Updates and Outcomes from the Guatemalan Digitization and Encoding Project

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McGill University

MEC/TEI Joint Conference: Encoding Cultures
08 September 2023

Introduction: The GuatC Collection

Collection of six polyphonic choirbooks, held at the *Archivo Histórico Arquidiocesano de Guatemala* (Archdiocesan Historical Archive of Guatemala, *AHAG*) in Guatemala City.

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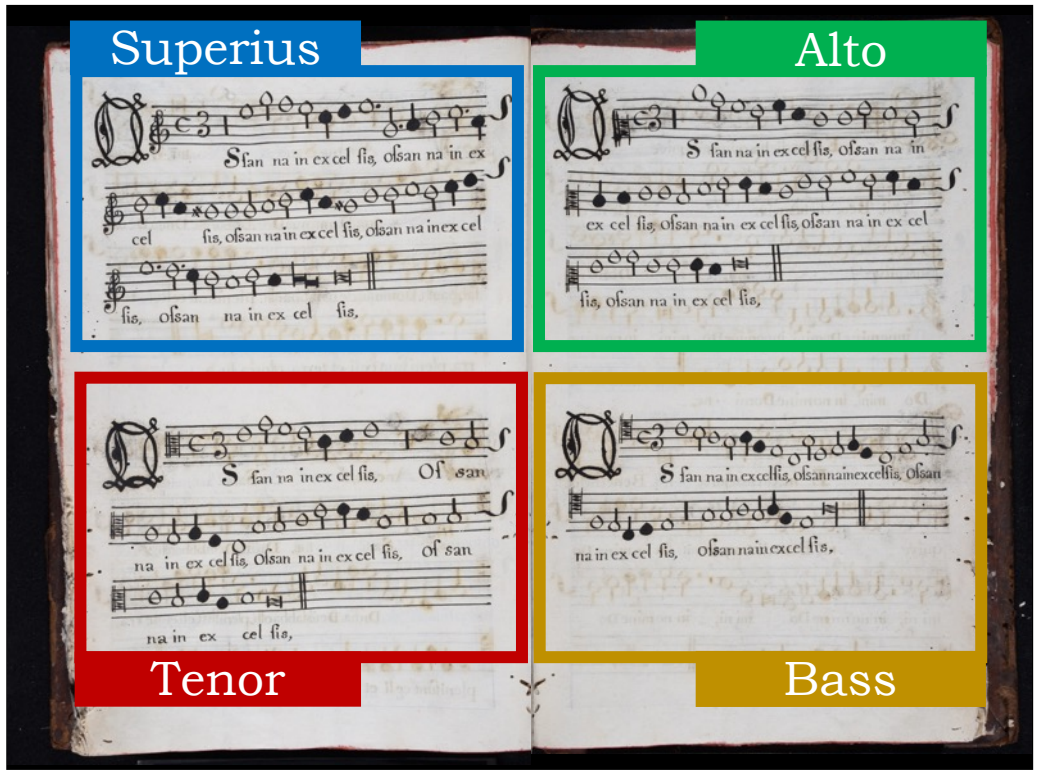


- Manuscripts
- Large dimensions
  - Average folio size = 30 cm x 45 cm
  - Book 6, size = 21.5 cm x 30 cm
- Voices in choirbook format
- And in mensural notation

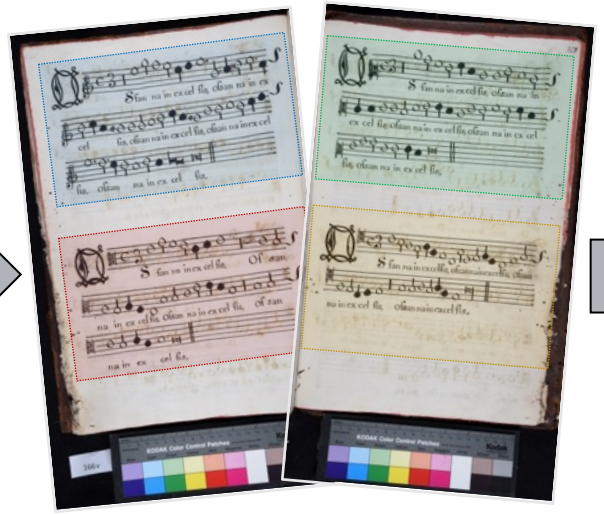
Introduction: The GuatC Collection

- Copied in the 17th and 18th centuries
- Repertoire: mostly 16th c. polyphonic music
- Document a continuous performance tradition of sacred choral music from the Renaissance through the 1800s
- Good for studying the transmission of music from Europe to Latin America

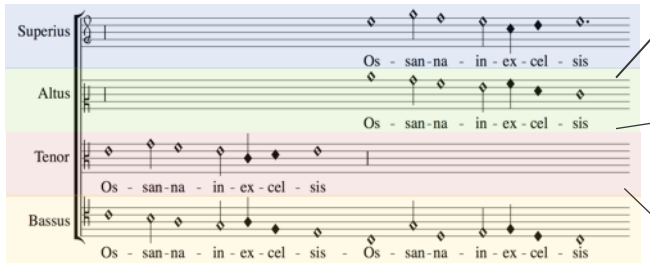
Introduction: The Project

- **Goal:** Preserve and increase access to this music corpus by using digitization and music-encoding technologies
- **Pilot project:** The first choirbook (GuatC 1) –> Book of Masses

Manuscript



Digital images
of the mensural pieces



MEI Score
interpreted durations,
an issue in mensural notation

playback

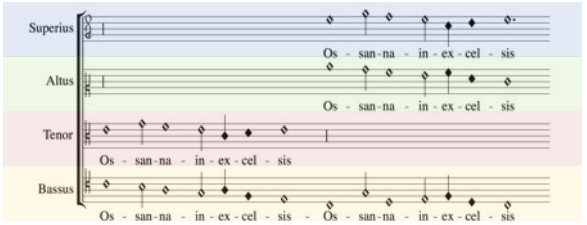
automatic transcription into modern values

comparison to concordant sources

Methodology: Three-Step Process

Digitization → Optical music recognition (OMR) → Automatic voice alignment & editorial correction

Manuscript



MEI Score file
interpreted durations

Methodology: Three-Step Process

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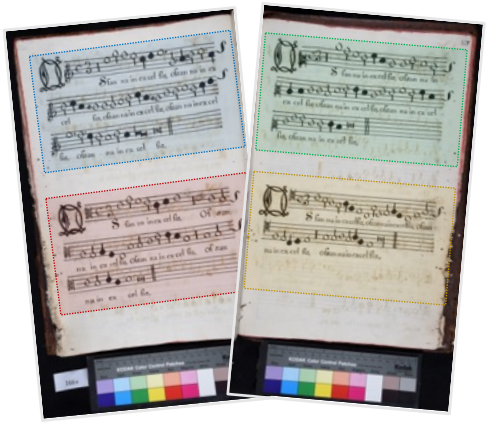

Digital images

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   <dot/>
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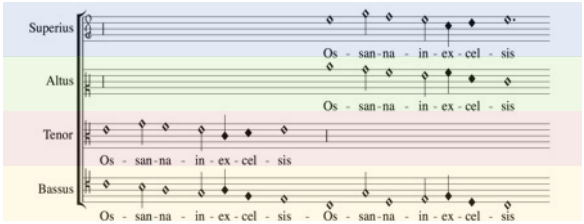
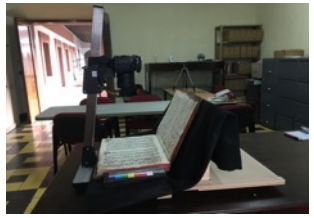
MEI Parts file
encodes the **symbols** in each **part/voice** of the images



MEI Score file
interpreted durations
(i.e., *alteration* & *imperfection*)

Methodology: Three-Step Process

Digitization



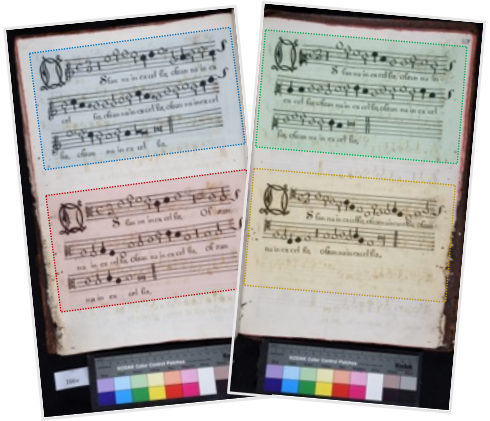
Optical music recognition (OMR)

MUSCIMA++
Music Recognition, encoding, and transcription

Automatic voice alignment & editorial correction

MEASURING POLYPHONY
DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC

Manuscript



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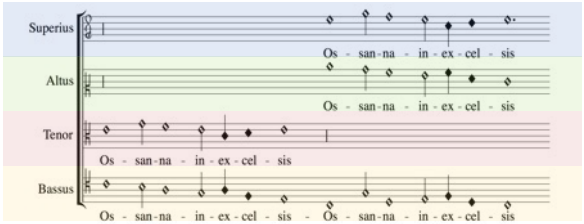

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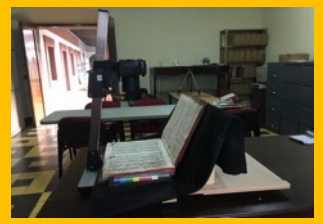
Digitization

Do-it-yourself (DIY) book scanner

Digitization



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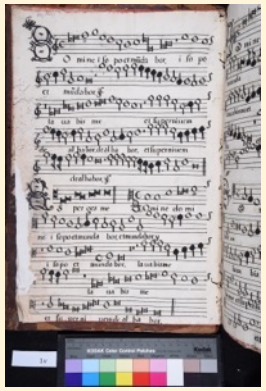
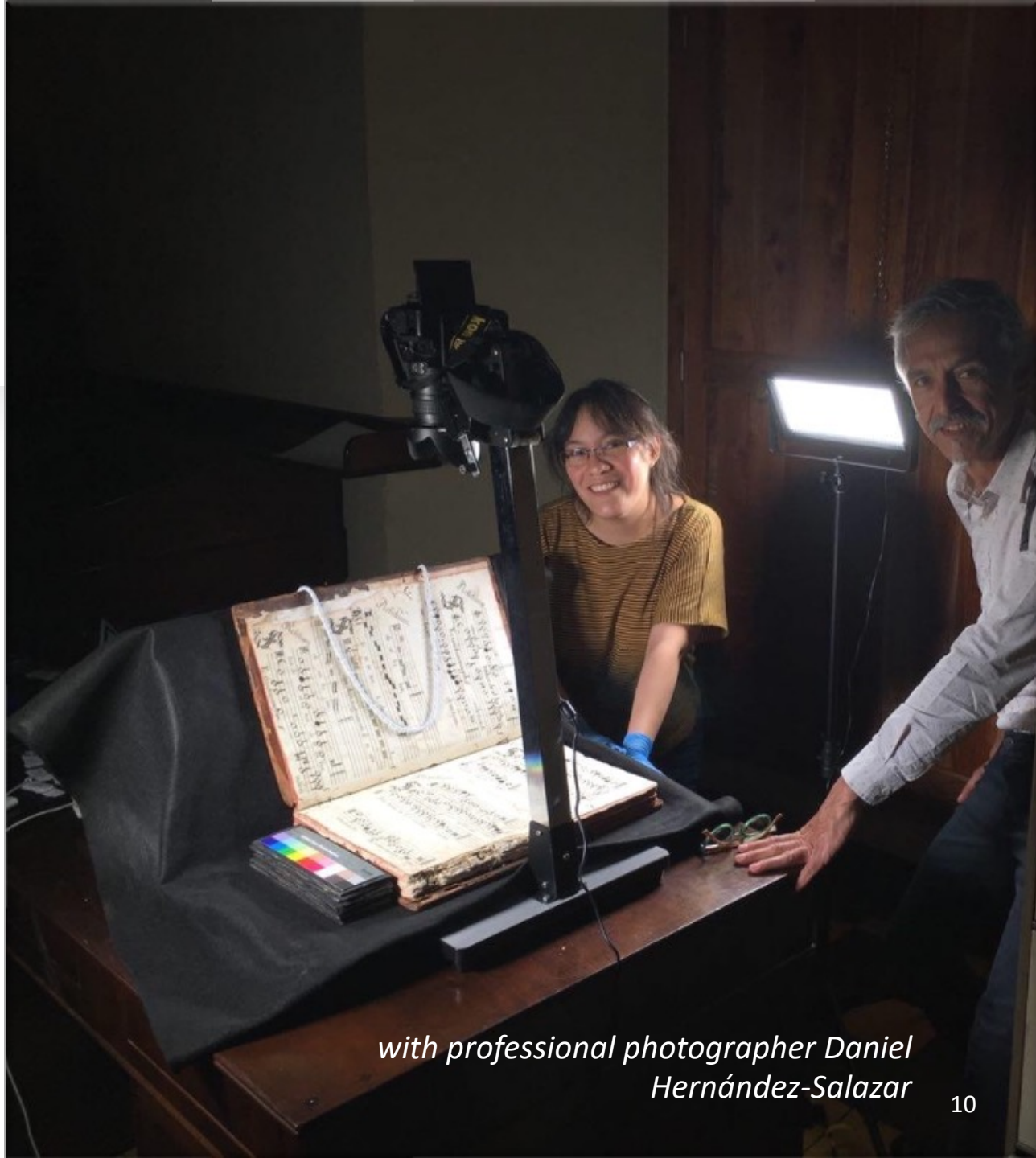


Digital image

Technology Used

DIY Book Scanner

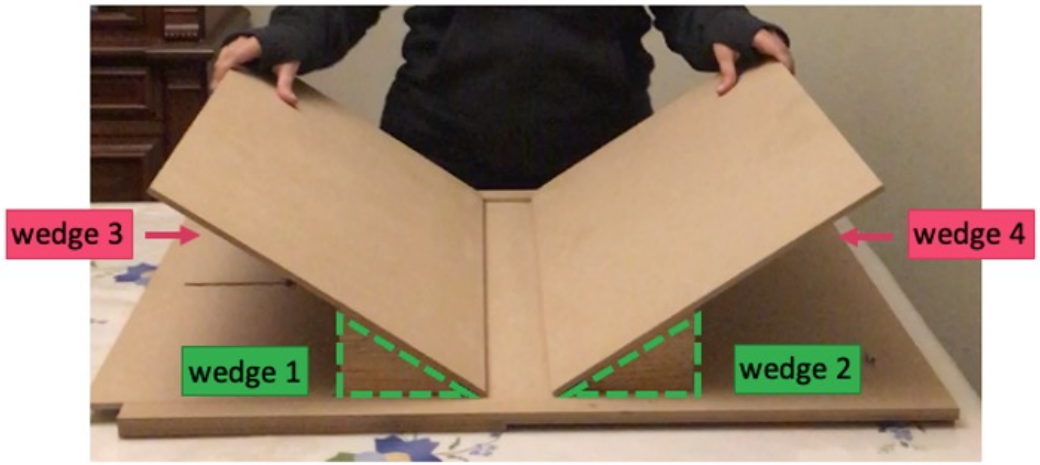
- Advice from various institutions including the *Digital Image Archive of Medieval Music* (*DIAMM*)
- With **borrowed** (camera & lights) and **built** parts (cradle)

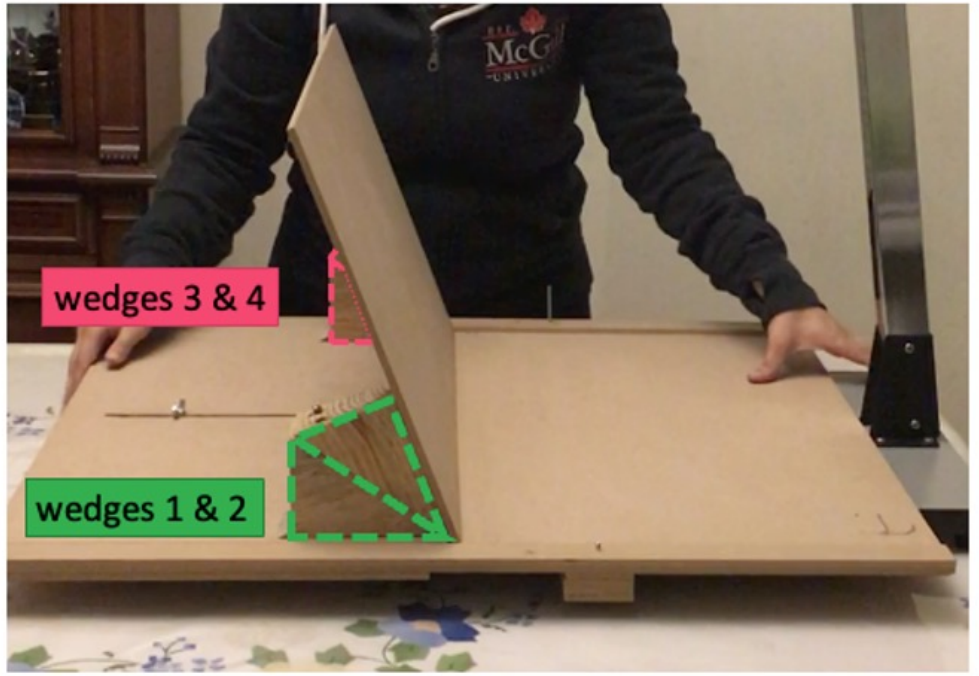


with professional photographer Daniel Hernández-Salazar

Technology Used

Book Cradle Configurations



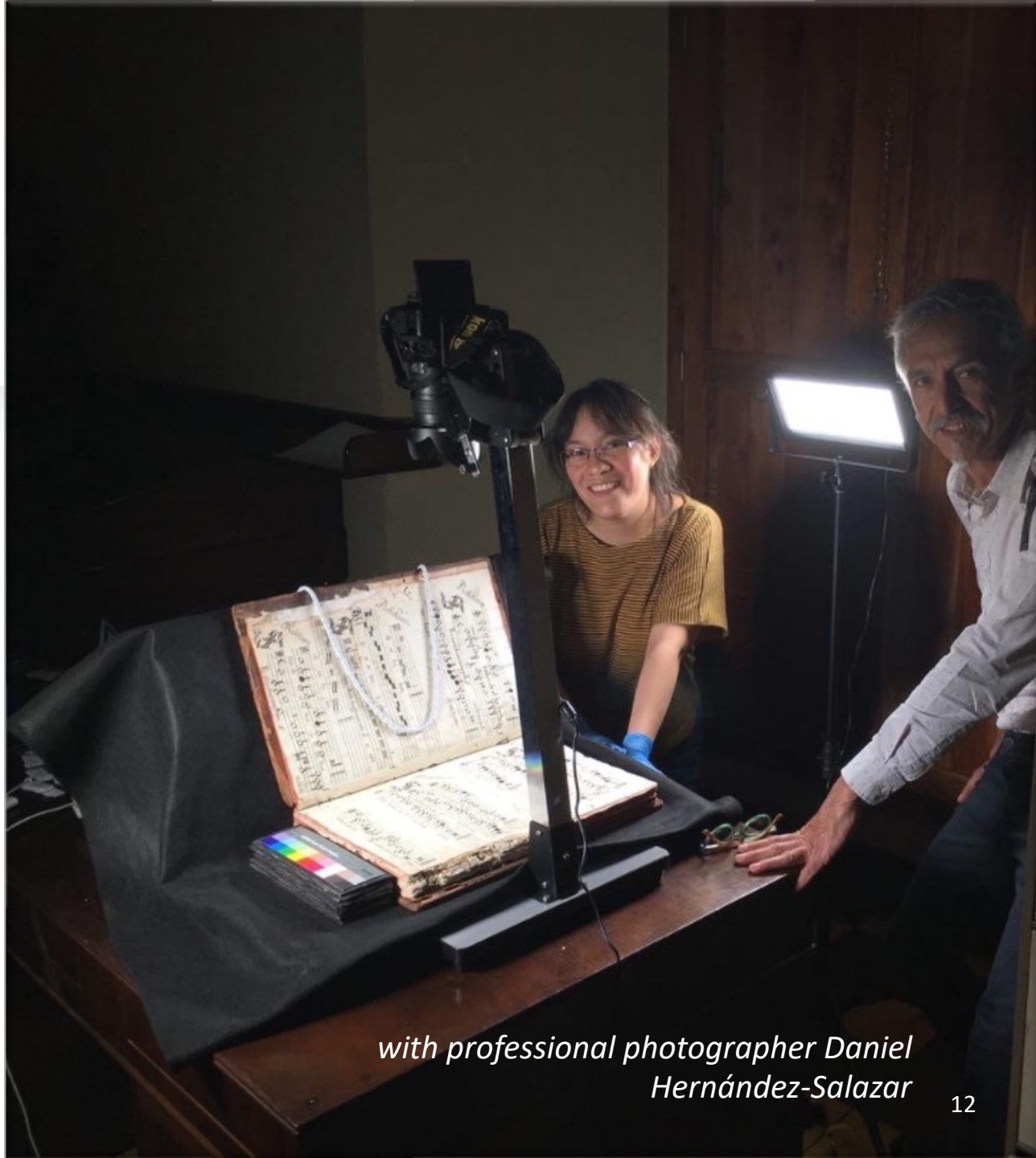


German Thomae

Digitization Stage

AFFORDABLE

- **Equipment:** Do-it-yourself (DIY) book scanner
- **Conservation task:** Outsourced to non-profit institution
- **Digitization task:** Conducted by me with a professional photographer hired for a few of sessions (setting camera parameters)



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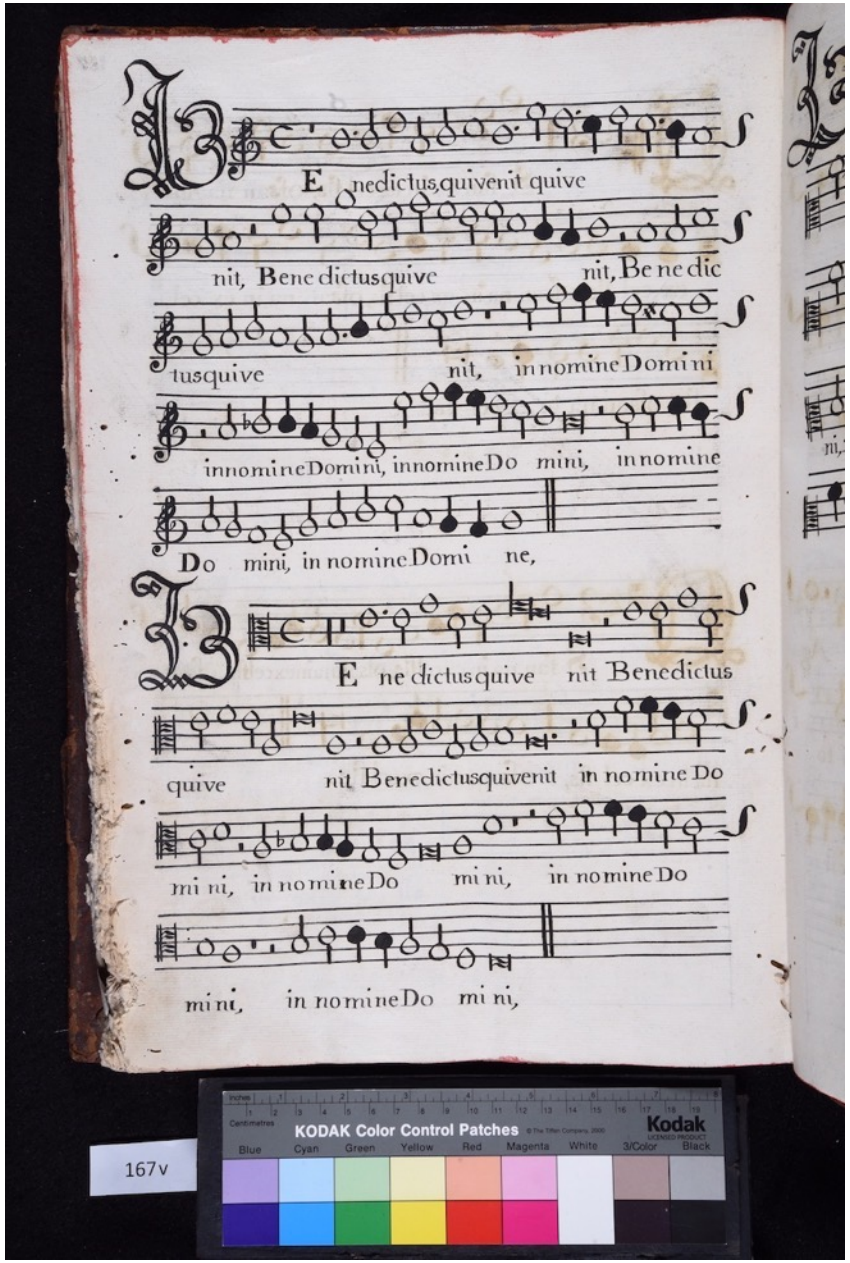
Results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Benedictusquive nit Benedictus
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nit Benedictusquivenit in nomine Do
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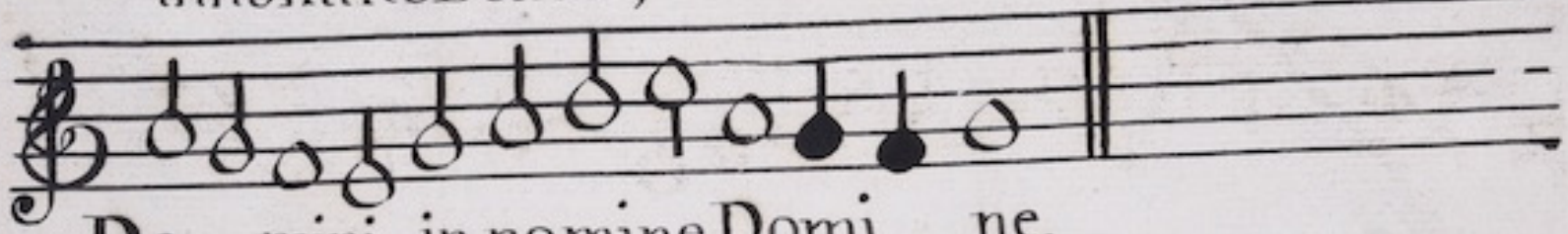
innomineDomini, innomineDo mini, innomine



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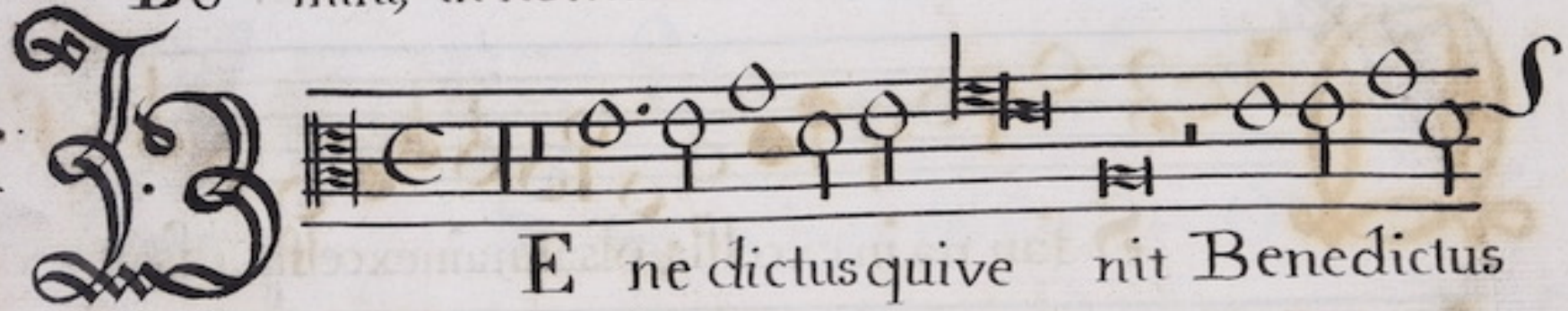

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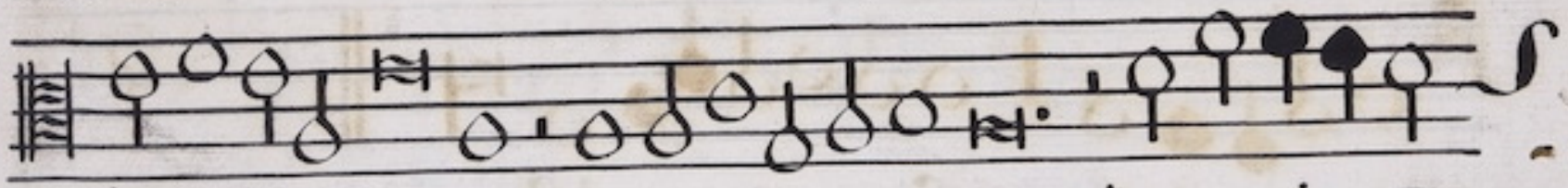

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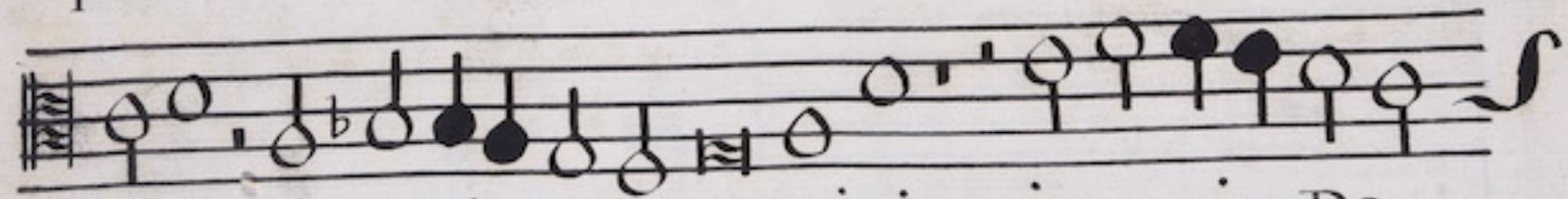
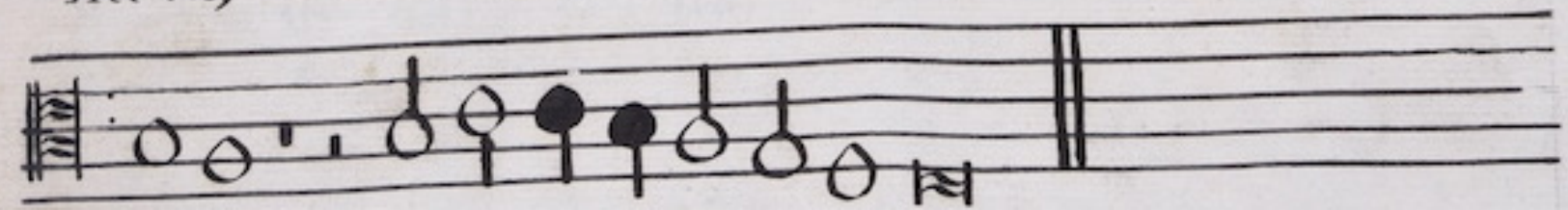


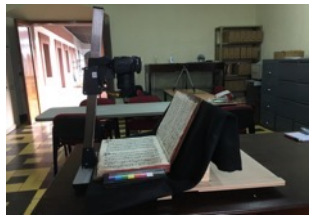
mi ni, in nomineDo mi ni, in nomineDo



Optical Music Recognition (OMR)

MuRET (Music Recognition Encoding and Transcription)

Digitization



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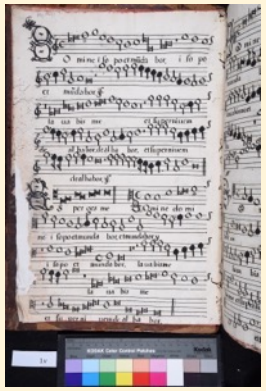

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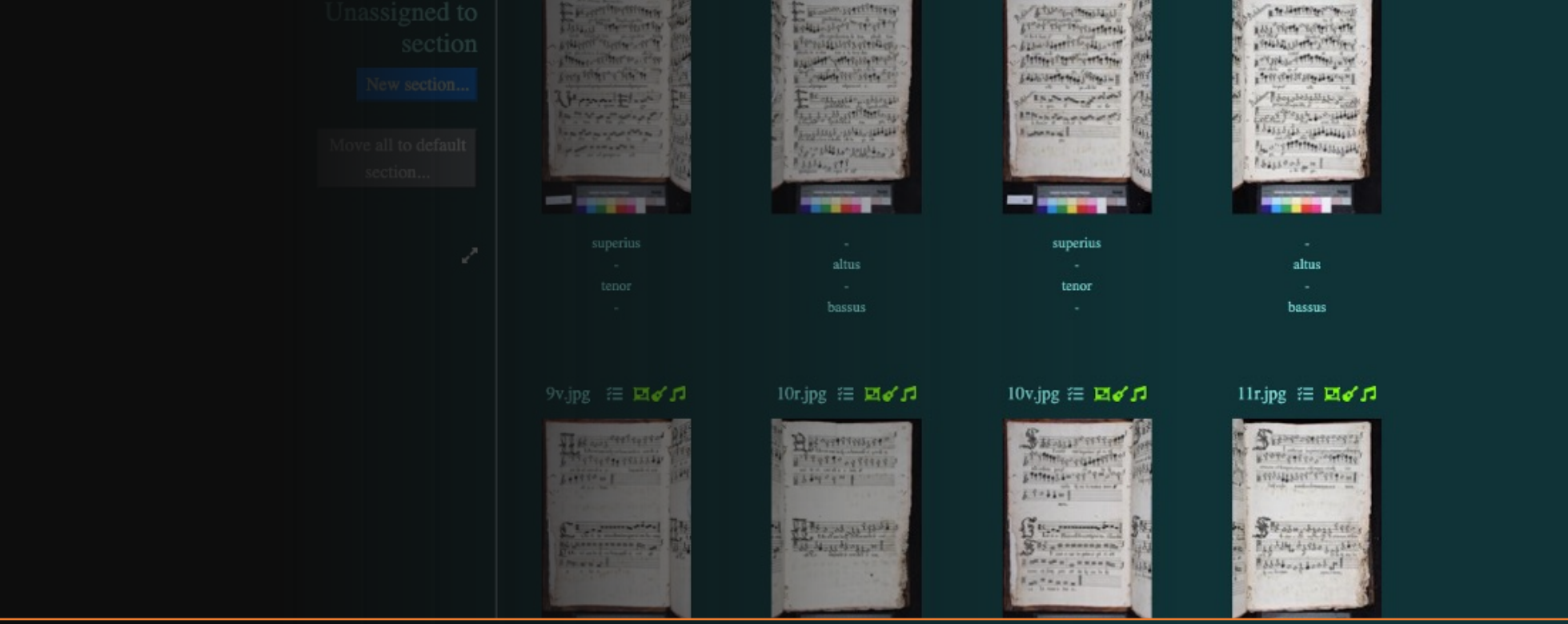

MuRET

Optical music recognition framework that supports mensural notation

MURET

Music Recognition, encoding, and transcription

Developed by David Rizo, University of Alicante

MURET

Guatemala / 3 Vidi aquam

Logout as **martha**

Document overview

Right click on selected images for further exporting and part linking

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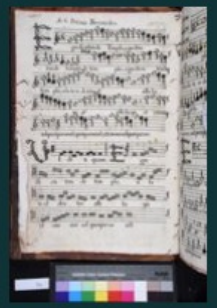
7v.jpg



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tenor
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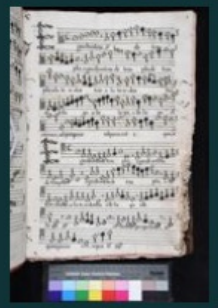

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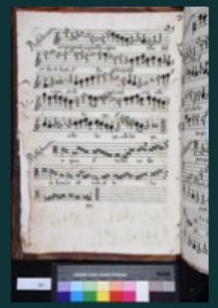

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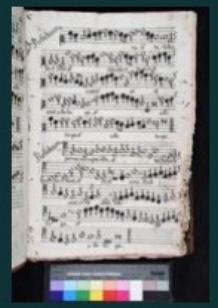

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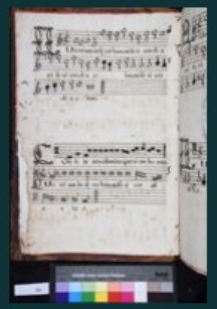

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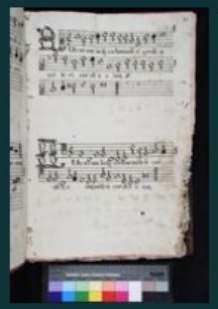

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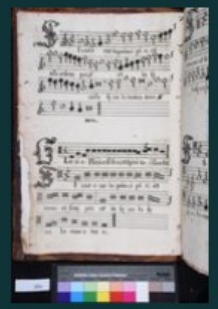

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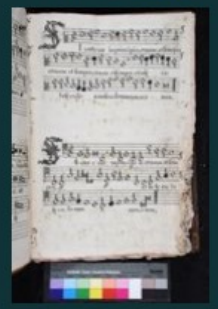

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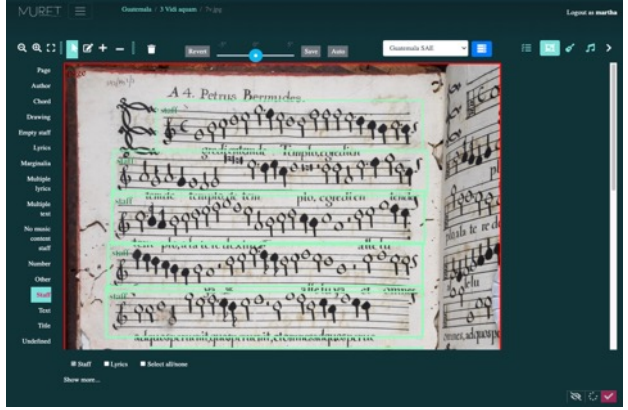

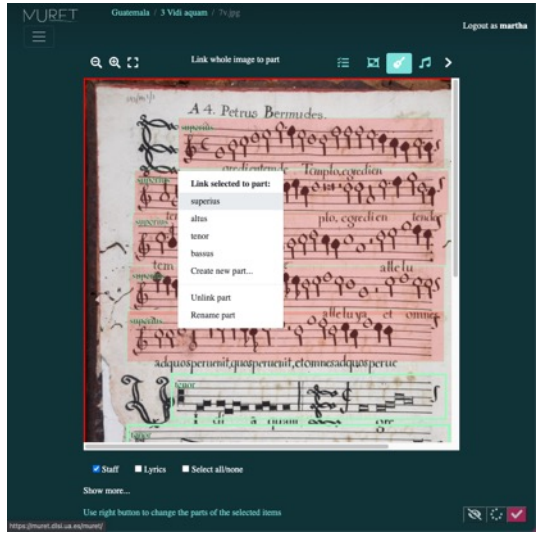

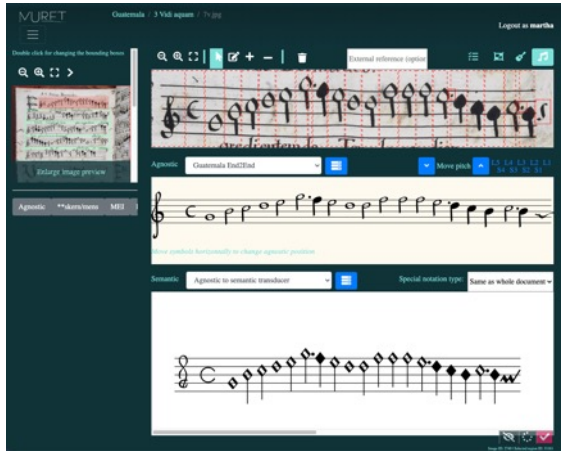

Revert -5° 0° 5° Save Auto Guatemala SAE

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Author
Chord
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Empty staff
Lyrics
Marginalia
Multiple lyrics
Multiple text
No music content staff
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Staff
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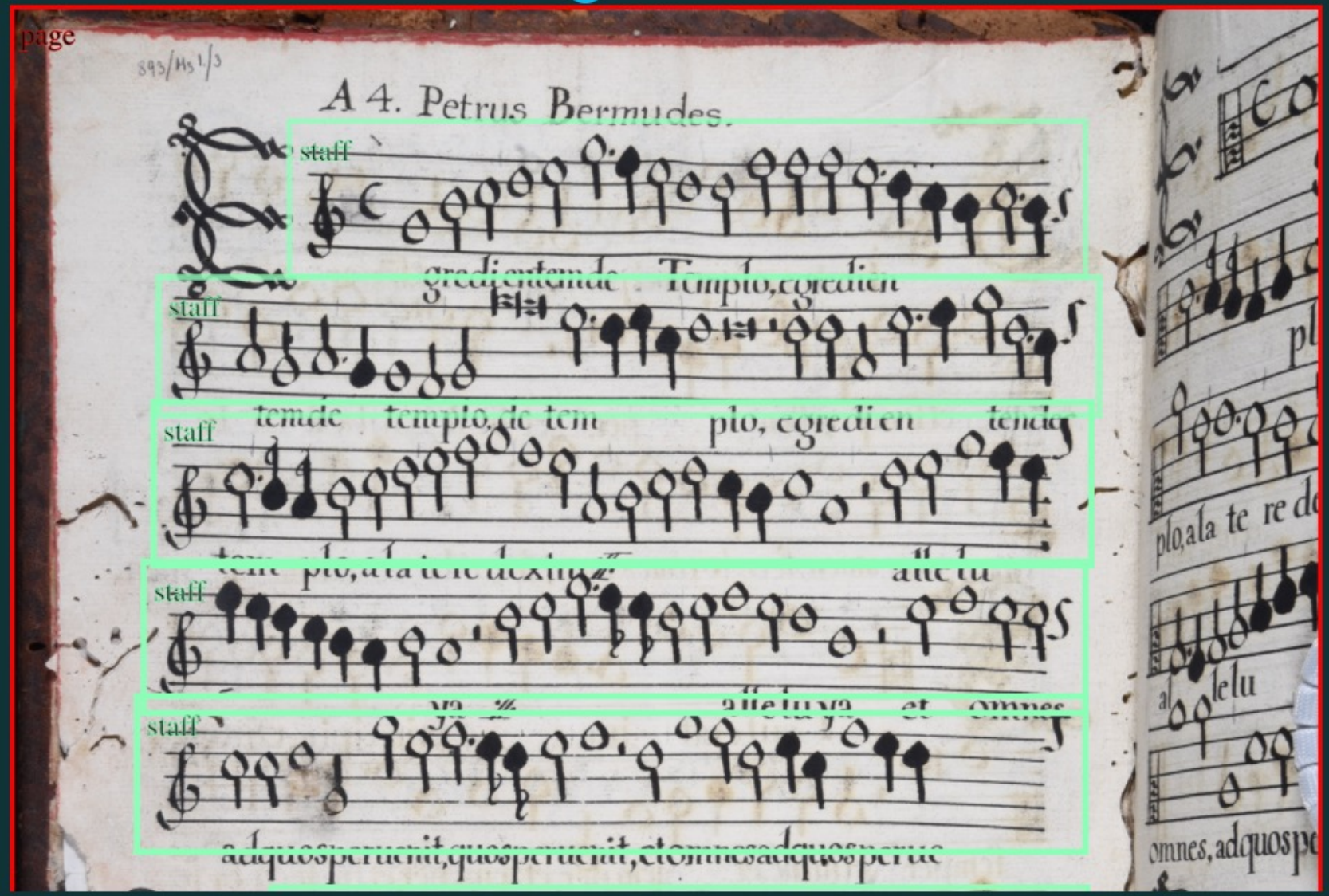
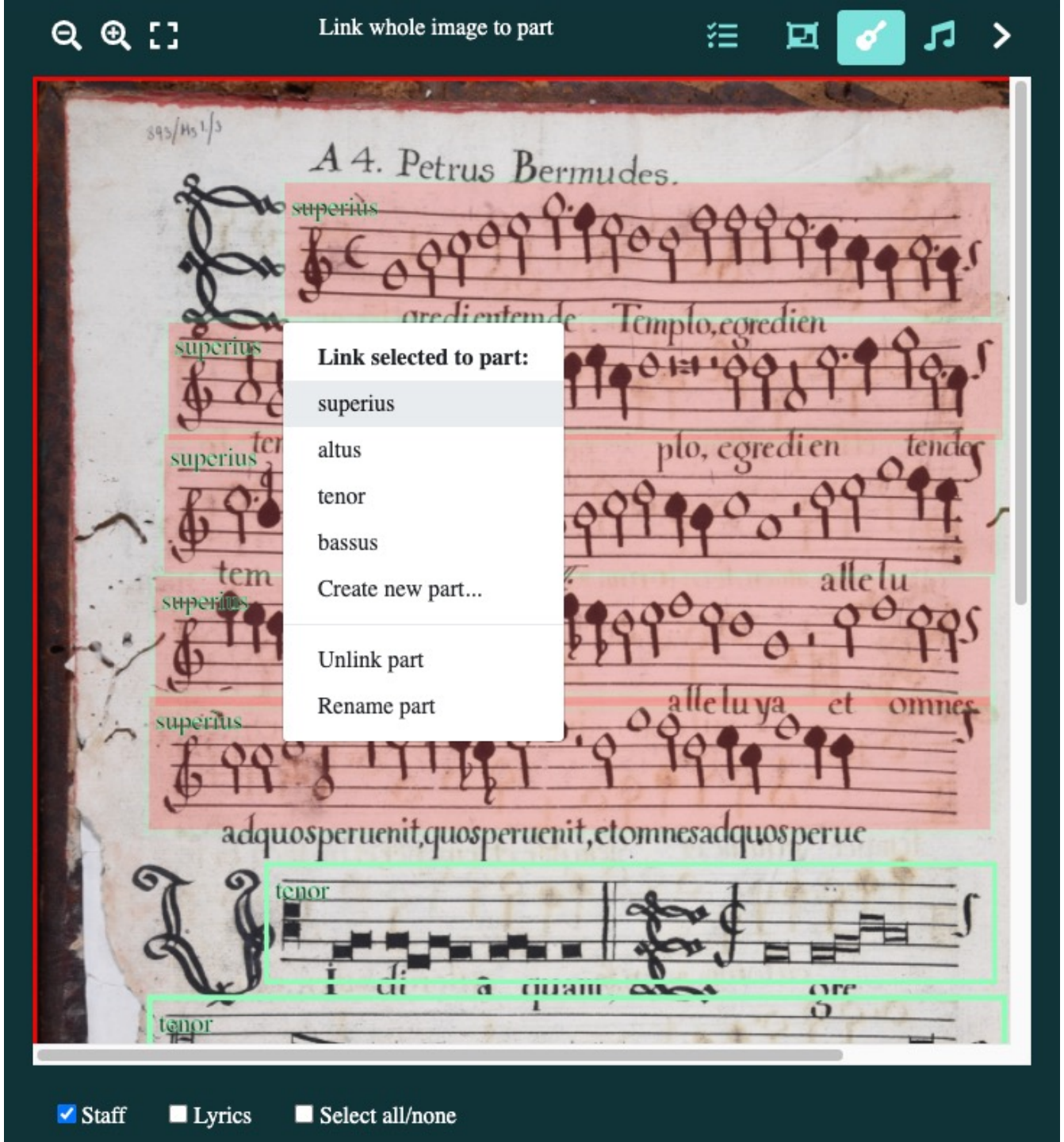


Staff Lyrics Select all/none


Link whole image to part
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superius
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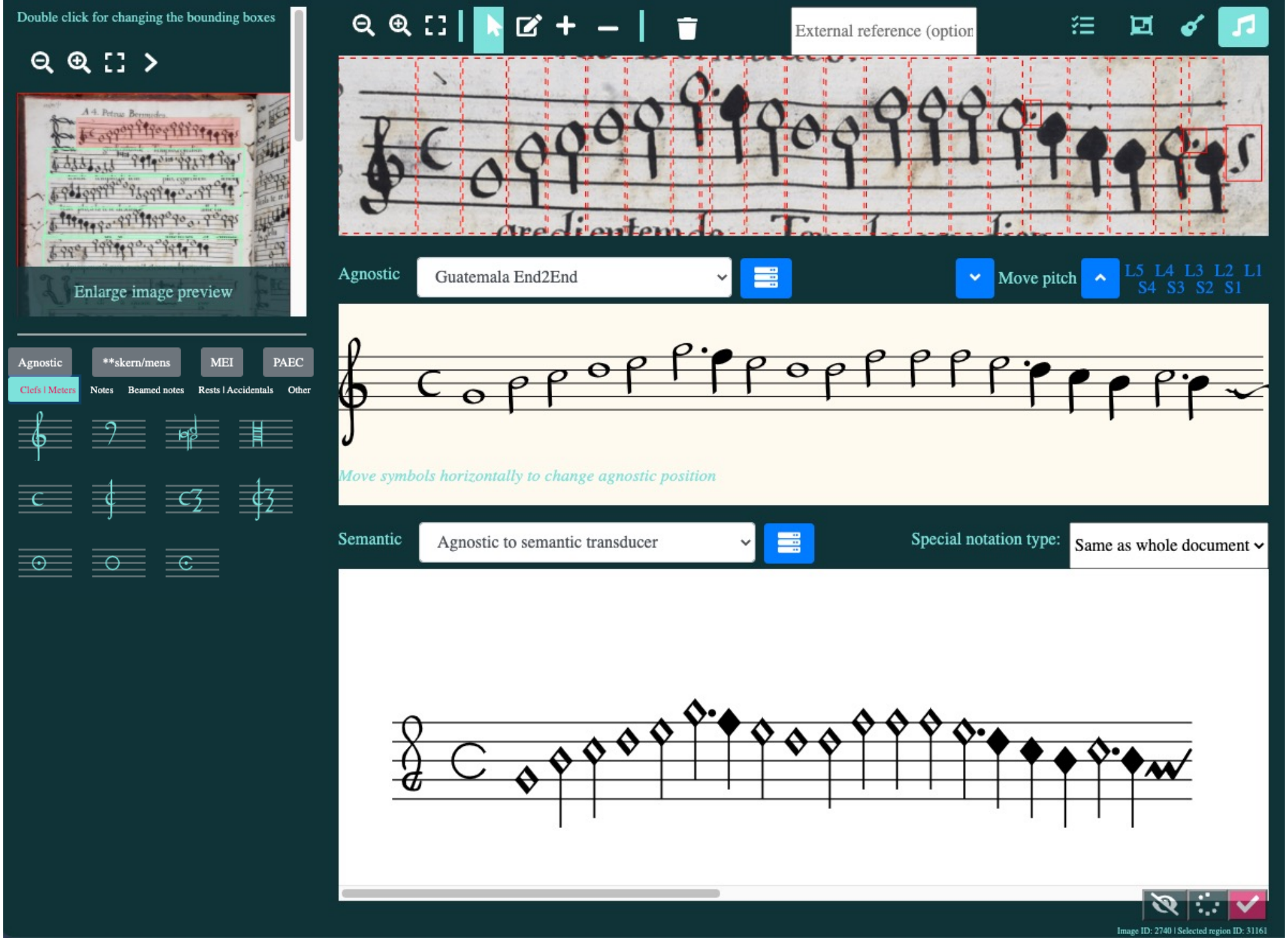
tenor
bassus
Create new part...
Unlink part
Rename part
Staff
Lyrics
Select all/none


Double click for changing the bounding boxes
Enlarge image preview
Agnostic
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MEI
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Clefs | Meters
Notes
Beamed notes
Rests | Accidentals
Other
External reference (optior
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Guatemala End2End
Move pitch
L5 L4 L3 L2 L1
S4 S3 S2 S1
Move symbols horizontally to change agnostic position
Semantic
Agnostic to semantic transducer
Special notation type:
Same as whole document
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MURET

Guatemala / 3 Vidi aquam

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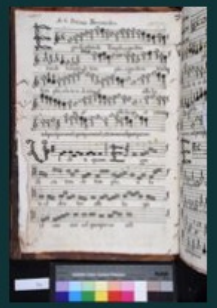

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-
tenor
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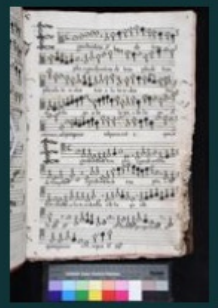
8r.jpg



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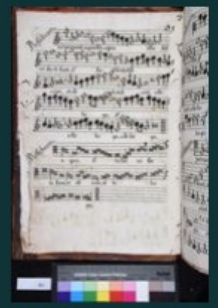

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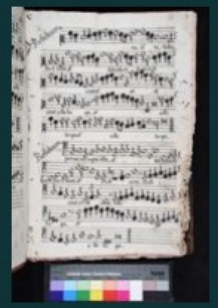

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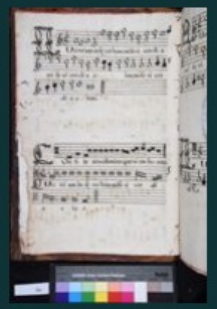

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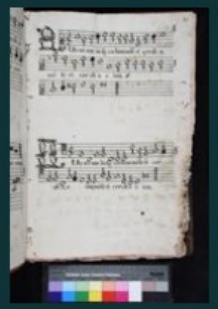

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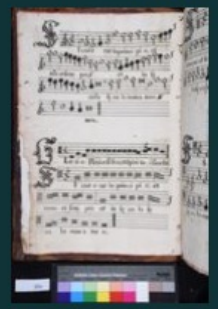

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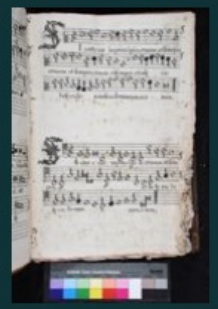
11r.jpg



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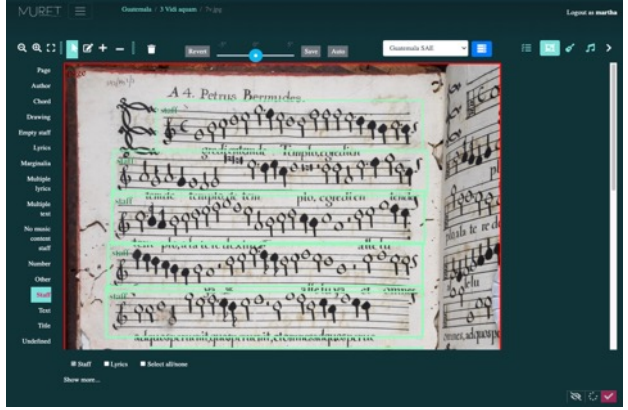
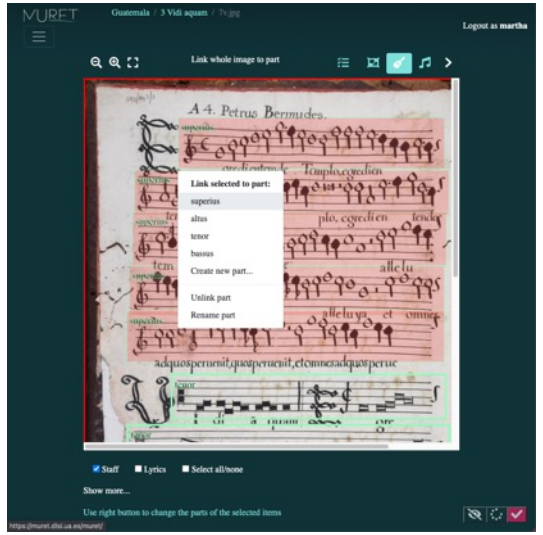
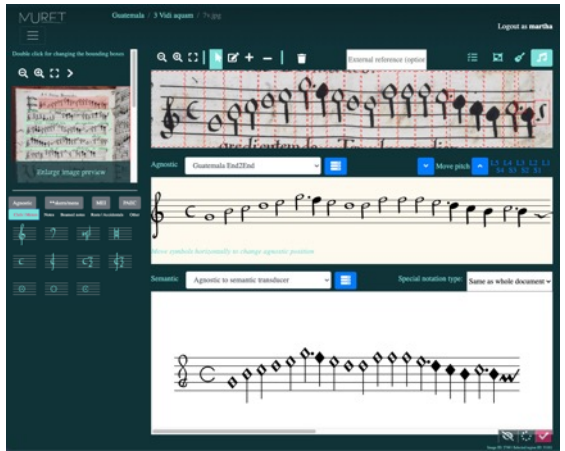






MURET

Guatemala / 3 Vidi aquam

Logout as **martha**

Document overview

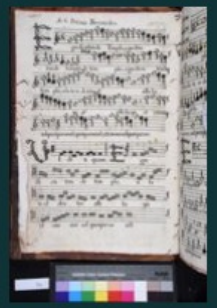
Right click on selected images for further exporting and part linking

Unassigned to section

New section...

Move all to default section...

7v.jpg



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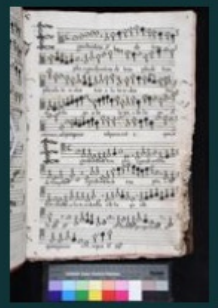

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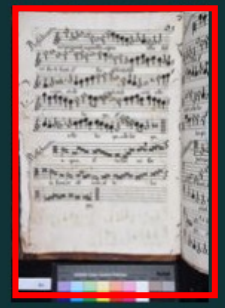

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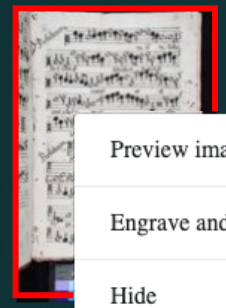

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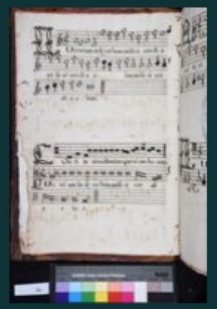

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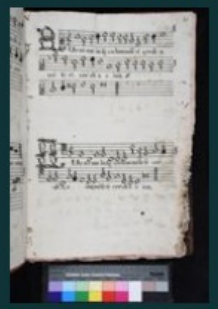

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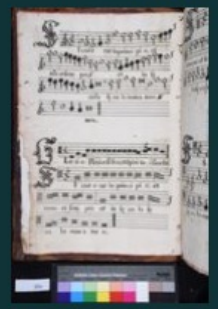
10v.jpg



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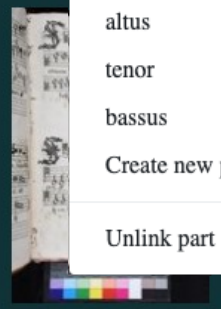
11r.jp



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altus
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bassus

Automatic Voice Alignment & Editorial Correction

Measuring Polyphony Editor (MP-Editor)

Digitization

Optical music recognition (OMR)

Automatic voice alignment & editorial correction

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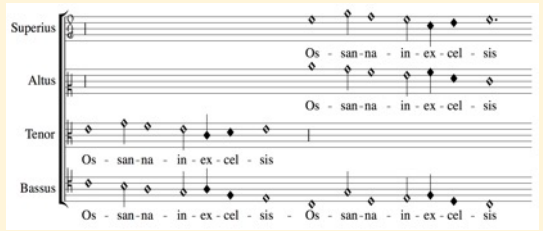
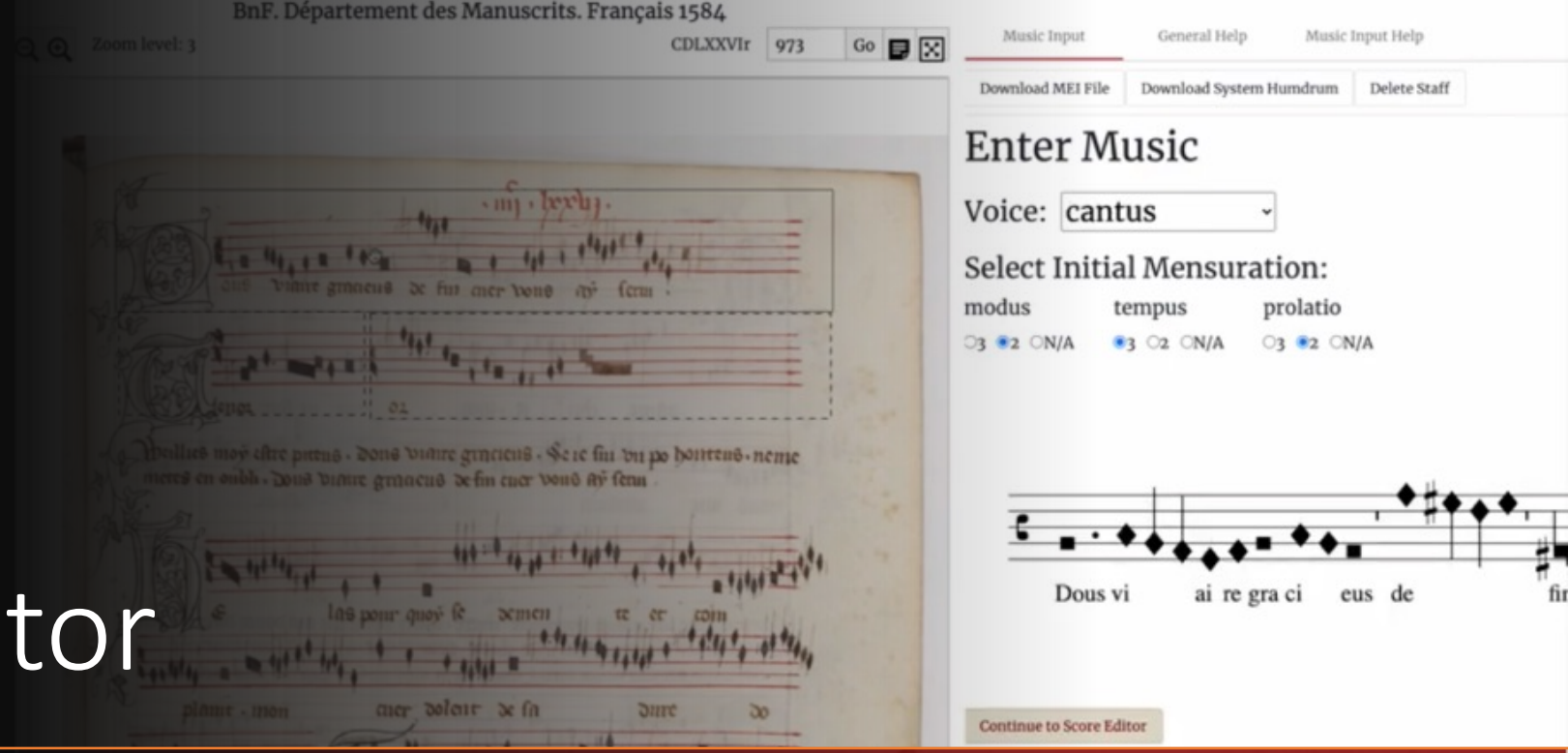
encodes the **symbols** in each **part/voice** of the images



MEI Score file
interpreted durations
(i.e., *alteration* & *imperfection*)

Measuring Polyphony Editor

Online editor for mensural notation

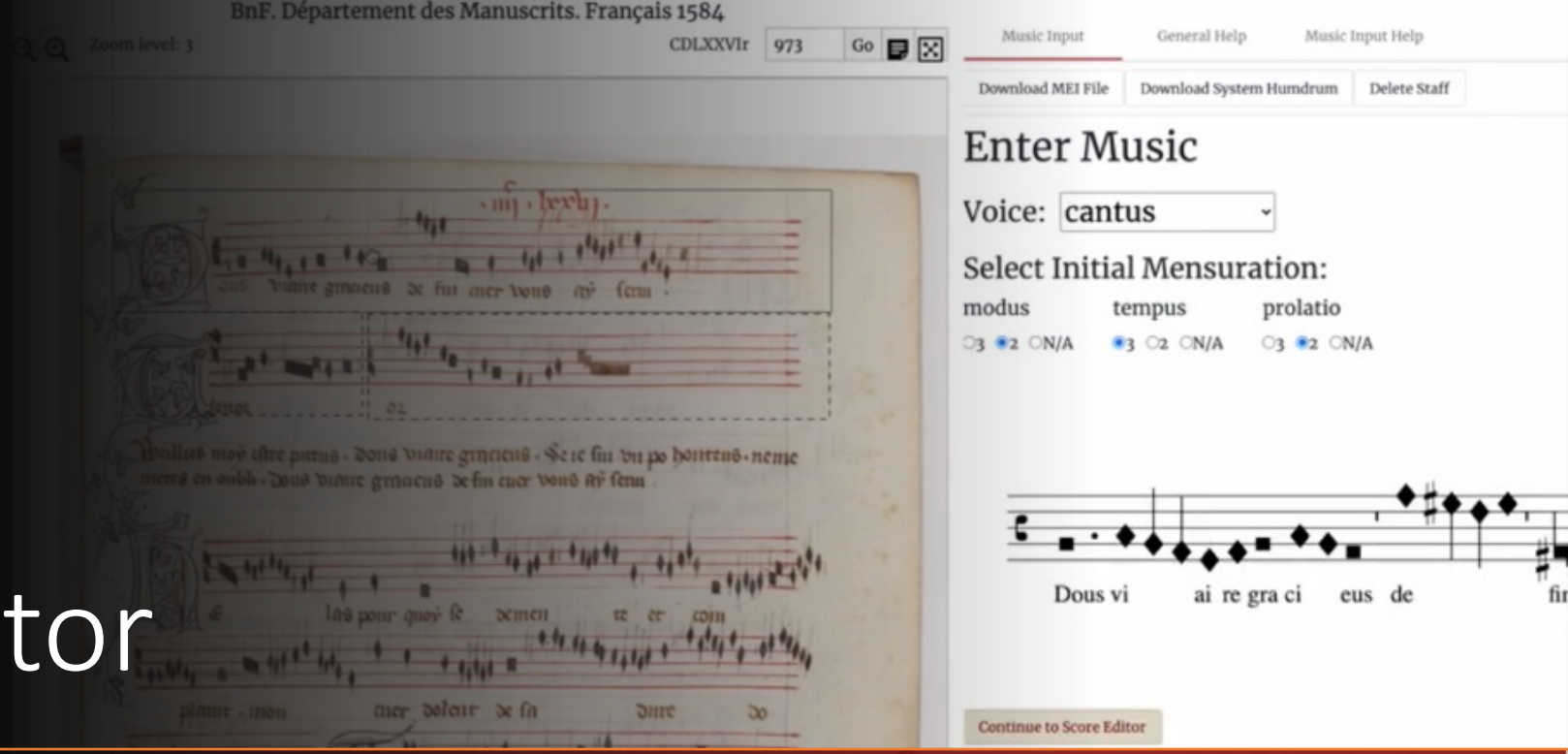


Karen Desmond (PI), Brandeis University

MEASURING POLYPHONY

DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC

Measuring Polyphony Editor



Online editor for mensural notation

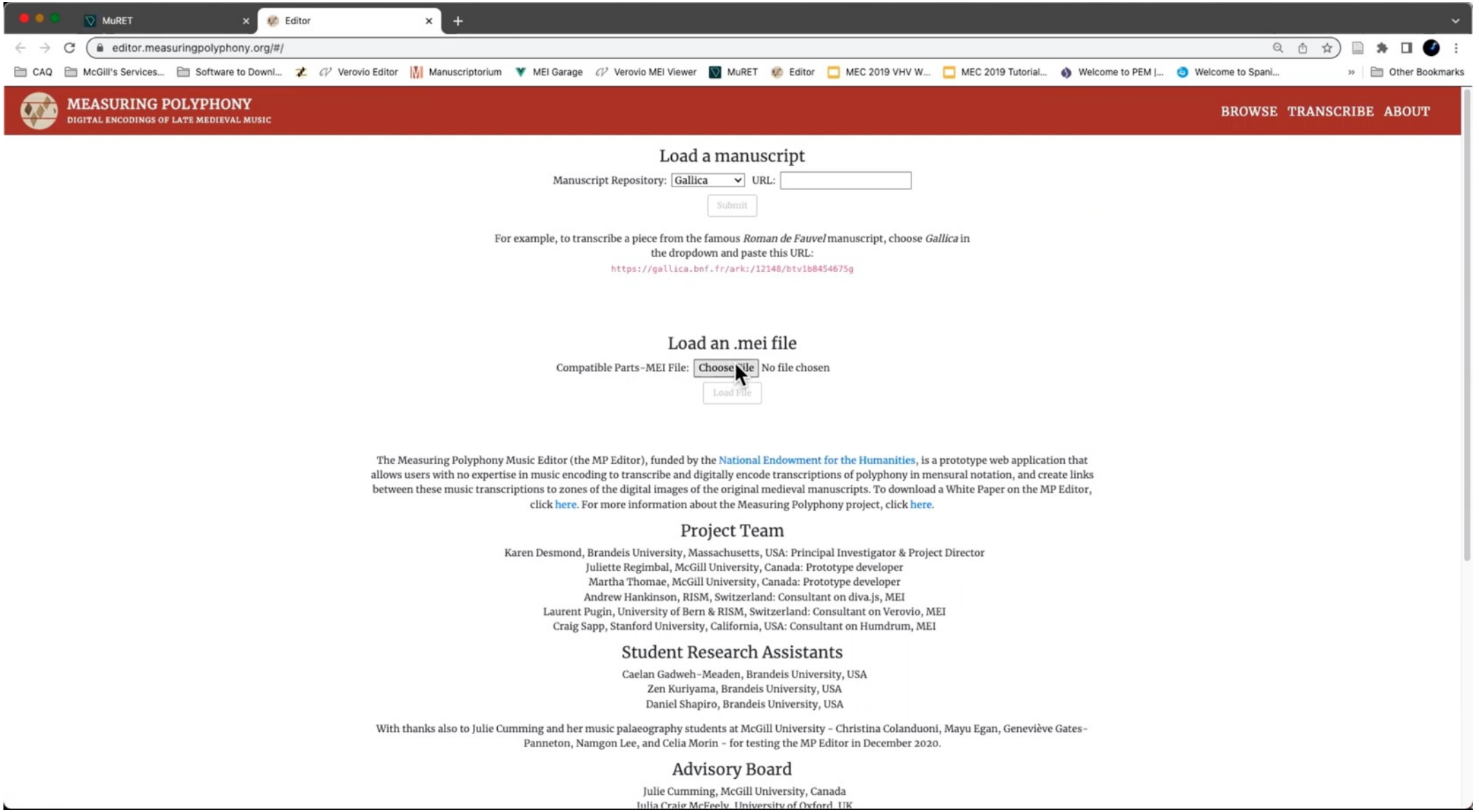
Mostly developed at McGill University:

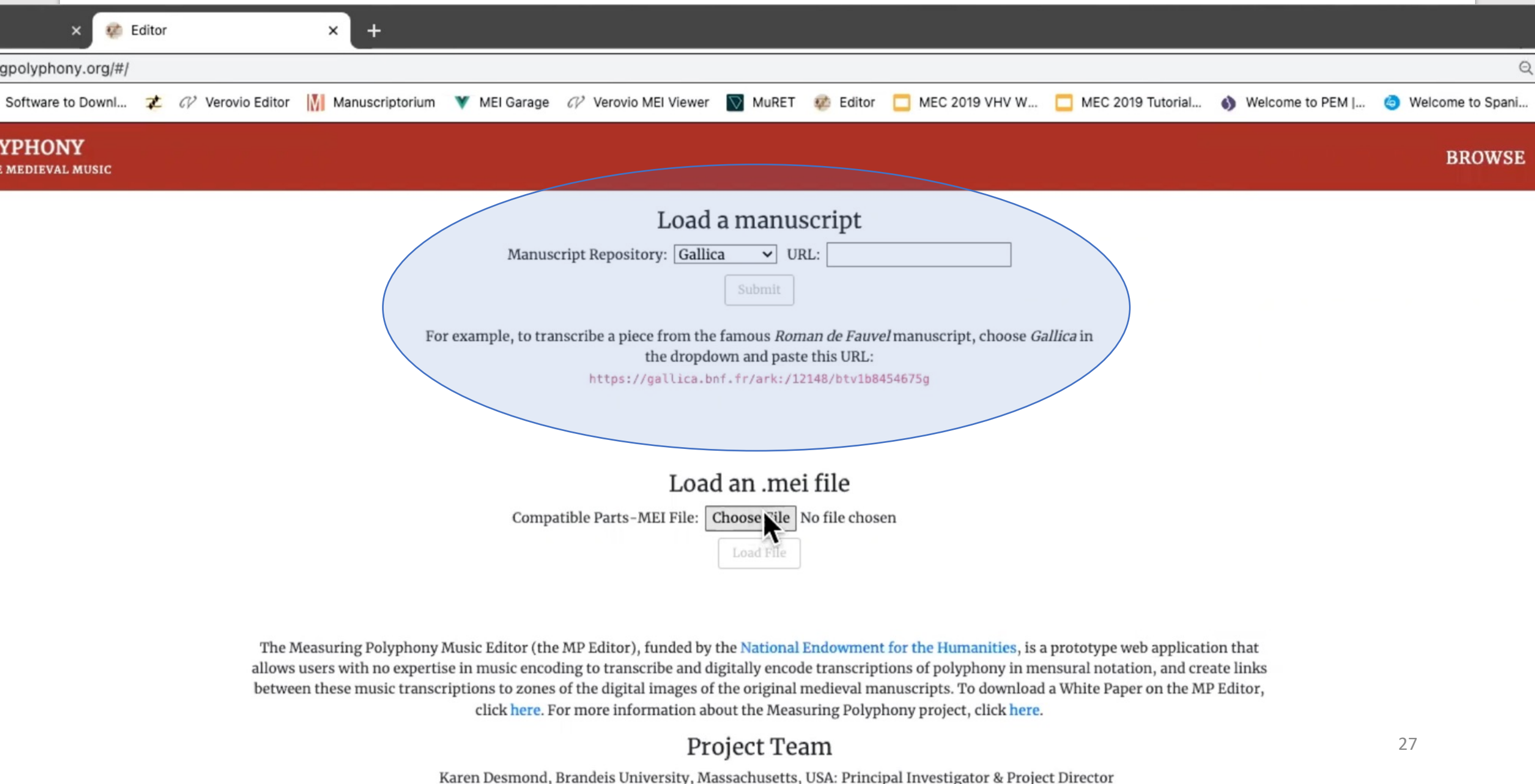
- **Juliette Regimbal** (lead developer)
- **Martha E. Thomae** (automatic voice alignment function)

And with **Laurent Pugin** (Verovio), **Craig Sapp** (Humdrum), and **Andrew Hankinson** (IIIF)

MEASURING POLYPHONY

DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC


MuRET
Editor
editor.measuringpolyphony.org/#/
CAQ
McGill's Services...
Software to Downl...
Verovio Editor
Manuscriptorium
MEI Garage
Verovio MEI Viewer
MuRET
Editor
MEC 2019 VHV W...
MEC 2019 Tutorial...
Welcome to PEM |...
Welcome to Spani...
Other Bookmarks
MEASURING POLYPHONY
DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC
BROWSE TRANSCRIBE ABOUT
Load a manuscript
Manuscript Repository: Gallica URL:
Submit
For example, to transcribe a piece from the famous Roman de Fauvel manuscript, choose Gallica in the dropdown and paste this URL:
https://gallica.bnf.fr/ark:/12148/btv1b8454675g
Load an .mei file
Compatible Parts-MEI File: Choose File No file chosen
Load File
The Measuring Polyphony Music Editor (the MP Editor), funded by the National Endowment for the Humanities, is a prototype web application that allows users with no expertise in music encoding to transcribe and digitally encode transcriptions of polyphony in mensural notation, and create links between these music transcriptions to zones of the digital images of the original medieval manuscripts. To download a White Paper on the MP Editor, click here. For more information about the Measuring Polyphony project, click here.
Project Team
Karen Desmond, Brandeis University, Massachusetts, USA: Principal Investigator & Project Director
Juliette Regimbal, McGill University, Canada: Prototype developer
Martha Thomae, McGill University, Canada: Prototype developer
Andrew Hankinson, RISM, Switzerland: Consultant on diva.js, MEI
Laurent Pugin, University of Bern & RISM, Switzerland: Consultant on Verovio, MEI
Craig Sapp, Stanford University, California, USA: Consultant on Humdrum, MEI
Student Research Assistants
Caelan Gadweh-Meaden, Brandeis University, USA
Zen Kuriyama, Brandeis University, USA
Daniel Shapiro, Brandeis University, USA
With thanks also to Julie Cumming and her music palaeography students at McGill University - Christina Colanduoni, Mayu Egan, Geneviève Gates-Panneton, Namgon Lee, and Celia Morin - for testing the MP Editor in December 2020.
Advisory Board
Julie Cumming, McGill University, Canada
Julia Craig McFeely, University of Oxford, UK


Editor
gpolyphony.org/#/
Software to Downl...
Verovio Editor
Manuscriptorium
MEI Garage
Verovio MEI Viewer
MuRET
Editor
MEC 2019 VHV W...
MEC 2019 Tutorial...
Welcome to PEM |...
Welcome to Spani...
YPHONY
E MEDIEVAL MUSIC
BROWSE
Load a manuscript
Manuscript Repository: Gallica
URL:
Submit
For example, to transcribe a piece from the famous Roman de Fauvel manuscript, choose Gallica in the dropdown and paste this URL:
https://gallica.bnf.fr/ark:/12148/btv1b8454675g
Load an .mei file
Compatible Parts-MEI File: Choose File No file chosen
Load File
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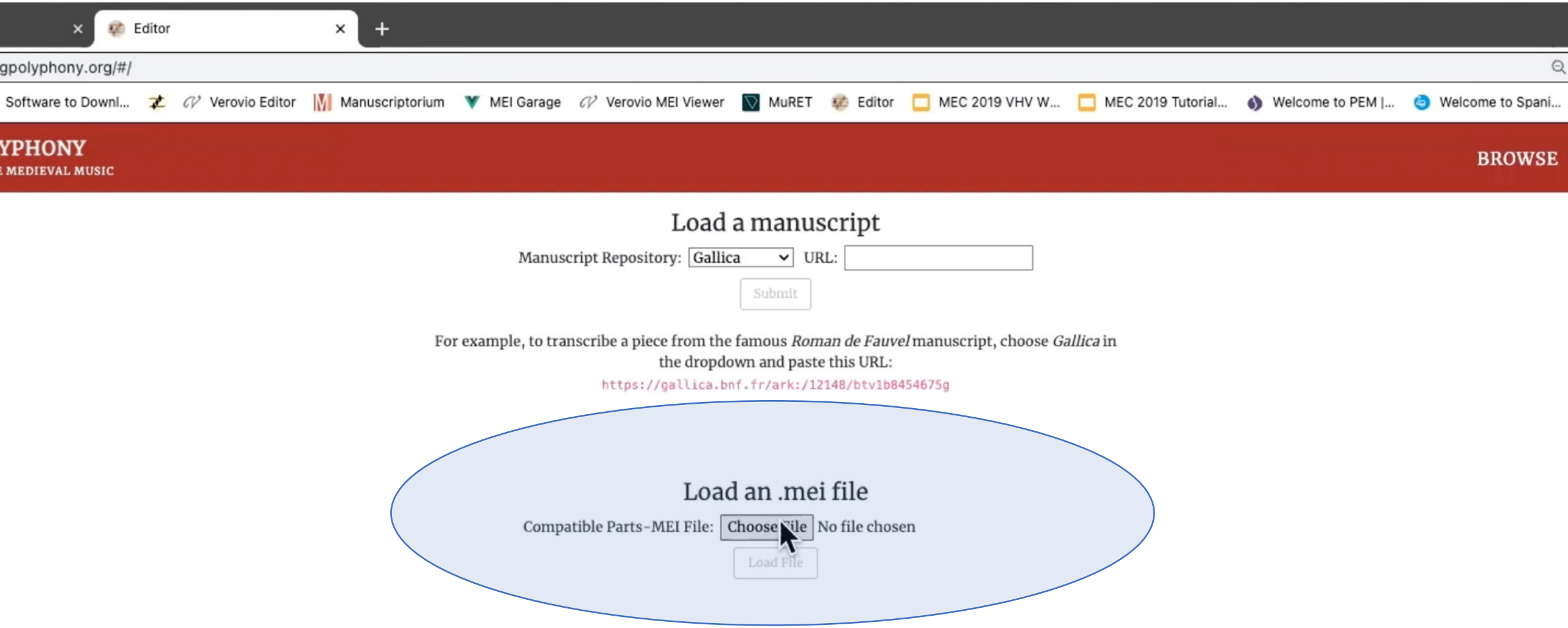
Editor
gpolyphony.org/#/
Software to Downl...
Verovio Editor
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Load a manuscript
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https://gallica.bnf.fr/ark:/12148/btv1b8454675g
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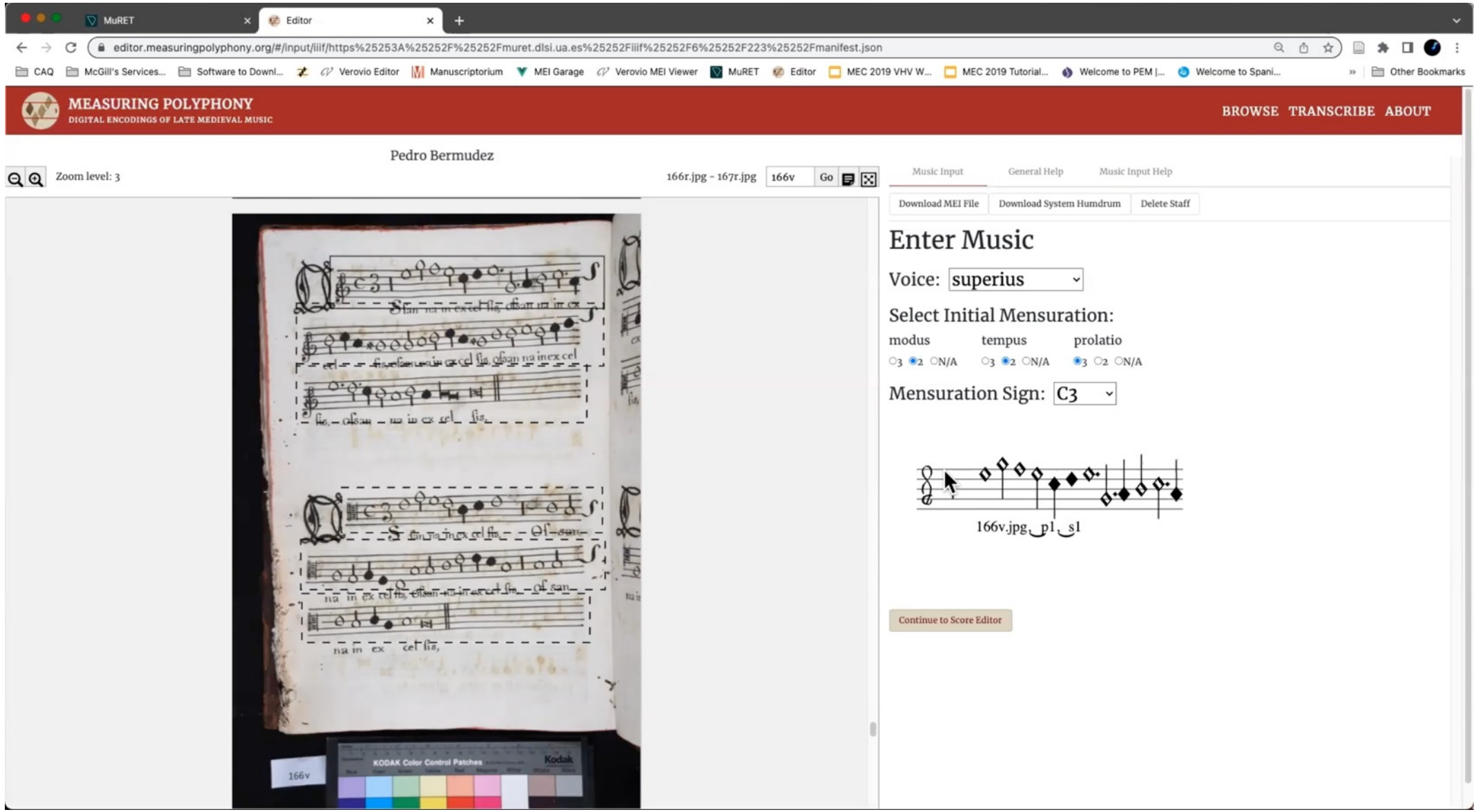
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editor.measuringpolyphony.org/#/input/liif/https%25253A%25252F%25252Fmuret.dlsi.ua.es%25252Fiiif%25252F6%25252F223%25252Fmanifest.json
CAQ
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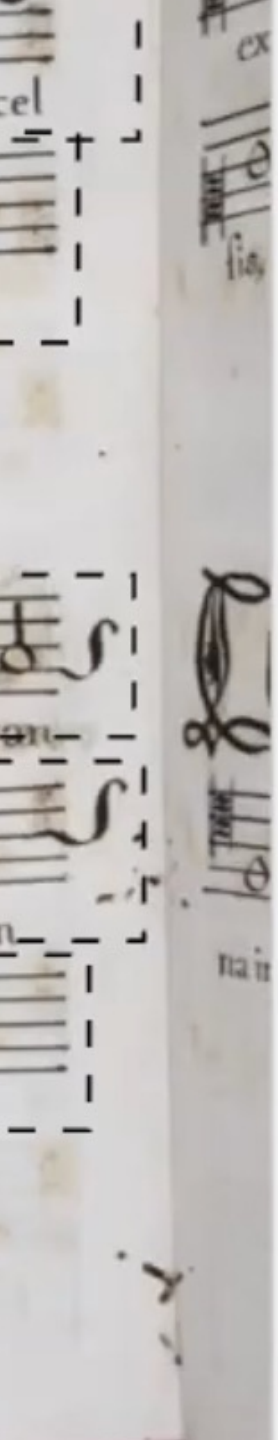
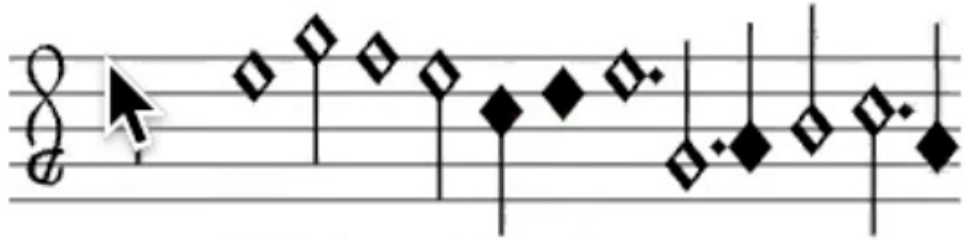
DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC
BROWSE TRANSCRIBE ABOUT
Pedro Bermudez
Zoom level: 3
166r.jpg - 167r.jpg
166v
Go
166v
KODAK Color Control Patches
Kodak
Music Input
General Help
Music Input Help
Download MEI File
Download System Humdrum
Delete Staff
Enter Music
Voice: superius
Select Initial Mensuration:
modus tempus prolatio
O3 O2 ON/A O3 O2 ON/A O3 O2 ON/A
Mensuration Sign: C3
166v.jpg_p1_s1
Continue to Score Editor



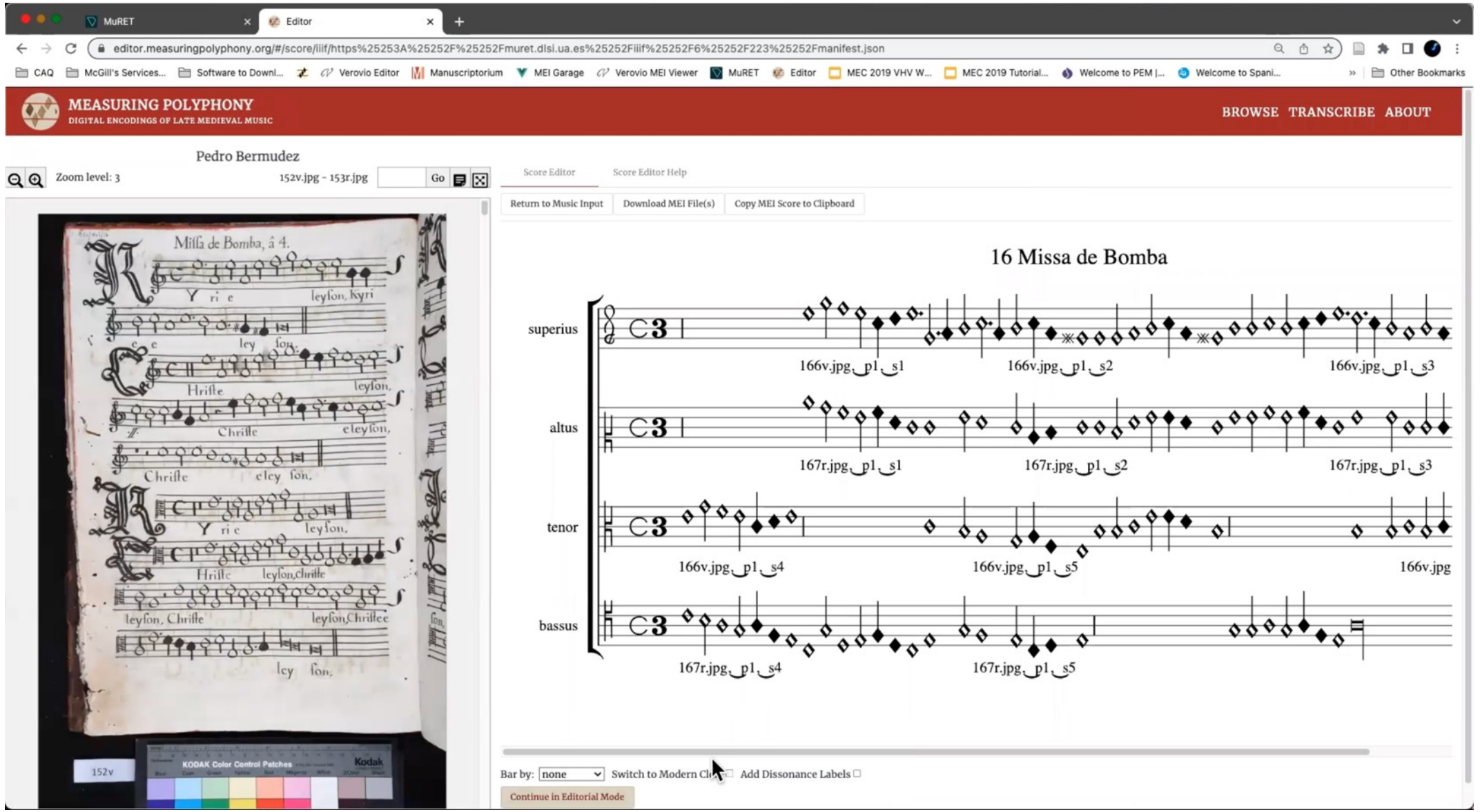
modus	tempus	prolatio
○3 ◉2 ○N/A	○3 ◉2 ○N/A	◉3 ○2 ○N/A

Mensuration Sign: C3



166v.jpg p1 s1

Continue to Score Editor


MuRET
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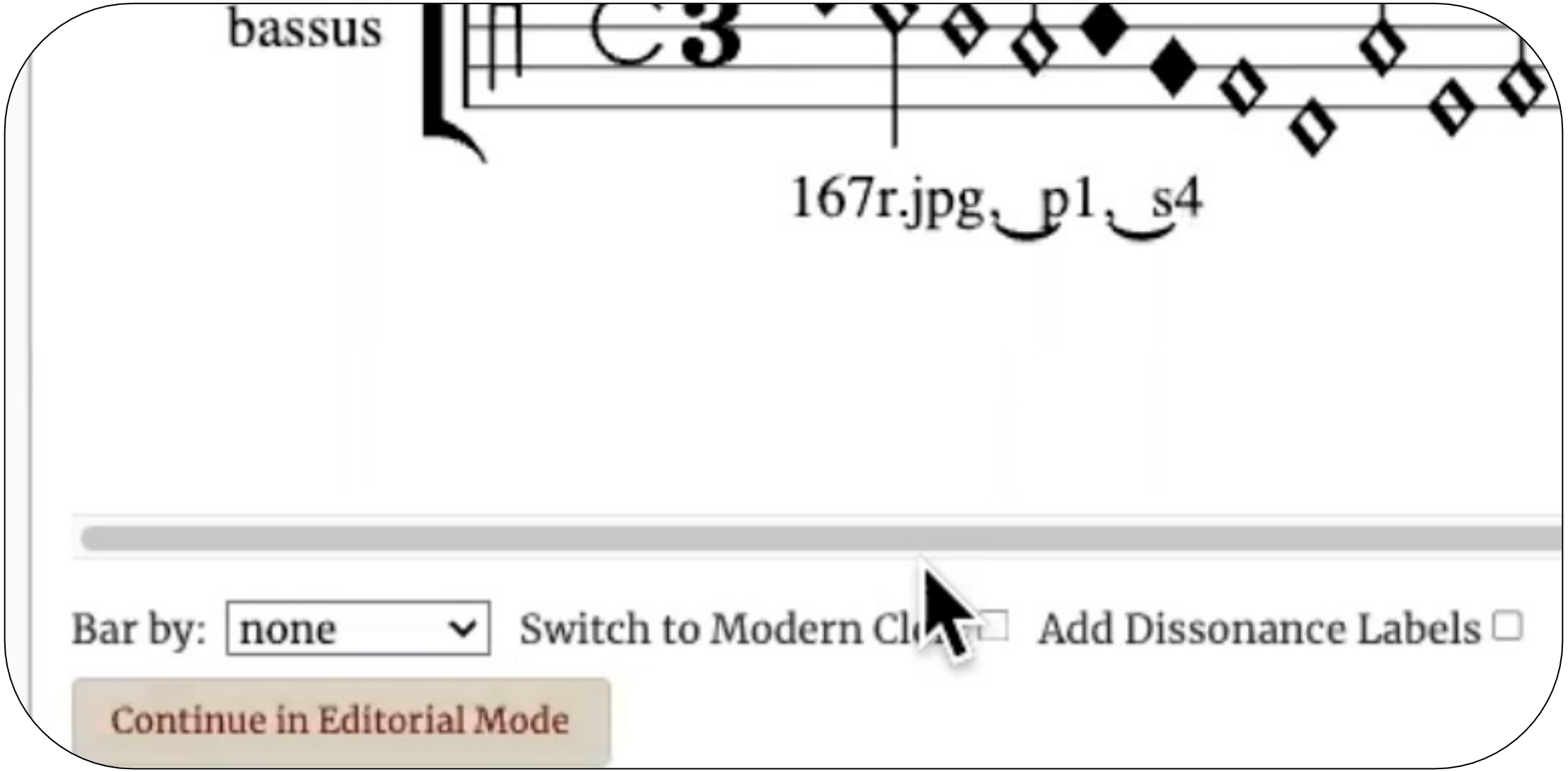
editor.measuringpolyphony.org/#/score/iiif/https%25253A%25252F%25252Fmuret.dlsi.ua.es%25252Fiiif%25252F6%25252F223%25252Fmanifest.json
MEASURING POLYPHONY
DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC
BROWSE TRANSCRIBE ABOUT
Pedro Bermudez
Zoom level: 3
152v.jpg - 153r.jpg
Go
Score Editor
Score Editor Help
Return to Music Input
Download MEI File(s)
Copy MEI Score to Clipboard
16 Missa de Bomba
superius
altus
tenor
bassus
166v.jpg_p1_s1
166v.jpg_p1_s2
166v.jpg_p1_s3
167r.jpg_p1_s1
167r.jpg_p1_s2
167r.jpg_p1_s3
166v.jpg_p1_s4
166v.jpg_p1_s5
166v.jpg
167r.jpg_p1_s4
167r.jpg_p1_s5
Missa de Bomba, â 4.
152v
KODAK Color Control Patches
Bar by: none
Add Dissonance Labels
Continue in Editorial Mode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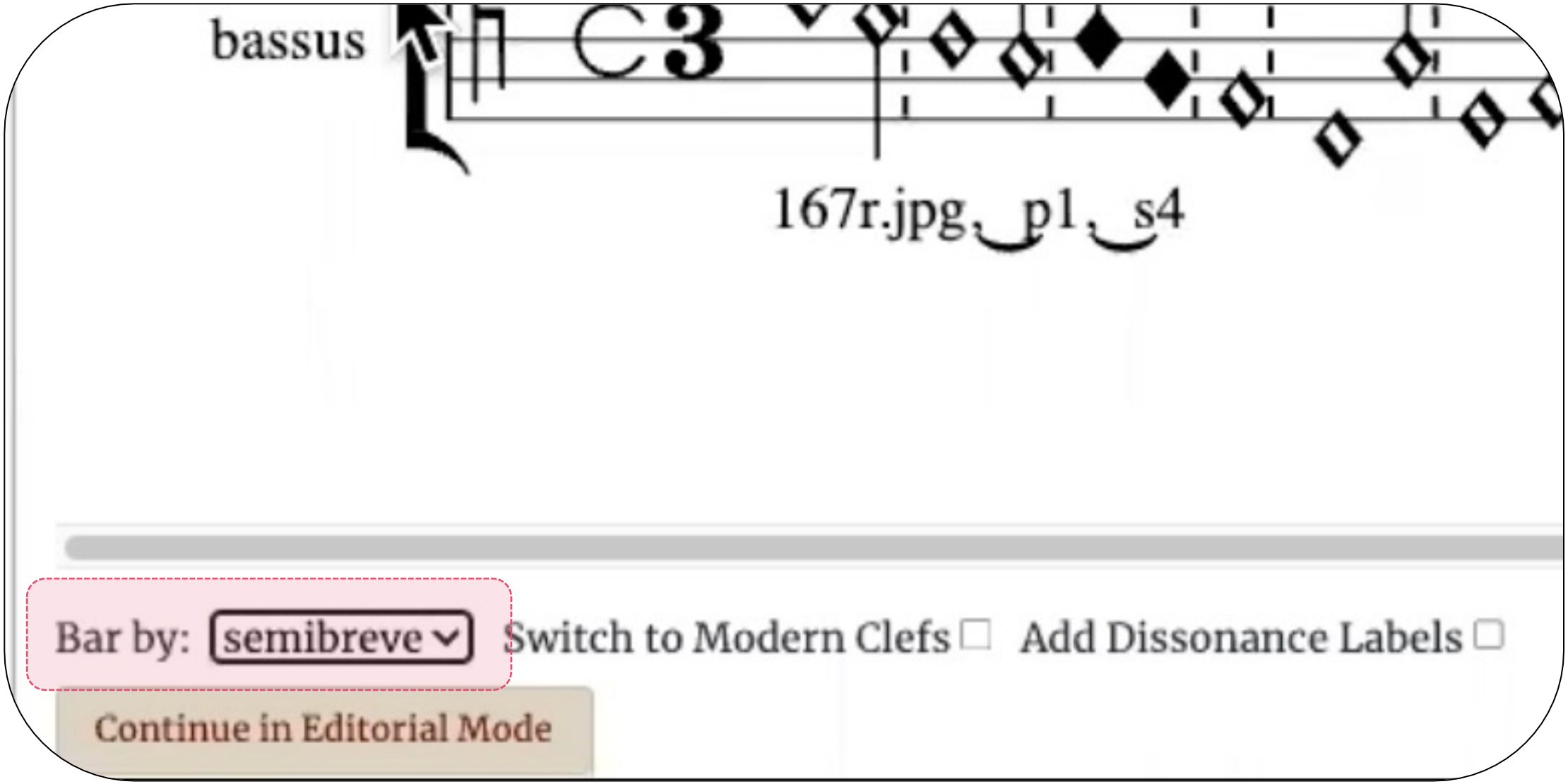
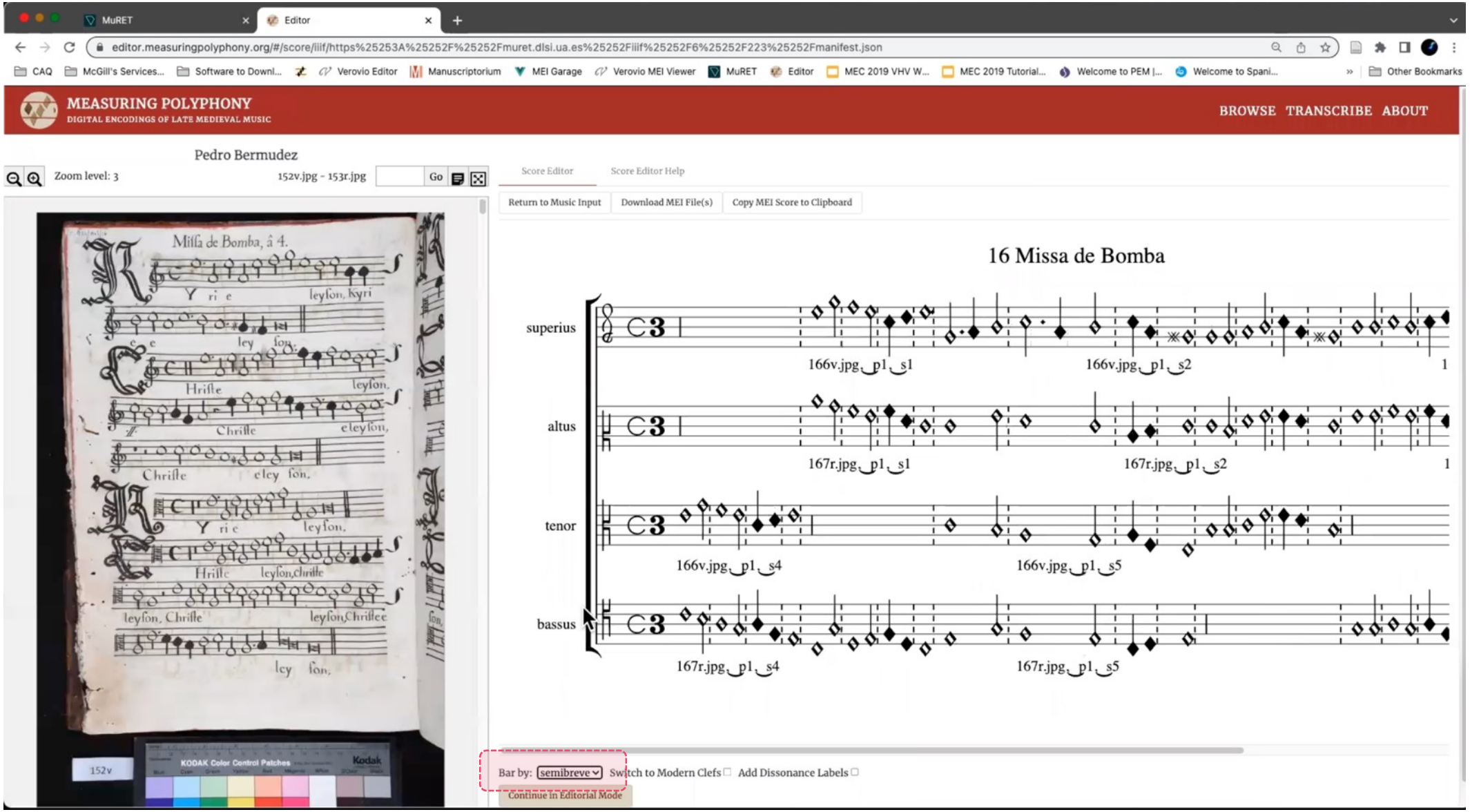
167r.jpg_p1_s4
Bar by:
none
Switch to Modern Cl
Add Dissonance Labels
Continue in Editorial Mode


bassus
167r.jpg_p1_s4
Bar by: semibreve
Switch to Modern Clefs
Add Dissonance Labels
Continue in Editorial Mode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BROWSE TRANSCRIBE ABOUT
Pedro Bermudez
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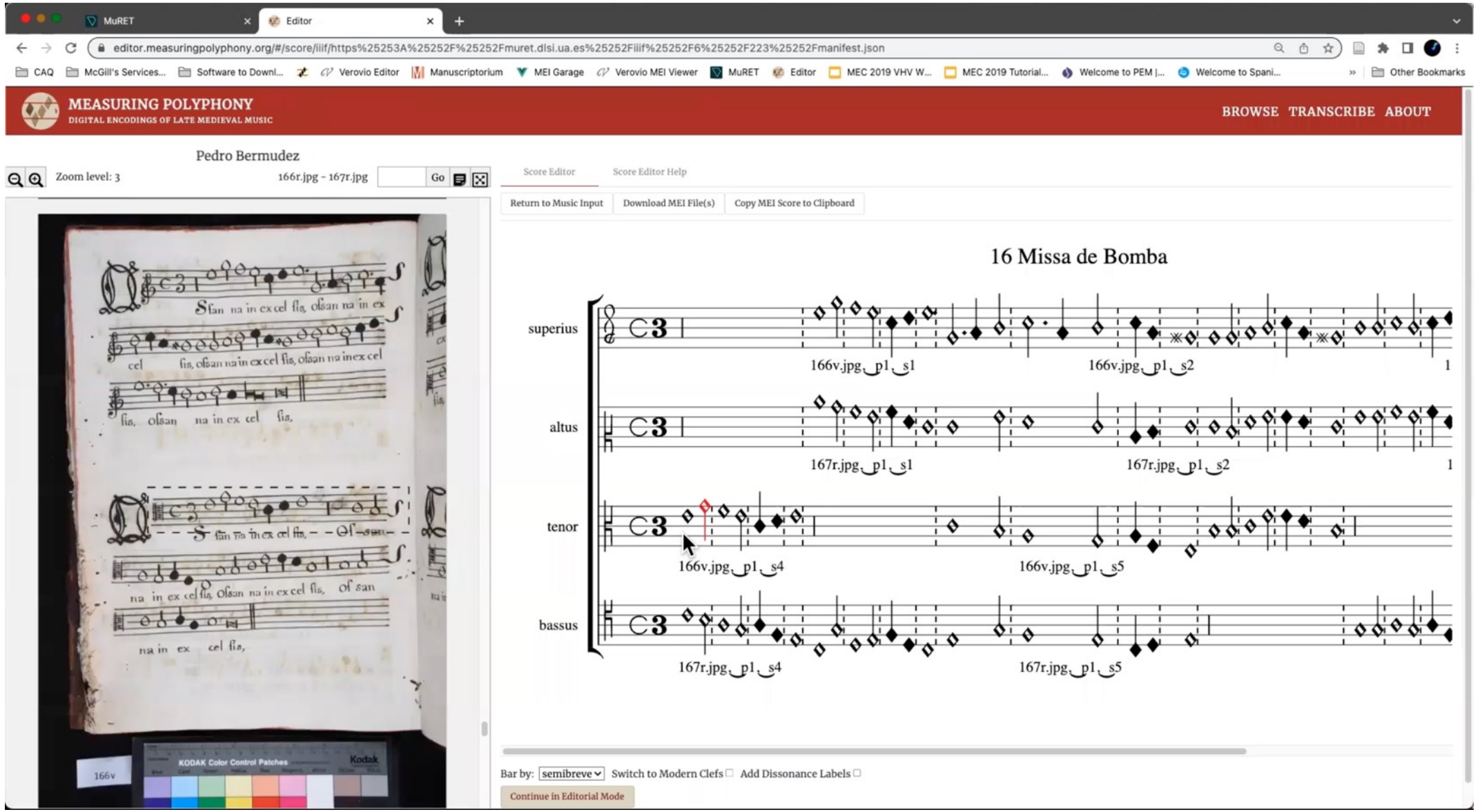
16 Missa de Bomba
superius
altus
tenor
bassus
166v.jpg_p1_s1
166v.jpg_p1_s2
167r.jpg_p1_s1
167r.jpg_p1_s2
166v.jpg_p1_s4
166v.jpg_p1_s5
167r.jpg_p1_s4
167r.jpg_p1_s5
Missa de Bomba, â 4.
152v
Bar by: semibreve
Switch to Modern Clefs
Add Dissonance Labels
Continue in Editorial Mode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editor.measuringpolyphony.org/#/score/iiif/https%25253A%25252F%25252Fmuret.dlsi.ua.es%25252Fiiif%25252F6%25252F223%25252Fmanifest.json
MEASURING POLYPHONY
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16 Missa de Bomba
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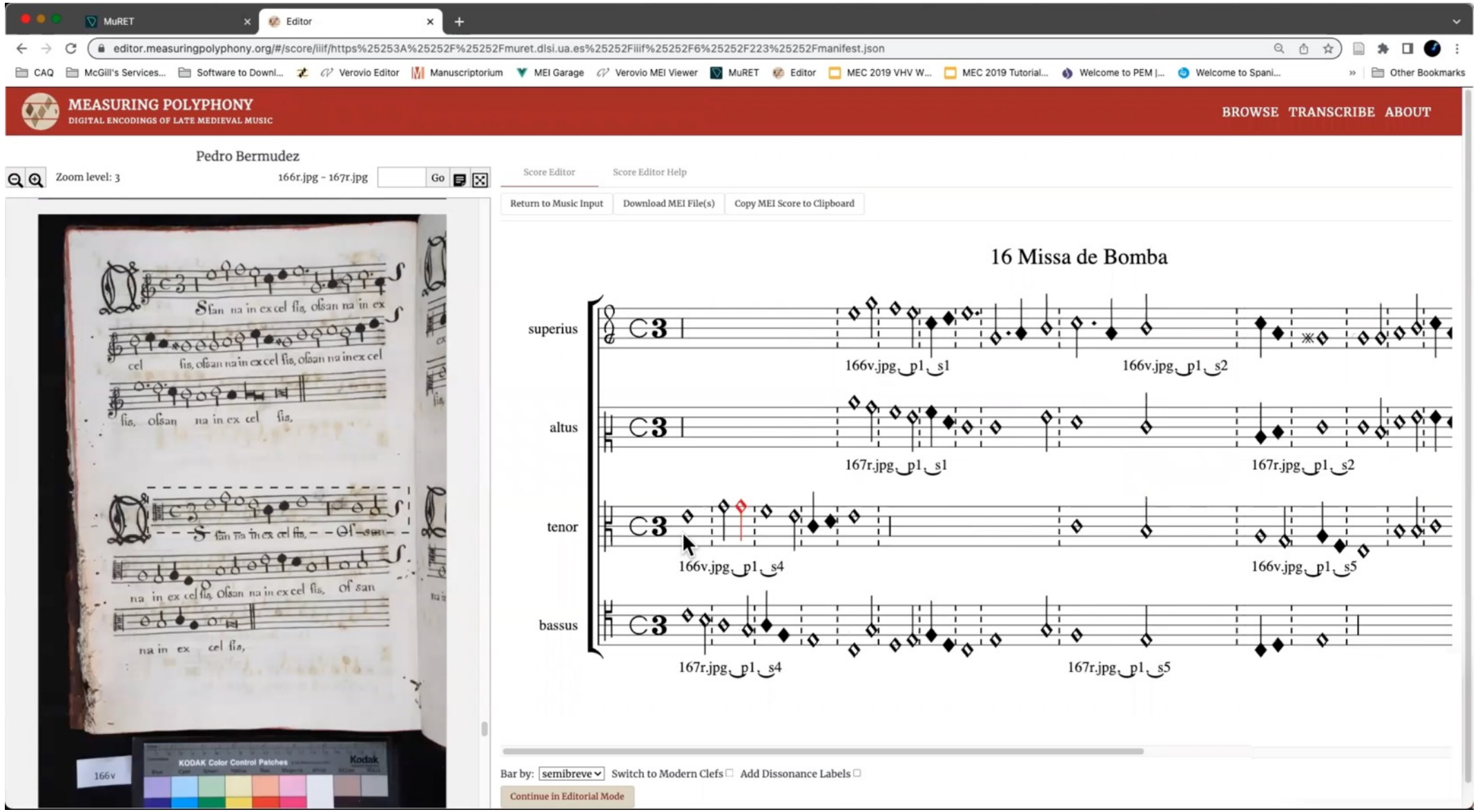
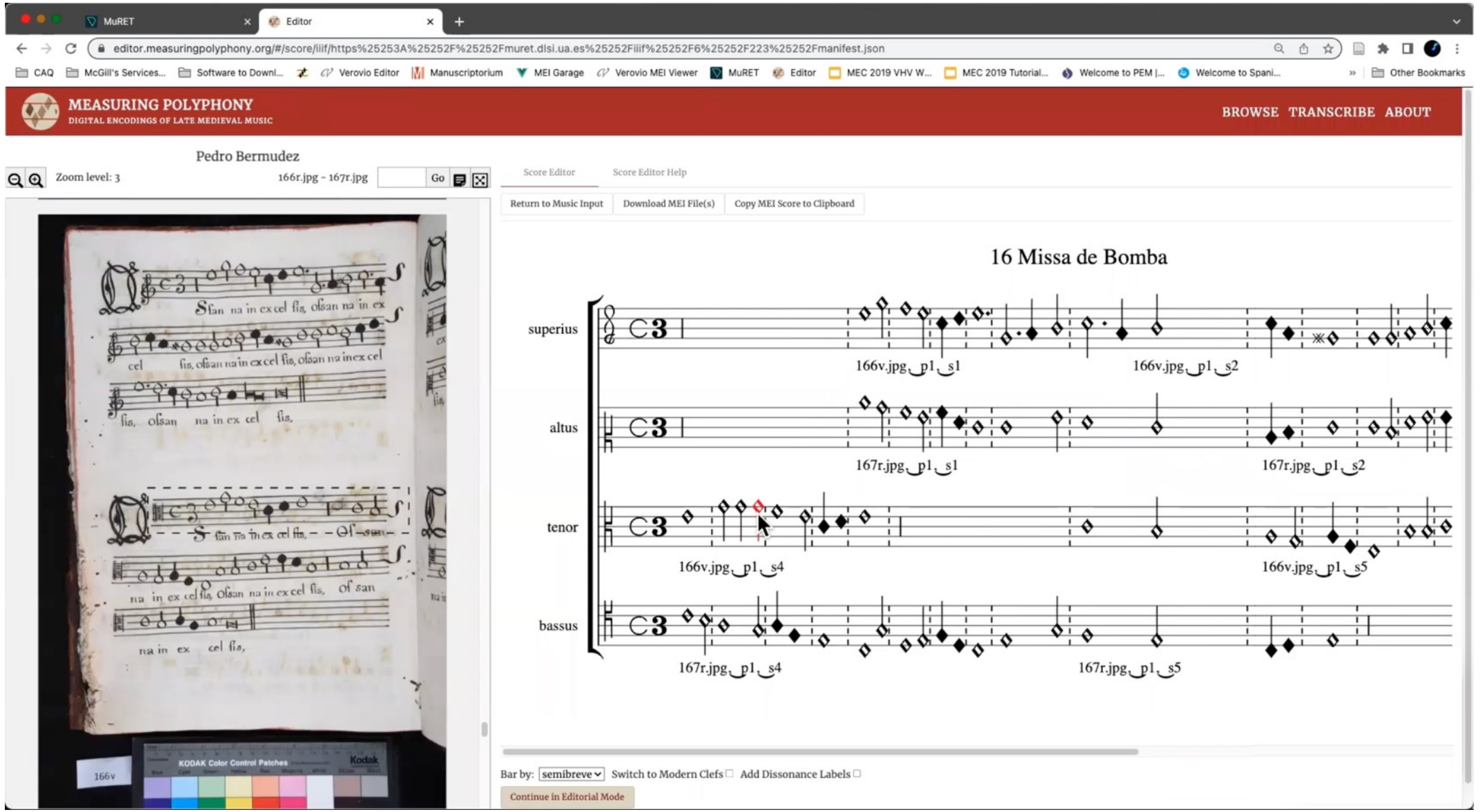
166v.jpg_p1_s1
166v.jpg_p1_s2
167r.jpg_p1_s1
167r.jpg_p1_s2
166v.jpg_p1_s4
166v.jpg_p1_s5
167r.jpg_p1_s4
167r.jpg_p1_s5
Bar by: semibreve
Switch to Modern Clefs
Add Dissonance Labels
Continue in Editorial Mode


MuRET
Editor
editor.measuringpolyphony.org/#/score/iiif/https%25253A%25252F%25252Fmuret.dlsi.ua.es%25252Fiiif%25252F6%25252F223%25252Fmanifest.json
MEASURING POLYPHONY
DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC
BROWSE TRANSCRIBE ABOUT
Pedro Bermudez
Zoom level: 3
166r.jpg - 167r.jpg
Go
Score Editor
Score Editor Help
Return to Music Input
Download MEI File(s)
Copy MEI Score to Clipboard
16 Missa de Bomba
superius
altus
tenor
bassus
166v.jpg_p1_s1
166v.jpg_p1_s2
167r.jpg_p1_s1
167r.jpg_p1_s2
166v.jpg_p1_s4
166v.jpg_p1_s5
167r.jpg_p1_s4
167r.jpg_p1_s5
Bar by: semibreve
Switch to Modern Clefs
Add Dissonance Labels
Continue in Editorial Mode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MEASURING POLYPHONY
DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC
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16 Missa de Bomba
superius
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tenor
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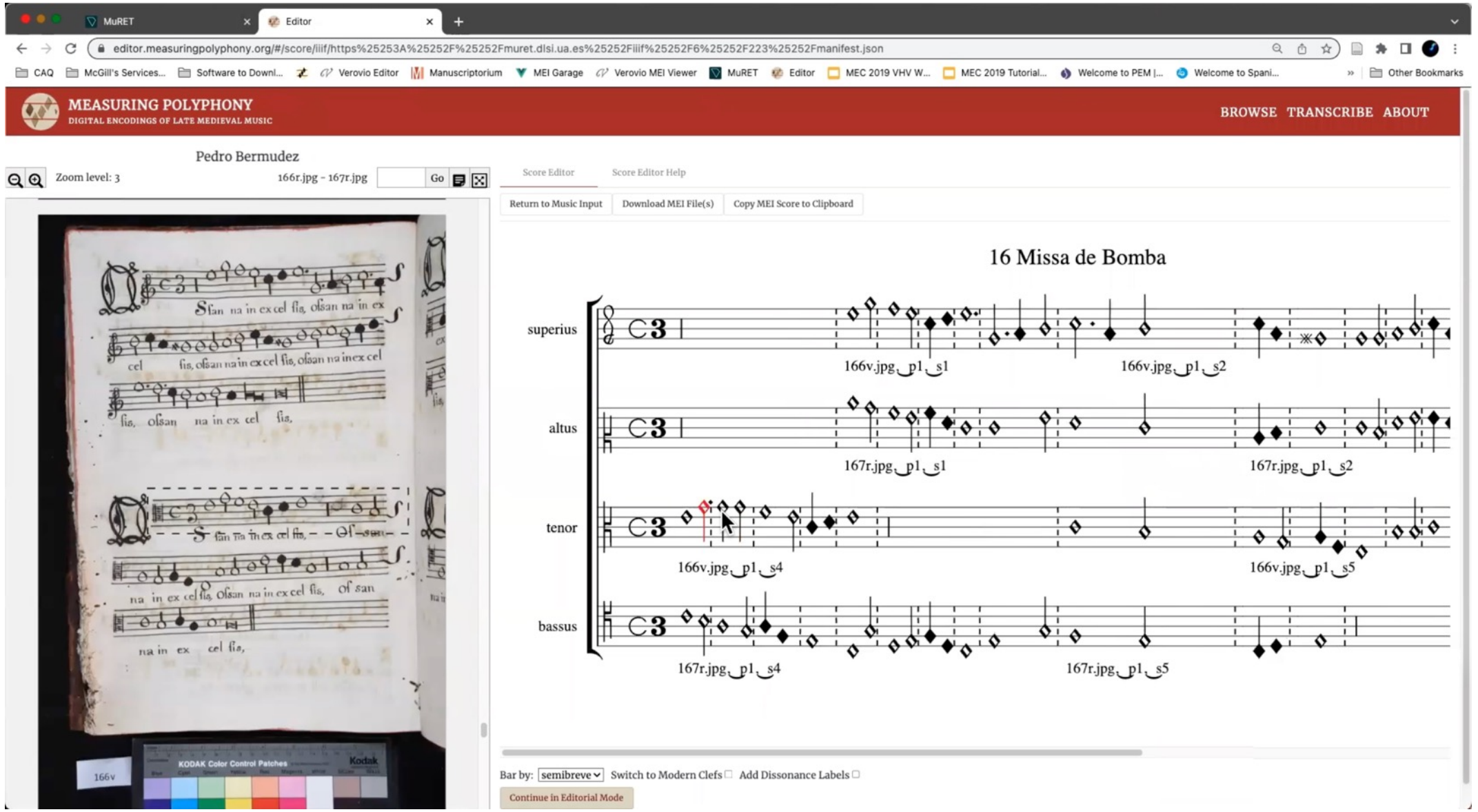
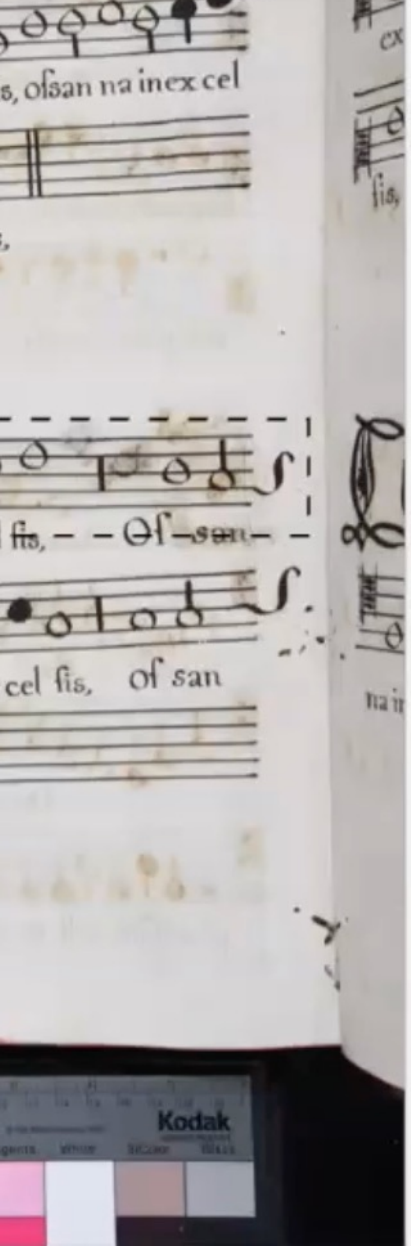
166v.jpg_p1_s1
166v.jpg_p1_s2
167r.jpg_p1_s1
167r.jpg_p1_s2
166v.jpg_p1_s4
166v.jpg_p1_s5
167r.jpg_p1_s4
167r.jpg_p1_s5
Bar by: semibreve
Switch to Modern Clefs
Add Dissonance Labels
Continue in Editorial Mode


MuRET
Editor
editor.measuringpolyphony.org/#/score/iiif/https%25253A%25252F%25252Fmuret.dlsi.ua.es%25252Fiiif%25252F6%25252F223%25252Fmanifest.json
MEASURING POLYPHONY
DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC
BROWSE TRANSCRIBE ABOUT
Pedro Bermudez
Zoom level: 3
166r.jpg - 167r.jpg
Go
Score Editor
Score Editor Help
Return to Music Input
Download MEI File(s)
Copy MEI Score to Clipboard
16 Missa de Bomba
superius
altus
tenor
bassus
166v.jpg,p1,s1
166v.jpg,p1,s2
167r.jpg,p1,s1
167r.jpg,p1,s2
166v.jpg,p1,s4
166v.jpg,p1,s5
167r.jpg,p1,s4
167r.jpg,p1,s5
Bar by: semibreve
Switch to Modern Clefs
Add Dissonance Labels
Continue in Editorial Mode



superius

166v.jpg_p1_s1 166v.jpg_p1_s2

altus

167r.jpg_p1_s1 167r.j

tenor

166v.jpg_p1_s4 166v.

bassus

167r.jpg_p1_s4 167r.jpg_p1_s5

Bar by: semibreve Switch to Modern Clefs Add Dissonance Labels

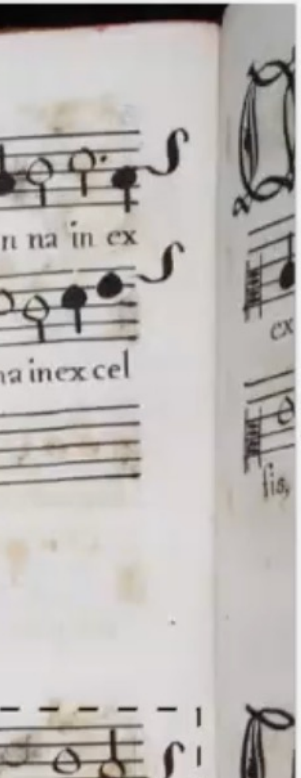
Continue in Editorial Mode

https%25253A%25252F%25252Fmuret.dlsi.ua.es%25252Fiiif%25252F6%25252F223%25252Fmanifest.json

Verovio Editor | Manuscriptorium | MEI Garage | Verovio MEI Viewer | MuRET | Editor | MEC 2019 VHV W... | MEC 2019 Tutorial... | Welcome to PEM |... | Welcome to Spani...

BROWSE TRAN

167r.jpg Go



Score Editor | Score Editor Help

Return to Music Input | Download MEI File(s) | Copy MEI Score to Clipboard

16 Missa de Bomba

superius

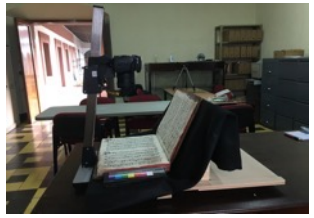
166v.jpg_p1_s1 166v.jpg_p1_s2

altus

167r.jpg_p1_s1 167r.jpg_p1

Methodology: Three-Step Process

Digitization



Optical music recognition (OMR)

MURET

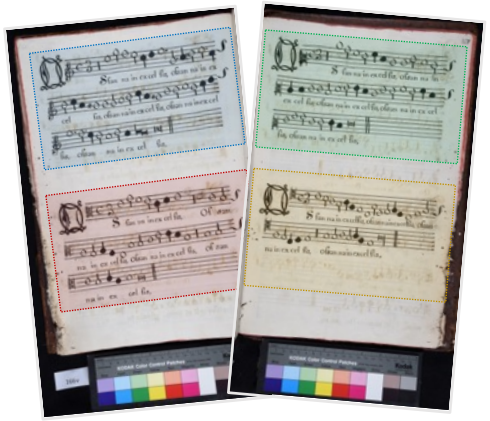
Music Recognition, encoding, and transcription

Automatic voice alignment & **editorial correction**

MEASURING POLYPHONY

DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC

Manuscript



Digital images

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<mei>
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   <note dur="semibrevis" pname="g" oct="5"/>
   <note dur="semibrevis" pname="d" oct="5"/>
   <dot/>
   <note dur="minima" pname="c" oct="5"/>
   <ligature form="recta">
    <note dur="semibrevis" pname="d" oct="5"/>
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   </ligature>
   <note dur="brevis" pname="b" oct="4"/>
  </staff>
 </music>
</mei>
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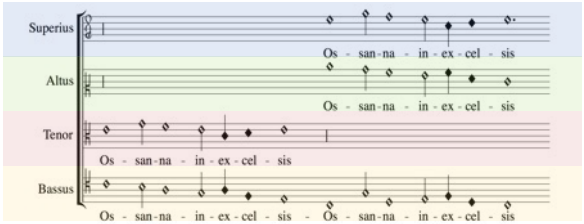
MEI Parts file
encodes the **symbols** in each **part/voice** of the images

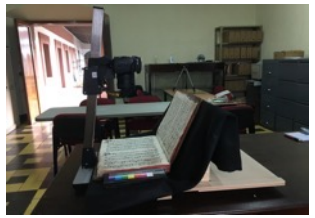


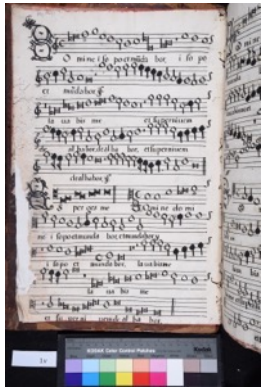
MEI Score file
interpreted durations
(i.e., *alteration* & *imperfection*)

Interoperability Work: *MuRET & MP Editor*

David Rizo, Juliette Regimbal, and Martha Thomae

Digitization





Digital image

Optical music recognition (OMR)

MURET

Music Recognition, encoding, and transcription

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  <staff n="1">
   <clef line="2" shape="G"/>
   <note dur="semibrevis" pname="g" oct="5"/>
   <note dur="semibrevis" pname="d" oct="5"/>
   <dot/>
   <note dur="minima" pname="c" oct="5"/>
   <ligature form="recta">
    <note dur="semibrevis" pname="d" oct="5"/>
    <note dur="semibrevis" pname="g" oct="4"/>
   </ligature>
   <note dur="brevis" pname="b" oct="4"/>
  </staff>
 </music>
</mei>
```

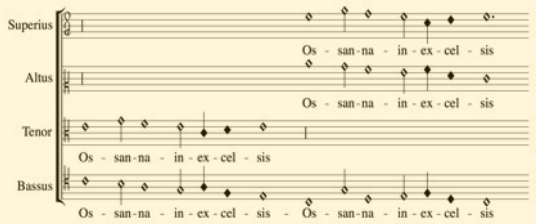
MEI Parts file
encodes the **symbols** in each **part/voice** of the images

Automatic voice alignment & editorial correction

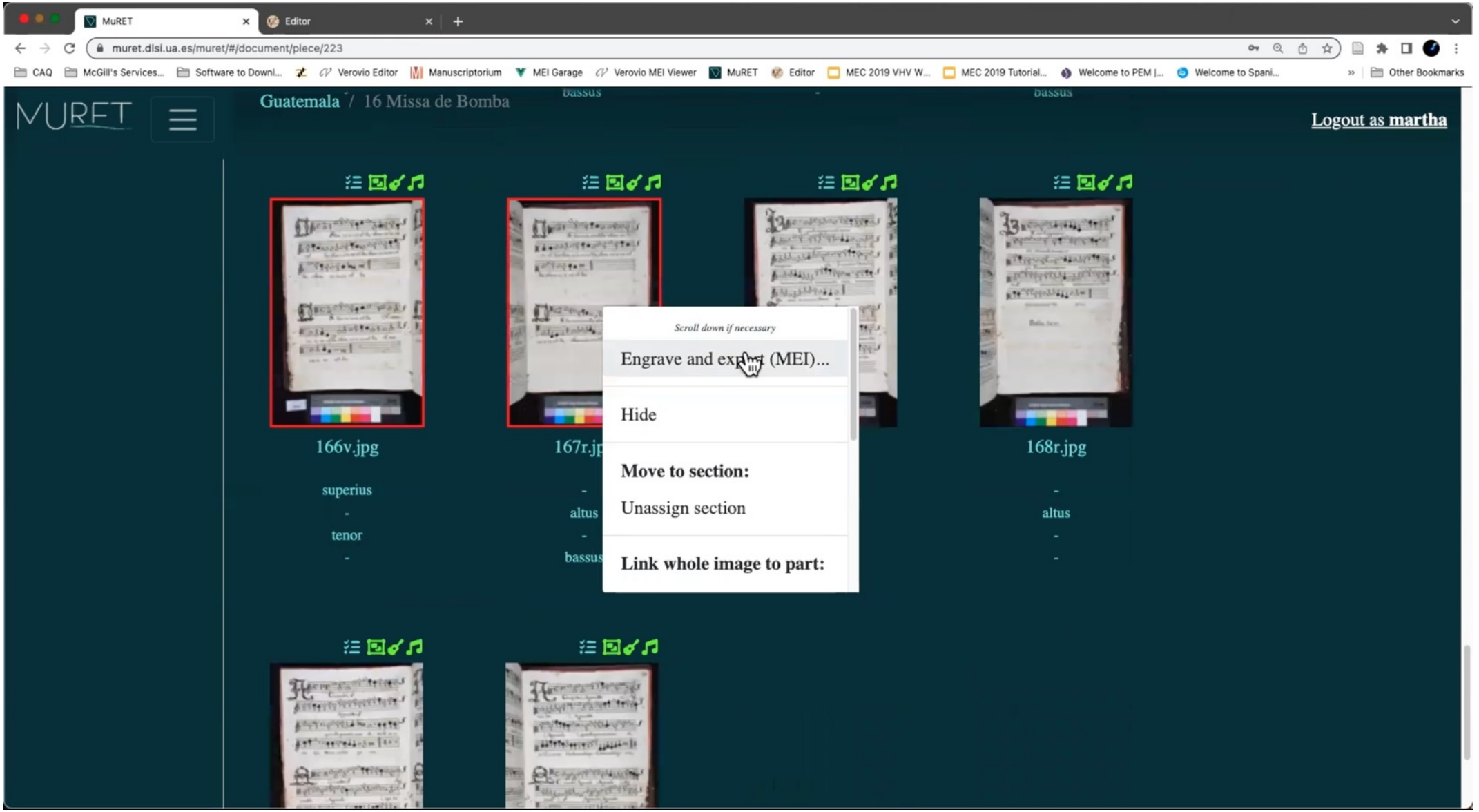
MEASURING POLYPHONY

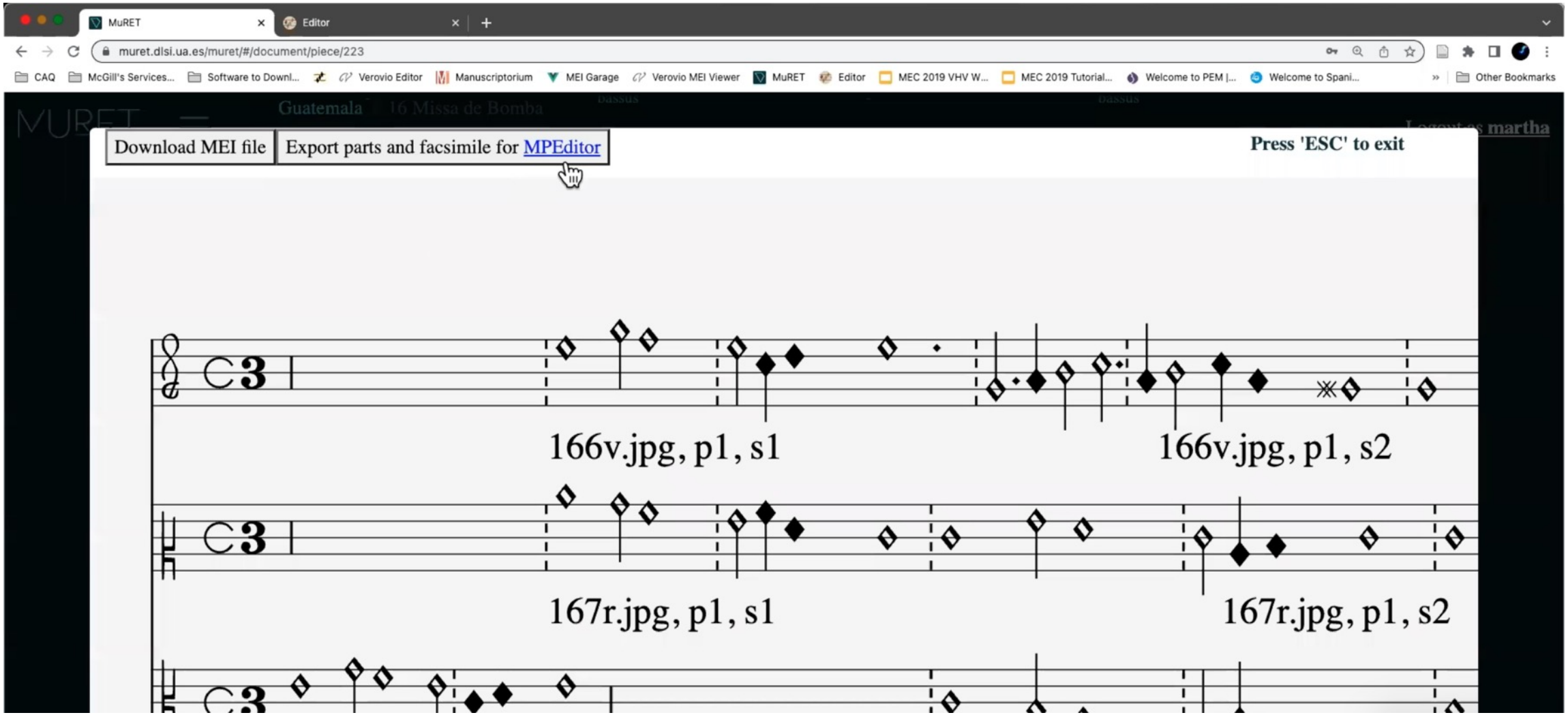
DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC

SCORE EDITOR



MEI Score file
interpreted durations
(i.e., *alteration* & *imperfection*)


MuRET
Editor
muret.dlsi.ua.es/muret/#/document/piece/223
CAQ
McGill's Services...
Software to Downl...
Verovio Editor
Manuscriptorium
MEI Garage
Verovio MEI Viewer
MuRET
Editor
MEC 2019 VHV W...
MEC 2019 Tutorial...
Welcome to PEM |...
Welcome to Spani...
Other Bookmarks
MURET
Guatemala / 16 Missa de Bomba
Logout as martha
166v.jpg
superius
-
tenor
-
167r.jp
altus
-
bassus
168r.jpg
-
altus
-
-
Scroll down if necessary
Engrave and export (MEI)...
Hide
Move to section:
Unassign section
Link whole image to part:


MuRET
Editor
muret.dlsi.ua.es/muret/#/document/piece/223
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MEC 2019 VHV W...
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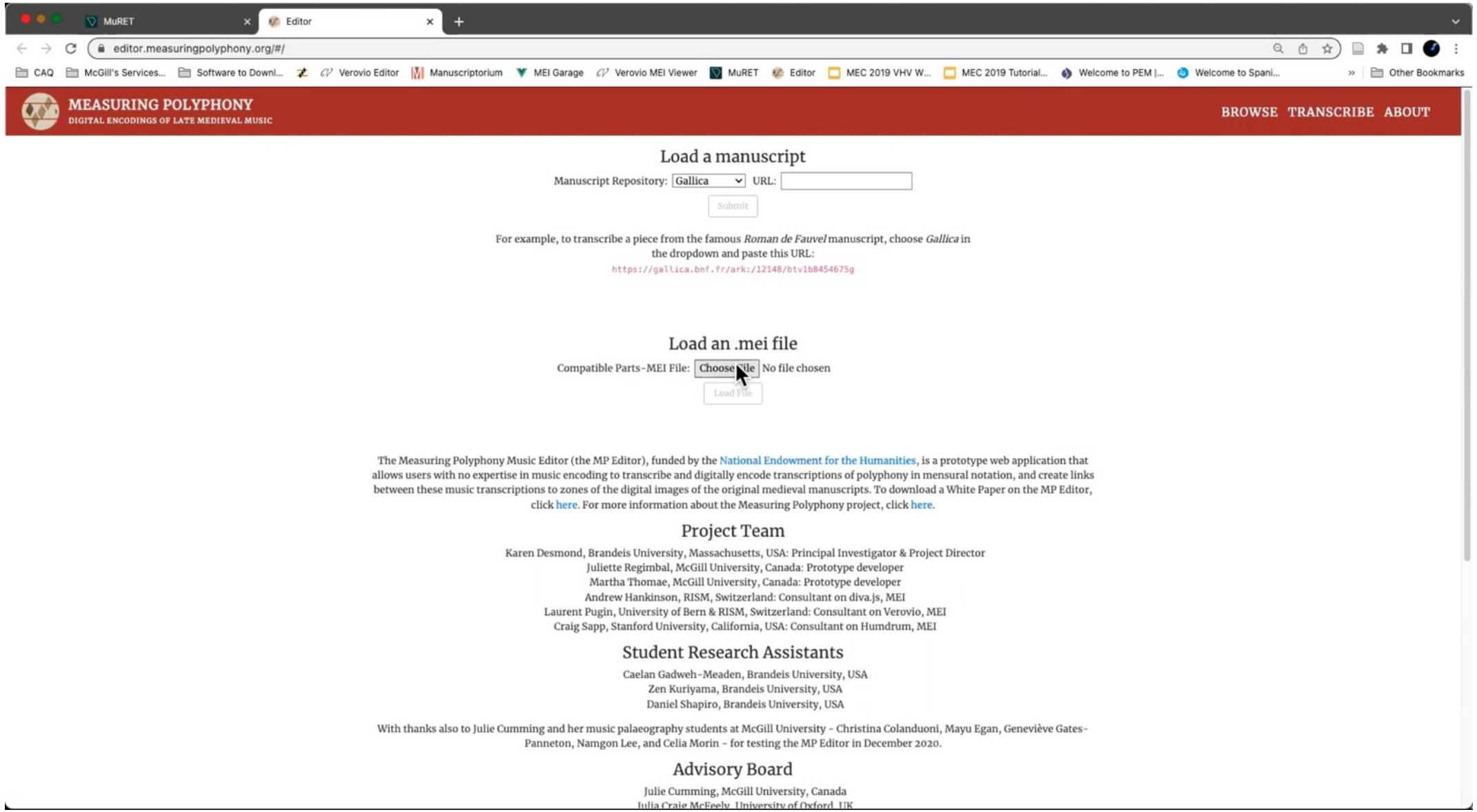
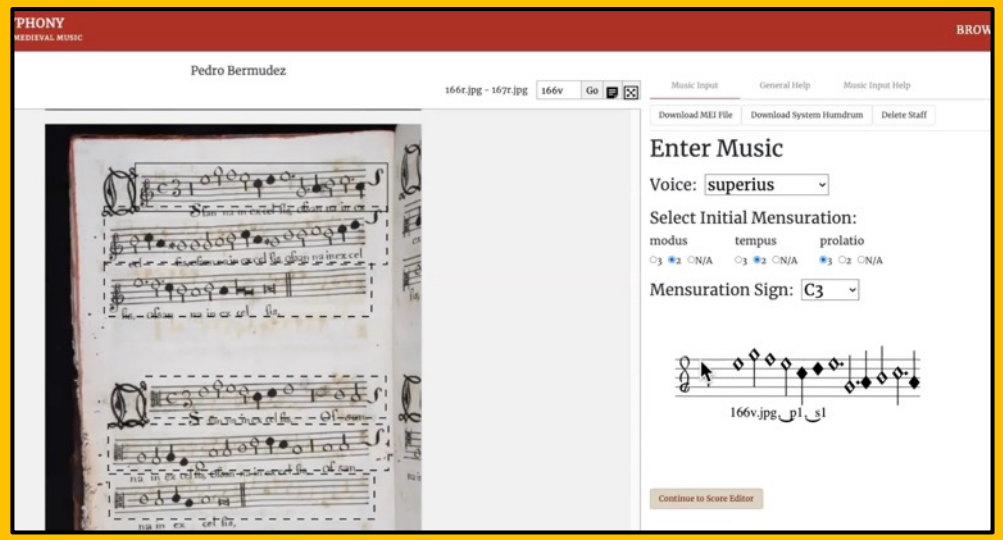
Welcome to PEM |...
Welcome to Spani...
Other Bookmarks
Guatemala
16 Missa de Bomba
Download MEI file
Export parts and facsimile for MPEditor
Press 'ESC' to exit
166v.jpg, p1, s1
166v.jpg, p1, s2
167r.jpg, p1, s1
167r.jpg, p1, s2


MuRET
Editor
editor.measuringpolyphony.org/#/
CAQ
McGill's Services...
Software to Downl...
Verovio Editor
Manuscriptorium
MEI Garage
Verovio MEI Viewer
MuRET
Editor
MEC 2019 VHV W...
MEC 2019 Tutorial...
Welcome to PEM |...
Welcome to Spani...
Other Bookmarks
MEASURING POLYPHONY
DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC
BROWSE TRANSCRIBE ABOUT
Load a manuscript
Manuscript Repository: Gallica URL:
Submit
For example, to transcribe a piece from the famous Roman de Fauvel manuscript, choose Gallica in the dropdown and paste this URL:
https://gallica.bnf.fr/ark:/12148/btv1b8454675g
Load an .mei file
Compatible Parts-MEI File: Choose File No file chosen
Load File
The Measuring Polyphony Music Editor (the MP Editor), funded by the National Endowment for the Humanities, is a prototype web application that allows users with no expertise in music encoding to transcribe and digitally encode transcriptions of polyphony in mensural notation, and create links between these music transcriptions to zones of the digital images of the original medieval manuscripts. To download a White Paper on the MP Editor, click here. For more information about the Measuring Polyphony project, click here.
Project Team
Karen Desmond, Brandeis University, Massachusetts, USA: Principal Investigator & Project Director
Juliette Regimbal, McGill University, Canada: Prototype developer
Martha Thomae, McGill University, Canada: Prototype developer
Andrew Hankinson, RISM, Switzerland: Consultant on diva.js, MEI
Laurent Pugin, University of Bern & RISM, Switzerland: Consultant on Verovio, MEI
Craig Sapp, Stanford University, California, USA: Consultant on Humdrum, MEI
Student Research Assistants
Caelan Gadweh-Meaden, Brandeis University, USA
Zen Kuriyama, Brandeis University, USA
Daniel Shapiro, Brandeis University, USA
With thanks also to Julie Cumming and her music palaeography students at McGill University - Christina Colanduoni, Mayu Egan, Geneviève Gates-Panneton, Namgon Lee, and Celia Morin - for testing the MP Editor in December 2020.
Advisory Board
Julie Cumming, McGill University, Canada
Julia Craig McFeely, University of Oxford, UK

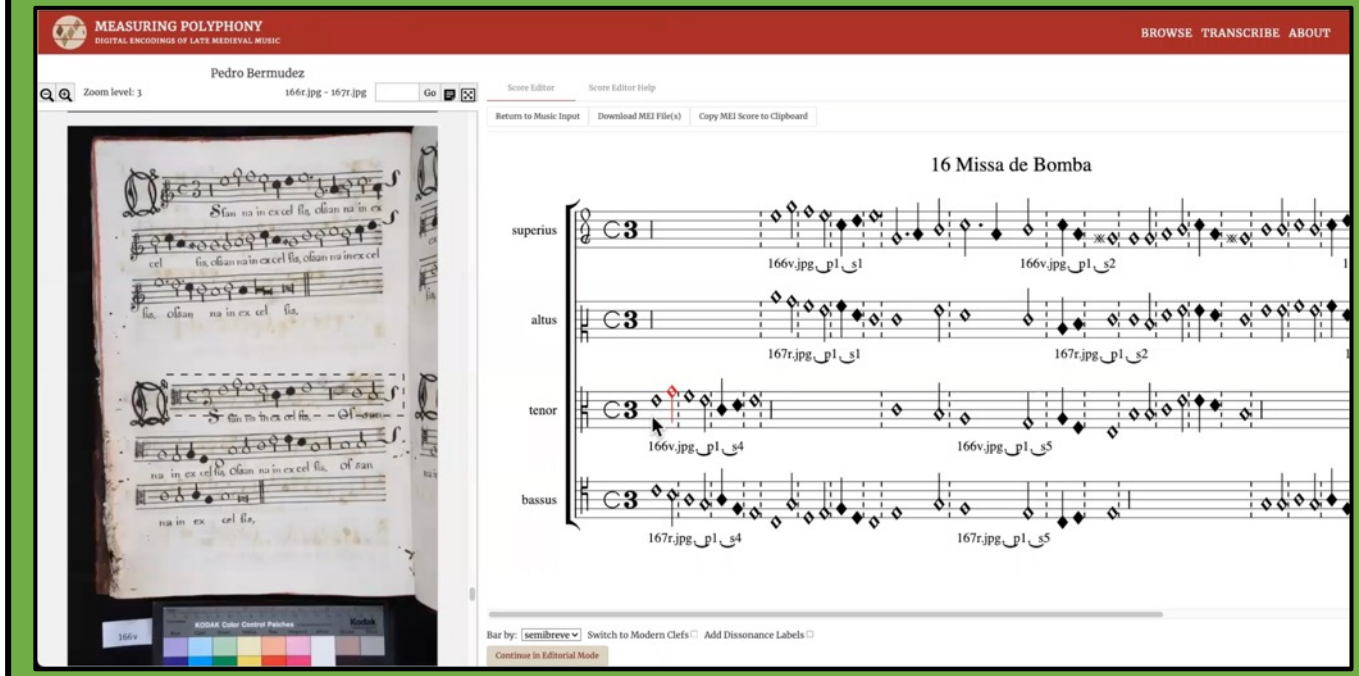
Input editor

Usually a manual task



Score editor

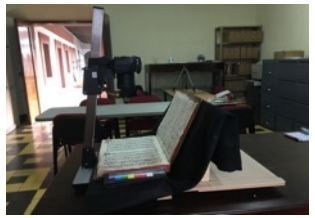
An automatic task (with manual correction)

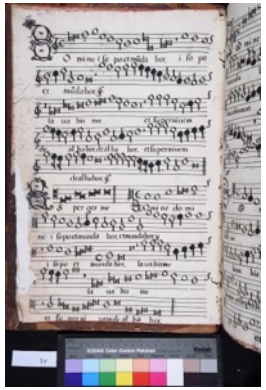


Interoperability Work: *MuRET & MP Editor*

David Rizo, Juliette Regimbal, and Martha Thomae

Digitization





Digital image

Optical music recognition (OMR)

MURET

Music Recognition, encoding, and transcription

```
<mei>
 <music>
  <staff n="1">
   <clef line="2" shape="G"/>
   <note dur="semibrevis" pname="g" oct="5"/>
   <note dur="semibrevis" pname="d" oct="5"/>
   <dot/>
   <note dur="minima" pname="c" oct="5"/>
   <ligature form="recta">
    <note dur="semibrevis" pname="d" oct="5"/>
    <note dur="semibrevis" pname="g" oct="4"/>
   </ligature>
   <note dur="brevis" pname="b" oct="4"/>
  </staff>
 </music>
</mei>
```

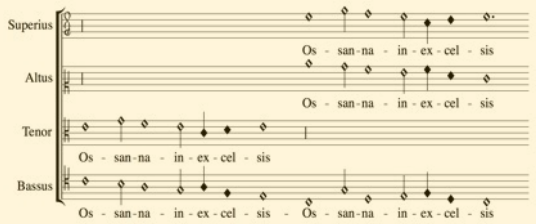
MEI Parts file
encodes the **symbols** in each **part/voice** of the images

Automatic voice alignment & editorial correction

MEASURING POLYPHONY

DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC

SCORE EDITOR

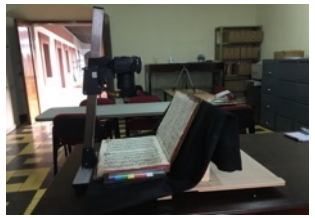


MEI Score file
interpreted durations
(i.e., *alteration* & *imperfection*)

Interoperability Work: *Humdrum DF & MP Editor*

Craig Sapp, Juliette Regimbal, and Martha Thomae

Digitization



Optical music recognition (OMR)

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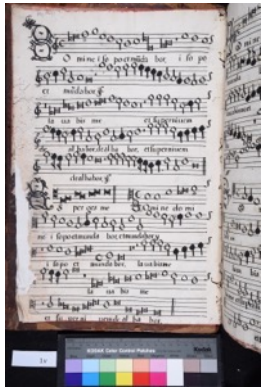
&
editorial correction

MEASURING POLYPHONY

DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC



Digital image

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    <note dur="semibrevis" pname="d" oct="5"/>
    <note dur="semibrevis" pname="g" oct="4"/>
   </ligature>
   <note dur="brevis" pname="b" oct="4"/>
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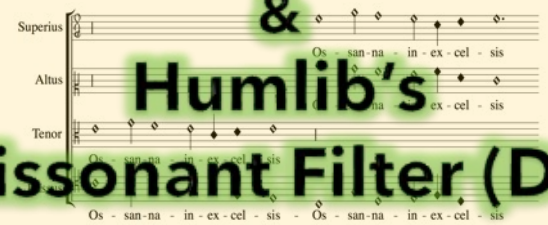
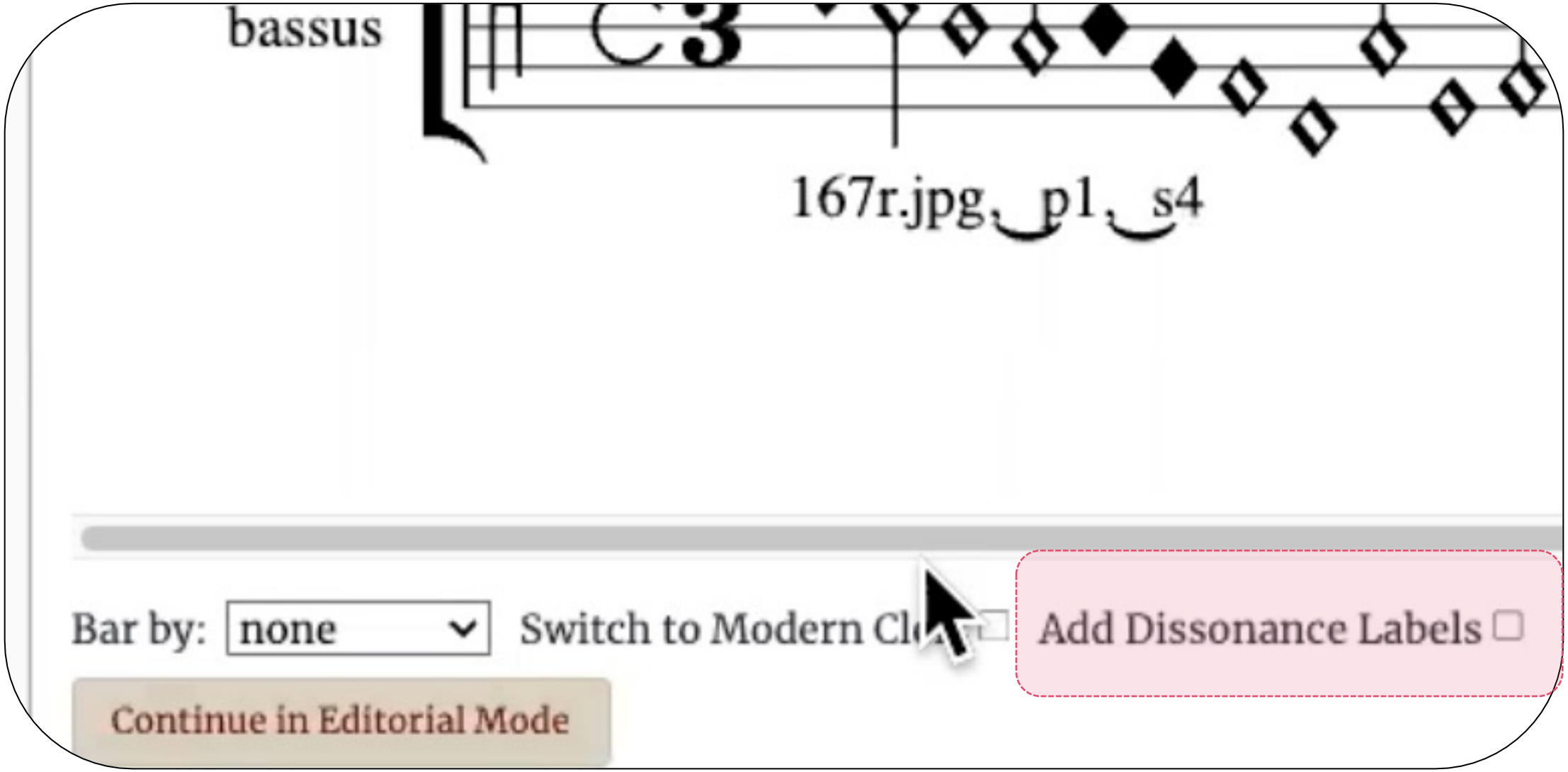
 </music>
</mei>
```

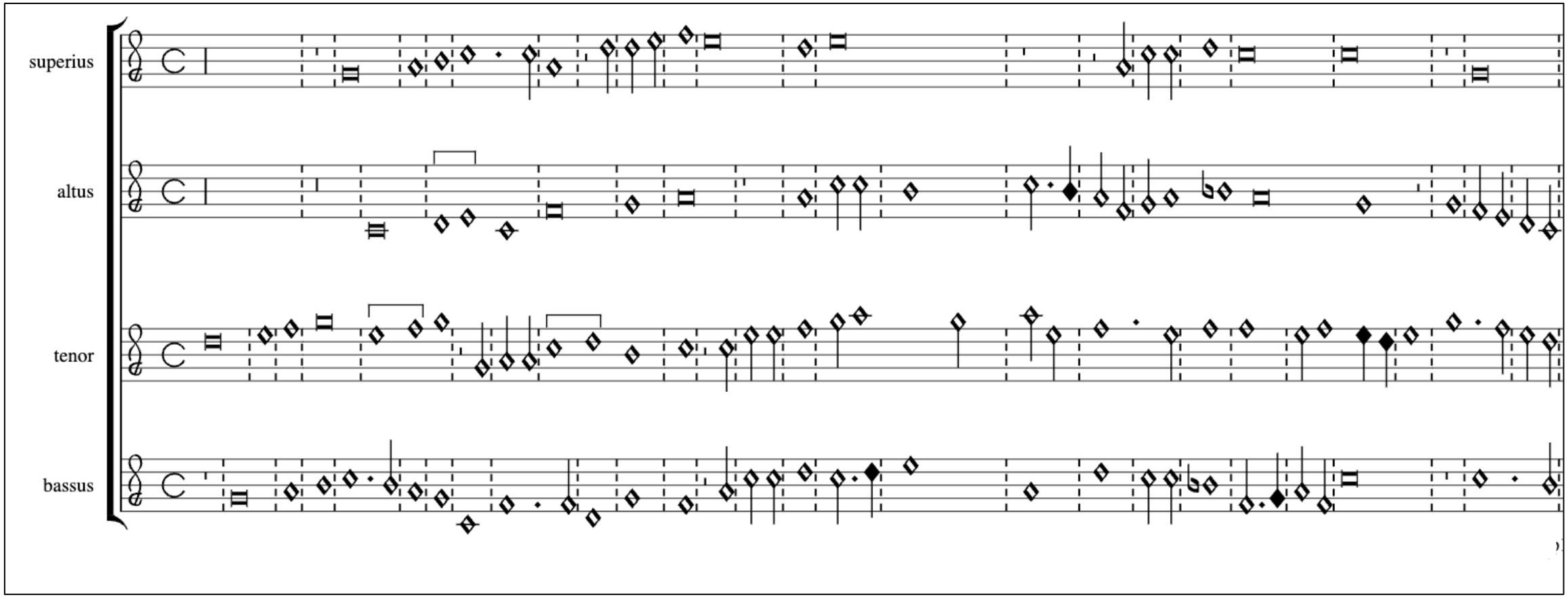
MEI Parts file
encodes the **symbols** in each **part/voice** of the images

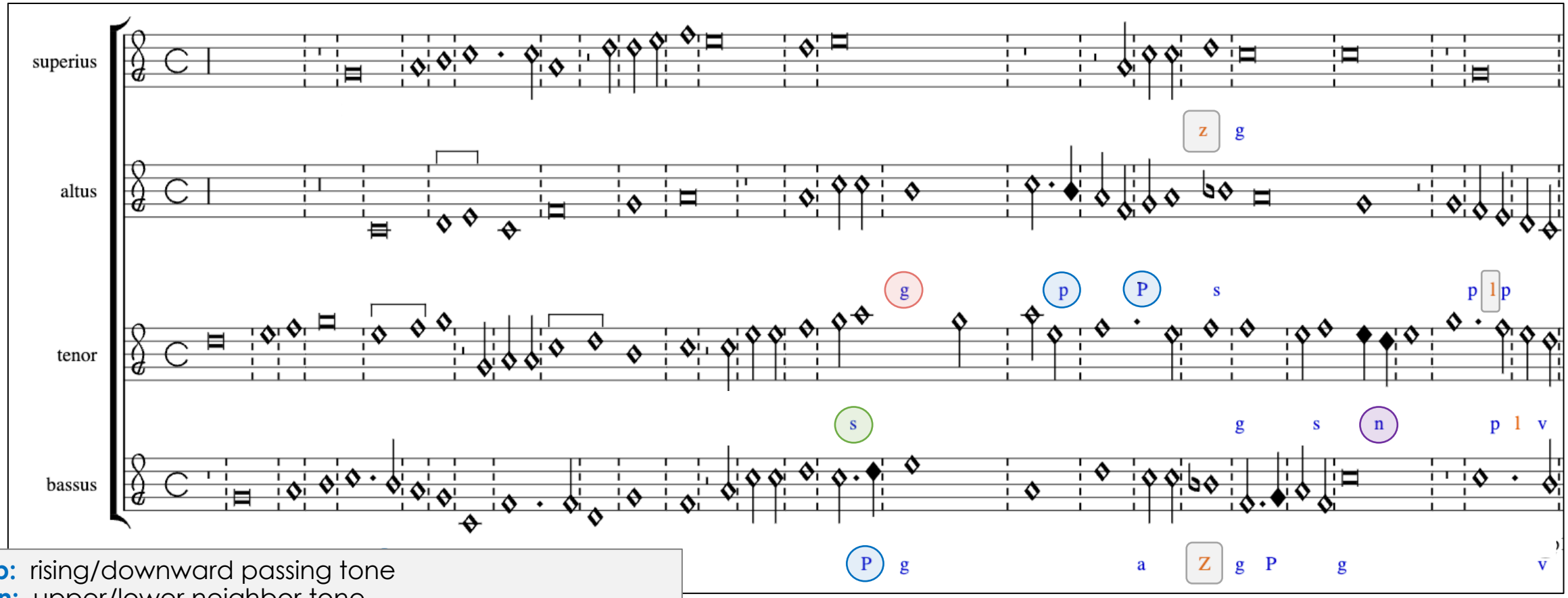
SCORE EDITOR
&
Humlib's
Dissonant Filter (DF)



MEI Score file
interpreted durations
(i.e., *alteration* & *imperfection*)


bassus
167r.jpg_p1_s4
Bar by:
none
Switch to Modern Cl
Add Dissonance Labels
Continue in Editorial Mode


superius
altus
tenor
bassus



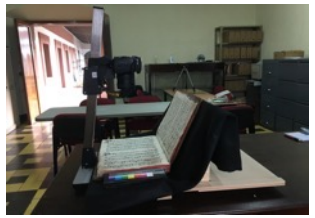
P/p: rising/downward passing tone
N/n: upper/lower neighbor tone
s: suspension
g: agent
Z/z: unclassified dissonance (2nd or 7th / 4th)
l: unclassified dissonance in parallel accompaniment

MP Editor with "legal" and "illegal" dissonances
(labels come from *humlib's dissonant filter,*
developed by Alex Morgan and Craig Sapp for the Josquin Research Project)

Interoperability Work: *Humdrum DF & MP Editor*

Craig Sapp, Juliette Regimbal, and Martha Thomae

Digitization



Optical music recognition (OMR)

MURET

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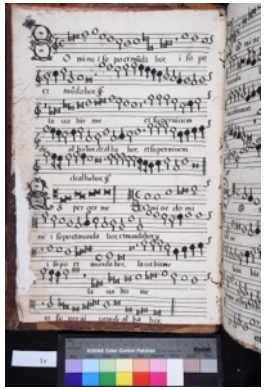
Automatic voice alignment
&
editorial correction

MEASURING POLYPHONY

DIGITAL ENCODINGS OF LATE MEDIEVAL MUSIC



Digital image

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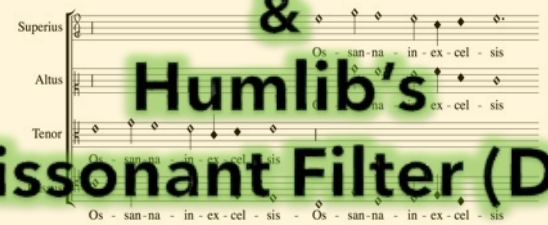
```

MEI Parts file
encodes the **symbols** in each **part/voice** of the images

SCORE EDITOR
&
Humlib's
Dissonant Filter (DF)



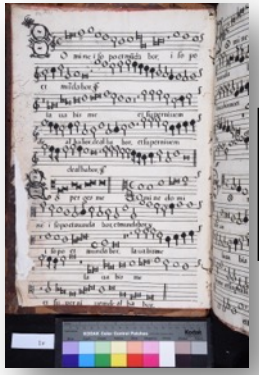
MEI Score file
interpreted durations
(i.e., *alteration* & *imperfection*)

Results

1. **Files:**
   - Digital images (DIAMM)
   - Mensural MEI files encoding the separate parts and the scores (GitHub)

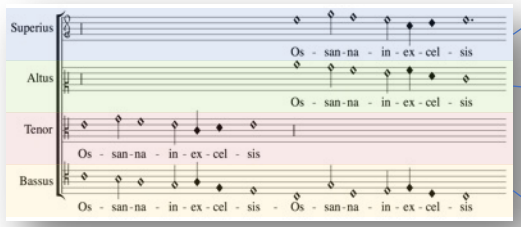
Manuscript

DIY book scanner



Digital image

MuRET & MP-Editor



Digital scores
Encoded in machine-readable files (MEI)

- playback
- automatic transcription into modern values
- comparison to concordant sources

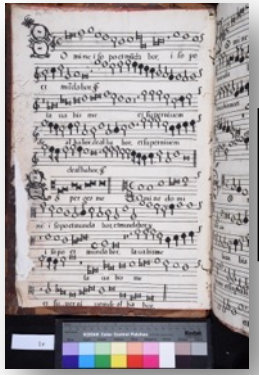
Results

2. Workflow:

- Allows for the semi-automatic transcription of mensural music from digital images of manuscripts in mensural notation
- Applicable to other mensural music sources
- It considers the use of DIY tools and free, online, and open software to be as accessible as possible to institutions with limited resources

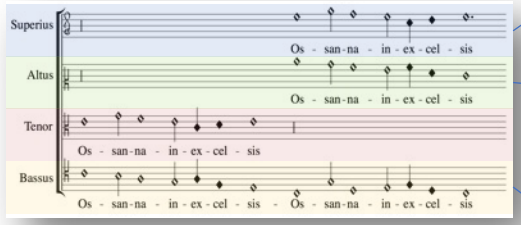
Manuscript

DIY book scanner



Digital image

MuRET & MP-Editor



Digital scores
Encoded in machine-readable files (MEI)

- playback
- automatic transcription into modern values
- comparison to concordant sources

Results and Contributions

- Case study in the use of open-source tools in music digitization and encoding
- Example of bringing projects and researchers together for a common goal
- Contributed to the development of various mensural-notation projects of the Music Encoding Community
  - MuRET, MP Editor, Humdrum **mens and humlib
  - Improve individual tools
  - Allow for their interoperability
- Reusability of this digitization and encoding method by other scholars, archives, and libraries
- Pedagogical use and involvement of students in preservation of these books

Papers Regarding this Work

- **Digitization:** Thomae, Martha E., Julie E. Cumming, and Ichiro Fujinaga. "Digitization of Choirbooks in Guatemala." In *Proceedings of the 9th International Conference on Digital Libraries for Musicology*, pp. 19-26. 2022.
- **Measuring Polyphony Editor (MP Editor) & Scoring Up:** Desmond, Karen. "Next Steps for Measuring Polyphony: A Prototype Editor for Encoding Mensural Music." In *Music Encoding Conference 2020*. 2020.
- **Interoperability work – MuRET (OMR) and Dissonance Filter integration into the MP Editor:** Desmond, Karen, Laurent Pugin, Juliette Regimbal, David Rizo, Craig Sapp, and Martha E. Thomae. "Encoding Polyphony from Medieval Manuscripts Notated in Mensural Notation." (2022).
- **Dissonant Filter use in the MP Editor:** Thomae, Martha E., Julie E. Cumming, and Ichiro Fujinaga. "Counterpoint error-detection tools for optical music recognition of Renaissance polyphonic music." In *Proceedings of the 23rd International Society for Music Information Retrieval Conference (ISMIR)*. 2022.

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