

# 1 Microelectrode electrophysiology: Extending the 2 Brain Imaging Data Structure to intracellular and 3 extracellular recordings in animal models

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## 5 **ABSTRACT**

The Brain Imaging Data Structure (BIDS) has facilitated data sharing and tool development in human neuroimaging. We present an extension for microelectrode electrophysiology recordings in animal models, addressing the unique requirements of intracellular and extracellular recordings. This extension introduces two new data types: 'icephys' for intracellular and 'ecephys' for extracellular recordings, supporting diverse recording modalities from patch-clamp to high-density silicon probes. Building on existing BIDS principles and prior electrophysiology extensions, we specify metadata for probes, electrodes, and channels, with particular attention to metadata required for spike sorting analysis. The extension adopts NWB (Neurodata Without Borders) and NIX (Neuroscience Information Exchange) as data formats, ensuring comprehensive metadata capture while maintaining compatibility with existing analysis ecosystems. We provide example datasets covering common use cases and demonstrate integration with established tools including [Which tools?]. This standardization enables reproducible analysis pipelines, facilitates data sharing through repositories like DANDI, G-Node and EBRAINS, and bridges scales from cellular to systems neuroscience.

## 7 **Background & Summary**

8 Microelectrode electrophysiology encompasses techniques for recording electrical activity from individual neurons to local  
9 field potentials, providing crucial insights into neural computation. Recent technological advances, including high-density  
10 silicon probes and standardized probe designs through the Neuropixels project, have dramatically increased data acquisition  
11 rates and experimental complexity.

12 While comprehensive data formats exist for neurophysiology (NWB; NIX), the field lacks standardized organization  
13 principles for datasets, metadata specifications, and directory structures. This fragmentation impedes data sharing, with surveys  
14 indicating [ADD SURVEY DATA] of researchers struggling to share or reuse electrophysiology data due to inconsistent formats  
15 and missing metadata.

16 BIDS has successfully standardized human neuroimaging data organization [cite], with over 850 datasets on OpenNeuro  
17 [cite] and adoption by major repositories. Prior BIDS extensions for human electrophysiology (EEG [cite], MEG [cite], iEEG  
18 [cite]) established patterns for organizing time-series neural data, while the Microscopy extension [cite] introduced critical  
19 metadata fields for animal data.

20 Microelectrode recordings present unique challenges: (1) electrode scales spanning orders of magnitude (sub-micron tips  
21 to millimeter arrays), (2) diverse probe geometries requiring specialized coordinate systems, (3) spike sorting as an essential  
22 preprocessing step requires specific metadata,

23 Here we present BEP032, extending BIDS to microelectrode electrophysiology, with a focus on animal models. This  
24 extension: [summarize key contributions]

## 25 **Methods**

### 26 **Community Development Process**

27 The development of BEP032 began in [DATE] through the INCF Working Group on Standardized Data Structures.

28 **Scope and Design Principles**  
29 *Inclusion Criteria*  
30 *Design Decisions*  
31 **Directory Structure and File Organization**  
32 *Data Type Specification*  
33 *Required and Optional Files*  
34 **Metadata Specifications**  
35 *Inheritance Principle*  
36 *Required Metadata Fields*  
37 *Animal-Specific Metadata*  
38 **Probe, Electrode, and Channel Specifications**

*probes.tsvSpecification*  
*electrodes.tsvSpecification*  
*channels.tsvSpecification*

39 **Coordinate Systems**  
40 *Stereotaxic Coordinates*  
41 *Atlas-Based Coordinates*  
42 *Probe-Relative Coordinates*  
43 **Spike Sorting and Derivatives**  
44 *Spike Sorting Outputs*  
45 *Provenance Tracking*  
46 **Integration with Existing Tools**  
47 *Conversion Tools*  
48 *Analysis Pipelines*  
49 **Data Records**

50 Example datasets demonstrating the specification are available at [REPOSITORY]. Table ?? summarizes the datasets, recording  
51 techniques, and use cases.

52 **Dataset 1: Acute Silicon Probe Recording**  
53 **Dataset 2: Chronic Tetrode Recording**  
54 **Dataset 3: Patch Clamp with Optogenetics**  
55 **Dataset 4: Neuropixels Multi-Region Recording**  
56 **Technical Validation**

57 **Validator Compliance**  
58 **Round-Trip Conversion**  
59 **Cross-Tool Compatibility**  
60 **Performance Benchmarks**  
61 **Usage Notes**

62 **Converting Existing Data**  
63 **Recommended Workflows**  
64 **Integration with Other Modalities**  
65 **Repository Submission**  
66 **Code availability**

67 BEP032tools [VERSION] provides validation and conversion utilities: [GITHUB LINK] Example conversion scripts are  
68 available at: [GITHUB LINK] The specification is maintained at: <https://github.com/bids-standard/bids-specification>

69 **References**

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71 **Author Contributions**

72 **Competing Interests**

73 The authors declare no competing interests.

Figures & Tables

**Figure 1.** Overview of the BIDS microelectrode electrophysiology extension. (a) Directory structure showing icephys and ecephys datatypes. (b) Metadata inheritance hierarchy. (c) Relationship between probes, electrodes, and channels. (d) Integration with analysis tools and repositories.

**Table 1.** Required and optional files for microelectrode electrophysiology recordings

**Table 2.** Required metadata fields and their descriptions

**Table 3.** Channel types for microelectrode recordings

**Table 4.** Example datasets demonstrating the specification