

# Improving micarraylib a2b: Implementing Array2SH in Python

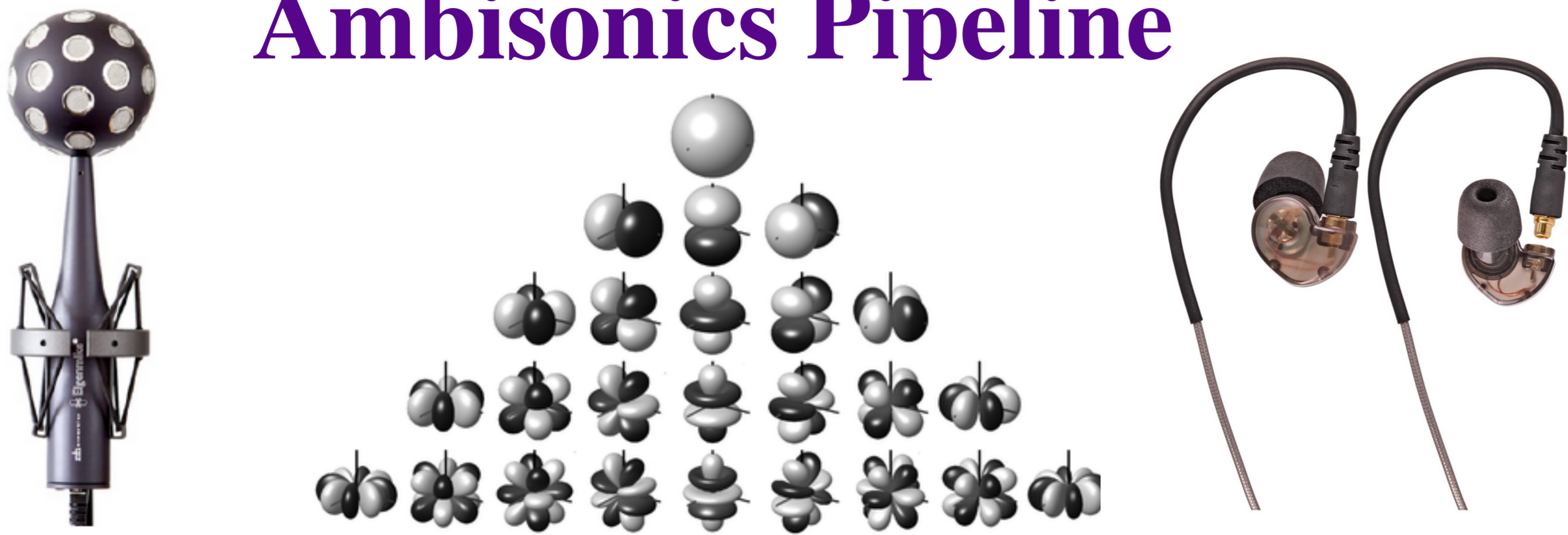
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## Ambisonics Pipeline



Microphone Array    Spherical Harmonic Channels    Listening Environment

- ▶ We translate the Eigenmike32 (shown above) ambisonics encoding pipeline
- ▶ Eigenmike has maximum B-format order of 4

## micarraylib

- ▶ “Python library to download, standardize, and aggregate existing microphone array recordings” (1)
- ▶ Created by Iran R. Roman and Juan P. Bello
- ▶ Featured in DCASE 2021

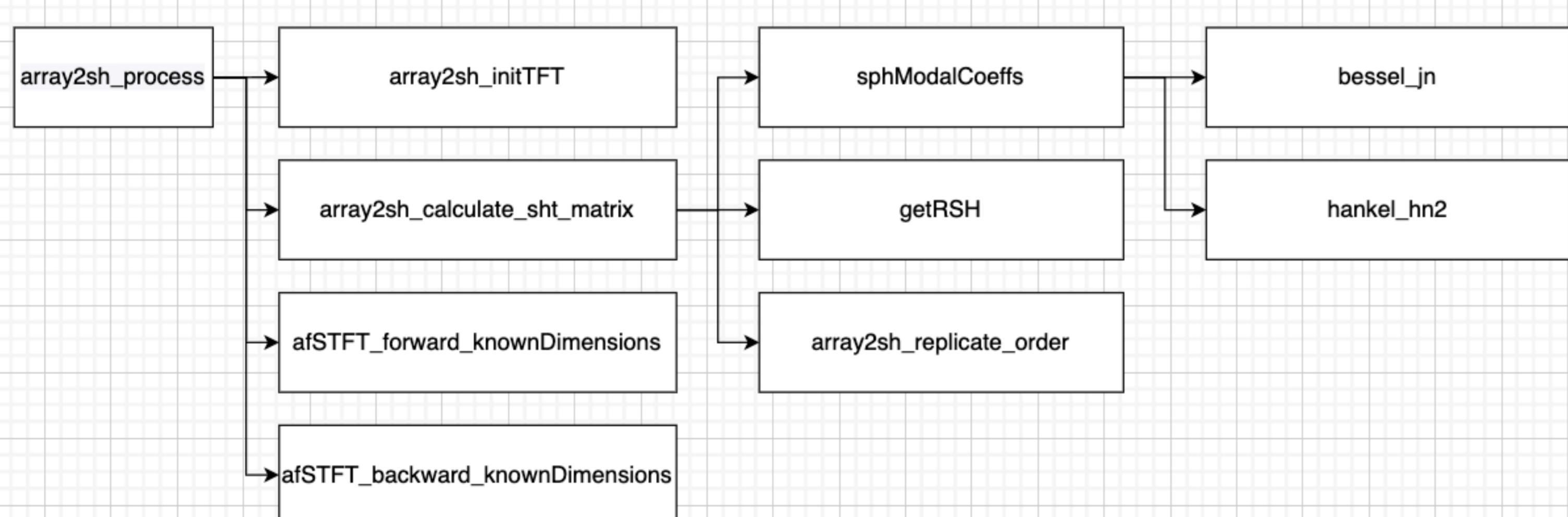
## micarraylib: a2b

- ▶ a2b is the current ambisonics encoder in micarraylib
- ▶ Multiplies signal by spherical harmonic weights for each sensor direction
- ▶ Considers microphone array capsule positions
- ▶ Doesn't consider microphone array capsule directivity, array enclosure, radius of sensors, speed of sound, array shape (spherical v cylindrical)

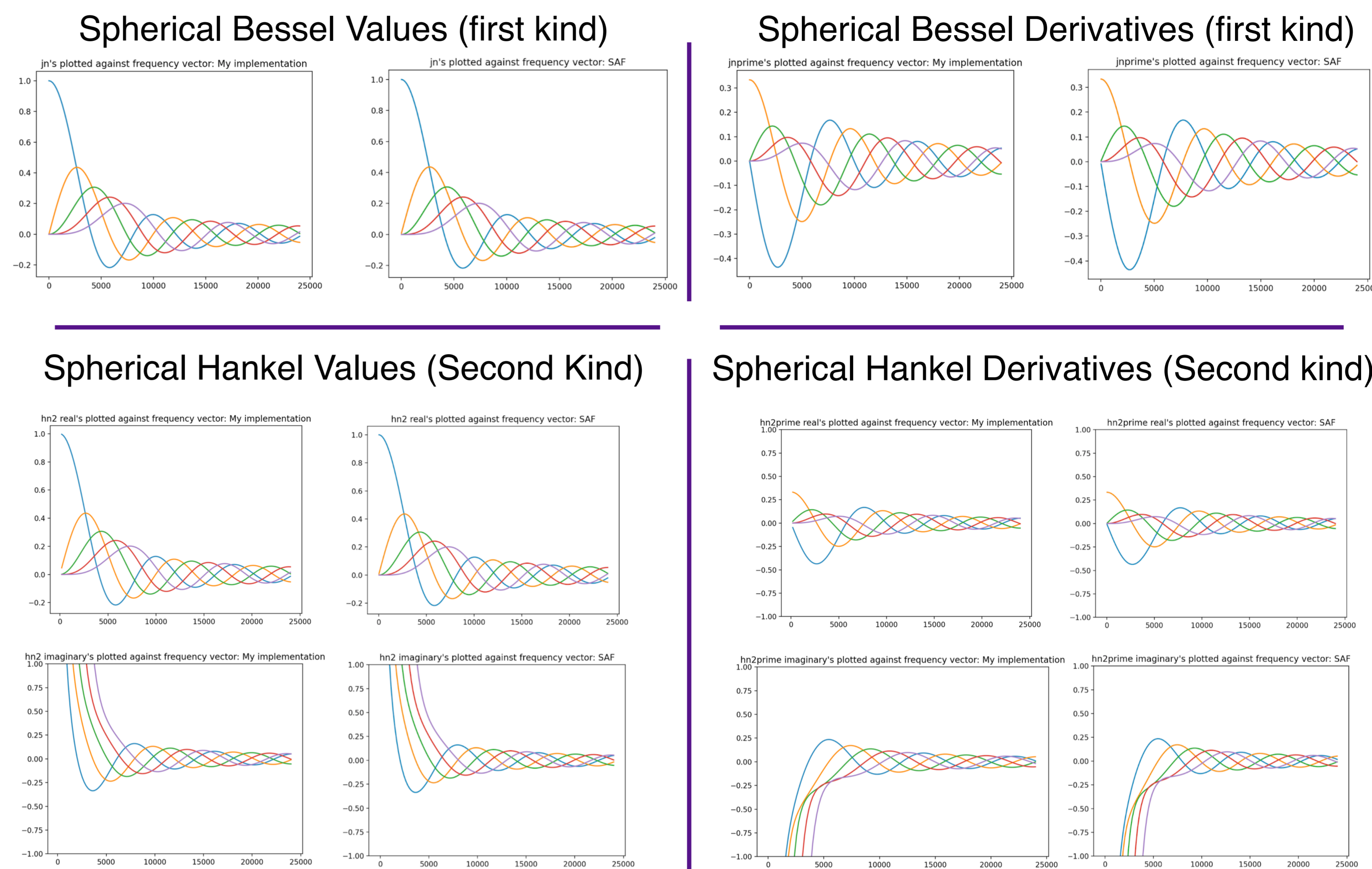
## Array2SH

- ▶ Array2SH is an open source ambisonics encoder plugin written in c
- ▶ Written by Leo McCormack, part of Spatial\_Audio\_Framework repository (2)
- ▶ Frequency dependent filters are generated -> DFT required
- ▶ Considers microphone array capsule directivity, array enclosure, radius of sensors, speed of sound (air v water), array shape (spherical v cylindrical)

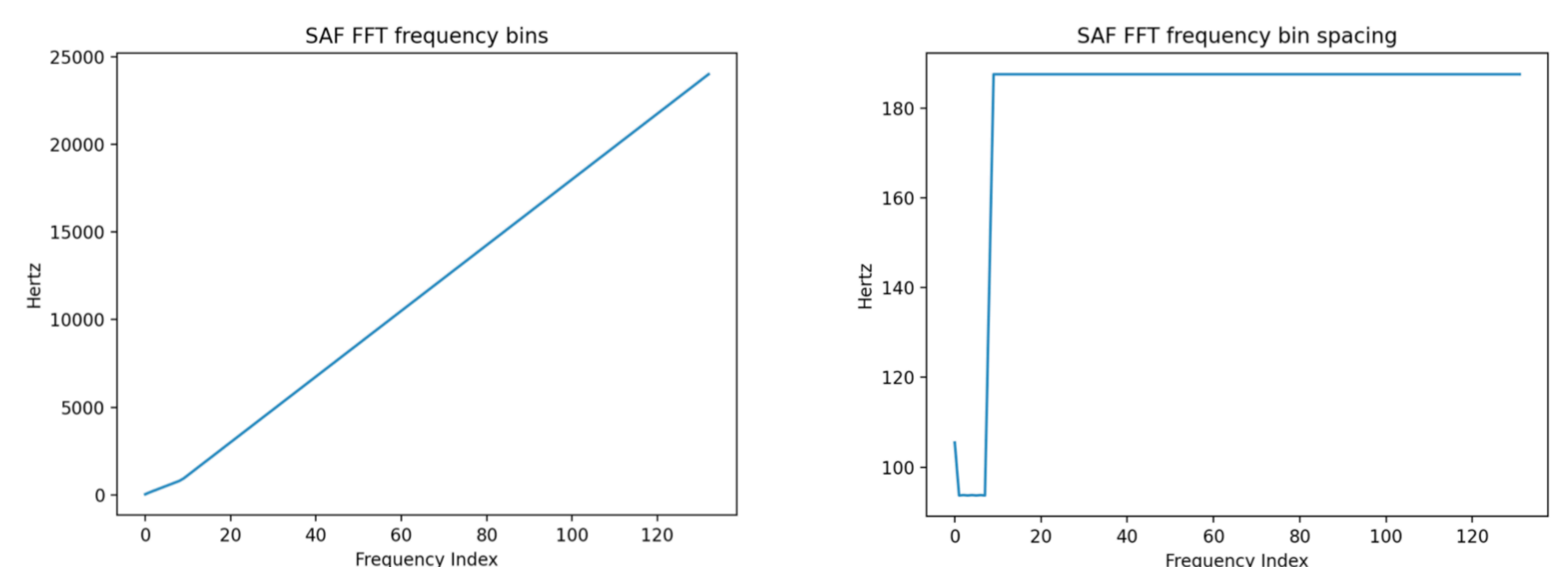
### Abbreviated array2sh\_process calls (EM32 Test):



## Tests



## DTFT in Array2SH



- ▶ array2sh\_process takes 128-sample frames over hops of 128 sample
- ▶ nFFT = 133, only positive frequencies
- ▶ We 0-padded to 264 for each frame to get 133 bands
- ▶ Array2SH has nonlinear frequency bin spacing
- ▶ Array2SH has no DC component

## DTFT implementation solutions

- ▶ Sample Rate Conversion
  - ▶ “Bandlimited Interpolation” provides a solution to computing different length DFT's (3)
  - ▶ Use resampy: “band-limited sinc interpolation method” (4)
- ▶ 0-Padding: Copy the signal and 0-pad to different lengths pre-FFT

## Next Steps

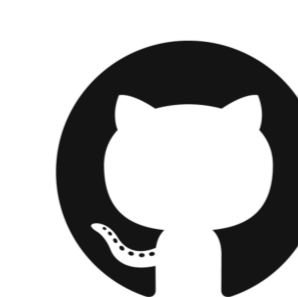
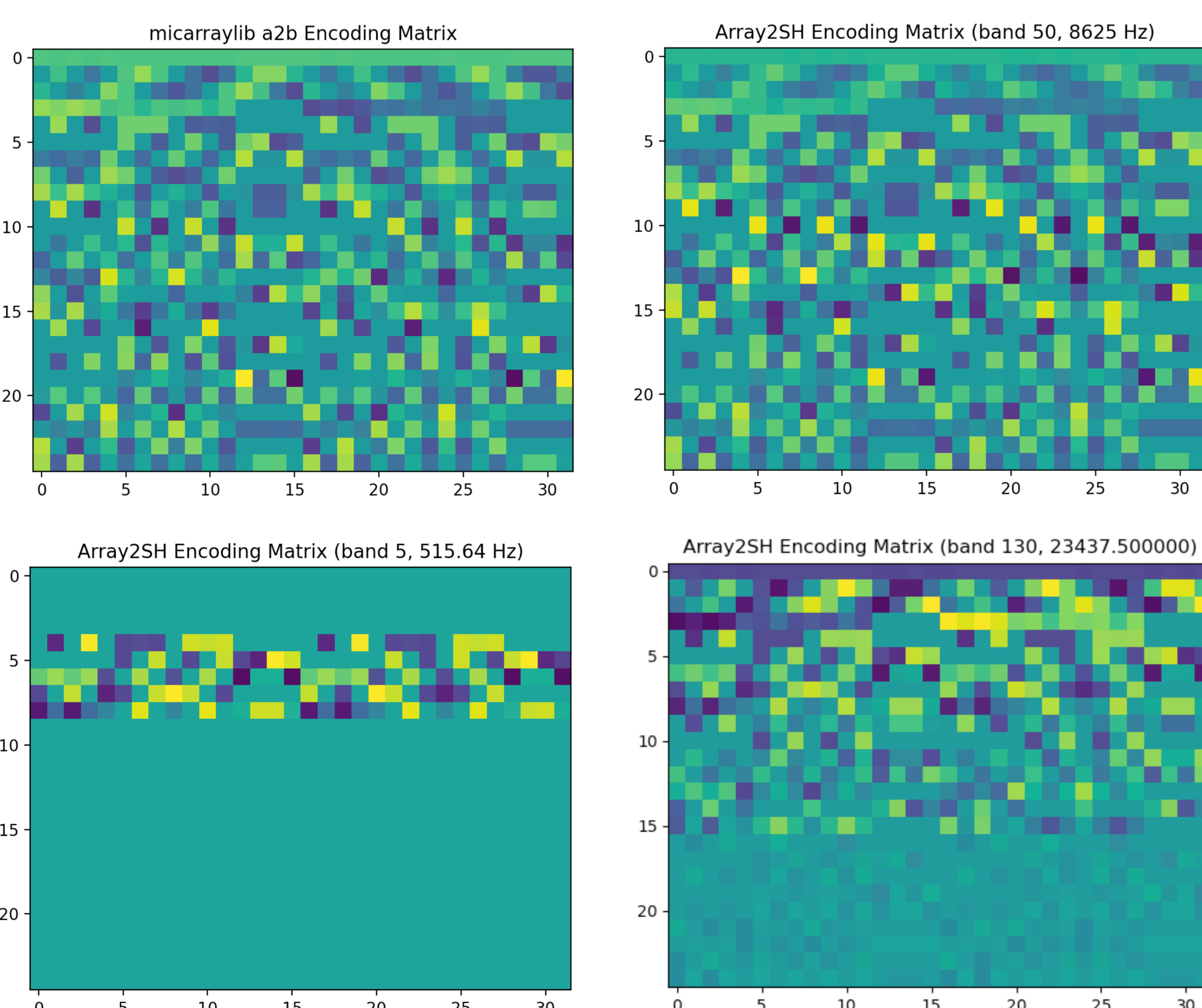
- ▶ Create FFT from resampling or 0 - padding method
- ▶ Create pipelines for other microphone directivities, array shapes, and array construction (baffle v open)

## References

- 1: <https://github.com/micarraylib/micarraylib>
- 2: [https://github.com/leomccormack/Spatial\\_Audio\\_Framework](https://github.com/leomccormack/Spatial_Audio_Framework)
- 3: [https://ccrma.stanford.edu/~jos/resample/What\\_Bandlimited\\_Interpolation.html](https://ccrma.stanford.edu/~jos/resample/What_Bandlimited_Interpolation.html)
- 4: <https://resampy.readthedocs.io/en/master/>

Pictures:

- [https://chem.libretexts.org/Bookshelves/Physical\\_and\\_Theoretical\\_Chemistry\\_Textbook\\_Maps/Physical\\_Chemistry\\_\(LibreTexts\)/06%3A\\_The\\_Hydrogen\\_Atom/6.02%3A\\_The\\_Wavefunctions\\_of\\_a\\_Rigid\\_Rotator\\_are\\_Called\\_Spherical\\_Harmonics](https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Physical_Chemistry_(LibreTexts)/06%3A_The_Hydrogen_Atom/6.02%3A_The_Wavefunctions_of_a_Rigid_Rotator_are_Called_Spherical_Harmonics)
- [https://www.researchgate.net/figure/Eigenmike-by-mh-acoustics-32-capsule-microphone-that-can-record-in-Ambisonics\\_fig10\\_280010078](https://www.researchgate.net/figure/Eigenmike-by-mh-acoustics-32-capsule-microphone-that-can-record-in-Ambisonics_fig10_280010078)
- <https://www.gear4music.ie/Recording-and-Computers/SubZero-SZ-IEM-In-Ear-Monitors/1SDF>



@micarraylib