BIDS Extension Proposal NIBS(BEP0TBA):

Template

version 0.0.1

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| This document contains a draft for non-invasive brain stimulation (NIBS) BIDS. It is a community effort to define standards in data / metadata storage for NIBS field. This is a working document in draft stage and any comments are welcome.  This specification is an extension of BIDS, and general principles are shared. The specification should work for many different settings and facilitate the integration with other imaging methods.  To see the original BIDS specification, see [this link](https://bids-specification.readthedocs.io). This document inherits all components of the original specification (e.g. how to store imaging data, events, stimuli and behavioral data), and should be seen as an extension of it, not a replacement. |
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# 2. Scope of NIBS-BIDS

This proposal extends the Brain Imaging Data Structure (BIDS) specification for non-invasive brain stimulation (NIBS) techniques i.e., transcranial magnetic stimulation (TMS), transcranial electrical stimulation (tES), transcranial focused-ultrasound stimulation (tFUS), both for standalone experiments or in combination with a neuroimaging technique, e.g.: electro- or magnetoencephalography, magnetic resonance imaging, … These data have Y PROPERTY.

## 2.1. Goals of NIBS-BIDS

This extension is motivated by the need to develop a reference schema for systematic and structured reporting of experimental practices in a machine-readable way.

It seeks to specify file types and metadata for a TMS experiment where the brain stimulation is combined with a detection technique, including: plain collection of behavioral responses, neuroimaging techniques, etc. ...

Cases D and E are not considered within the scope of this extension.

For all the cases, it was developed a standardized file structure to keep track of information related to three domains of data:

1. General information related to the stimulation system, including device manufacturers and (optional) neuronavigation systems;
2. Spatial localization related to both the coordinate system and the location of the pulses throughout the scalp;
3. Temporal information related to the timing.

## 2.2. Relation of NIBS-BIDS to BIDS

Most core principles of the original BIDS-Raw specification are inherited by the neuroimaging/behavioural specification, though some special considerations and additional fields are noted below.

## 2.3 Describing brain state manipulations rather than acquisitions

NIBS techniques, by definition, are not related to specific ways to represent and detect brain states. That is why systematic, machine readable descriptions of experiments taking advantage of these techniques are not centered on how to store information, file formats etc.

The abstract way in which this kind of technique is represented in this specification is as a rich, machine readable integration to a BIDS-compliant, standalone description of an experimental setup.

That is why this specification follows a strict “stick to BIDS” principle whenever possible, instantiated in the following guidelines:

* No proliferation of new / unnecessary descriptor files;
* Integration of standard BIDS files with ad-hoc information;
* Systematic use of the json sidecars to explain ad-hoc information.

Ideally, a well-formed NIBS-BIDS collection of data could even be a BIDS-compliant dataset where the NIBS-related information is stored in the task-events tsv files and described in the json sidecar.

## 2.4 Keywords and terminology

Please refer to general BIDS specification document for context and general guidelines (definitions, units, directory structure, missing values, stimulus and event information, etc.).: <https://bids-specification.rtfd.io>

The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [[RFC2119](https://www.ietf.org/rfc/rfc2119.txt)].

The terminology that will be used is inherited from BIDS-Raw and includes the following:

* Subject: A human participant whose brain was stimulated using NIBS
* Session: a non-intermittent period during which the subject undergoes a set of experiments under the same conditions. There might be several sessions for the same Subject

# 3. NIBS-BIDS

BIDS contains “required”, “recommended” and “optional” fields. These are indicated throughout the document:

* REQUIRED: essential to be BIDS compliant (i.e., MUST as per RFC2199)
* RECOMMENDED: gives a warning if not present (i.e., SHOULD as per RFC2199)
* OPTIONAL: no warning if missing (i.e., MAY as per RFC2199)

As in BIDS-Raw, the following apply:

1. All specifications of paths need to use forward slashes.
2. The inheritance principle applies: any metadata file (.json, .tsv, etc.) may be defined at any directory level. The values from the top level are inherited by all lower levels unless they are overridden by a file at the lower level. For details see BIDS-Raw ([The Inheritance Principle](https://bids-specification.readthedocs.io/en/stable/02-common-principles.html#the-inheritance-principle)).

## 3.1. Storing relevant information

Following the principle introduced in section 2.3, there are four main actions to accomplish in order to systematically describe a NIBS experiment in BIDS:

1. Describe the generic NIBS hardware and experimental setup info – NIBSspec.json
2. Describe the localization of the stimulation. \_events.tsv (+json) and coordsystem.json
3. Describe the temporal information related to the timing. \_events.tsv (+json) and NIBSspec.json
4. Describe the information related to session description and order. \_session.tsv + json

## 3.2. Directory Structure

New directories and file types can be introduced in summary in a mock directory structure. e.g.,

dataset/

sub-<label>/[ses-<label>/]

sub-<label>[\_ses-<label>]\_<NIBS>spec.json

sub-<label>[\_ses-<label>]\_sessions.json

sub-<label>[\_ses-<label>]\_sessions.tsv

<context>/

sub-<label>[\_ses-<label>]\_events.tsv

sub-<label>[\_ses-<label>]\_events.json

sub-<label>[\_ses-<label>]\_coordsystem.json

<NIBS> is a generic label referring to all the techniques included in the specification. It could be:

TMS

TES

TFUS

Each of these cases is covered in section 3.3.

*Existing directories and files that are modified by the spec, for example by adding new metadata, should also be highlighted here. This will be the union of all templates shown below.*

## 3.3. Example experimental information files

Prefatory remarks for the change that are not redundant with prior sections.

### Template

sub-<label>/[\_ses-<label>/]

sub-<label>[\_ses-<label>]\_<NIBS>spec.json

This template should be present no matter which technique is used. Filename should be named accordingly.

#### 3.3.1 Experimental Setup specs - Case: Transcranial Magnetic Stimulation (TMS)

#### Metadata fields

MUST BE PRESENT

| **Field name** | **Definition** |
| --- | --- |
| TMS\_Manufacturer | Manufacturer of the Stimulation system (e.g., “MagVenture” etc.) (Units: N/A) |
| TMS\_ManufacturersModelName | Model name of the Stimulation system |
| TMS\_ManufacturersFirmware | Firmware version of the stimulator |
| TMS\_Protocol | Type of protocol used (e.g., “rTMS”, etc.) see Rossi et al., 2009 per specifications. |
| TMS\_InterStimulusInterval | ISI |
| TMS\_Waveform | Waveform of the stimulation (g.g., “Biphasic”, etc.) |
| TMS\_SoftwareSpecification | Ideally key:value pairs of pre-applied software specifications and their parameter values: e.g., {"ChargeDelay": "none": , "triggermode", "external". Write “none” if no software specifications were applied |
| TMS\_AuditoryMasking | The way in which participants were masked for external auditory stimuli. E.g.: “earplugs” |
| TMS\_Coil\_ManufacturersModelName | The name of the coil according to manufacturers. E.g., “Double 70mm Alpha Coil”, etc.) |
| TMS\_MotorThreholdSpecification | review |
| TMS\_StimulationIntensity |  |
| TMS\_StimulationSpecification |  |

#### OPTIONAL

| TMS\_DeviceSerialNumber | OPTIONAL. Some fields may only apply in certain situations or not be available for all data sets, but nonetheless be useful if available. |
| --- | --- |
| TMS\_AuditoryMasking |  |
| TMS\_Coil\_DeviceSerialNumber |  |
| TMS\_StimulationSite | Struttura con: 1) un campo che spieghi a cosa si riferiscono (es. Elettrodo / coordinates (se coordinates aggiungere anche specifiche sul sistema di riferimento)  {SiteType = Electrode/AnatomicalLandmarks , {site1=REF},{site2=REF}}   * Campi come in coordinatesystem.json ES:   "AnatomicalLandmarkCoordinateSystem":"MNIColin27",  "AnatomicalLandmarkCoordinateSystemDescription":"RAS - 0 is at the center of the head.",  "AnatomicalLandmarkCoordinateUnits":"mm", |

#### OPTIONAL - REQUIRED IF THERE IS NEURONAVIGATION SYSTEM

| Neuronavigation\_Manufacturer | OPTIONAL. Some fields may only apply in certain situations or not be available for all data sets, but nonetheless be useful if available. |
| --- | --- |
| Neuronavigation\_ManufacturersModelName |  |
| Neuronavigation\_DeviceSerialNumber |  |
| Neuronavigation\_Software |  |
| Neuronavigation\_SoftwareVersions |  |
| Neuronavigation\_intendedfor | Percorso File di risonanza |

#### 3.3.2 Experimental Setup specs - Case: Transcranial Electrical Stimulation (TES)

#### Metadata fields

MUST BE PRESENT

| **Field name** | **Definition** |
| --- | --- |
| TES\_Manufacturer | Manufacturer of the Stimulation system (e.g., “MagVenture” etc.) (Units: N/A) |
| TES\_ManufacturersModelName | Model name of the Stimulation system |
| TES\_ManufacturersFirmware | Firmware version of the stimulator |
| TES\_Protocol | Type of protocol used (e.g., “rTES”, etc.) see Rossi et al., 2009 per specifications. |
| TES\_InterStimulusInterval | ISI |
| TES\_Waveform | Waveform of the stimulation (g.g., “Biphasic”, etc.) |
| TES\_SoftwareSpecification | Ideally key:value pairs of pre-applied software specifications and their parameter values: e.g., {"ChargeDelay": "none": , "triggermode", "external". Write “none” if no software specifications were applied |
| TES\_AuditoryMasking | The way in which participants were masked for external auditory stimuli .( Ee.g.,: “earplugs” |
| TES\_Coil\_ManufacturersModelName | The name of the coil according to manufacturers . (eE.g., “Double 70mm Alpha Coil”, etc.) |
| TES\_MotorThreholdSpecification | review |
| TES\_StimulationIntensity |  |
| TES\_StimulationSpecification |  |

#### OPTIONAL

| TES\_DeviceSerialNumber | OPTIONAL. Some fields may only apply in certain situations or not be available for all data sets, but nonetheless be useful if available. |
| --- | --- |
| TES\_AuditoryMasking |  |
| TES\_Coil\_DeviceSerialNumber |  |

#### OPTIONAL - REQUIRED IF THERE IS NEURONAVIGATION SYSTEM

| Neuronavigation\_Manufacturer | OPTIONAL. Some fields may only apply in certain situations or not be available for all data sets, but nonetheless be useful if available. |
| --- | --- |
| Neuronavigation\_ManufacturersModelName |  |
| Neuronavigation\_DeviceSerialNumber |  |
| Neuronavigation\_Software |  |
| Neuronavigation\_SoftwareVersions |  |
| Neuronavigation\_Type | Single subject MR or template |

transcranial focused-ultrasound stimulation

#### 3.3.3 Experimental Setup specs - Case: Transcranial Focused-Ultrasound Stimulation (TFUS)

#### Metadata fields

MUST BE PRESENT

| **Field name** | **Definition** |
| --- | --- |
| TFUS\_Manufacturer | Manufacturer of the Stimulation system (e.g., “MagVenture” etc.) (Units: N/A) |
| TFUS\_ManufacturersModelName | Model name of the Stimulation system |
| TFUS\_ManufacturersFirmware | Firmware version of the stimulator |
| TFUS\_Protocol | Type of protocol used (e.g., “rTMS”, etc.) see Rossi et al., 2009 per specifications. |
| TFUS\_InterStimulusInterval | ISI |
| TFUS\_Waveform | Waveform of the stimulation (g.g., “Biphasic”, etc.) |
| TFUS\_SoftwareSpecification | Ideally key:value pairs of pre-applied software specifications and their parameter values: e.g., {"ChargeDelay": "none": , "triggermode", "external". Write “none” if no software specifications were applied |
| TFUS\_AuditoryMasking | The way in which participants were masked for external auditory stimuli .( Ee.g.,: “earplugs” |
| TFUS\_Coil\_ManufacturersModelName | The name of the coil according to manufacturers . (eE.g., “Double 70mm Alpha Coil”, etc.) |
| TFUS\_MotorThreholdSpecification | review |
| TFUS\_StimulationIntensity |  |
| TFUS\_StimulationSpecification |  |

#### OPTIONAL

| TFUS\_DeviceSerialNumber | OPTIONAL. Some fields may only apply in certain situations or not be available for all data sets, but nonetheless be useful if available. |
| --- | --- |
| TFUS\_AuditoryMasking |  |
| TFUS\_Coil\_DeviceSerialNumber |  |

#### OPTIONAL - REQUIRED IF THERE IS NEURONAVIGATION SYSTEM

| Neuronavigation\_Manufacturer | OPTIONAL. Some fields may only apply in certain situations or not be available for all data sets, but nonetheless be useful if available. |
| --- | --- |
| Neuronavigation\_ManufacturersModelName |  |
| Neuronavigation\_DeviceSerialNumber |  |
| Neuronavigation\_Software |  |
| Neuronavigation\_SoftwareVersions |  |
| Neuronavigation\_Type | Single subject MR or template |

## 3.4. Example modified TSV file

NIBS data requires an additional newcol column in [task events](https://bids-specification.readthedocs.io/en/stable/04-modality-specific-files/05-task-events.html) files.

### Template

sub-<label>/[\_ses-<label>/]

func/

<matches>\_events.tsv

<matches>\_events.json

MUST BE PRESENT

| **Column name** | **Description** |
| --- | --- |
| type | REQUIRED. A description of the meaning of the column, including allowable values and units. |
| value |  |
| stimulation\_area |  |
| x |  |
| y |  |
| z |  |

REQUIRED IF TMS

| tms\_intensity |  |
| --- | --- |
| resting\_mt |  |
| percent\_resting\_mt |  |

REQUIRED IF TES

| tes\_protocol |  |
| --- | --- |
| tes\_intensity |  |
| ... |  |

OPTIONAL

| sample | REQUIRED. A description of the meaning of the column, including allowable values and units. |
| --- | --- |

### Example

onset duration newcol

0.0 1.0 A

2.0 1.0 B

...

### Metadata fields

Optional metadata is conformant with the [tabular file](https://bids-specification.readthedocs.io/en/stable/02-common-principles.html#tabular-files) definition.

## 3.5. Example modified JSON file

NIBS-BIDS datasets require an additional field in the dataset\_description.json that allows NIBS-specific metadata to be represented.

| **Field name** | **Definition** |
| --- | --- |
| NIBSMeta.Version | REQUIRED. String in “x.y.z” format indicating the version of an imagined external NIBS standard. |
| NIBSMeta.Extra | OPTIONAL. A piece of metadata that’s useful for understanding the dataset or the processes that produced it. |

### Example

{

"Name": "A study of the effects of affects on students",

"BIDSVersion": "1.2.0",

"NIBSMeta": {

"Version": "3.2.1",

"Extra": "This dataset was not compiled under duress, but given freely."

}

}

# 4. NIBS-BIDS Example dataset

Here a full template, similar to 3.2 while also including a full set of standard BIDS files, might be included.

# 5. Change-log

**v0.0.1 YYYY-MM-DD:**

* Initial work on specification
* X, Y and Z features added

20210701