IVOA November 2021. Interoperability Meeting

ASTRONOMICAL DATA SONIFICATION

Towards a proposal for an Auditory Virtual Observatory based on Deep Learning

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CHALLENGES AND CONTEXT

- Allow the automatic auditory exploration of astronomical databases
- Identify the fields in which multimodal representations can be useful in Astronomy
- Develop user-friendly non-time-consuming sonification environments
- Build a proposal of an Auditory Virtual Observatory based on *Deep Learning*
- Expand the possibilities in the use of astronomical data in Music
- Create an astronomical Music composition system using *Artificial Intelligence*

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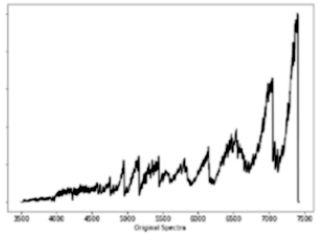
FITS2OSC EXPLORATION PIPELINE CONCEPT

FITS

Computing

PYTHON

Astropy
Numpy
Matplotlib
Python-osc



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OSC (Open Sound Control Protocol)

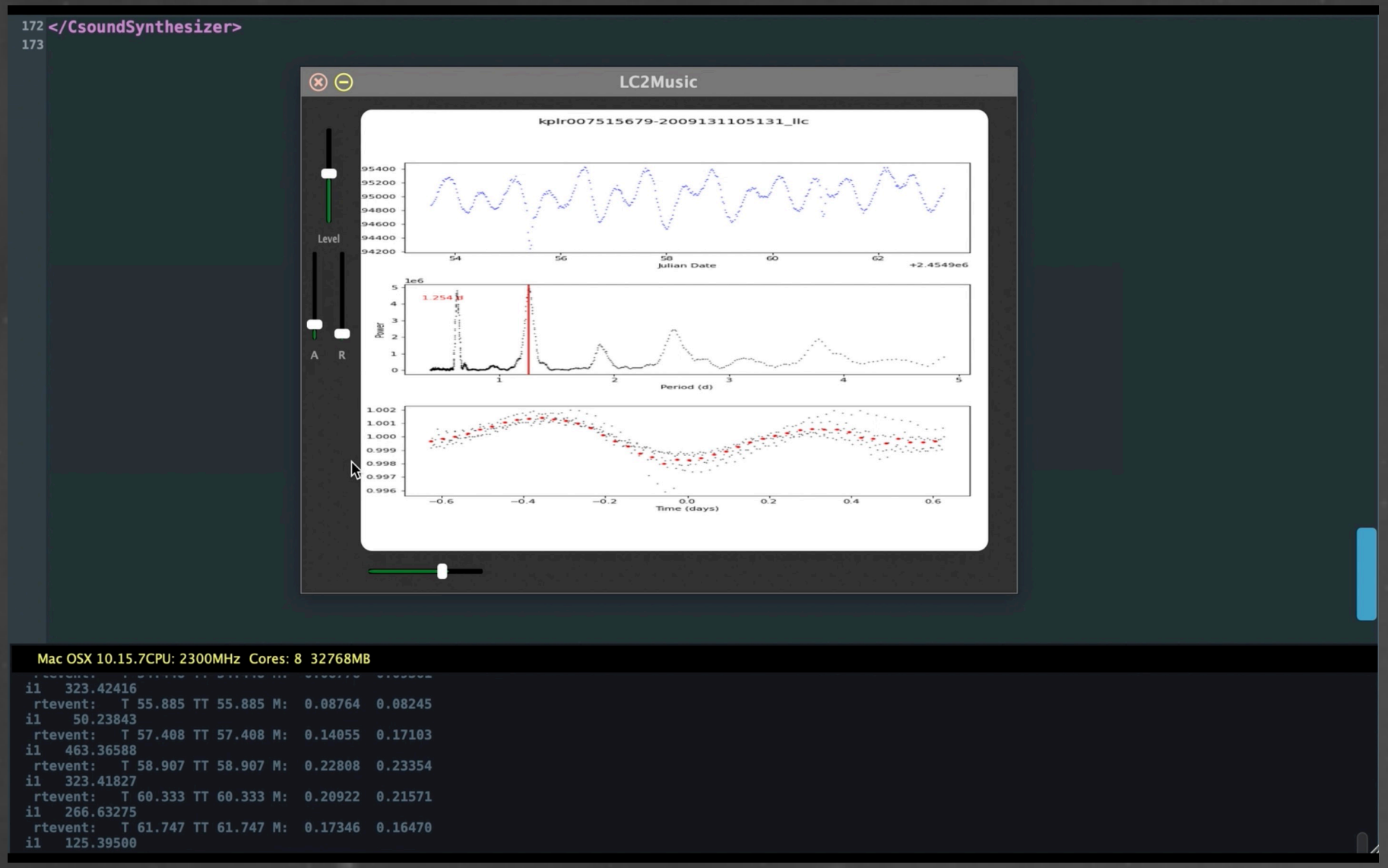
- Library: *Stelib, SVO*
- 256 stellar spectra

CSOUND
&
CABBAGE

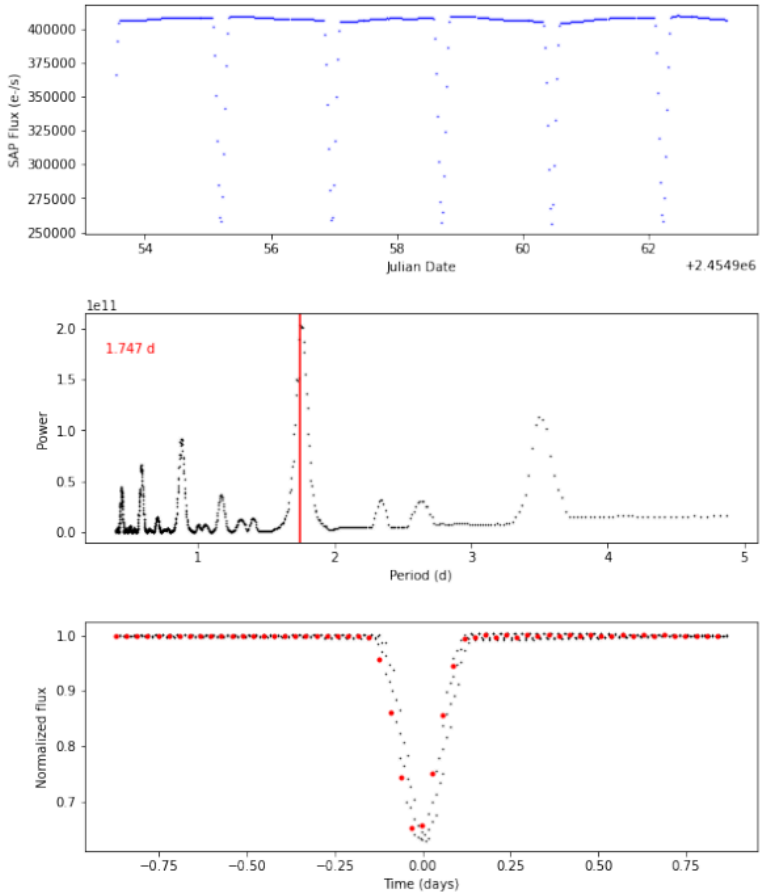
Visualization

Sonification

AUTOMATIC CATALOG EXPLORATION. *STELIB* LIBRARY, *SVO*



BOX LEAST SQUARES (BLS) PERIODOGRAM "BEST FIT" TO NOTE



FITS

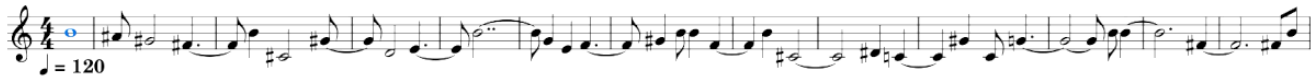
PYTHON

Astropy
Numpy
Matplotlib

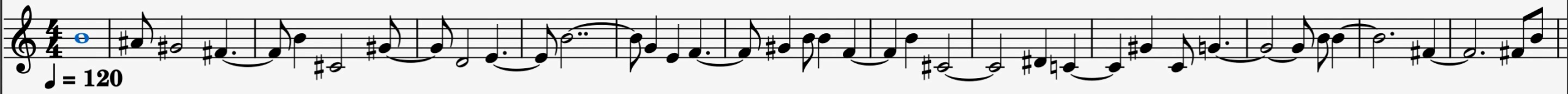
Music21

MUSESCORE

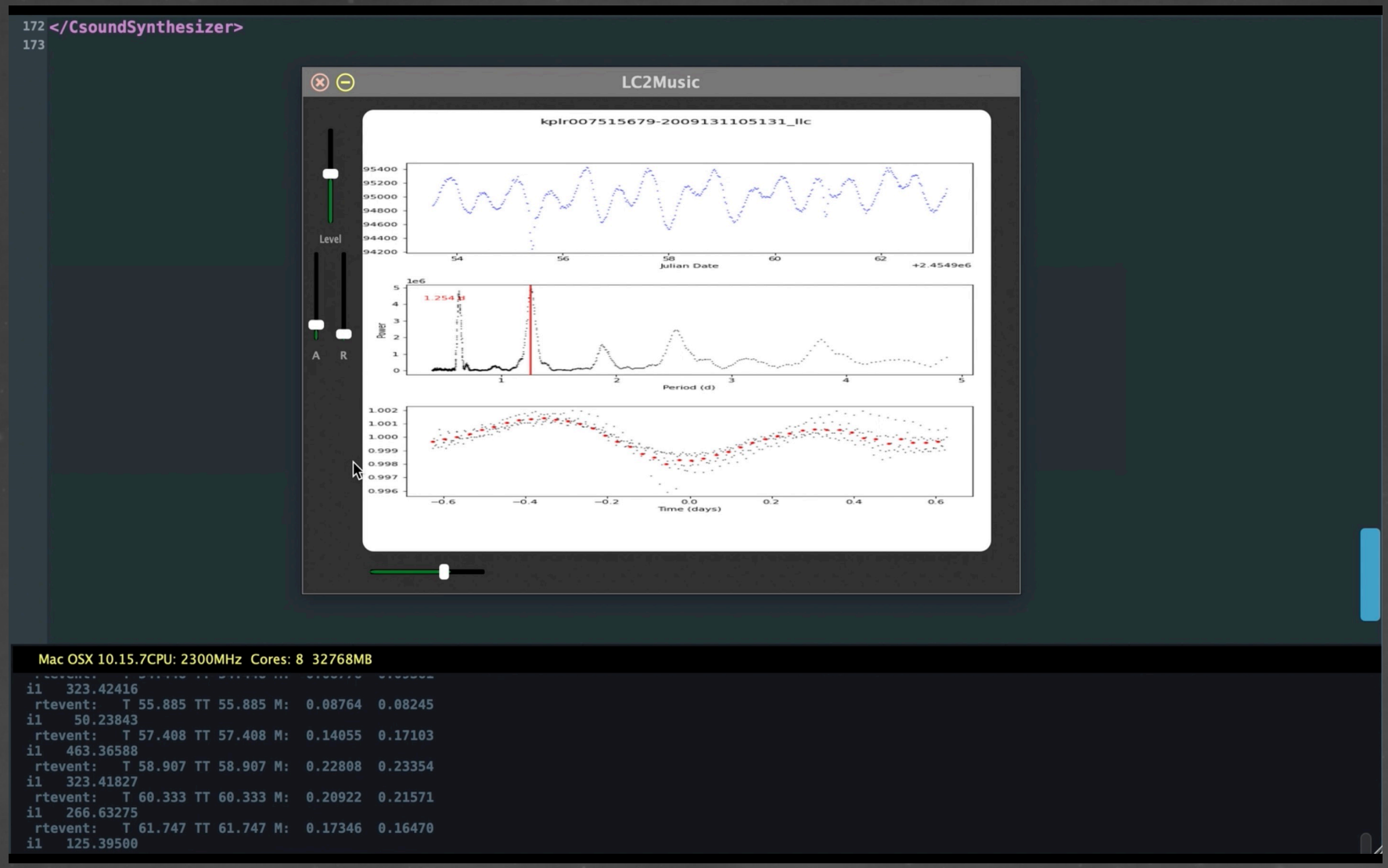
- KOI_Q0_long, *STScI*
- 802 light curves
- f= 100·T_{best}
- Random note durations



PERIODOGRAMS TO SCORE. *KOI* CATALOG, *STSCI*



“BEST FIT” PERIOD TO SYNTHESIZED FLUTE. *KOI* CATALOG, *STSCI.*

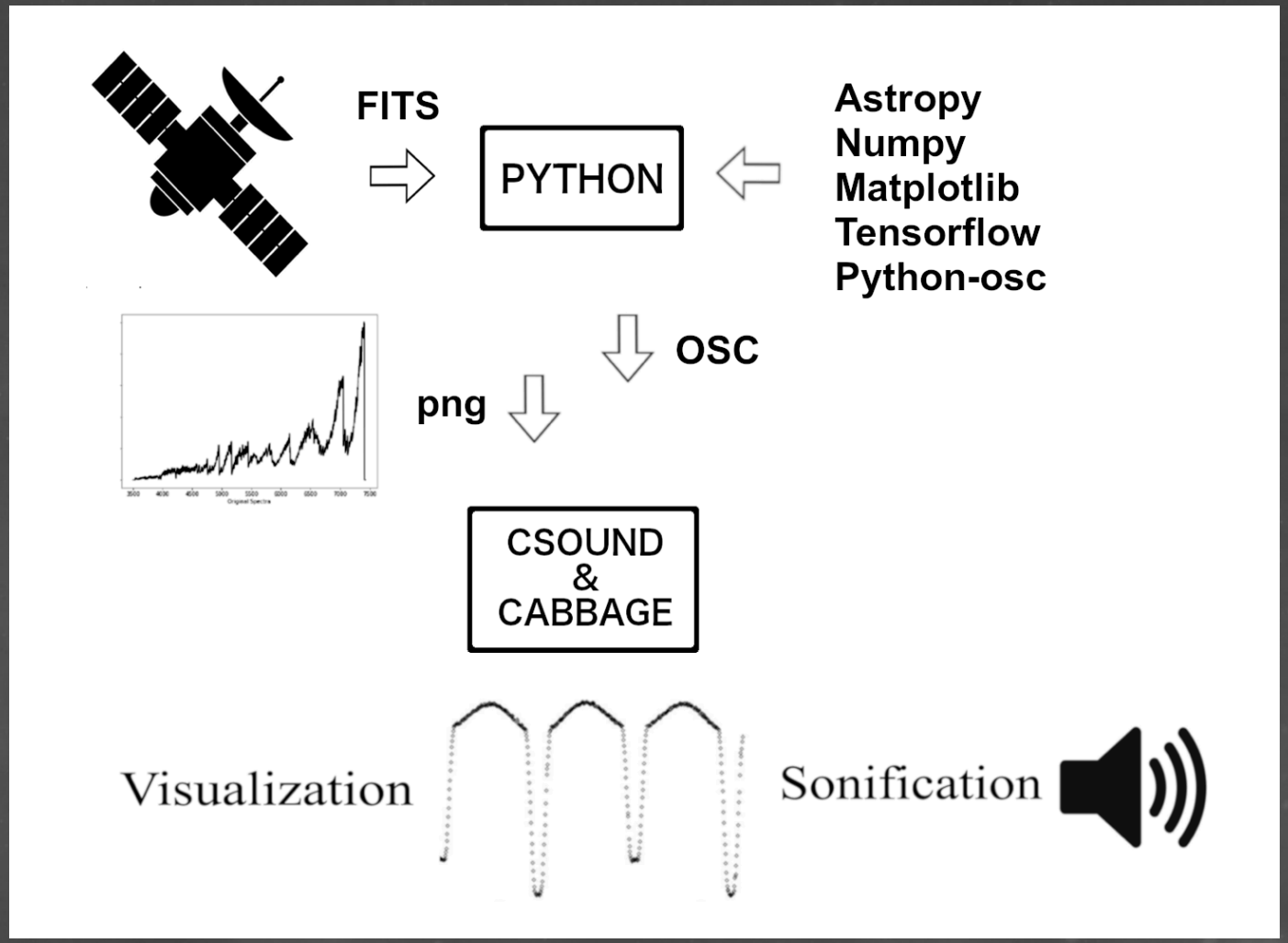


AUTOENCODERS' LATENT SPACE SONIFICATION CONCEPT

- Library: *Miles, SVO*
- Training set : 985 stellar spectra
- Latent space dimensions:
  - Simple autoencoder: 10
  - VAE: 12
- Number of parameters trained:
  - Simple autoencoder: 4,012,525
  - VAE: 3,188,627

Loss results:

  - Simple autoencoder: 0.0022
  - VAE: 0.0158



AUTOENCODER TO NOTES. *MILES* LIBRARY, *SVO*

```
 10 Spectrum represented: miles_spec_fits_s0939
[5064.29493427]
[1590.76094627]
[46.34529352]
[1195.71387768]
[316.55311584]
[244.06403303]
[197.05832005]
[6.30736351]
[9439.50295448]
[23.09888601]
 11 Spectrum represented: miles_spec_fits_s0893
[5325.59633255]
[1529.79403734]
[42.54698753]
[1258.10921192]
[323.71520996]
[244.47411299]
[216.57913923]
[5.93364239]
[9487.2379303]
[22.34250307]
```

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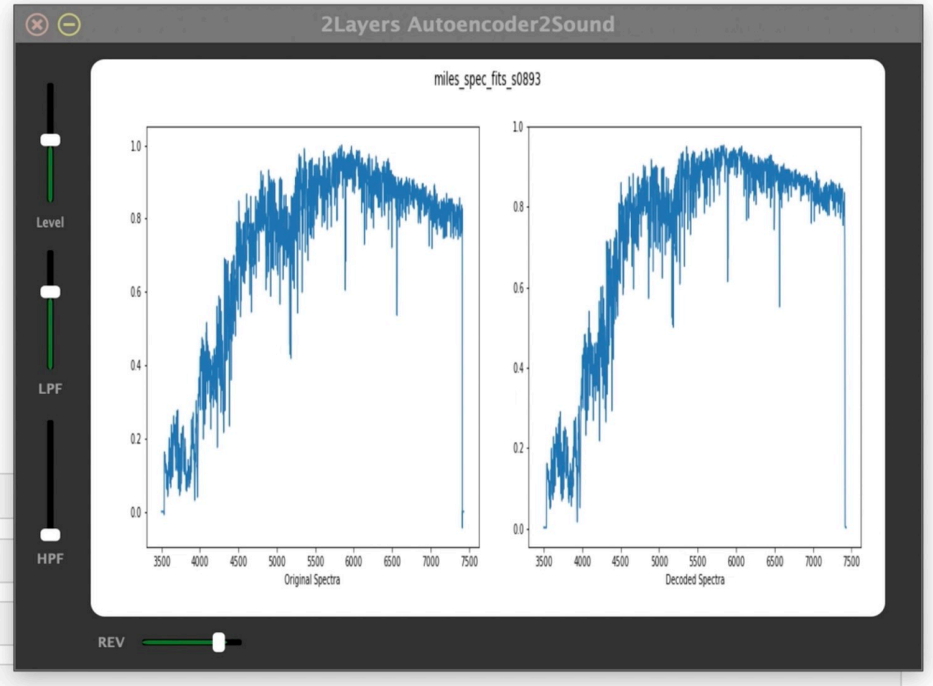
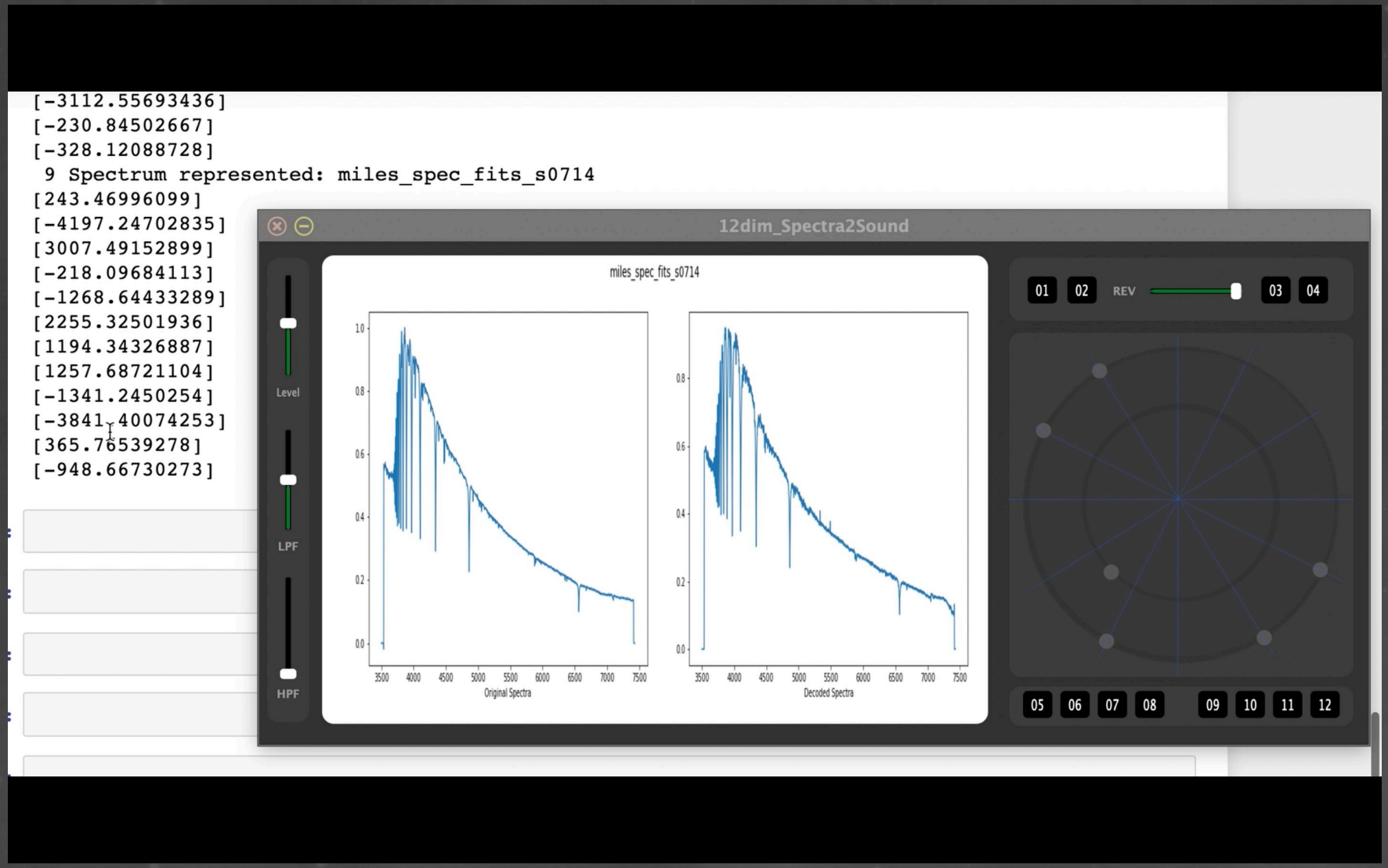


AUTOENCODER TO SPACIALIZED CHORDS. *MILES* LIBRARY, *SVO*



PROSPECTIVE

- Invest efforts in sharing the prototypes with an operational format
- Include Aladin widget, Vizier and Pyvo access
- Publish single target and sequential catalog auditory exploration notebooks
- Analysis and evaluation by specialized and non specialized users
- Collaboration with specialist on science case studies

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Thank you.

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