

# Zyphra ZUNA: BCI Foundation Model Uses 4D Rotary Encoding to Generalize Across Any EEG System

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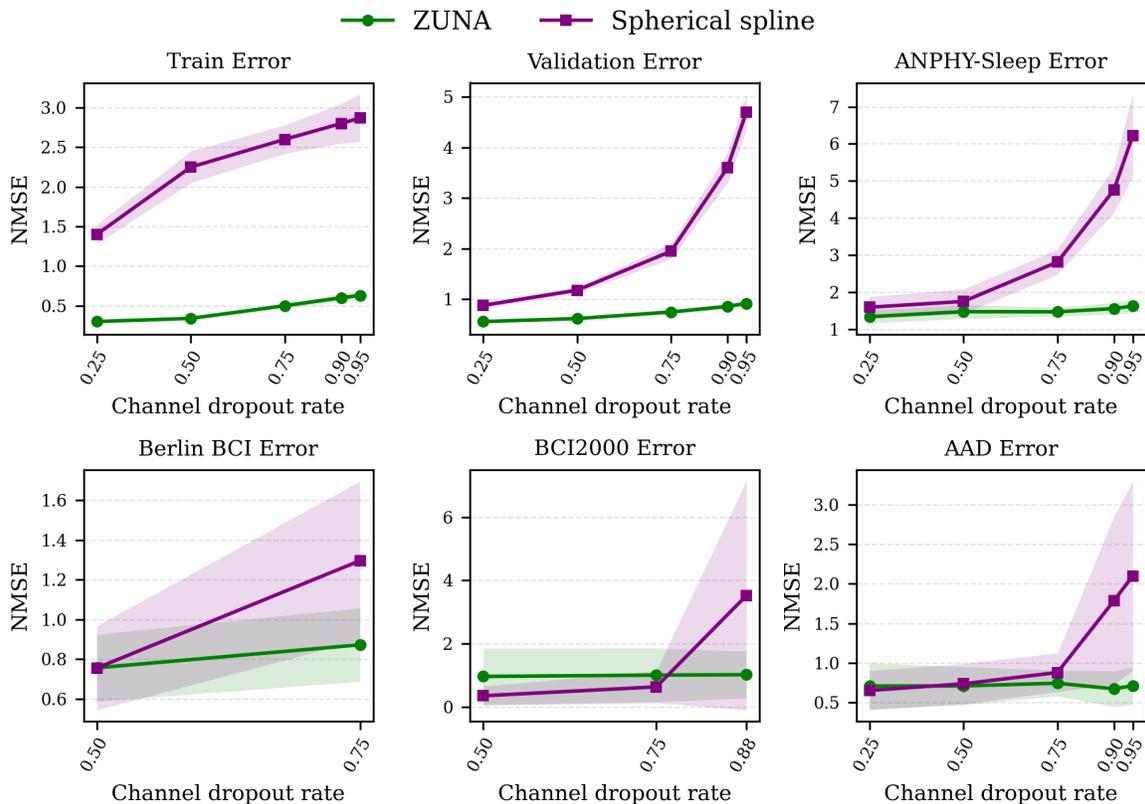


Figure 1: Zyphra ZUNA

Zyphra released ZUNA, a 380M-parameter foundation model for EEG (electroencephalogram) signals. It uses 4D Rotary Positional Encoding to map each EEG token to a 4D coordinate: 3D scalp position (x, y, z) plus a time index. This lets it process any channel layout without assuming a fixed electrode grid. The model is a masked diffusion autoencoder trained by randomly dropping 90% of channels and reconstructing them from the remaining 10%. Training data spans 208 public datasets, roughly 2 million channel-hours. ZUNA outperforms spherical-spline interpolation (the standard method), across all benchmarks. The gap widens sharply at high dropout rates where spline methods fail.

EEG models have historically broken when applied to datasets with different electrode counts or positions. ZUNA eliminates that constraint. Researchers can recover partially corrupted recordings instead of discarding them. Consumer EEG headsets, which use fewer electrodes to stay portable and affordable, can be computationally upsampled toward lab-grade resolution. The model runs on a consumer GPU or CPU and installs with `pip install zuna`. For clinical and research labs, this removes the dependency on fixed electrode layouts that has fragmented the field and made cross-dataset analysis impractical.

Zyphra positions ZUNA as a first step toward thought-to-text, which they frame as the next modality after language, audio, and vision. The open release with full MNE-Python compatibility could make ZUNA shared infrastructure for brain-computer interface research, similar to how pretrained language models became standard in NLP. If this approach scales, the gap between what consumer headsets measure and what clinical systems decode narrows considerably, moving noninvasive brain-computer interfaces closer to deployment outside controlled labs.

Sources:

- [Zyphra ZUNA Technical Details](#)
- [ZUNA Technical Paper](#)
- [MarkTechPost: Zyphra ZUNA](#)
- [ZUNA on HuggingFace](#)

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