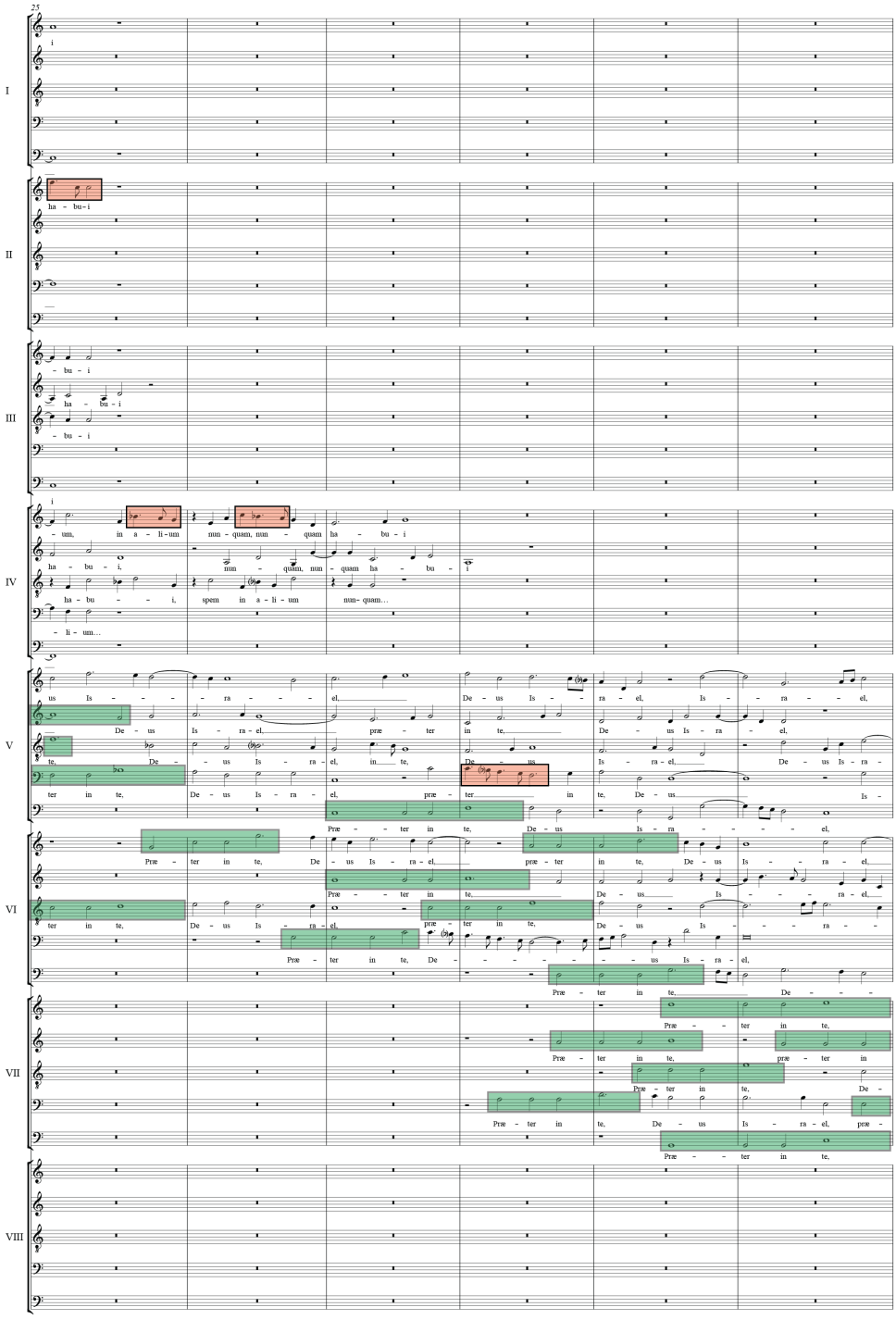
Appendix 5
Annotated Score



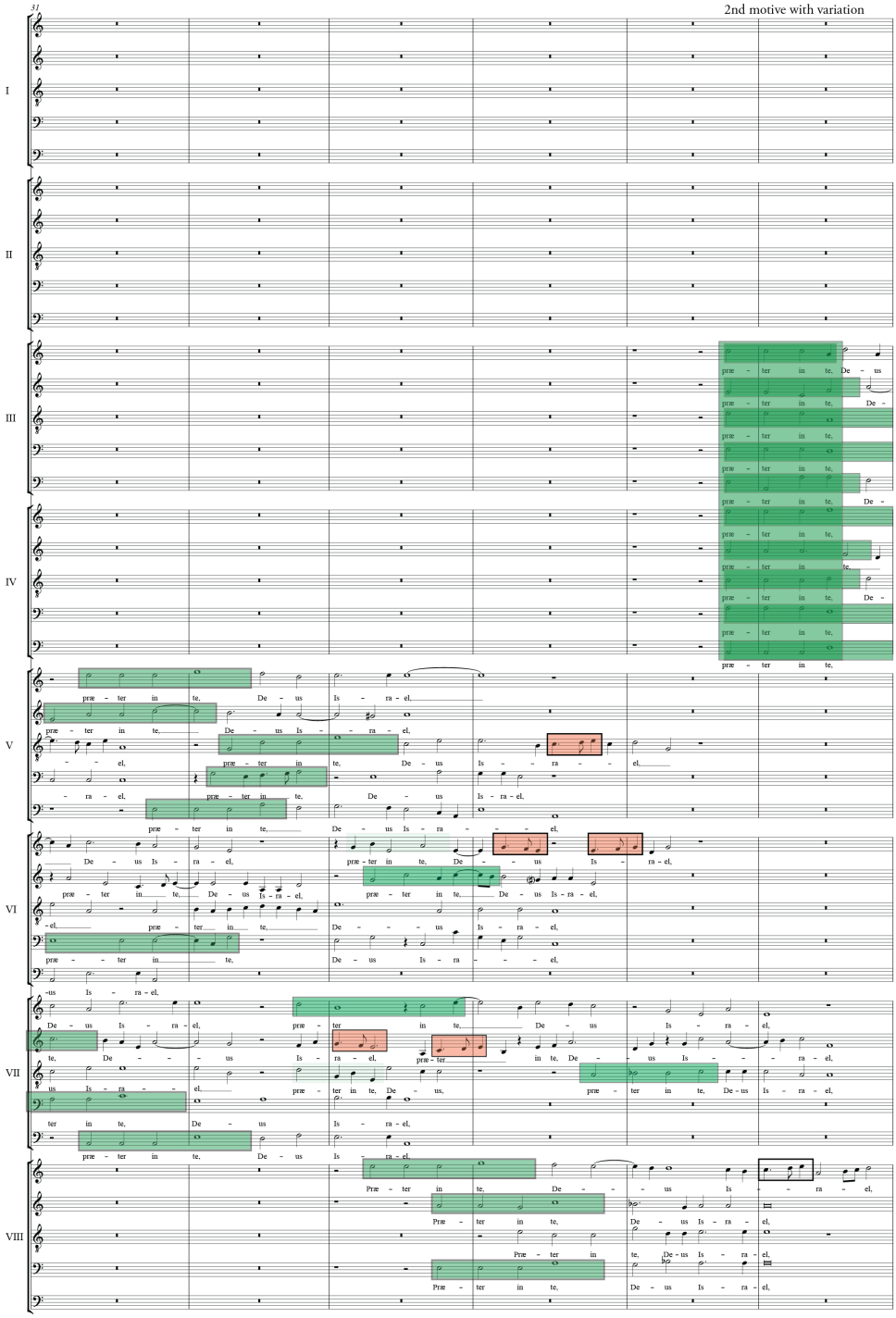

I
II
III
IV
V
VI
VII
VIII

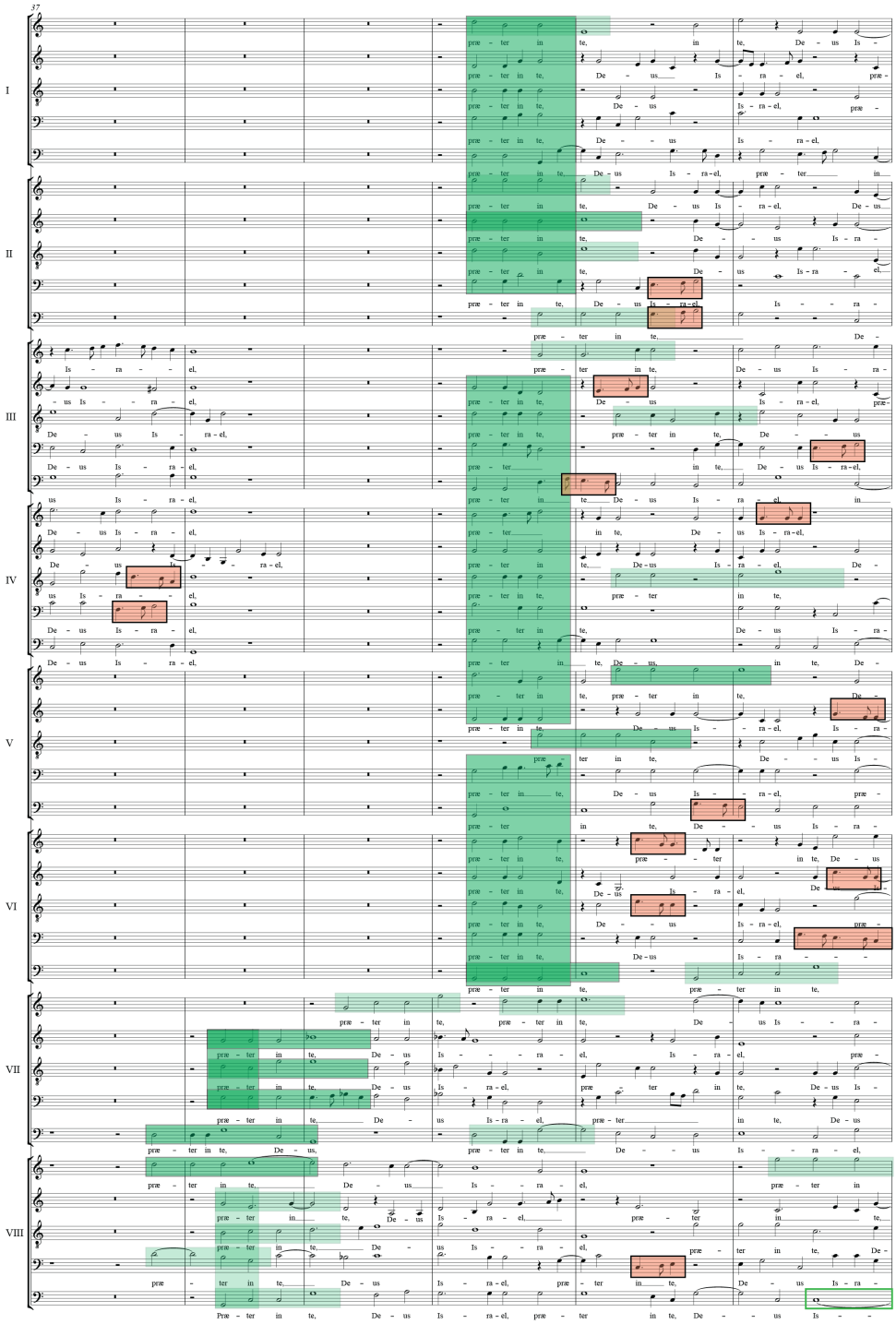

13
I
II
III
IV
V
VI
VII
VIII

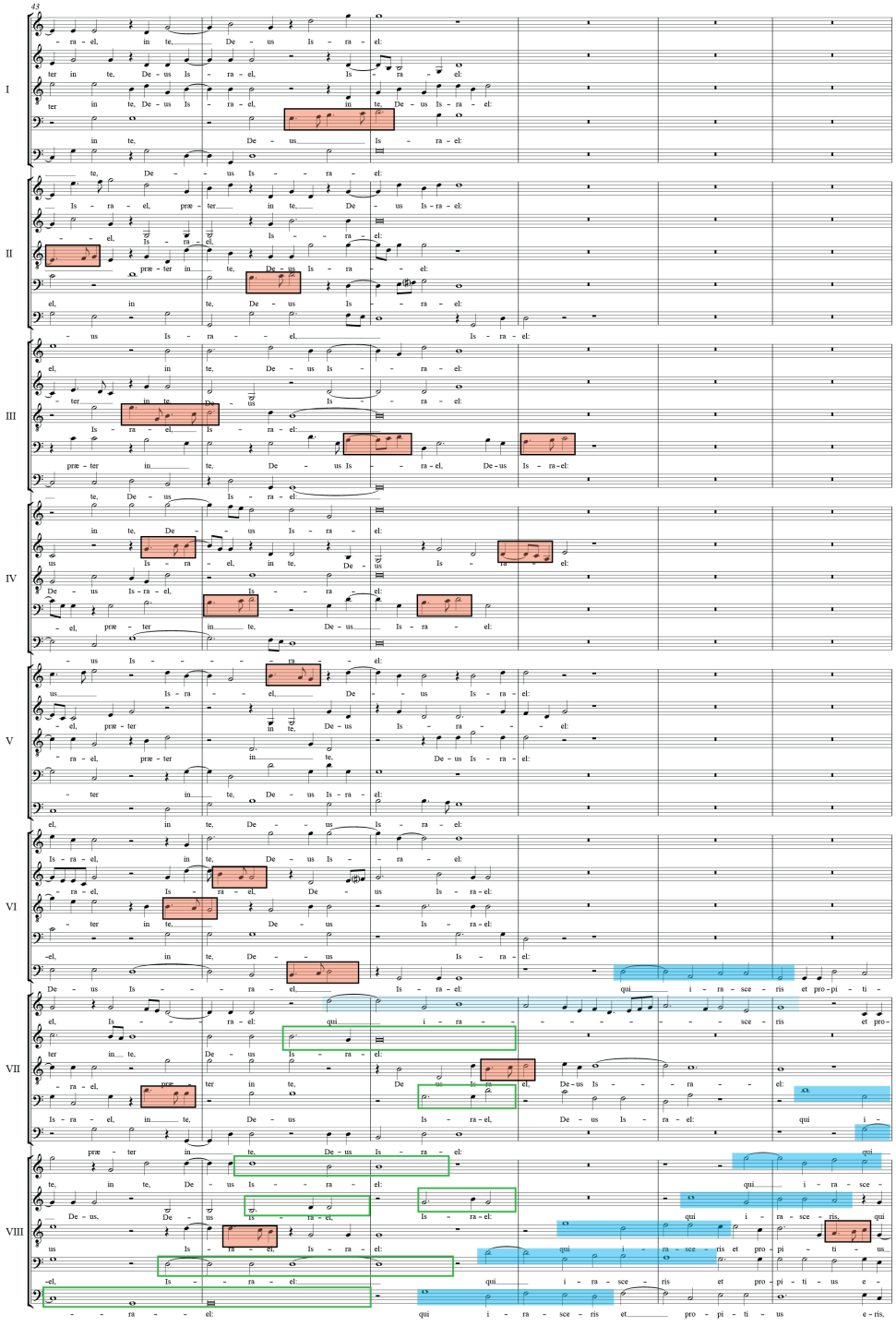

19
I
II
III
IV
V
VI
VII
VIII


25
I
i
II
ha – bu – i
III
– bu – i
ha – bu – i
– bu – i
IV
i
– um, in a – li – um nun – quam, nun – quam ha – bu – i
ha – bu – i, nun – quam, nun – quam ha – bu – i
ha – bu – – – i, spem in a – li – um nun – quam…
– li – um…
V
us Is – – – – ra – – – el,
De – us Is – – ra – el, Is – – ra – – el,
De – us Is – ra – el, præ – ter in te, De – us Is – ra – el,
te, De – – us Is – ra – el, in te, De – us Is – ra – el, De – us Is – ra –
ter in te, De – us Is – ra – el, præ – ter in te, De – us Is –
Præ – – – ter in te, De – us Is – ra – – – – – el,
VI
Præ – ter in te, De – us Is – ra – el, præ – ter in te, De – us Is – – – ra – el,
Præ – – – ter in te, De – us Is – – – ra – el,
ter in te, De – us Is – ra – el, præ – ter in te, De – us Is – – – – ra – –
Præ – ter in te, De – – – – – – – us Is – ra – el,
Præ – ter in te, De – – –
VII
Præ – – ter in te,
Præ – ter in te, præ – ter in
Præ – ter in te, De –
Præ – ter in te, De – us Is – ra – el, præ –
Præ – – ter in te,
VIII

First double choir,
2nd motive with variation




37
I
II
III
IV
V
VI
VII
VIII


43
I
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IV
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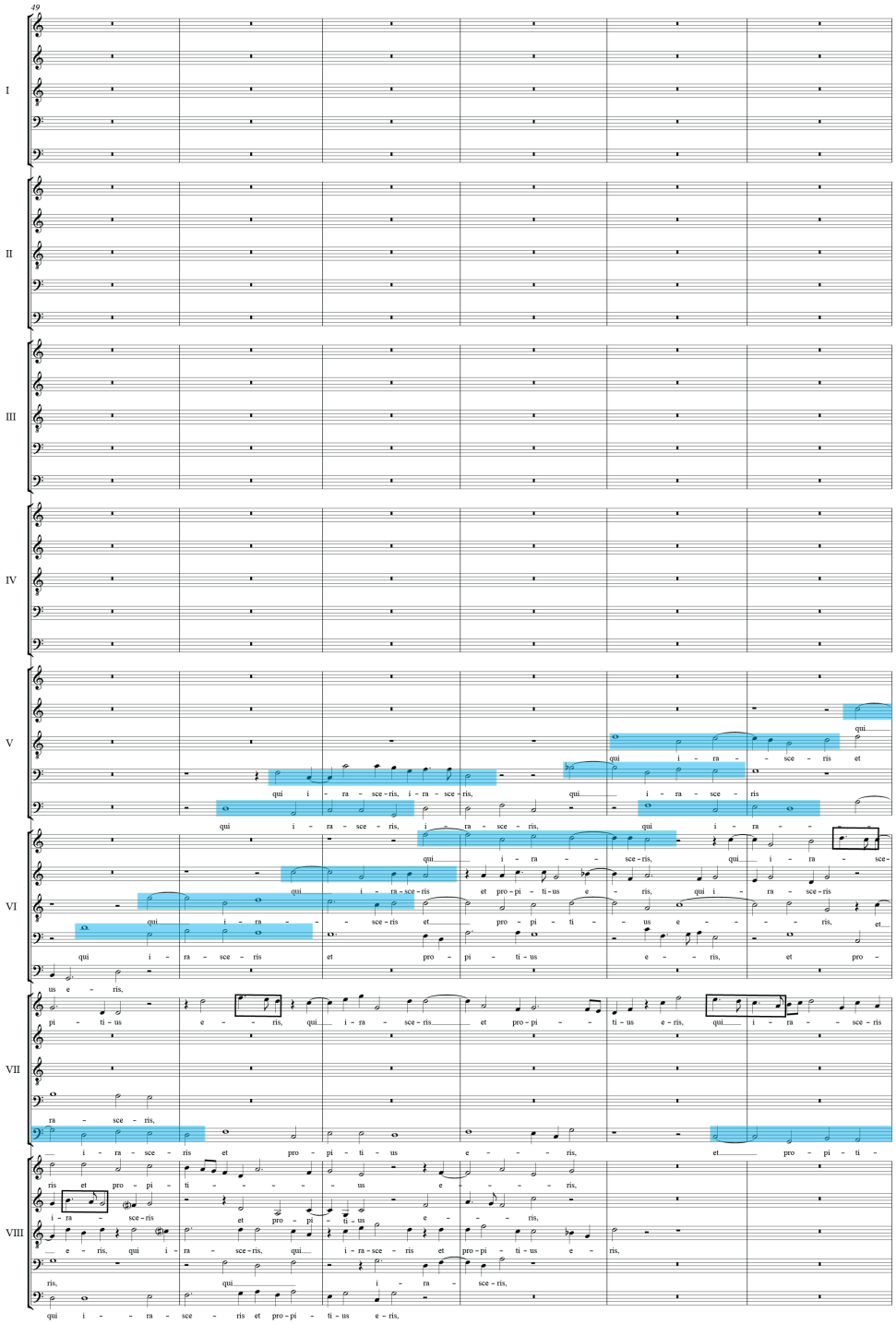
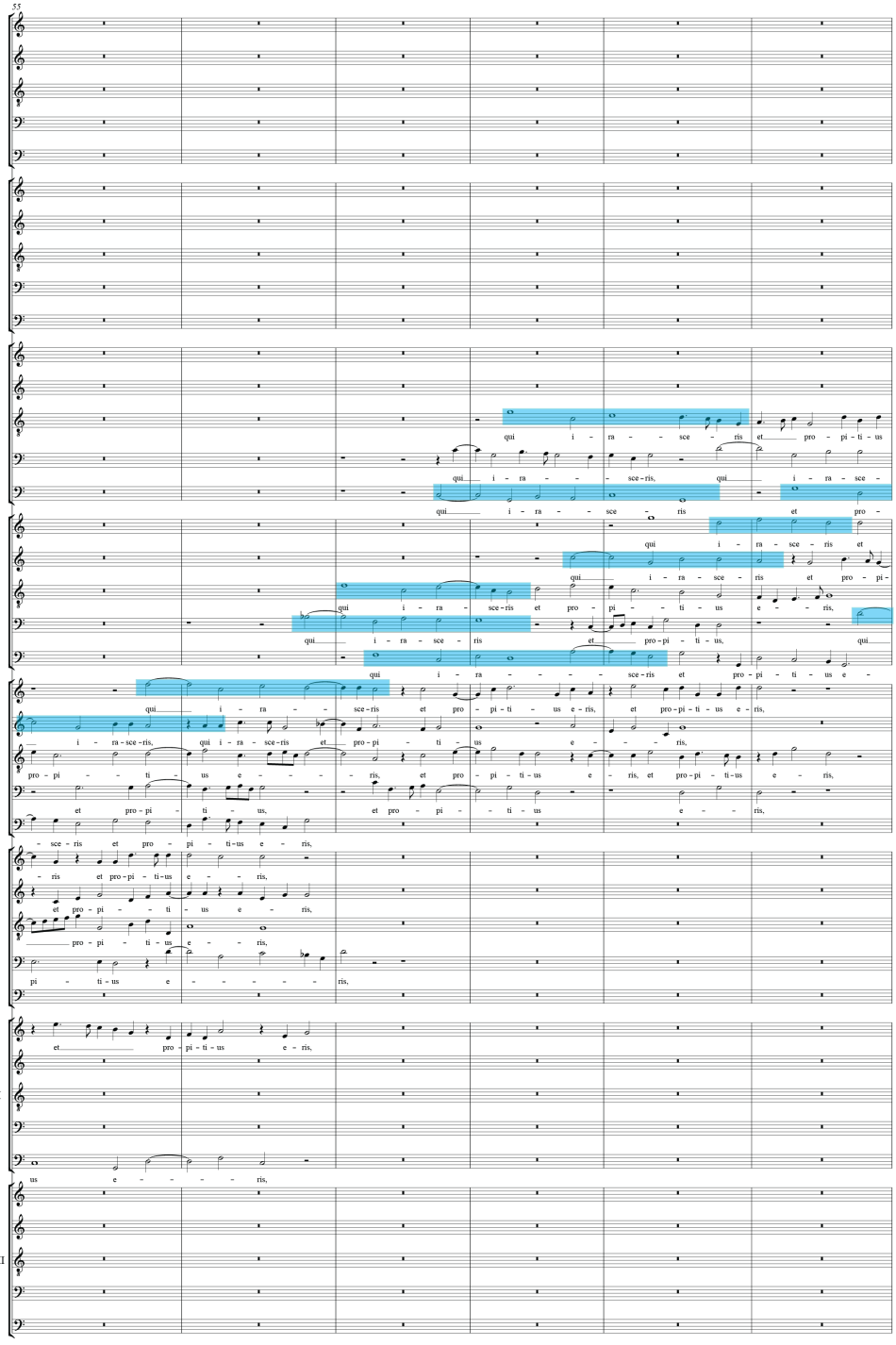
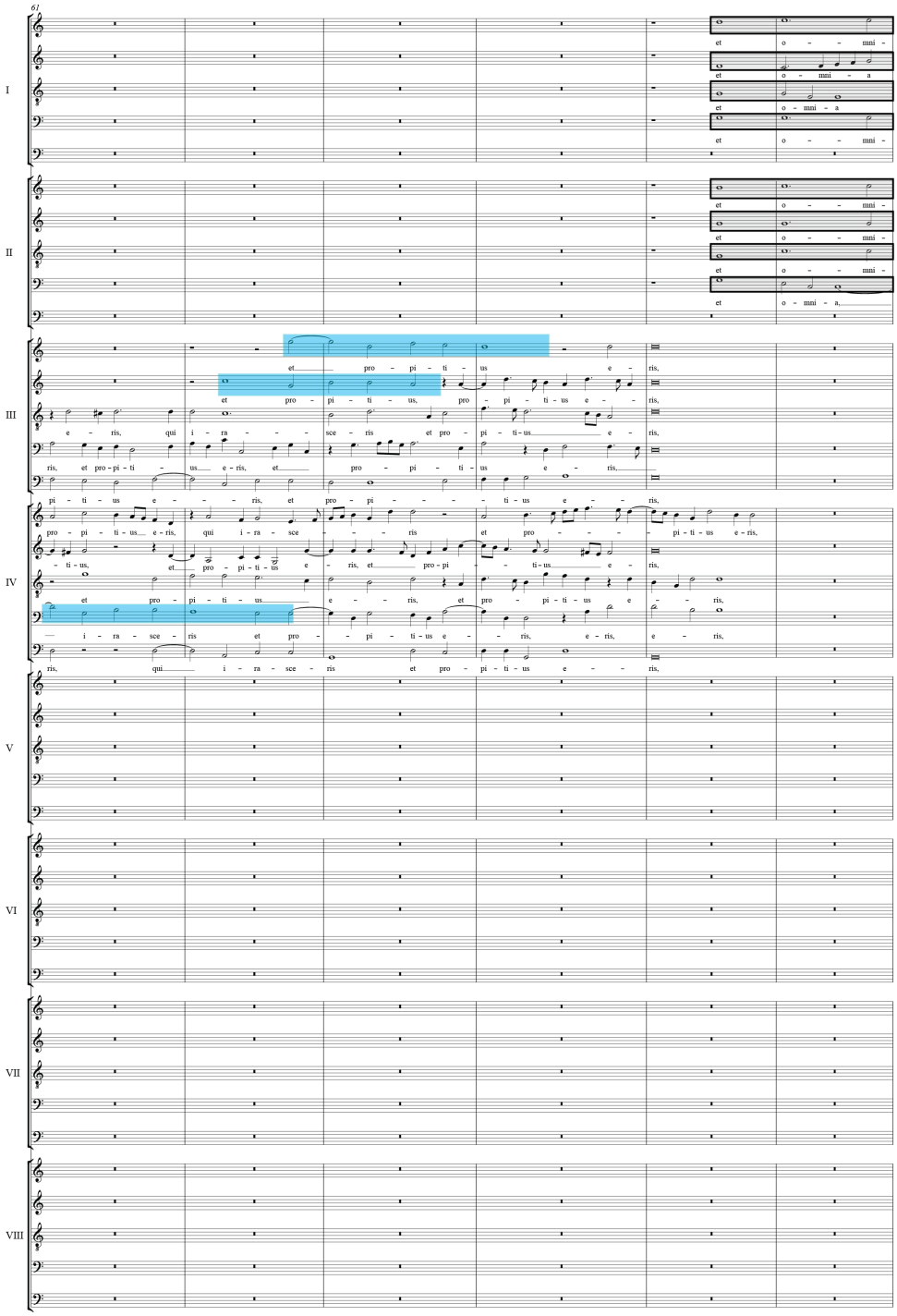
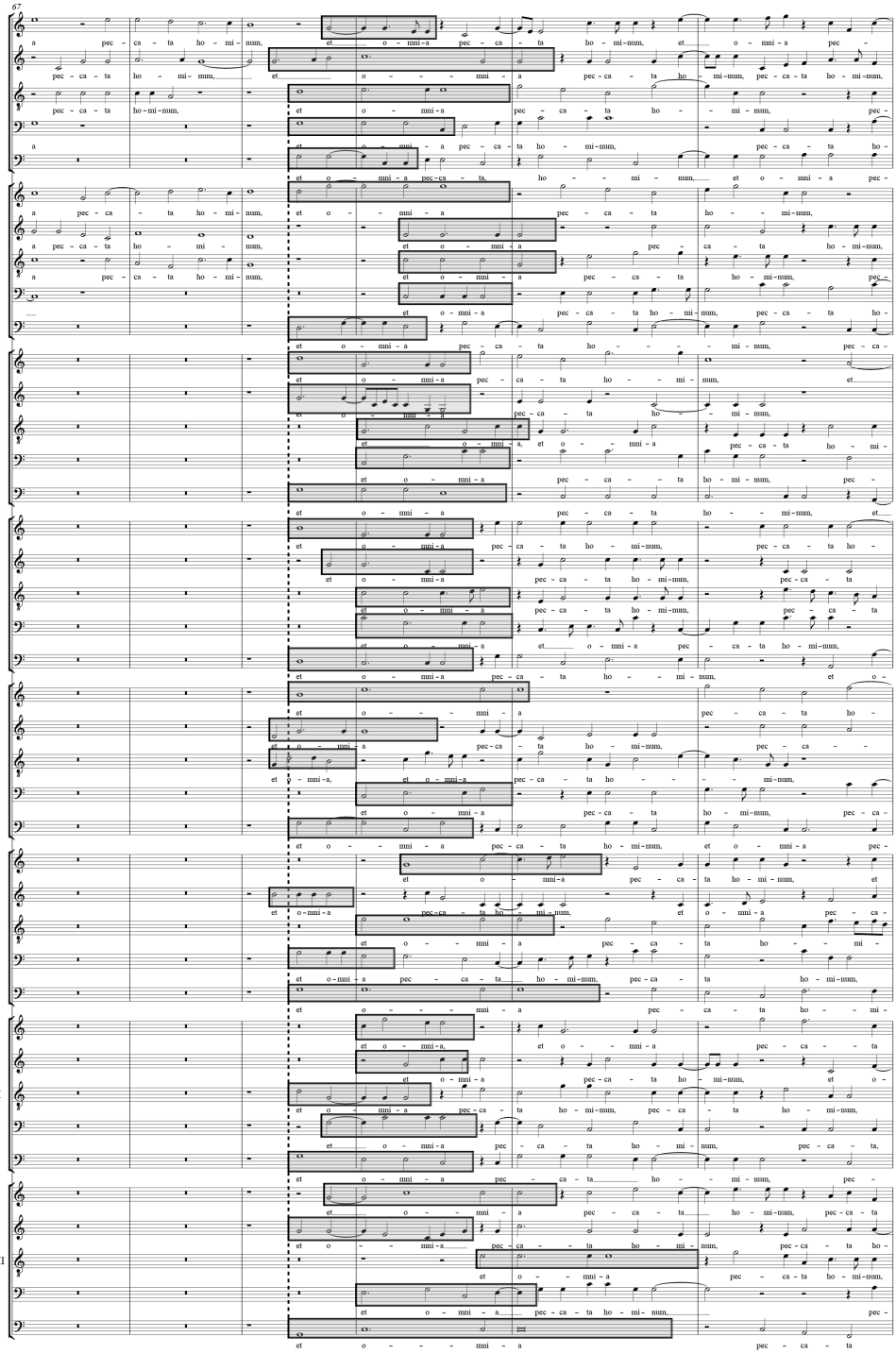
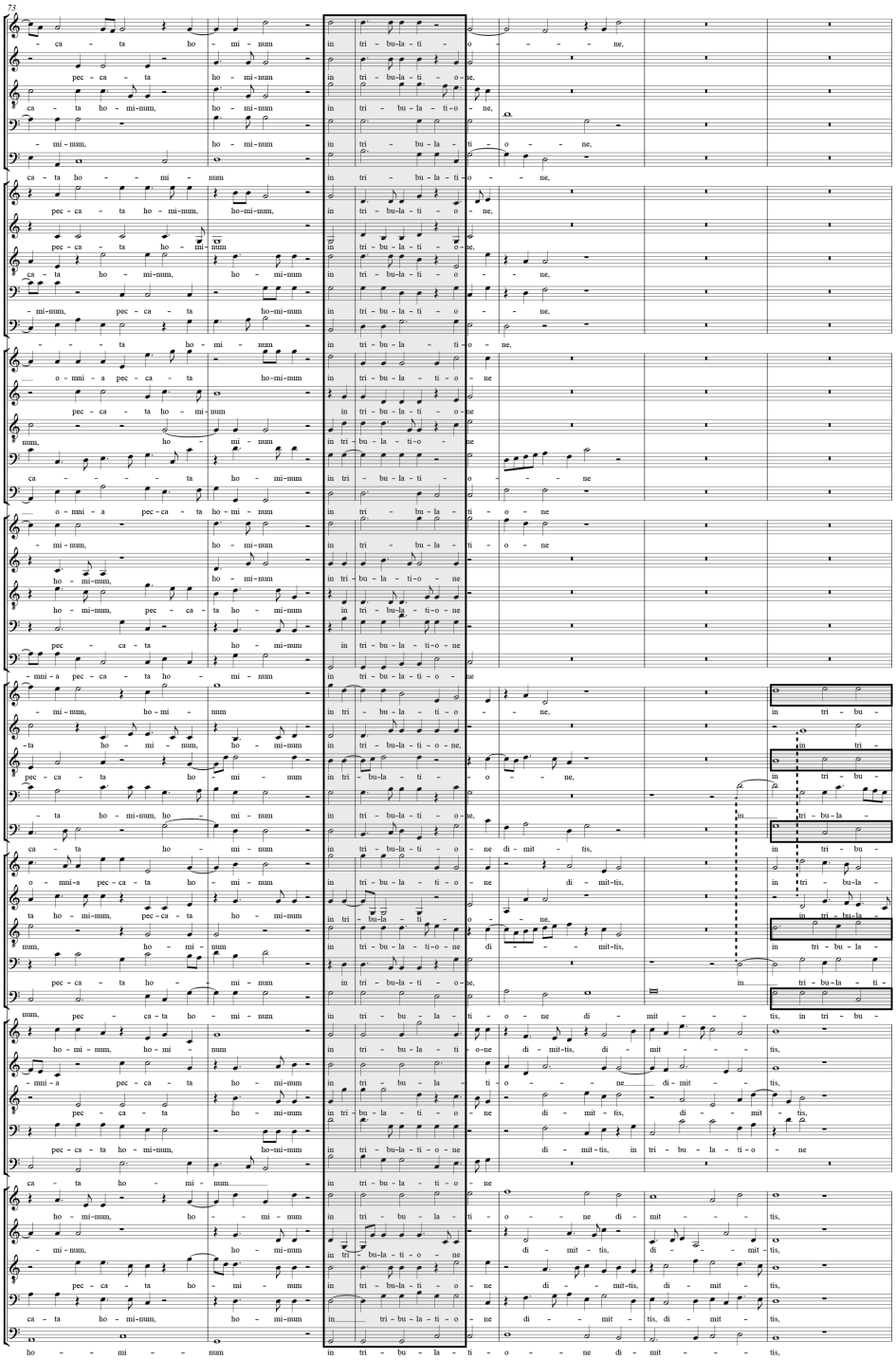
VI
VII
VIII

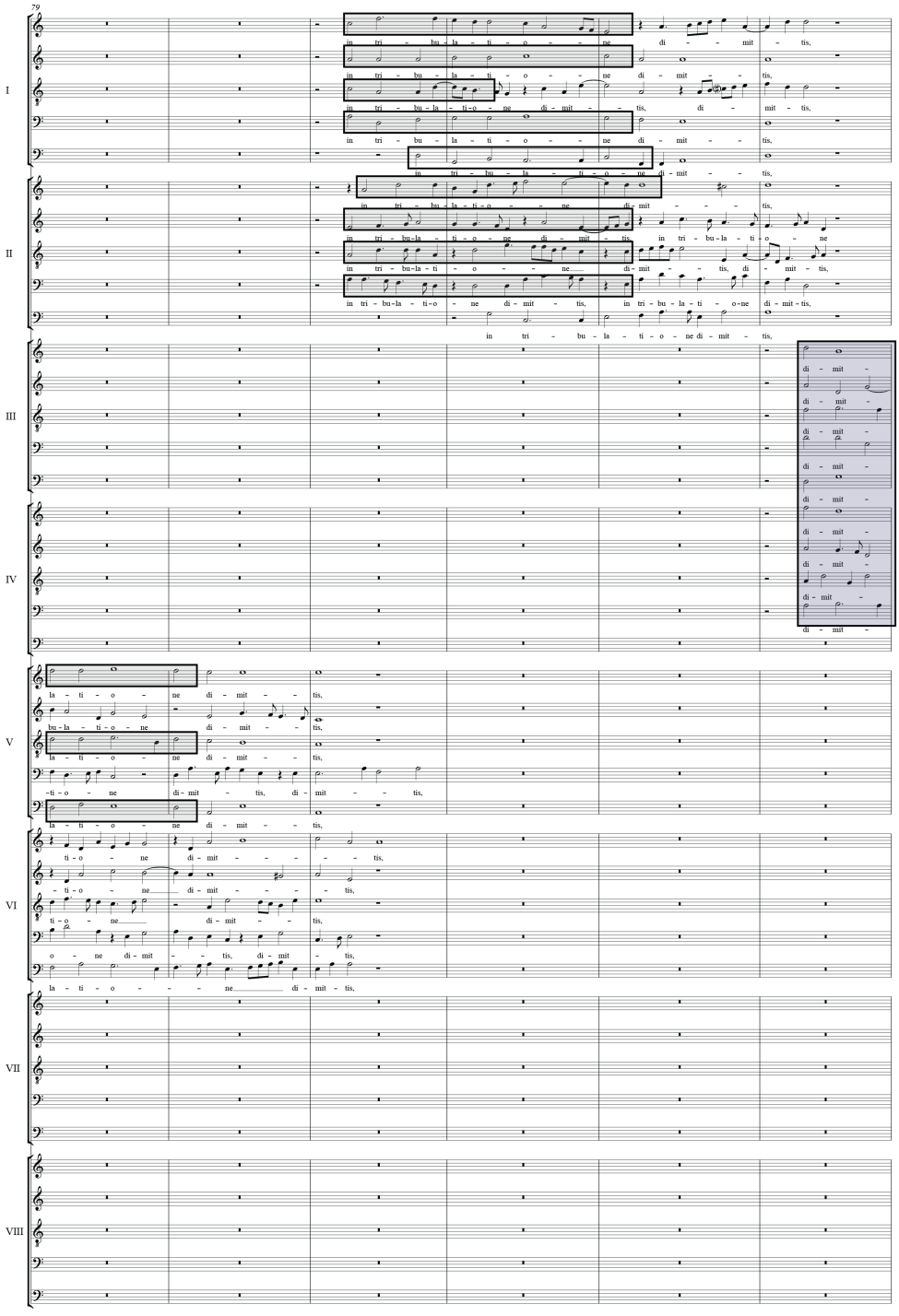

49
I
II
III
IV
V
VI
VII
VIII
qui i – ra – sce – ris, et pro – pi – ti – us e – ris,
qui i – ra – sce – ris, et pro – pi – ti – us e – ris,
qui i – ra – sce – ris, et pro – pi – ti – us e – ris,
qui i – ra – sce – ris, et pro – pi – ti – us e – ris,
qui i – ra – sce – ris, et pro – pi – ti – us e – ris,
qui i – ra – sce – ris, et pro – pi – ti – us e – ris,
qui i – ra – sce – ris, et pro – pi – ti – us e – ris,
qui i – ra – sce – ris, et pro – pi – ti – us e – ris,

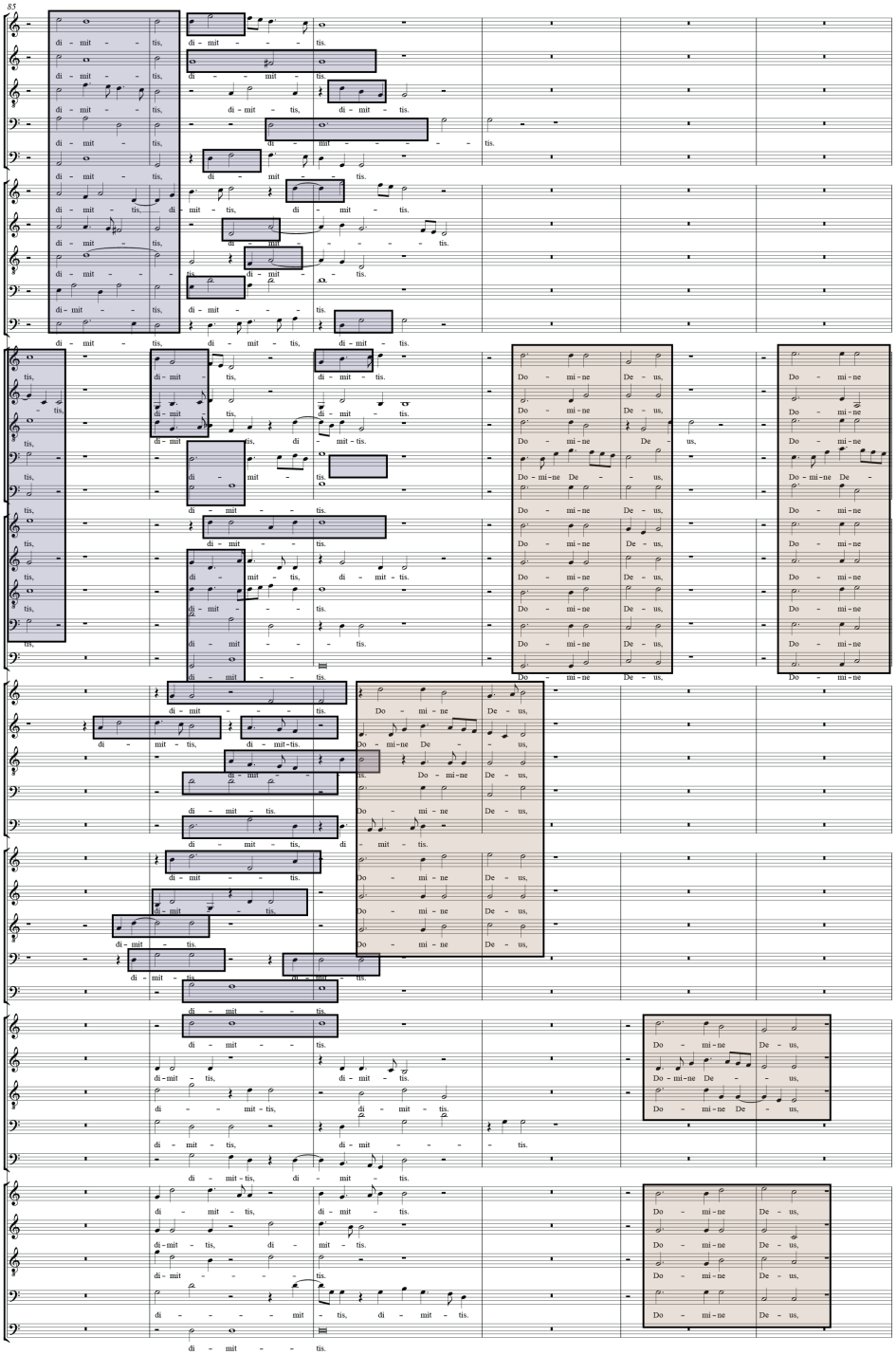

55
I
II
III
qui i – ra – – sce – ris et pro – pi – ti – us
qui i – ra – – sce – ris, qui i – ra – sce –
qui i – ra – – sce – ris et pro –
IV
qui i – ra – sce – ris et
qui i – ra – sce – ris et pro – pi –
qui i – ra – sce – ris et pro – pi – – ti – us e – – – ris,
qui i – ra – sce – ris et pro – pi – ti – us, qui
qui i – ra – – – sce – ris et pro – pi – ti – us e –
V
qui i – ra – – sce – ris et pro – pi – ti – us e – ris, et pro – pi – ti – us e – ris,
i – ra – sce – ris, qui i – ra – sce – ris et pro – pi – ti – us e – – – ris,
pro – pi – – ti – us e – – – ris, et pro – pi – ti – us e – ris, et pro – pi – ti – us e – ris,
et pro – pi – ti – us, et pro – pi – – ti – us e – – ris,
– sce – ris et pro – pi – ti – us e – ris,
VI
– ris et pro – pi – ti – us e – – – ris,
et pro – pi – – ti – us e – ris,
pro – pi – ti – us e – – – ris,
pi – ti – us e – – – – – ris,
VII
et pro – pi – ti – us e – ris,
us e – – – – – ris,
VIII

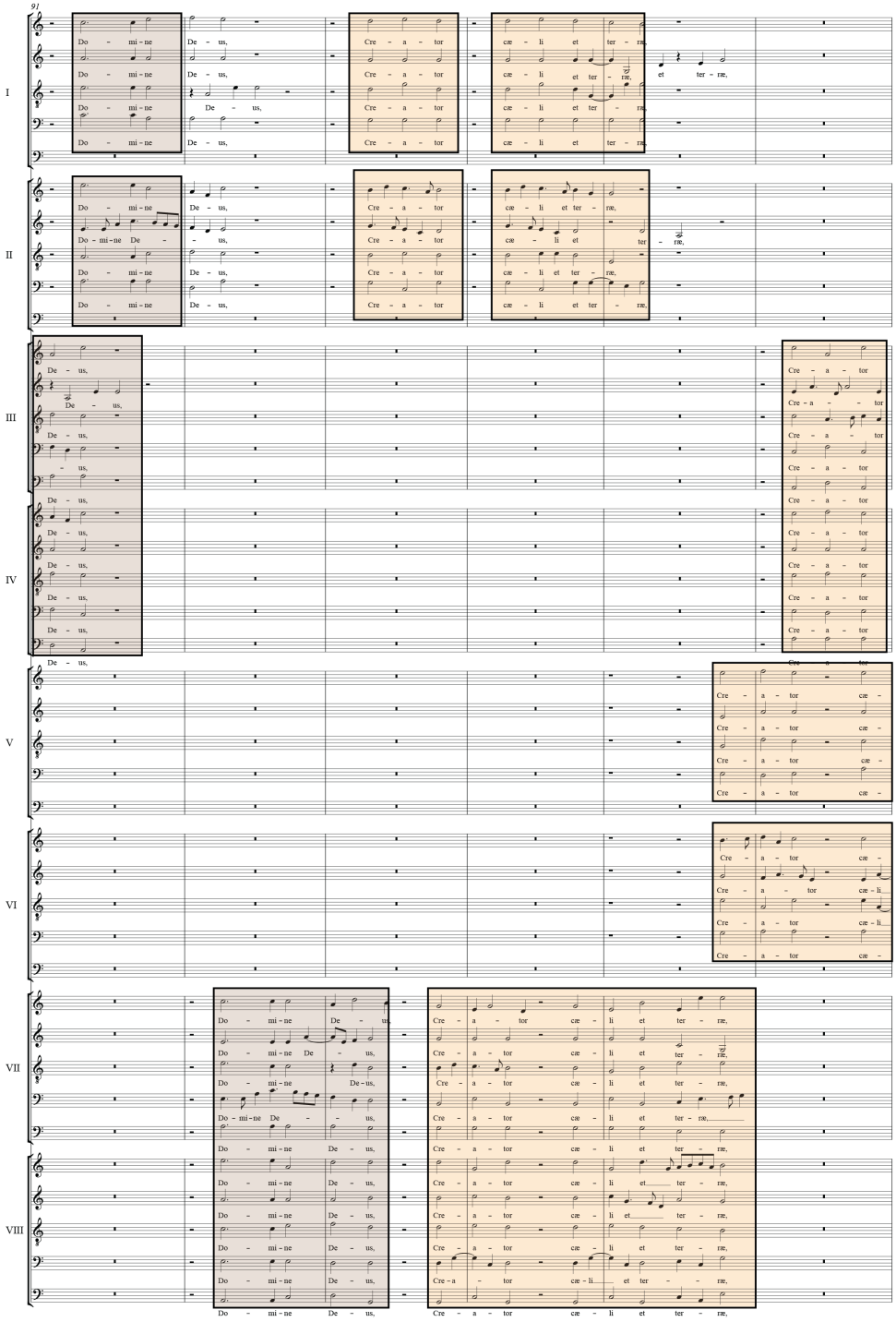

61
I
et o – – mni –
et o – mni – a
et o – mni – a
et o – – mni –
II
et o – – mni –
et o – – mni –
et o – – mni –
et o – mni – a,
III
et pro – pi – ti – us e – ris,
et pro – pi – ti – us, pro – pi – ti – us e – – ris,
e – ris, qui i – ra – – – sce – ris et pro – pi – ti – us e – ris,
ris, et pro – pi – ti – us e – ris, et pro – pi – ti – us e – ris,
pi – ti – us e – – – ris, et pro – pi – – – – ti – us e – – ris,
IV
pro – pi – ti – us e – ris, qui i – ra – sce – – – – ris et pro – – – – pi – ti – us e – ris,
– ti – us, et pro – pi – ti – us e – ris, et pro – pi – – ti – us e – ris,
et pro – pi – ti – us e – – ris, et pro – pi – ti – us e – – ris,
i – ra – sce – ris et pro – – pi – ti – us e – – ris, e – ris, e – ris,
ris, qui i – ra – sce – ris et pro – pi – ti – us e – – ris,
V
VI
VII
VIII

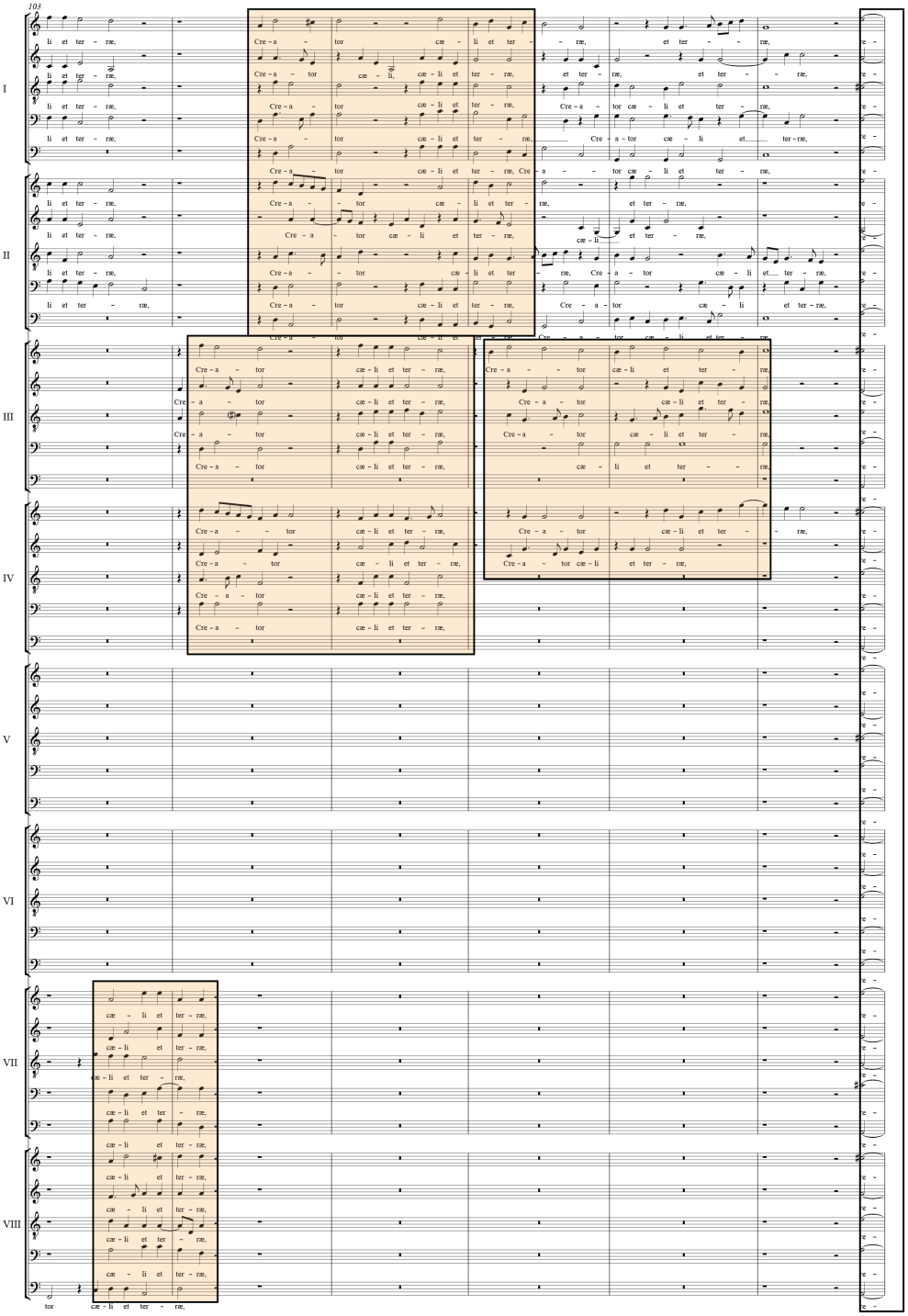

67
I
II
III
IV
V
VI
VII
VIII

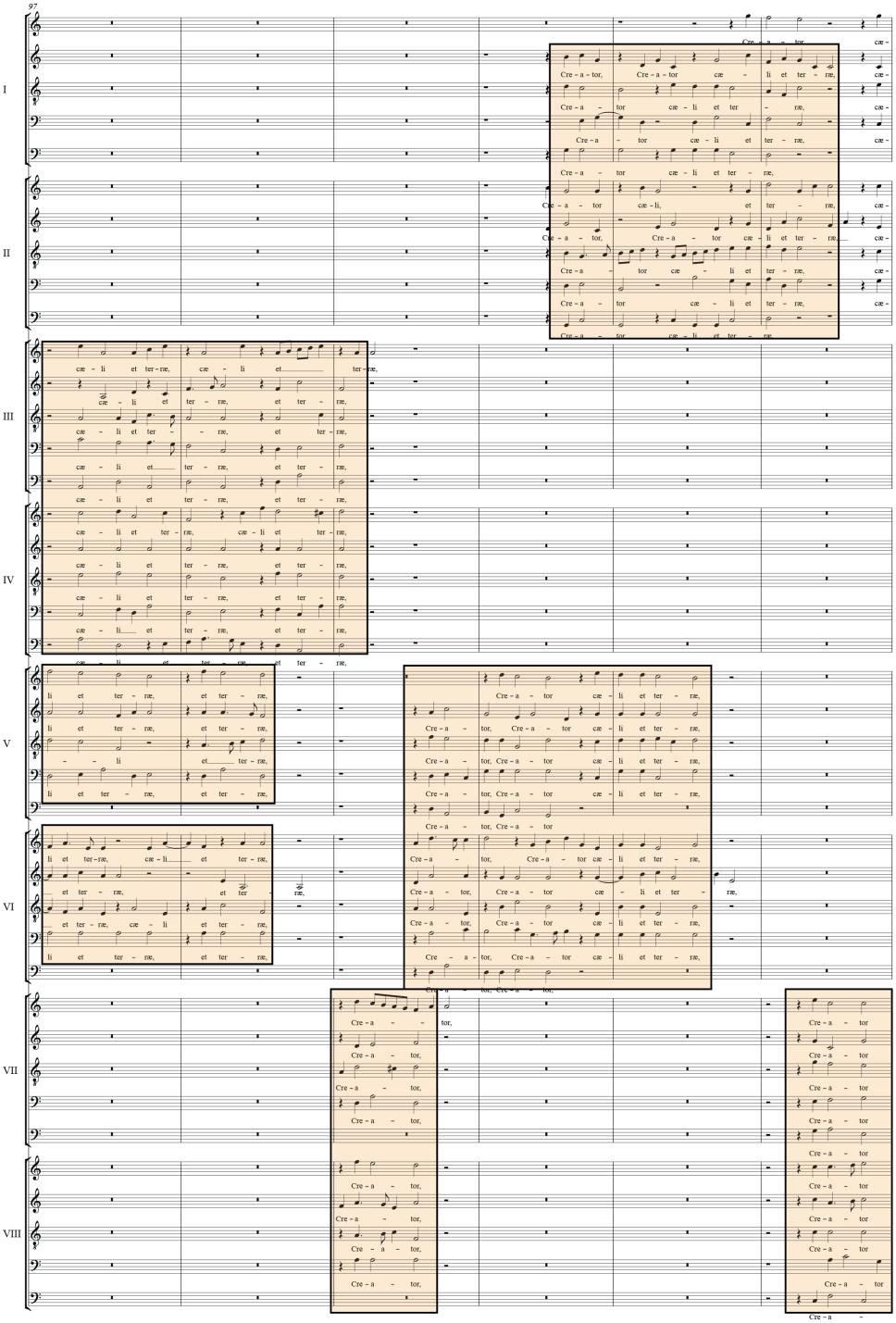

73
I
II
III
IV
V
VI
VII
VIII

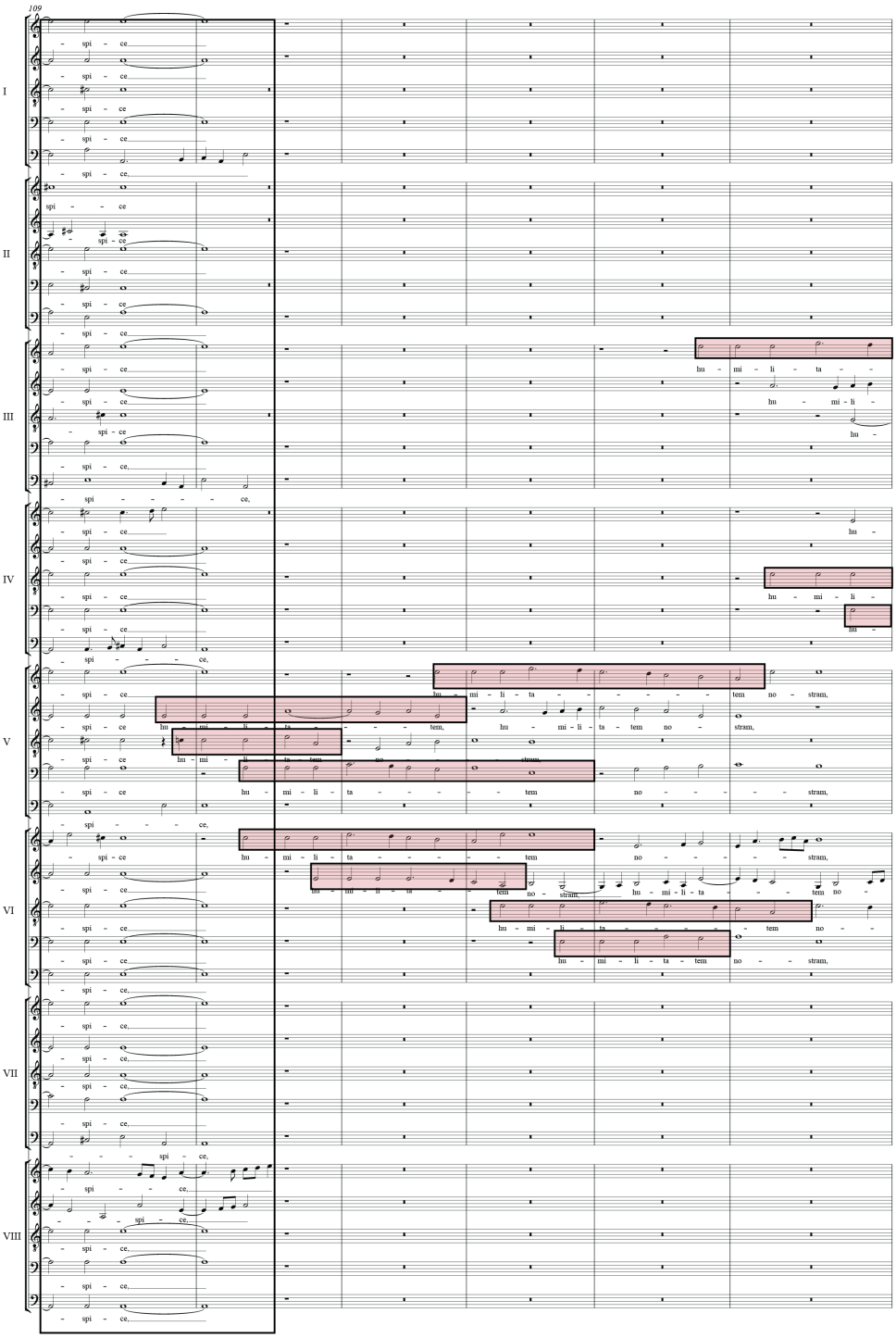

79
I
II
III
IV
V
VI
VII
VIII
in tri – bu – la – ti – o – ne di – mit – tis,
di – mit – tis,
la – ti – o – ne di – mit – tis,
ti – o – ne di – mit – tis,
o – ne di – mit – tis, di – mit – tis,
la – ti – o – ne di – mit – tis,

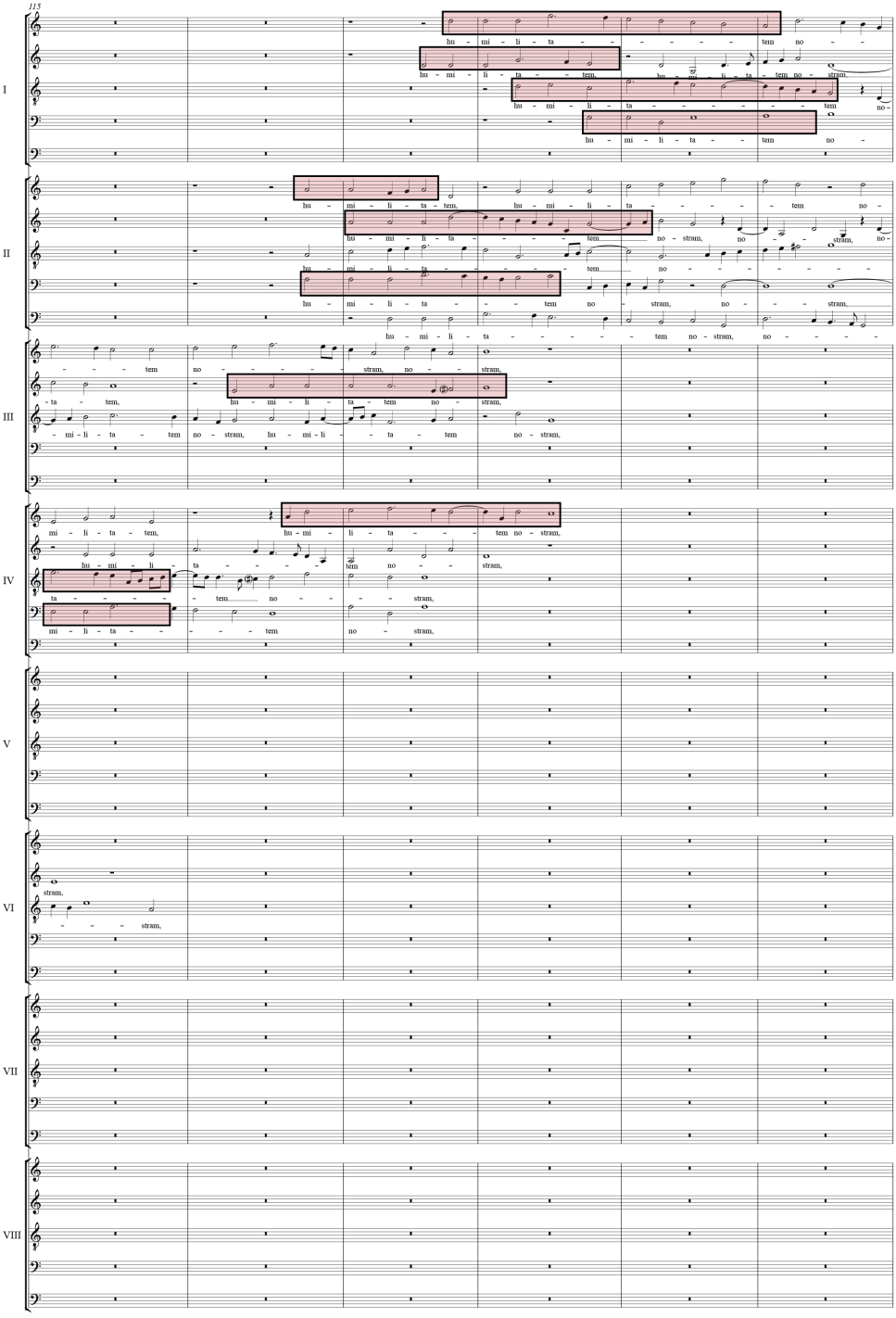

85
I
II
III
IV
V
VI
VII
VIII
di - mit - tis.
Do - mi - ne De - us,

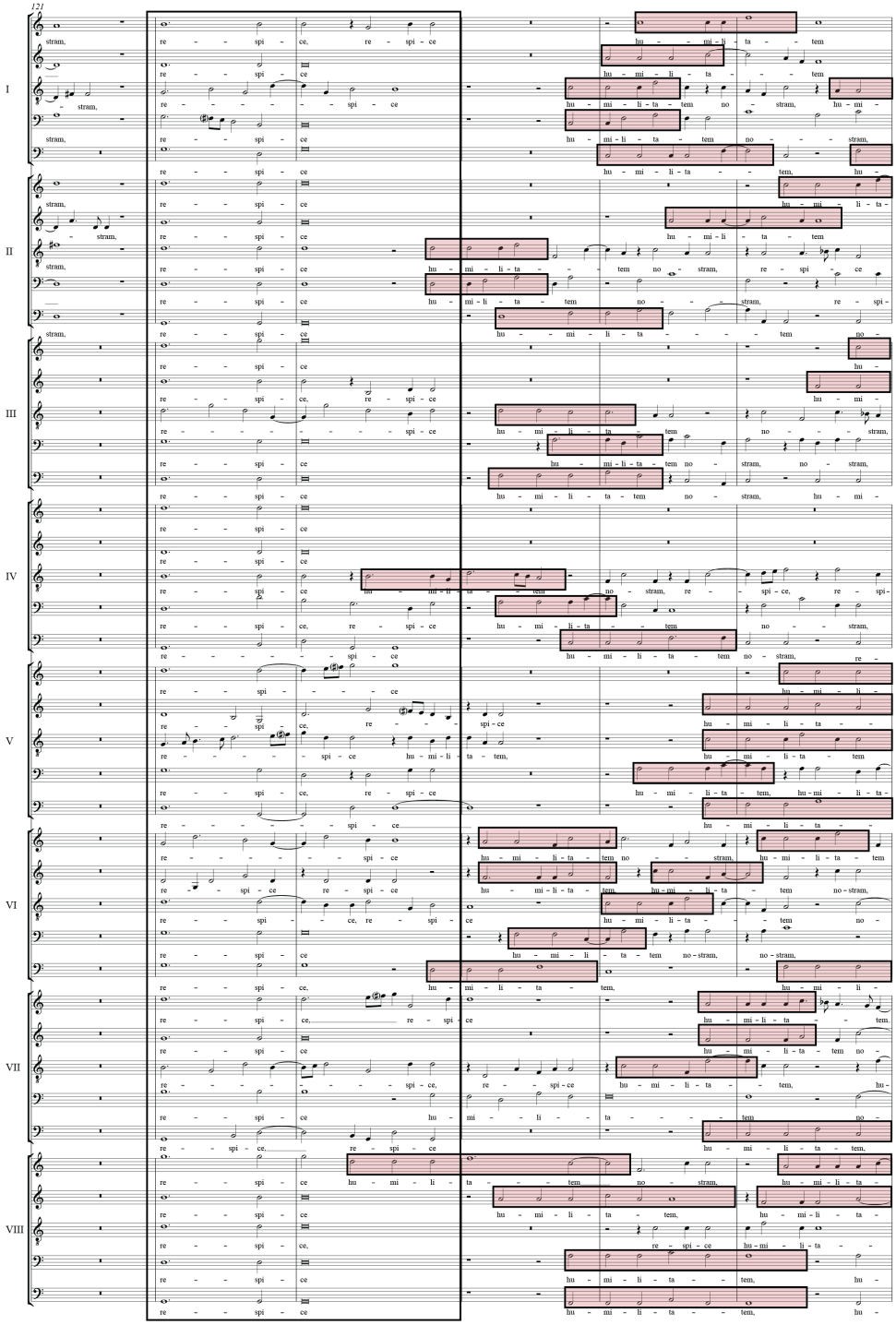

91
I
Do – mi – ne De – us,
Cre – a – tor
cæ – li et ter – ræ,
II
III
IV
V
VI
VII
VIII

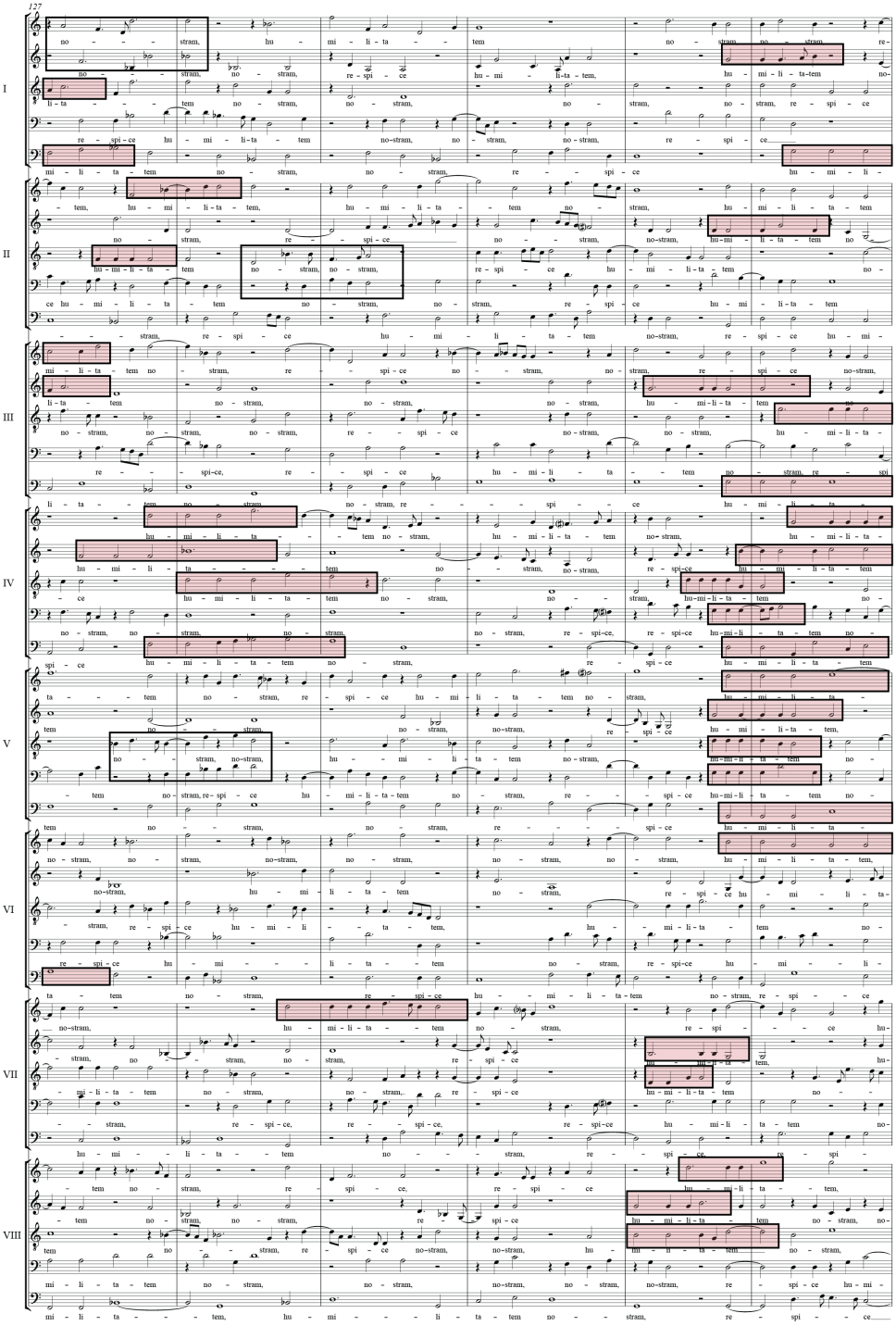

103
I
II
III
IV
V
VI
VII
VIII
li et ter – ræ,
Cre – a – tor cæ – li et ter – ræ,
et ter – ræ,
Cre – a – tor cæ – li et ter – ræ, Cre – a – tor cæ – li et ter – ræ,
cæ – li et ter – ræ,
tor cæ – li et ter – ræ,

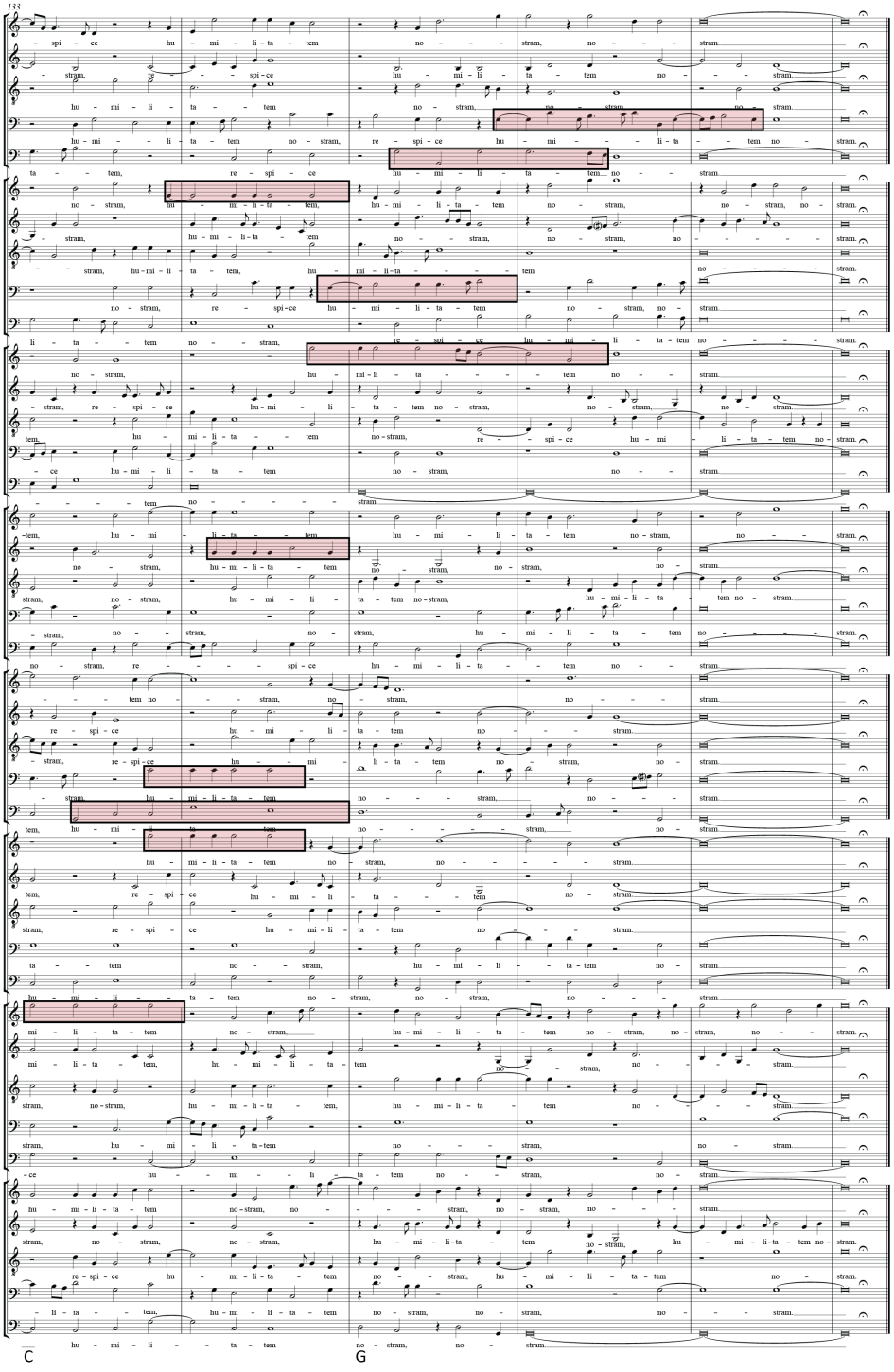

97
I
II
III
IV
V
VI
VII
VIII
Cre – a – tor, Cre – a – tor cæ – li et ter – ræ,
Cre – a – tor cæ – li et ter – ræ,
cæ – li et ter – ræ, et ter – ræ,
et ter – ræ,


109
I
II
III
IV
V
VI
VII
VIII
spi – ce
hu – mi – li – ta – tem no – stram,


115
I
II
III
IV
V
VI
VII
VIII


121
I
II
III
IV
V
VI
VII
VIII


127
I
II
III
IV
V
VI
VII
VIII


133
I
II
III
IV
V
VI
VII
VIII
C
G