Ancient theatre acoustics

Subjective quality designed by ancient engineers

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T-Mobile PL

Ancient-acoustics.com

Theatre of Epidaurus

The motivation

- Subjective quality of sound: compression
- Same hearing as 2000 years ago
- Something that was optimal then, may be useful for us today
- We have an account of the ancient engineers' view

Vitruvius 'De architectura libri decem'

- The art of designing cities, private houses, basilicas
- Therms, theatres, aqueducts, ballistas, catapults
- Story of Archimedes and Eureka
- Bronze vases resonating at given notes
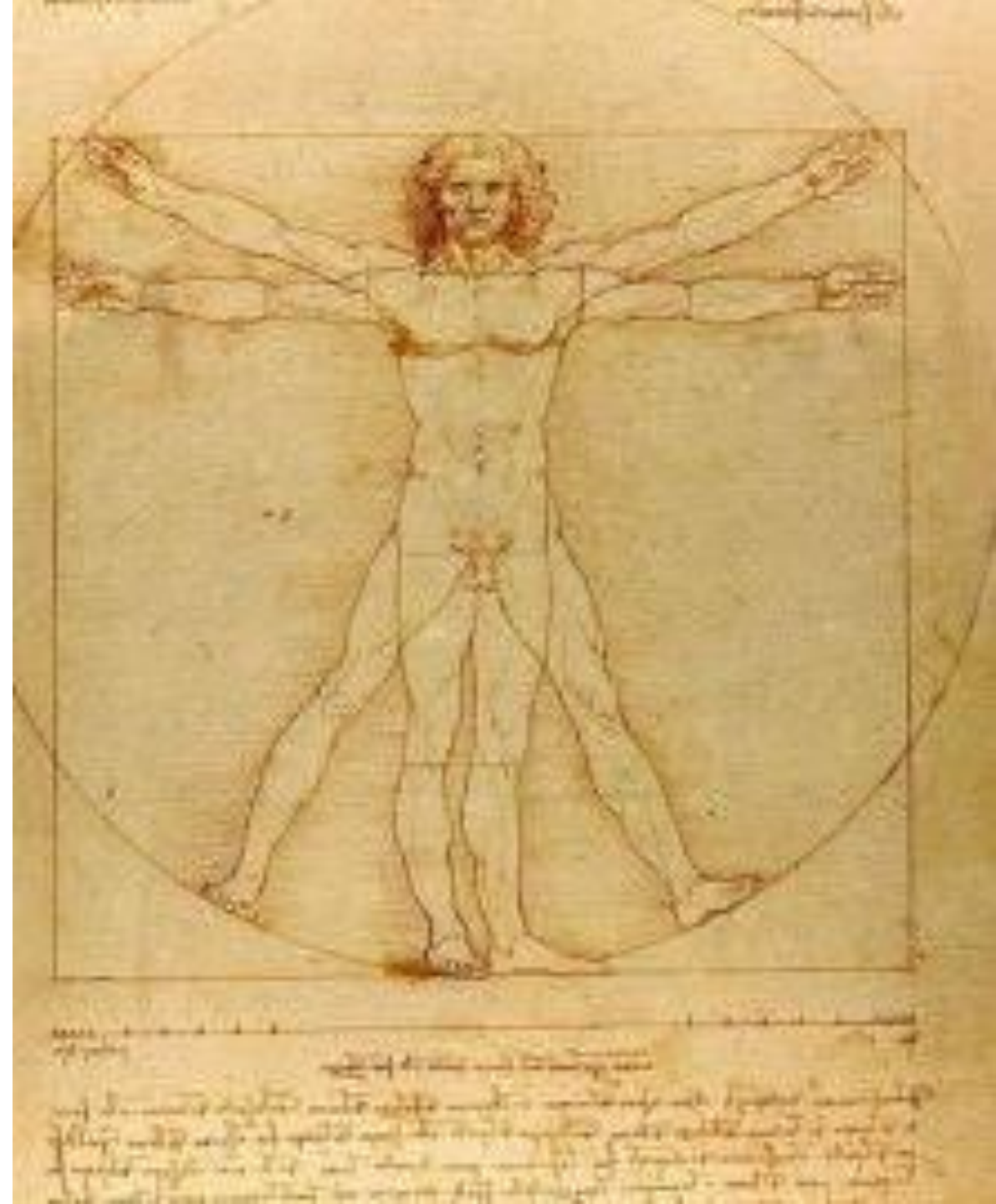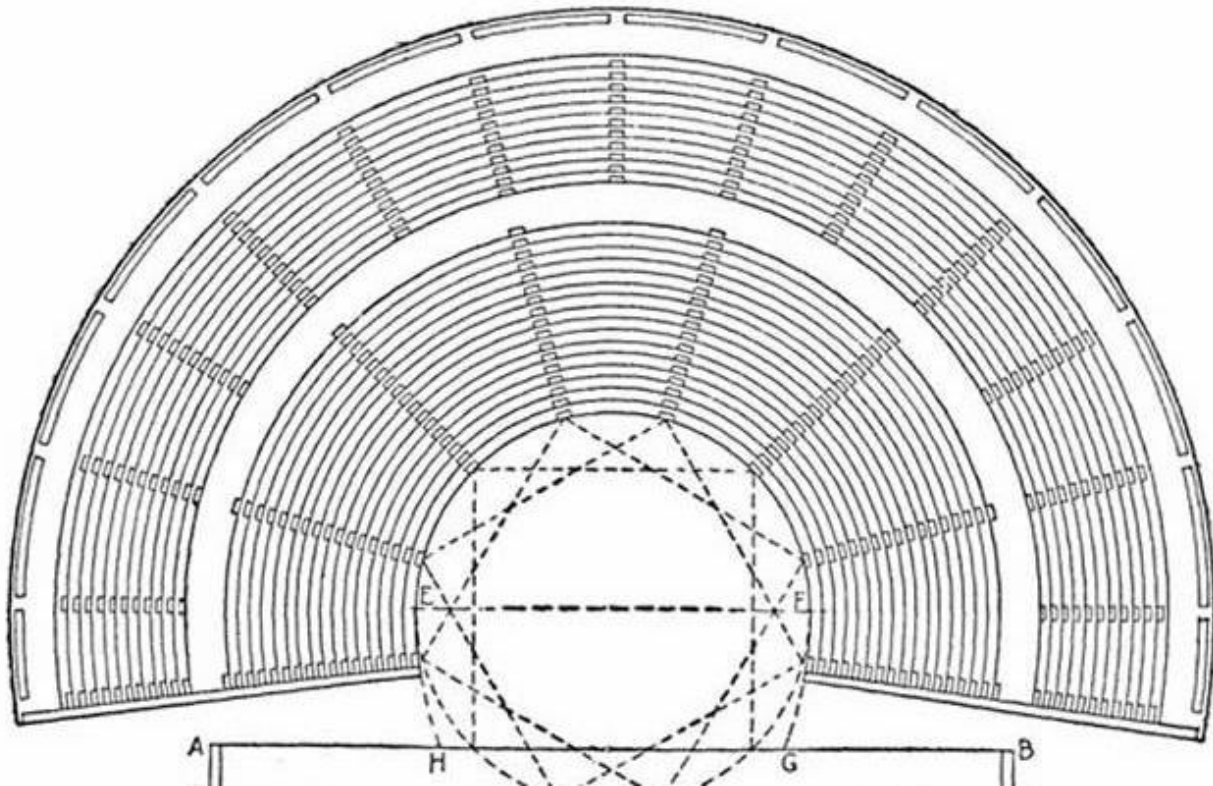
The Android app

- **Hardly audible**
- **Audible**
- **Very audible**

VST plug-in SIR + IR

- Original + Wet (-2dB)
- Original + Wet (-6dB)
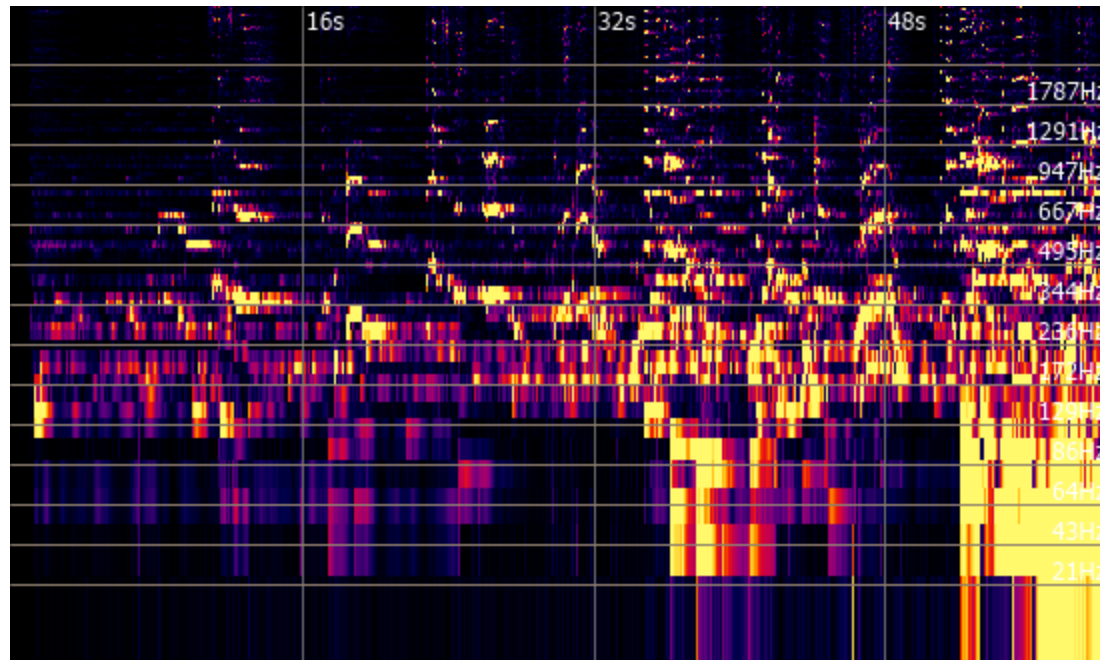- Original(-10dB) + Wet (+20dB)

Example

- On ancient Greek music
  - Promoleth Helikona
- On modern music
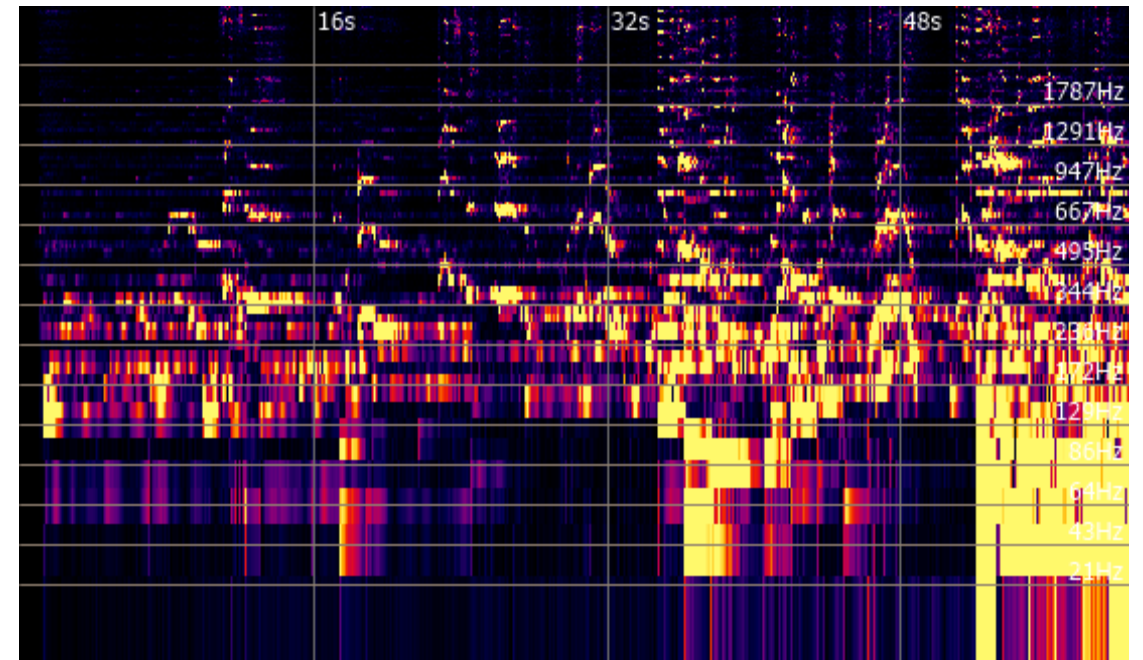 - **C. Dion "Immortality"**
  - B. Craven "Love scenes"

Impact

- In listening to music
- Hearing improvement
- In music postprocessing
- In concerts
- ANCIENT THEATRE & ORCHESTRA

Celine Dion 'Immortality'
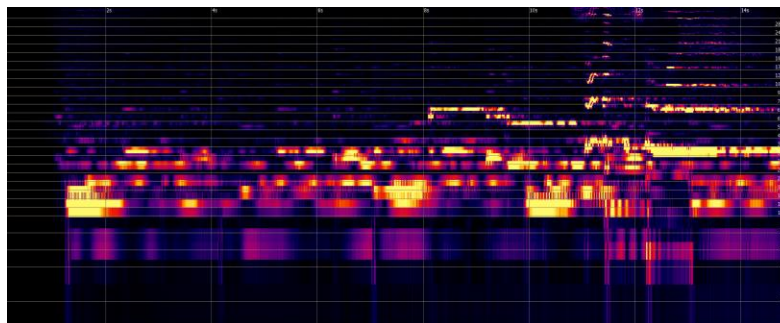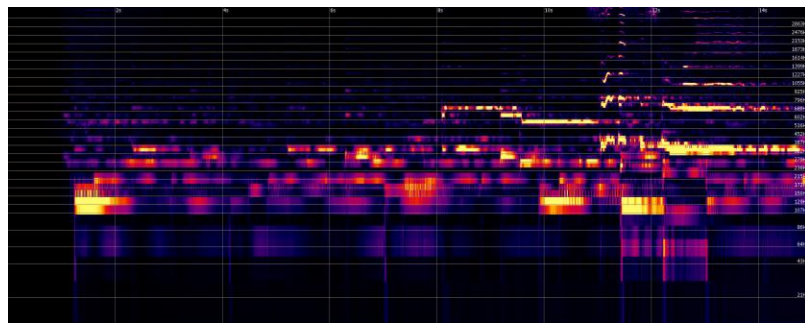# SKENE filter

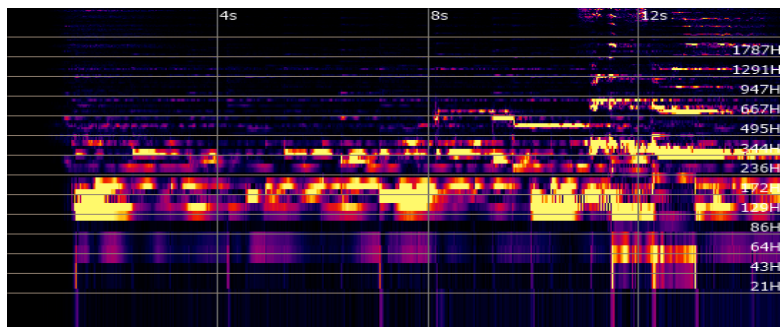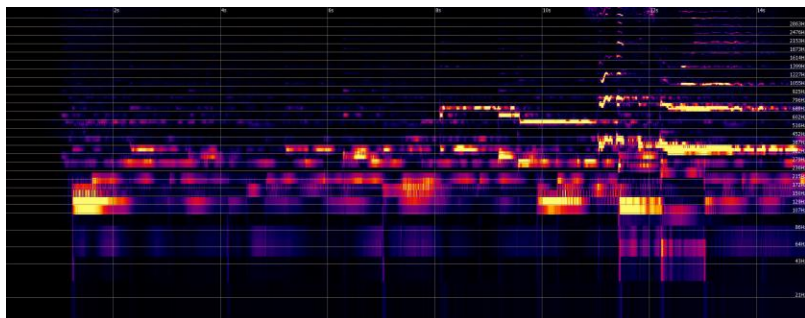Original   Processed

Celine Dion 'Immortality' 15 s – SKENE filter

p2

m10w0

Background

- Time-frequency & time-scale decompositions

- High ratio compression

- Subjective quality

- Theoretical foundations of signal & image processing

- Institute of Mathematics, Polish Academy of Sciences 2004-2011

- Data Science experience

- Long-term project on ancient theatre acoustics

The method

- Diffusion into walls **PL 223995**

- Geometrical rules of reflection in the air

- Wooden theatre

- Proportions of Greek theatre i.e. venue designed for musical performances

- Size of Epidaurus theatre

- Pairs of delay and attenuation

The model

- We consider 2 seconds of impulse response
- We include effects of multiple reflections & propagation into walls
- Pairs of delay and attenuation
- The model is simulated on the computer then applied with VST plug-in or a developed software or uploaded to the DSP unit.
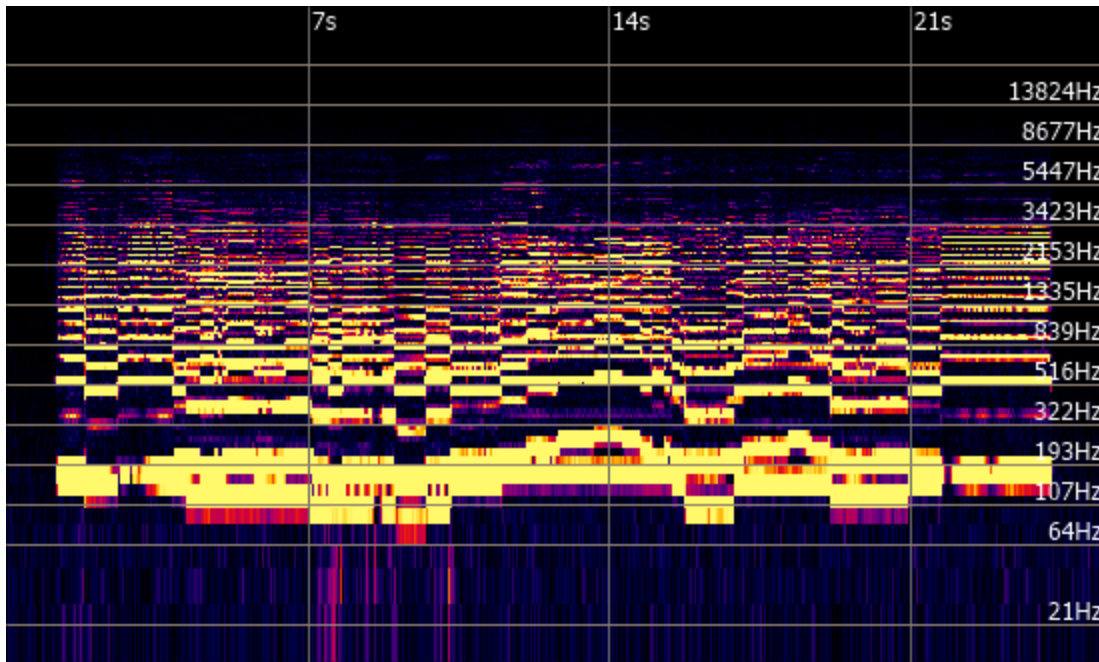
Subjective quality

- Mainly echo and noise cancellation
- Psycho-acoustic effects
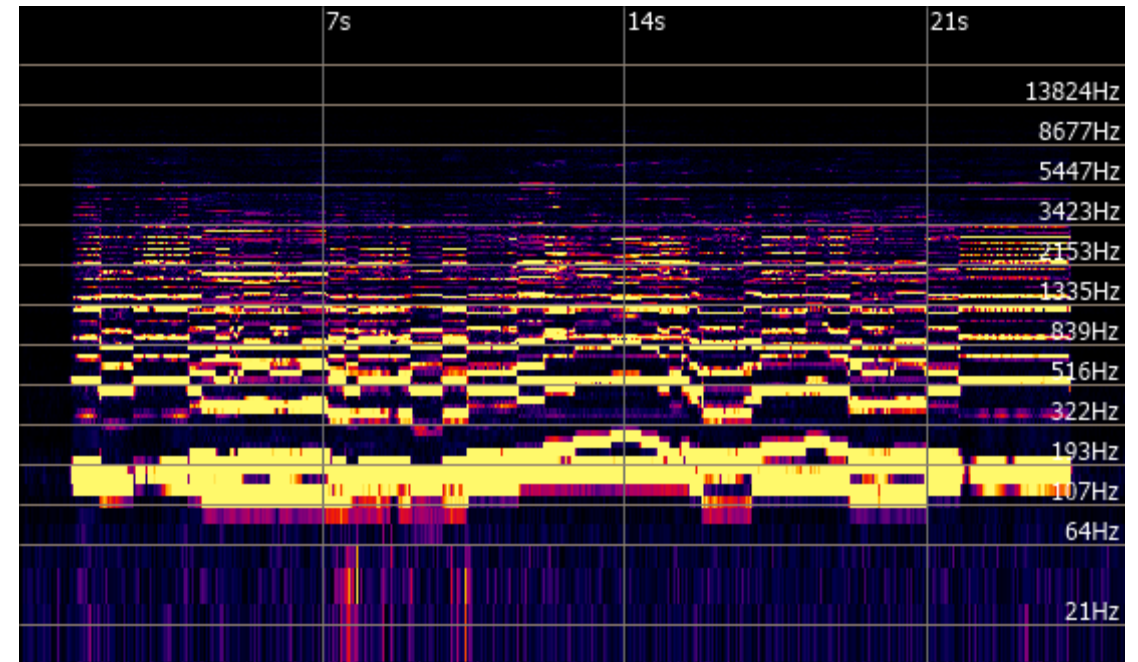- *Head Related Transfer Function
- Surround sound

Example

- On ancient Greek music
  - Promoleth Helikona
- On modern music
  - C. Dion "Immortality"
  - B. Craven "Love scenes"

Stefan Hagel, aulos
Institute for the Study of Ancient Culture
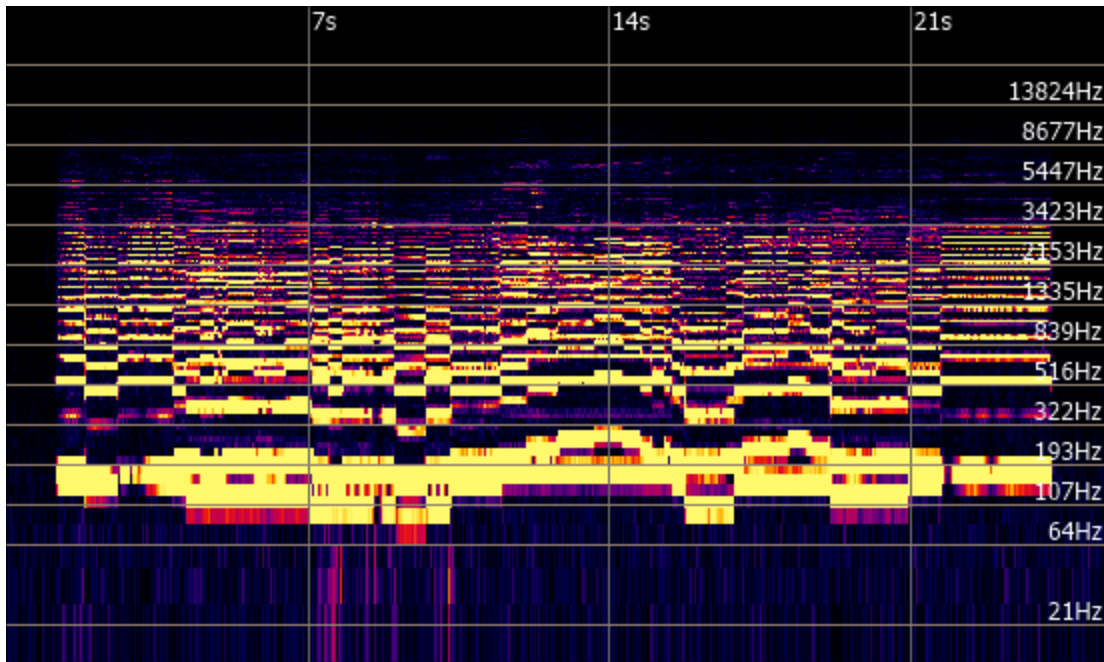## Austrian Academy of Sciences
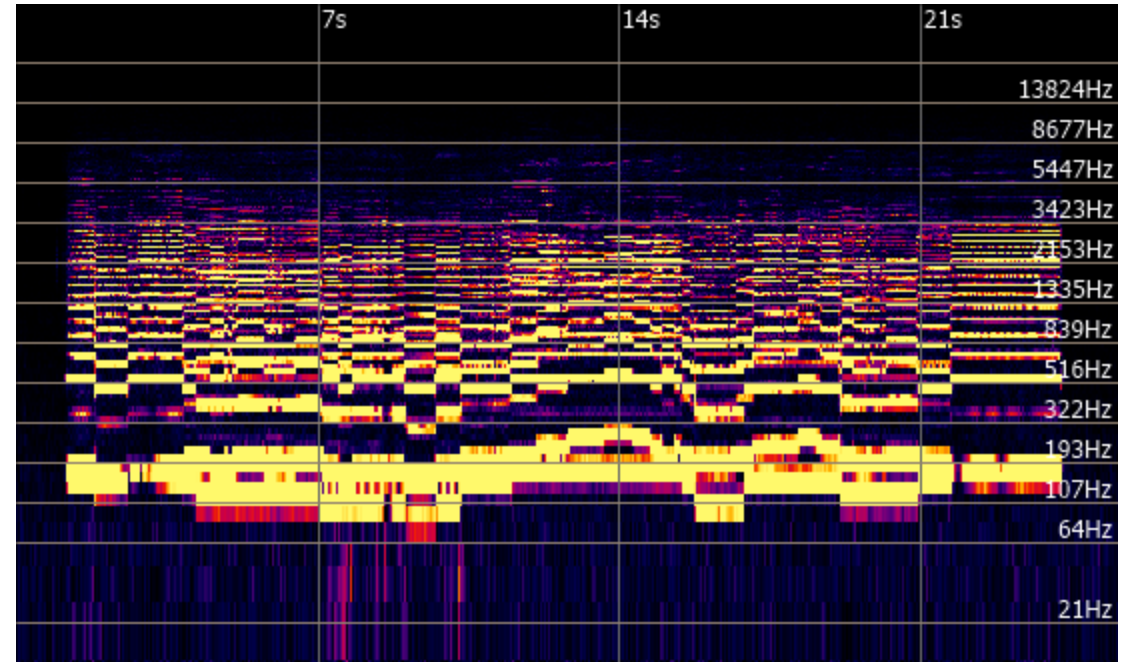

Original

Processed

Stefan Hagel, aulos
Institute for the Study of Ancient Culture
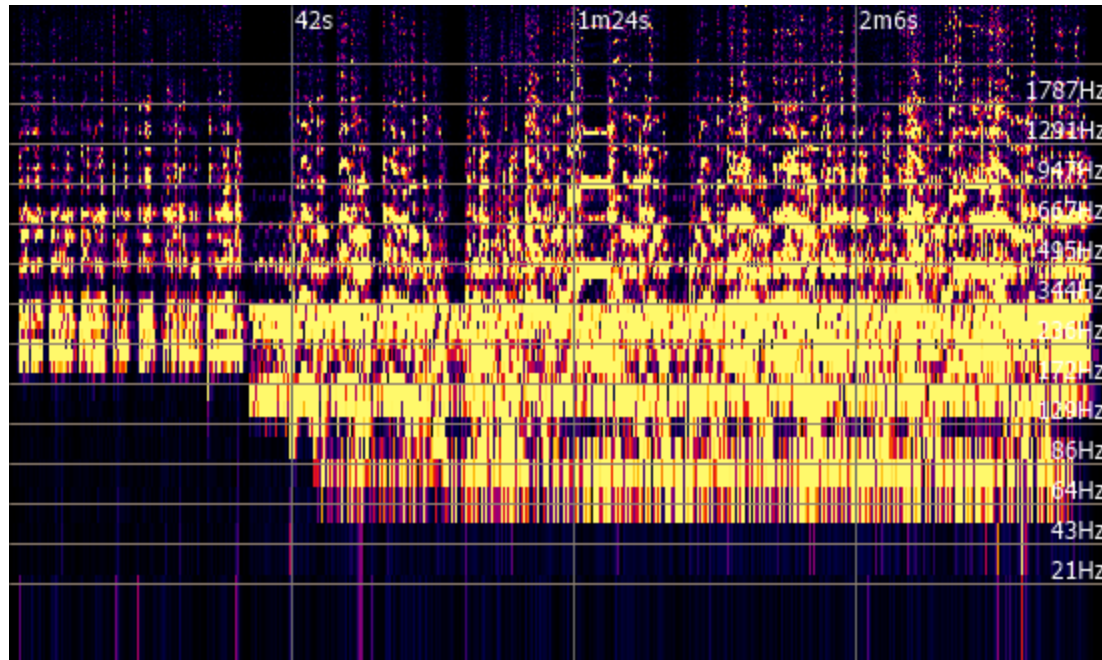Austrian Academy of Sciences

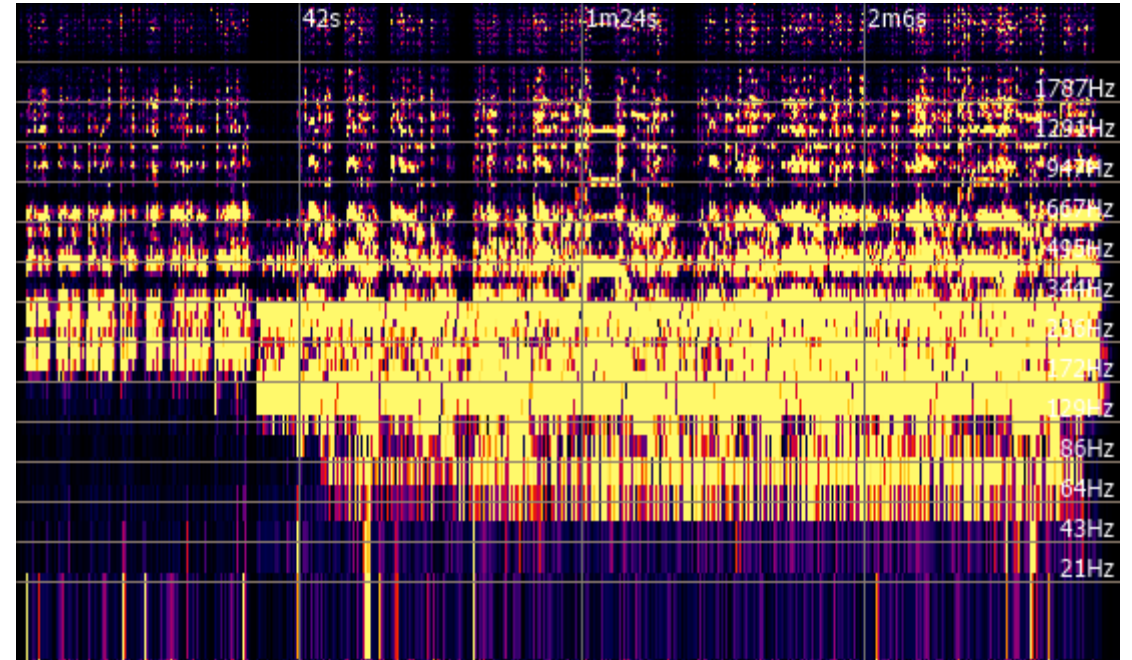Original   SAME

CHOREA / Orkiestra Antyczna [Ancient Orchestra]
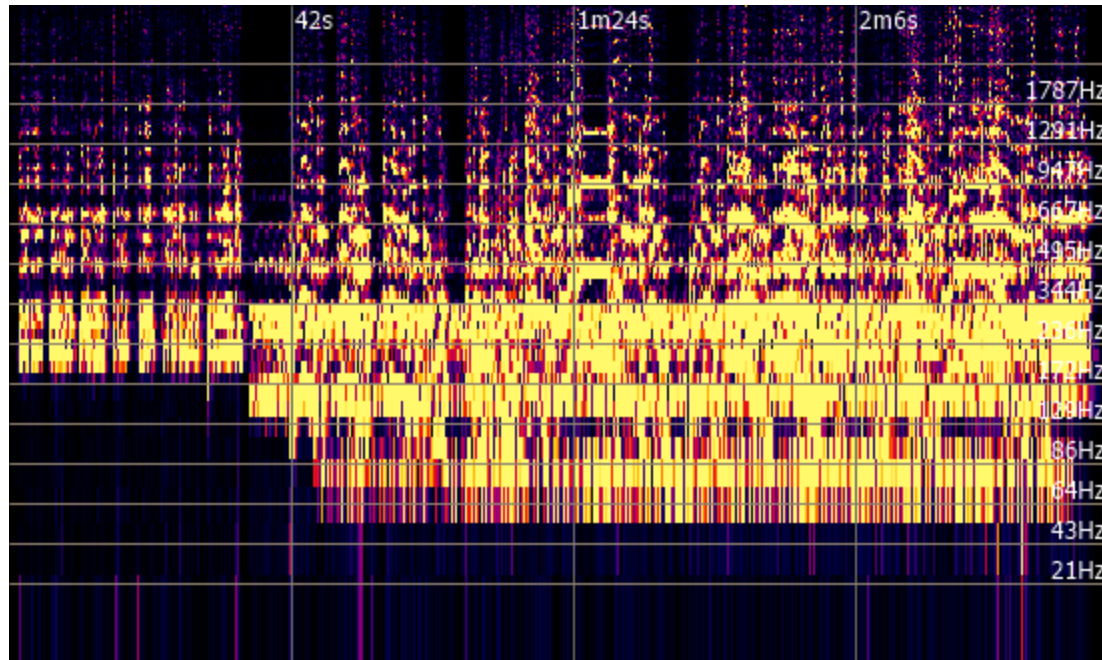## Promoleth Helikona – orchestra filter
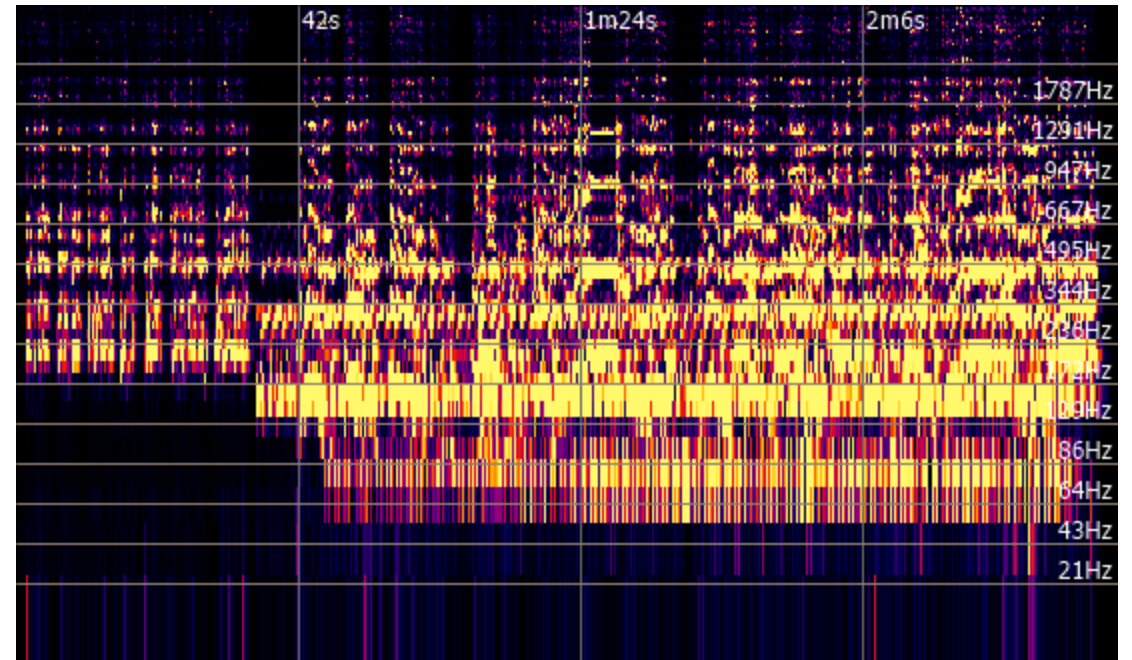

Original   Processed

CHOREA / Orkiestra Antyczna [Ancient Orchestra]
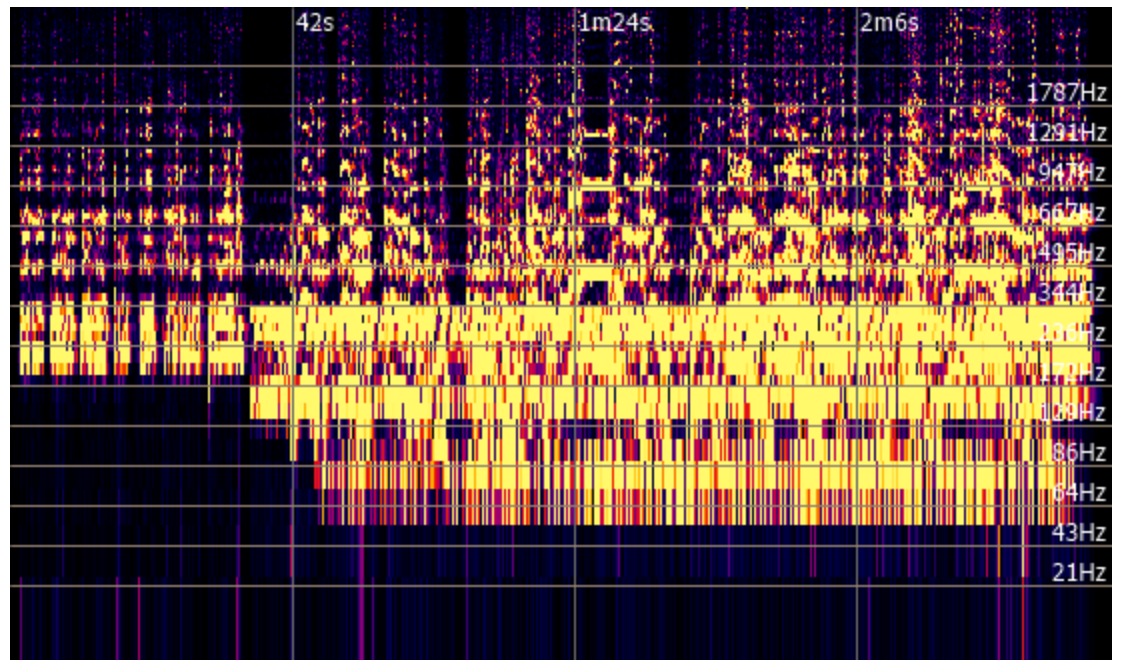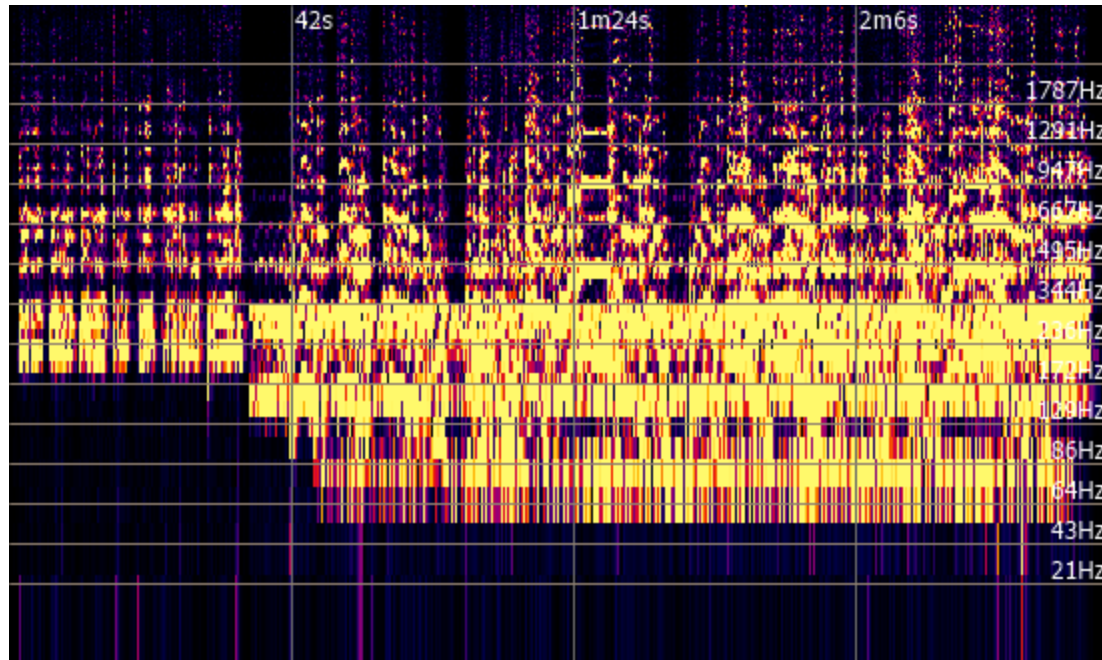## Promoleth Helikona – SKENE filter

Original

Processed

CHOREA / Orkiestra Antyczna [Ancient Orchestra]
Promoleth Helikona – same

Original

Conclusions

- The new method of impulse response reconstruction

- Time-frequency effects

- Impact on the modern music

- Preferably imposed in the post-processing
  - (percussion and clapping are undesired occurences)

Thank you for your attention!